IALE

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Memorial Union
Arizona State University
Tempe, Arizona

april
25-29
2001

16th Annual Symposium

of the International Association
of Landscape Ecology-U.S. Chapter

Program Chair:
Dr. Jianguo (Jingle) Wu

Program Coordinator:
Dr. Laura Musacchio

National Endowment for the Arts

Supported by Arizona Commission on the Arts

EPA United States Environmental Protection Agency
"...to protect human health and to safeguard the natural environment..."

The 16th Annual Symposium of the U.S. Regional Association of the International Association of Landscape Ecology

Pattern, Process, Scale, and Hierarchy: Interactions in Human-Dominated and Natural Landscapes

A major goal of landscape ecology is to understand the interactions between spatial pattern and ecological processes, the role of scale, and hierarchical linkages in heterogeneous landscapes that are increasingly shaped by human activities. This understanding is essential not only for unraveling how nature works, but also for developing a harmonious relationship between humanity and nature. In the past two decades, landscape ecologists have addressed various aspects of this goal through numerous theoretical and empirical studies. As we embark on a new stage of landscape ecology in the twenty-first century, it is important to reflect on the advances that have been made and to identify new directions that must be taken toward this goal. Therefore, the theme of the 2001 U.S.–IALE Symposium will be understanding the interactions among pattern, process, scale, and hierarchy in human-dominated and natural landscapes, with a special emphasis on landscapes that have been most profoundly modified by humans—the urban environment. The symposium will focus on the following topics:

- What do we know about the relationships among pattern, process, scale, and hierarchy, and how do these relationships differ between natural and human-dominated landscapes?
- How do spatial heterogeneity and hierarchical structure affect the translation of information across scales in different landscapes, or how do we scale up pattern and process in heterogeneous landscapes?
- How can theories and principles of pattern-process interactions, scaling, and hierarchy be applied to landscape management, landscape architecture, urban planning, and nature conservation?
- What new technologies and methods are available for facilitating our study of the relationships among pattern, process, scale, and hierarchy, and how can they be best utilized?
- What role does long-term ecological research play in landscape ecology, and what have we learned from the existing urban LTER studies?
- How can natural and social sciences be more effectively integrated into landscape ecology? How can the ongoing discussion on the relationship between culture and nature influence the development of theory and practice in landscape ecology?
- How can we effectively integrate landscape ecology with the design and planning of landscapes? What is the significance of the relationship between urbanism and landscape ecology?

CONTENTS

SUMMARY

PATTERN PROCESS SCALE & HIERARCHY:
Interactions in Human-Dominated and Natural Landscapes

Program Summary

U.S.–IALE 2001 PROGRAM AT A GLANCE

	Wednesday 4/25	Thursday 4/26	Friday 4/27	Saturday 4/28	Sunday 4/29
AM		Plenary Speech Oral Sessions Poster Session	Oral Sessions	Plenary Speech Oral Sessions Poster Session	Full-Day Field Trip
PM	Registration	Plenary Speech Oral Sessions Poster Session	Half-Day Field Trips	Oral Sessions Poster Session	
EVENING EVENT	Welcome Reception	U.S.–IALE Public Meeting NASA–MSU Dinner Student Social	Banquet		

U.S.–IALE 2001 PROGRAM SUMMARY

APRIL 25, 2001, WEDNESDAY

4/25/01	TIME	EVENTS
MORNING	10:00–12:00	Organizational Meeting for Student Workers Rincon Room (Rm. 225), Memorial Union
AFTERNOON	1:00–5:00	**Registration** Second Floor, Memorial Union, Arizona State University, Tempe, Arizona Outside of the Arizona Ballroom (Rm. 207)
	1:00–6:00	**Slide Preview / Computer Presentation Preview** Rm. 208 C, Memorial Union (35mm slide projector and computer projector available) **NOTE**: The presentation preview room will be open from 7:30 AM, April 26 to 5:30 PM, April 28.
	1:00–5:30	**U.S.–IALE Executive Committee Meeting** Rincon Room (Rm. 225), Memorial Union
	5:00	A Non–IALE 2001 Event ASU School of Planning and Landscape Architecture Seminar Location: College of Architecture and Environmental Design (North Building) AED 60 “Landscape Planning: A History of Ideas” by Dr. Carl Steinitz, Harvard University
EVENING	6:00–6:05	Welcome by Dr. Laura Musacchio (Program Coordinator) and Dr. Jianguo Wu (Program Chair)
	6:05–6:15	**Welcome Speech** by Dr. John Meunier, Dean of the College of Architecture and Environmental Design
	6:15–9:00	**Welcome Mixer** Location: College of Architecture and Environmental Design (North Building) Charlie's Café (2^{nd} Floor)

APRIL 26, 2001, THURSDAY

4/26/01	TIME	EVENTS				
MORNING * * * * * **Poster Session:** (April 26, 2001) Place: Arizona Ballroom (Rm. 207) Set-up: 7:30AM–8:00AM Duration: 8:00AM–5:30PM Author Available: 11:00AM–12:15PM 4:00PM–5:30PM Poster Topics: see below	7:30–5:00	**Registration** Outside of the Arizona Ballroom (Rm. 207), Memorial Union				
	8:15–8:20	Opening Remarks by **Program Chair**, Dr. Jianguo (Jingle) Wu				Location: Ventana Room (Rm. 226) Memorial Union
	8:20–8:30	Welcome Remarks by **ASU VP for Research**, Dr. Jonathan Fink				
	8:30–8:40	Welcome Address by **President of U.S.–IALE**, Dr. Virginia Dale				
	8:40–8:45	Welcome Remarks by **Program Coordinator**, Dr. Laura Musacchio				
	8:45–9:45	**Plenary Address by Dr. Steward A. Pickett**				
	9:45–10:00	**COFFEE BREAK**				
		Concurrent Session #1 Pima (Rm. 218)	Concurrent Session #2 Cochise (Rm. 212)	Concurrent Session #3 Alumni (Rm. 202)	Concurrent Session #4 Mohave (Rm. 222)	
	10:00–10:15 10:15–10:30 10:30–10:45 10:45–11:00	*Special Session:* Top 10 List For Landscape Ecology (I) Chair: Jianguo (Jingle) Wu	Landscape Mapping and Characterization: Methods and Applications (I) Chair: Pong Gong	*Special Session:* Landscape Fire Succession Modeling (I) Co-chairs: Robert Keane and Sandra Lavorel	Landscape Management: Approaches and Practices (I) Chair: Patrick A. Zollner	
	11:00–11:15	**COFFEE BREAK**				
	11:15–11:30 11:30–11:45 11:45–12:00 12:00–12:15	*Special Session:* Top 10 List For Landscape Ecology (II) Chair: Jianguo (Jingle) Wu	Landscape Mapping and Characterization: Methods and Applications (II) Chair: P. Gong	*Special Session:* Landscape Fire Succession Modeling (II) Co-chairs: Robert Keane and Sandra Lavorel	Landscape Management: Approaches and Practices (II) Chair: Patrick A. Zollner	
	12:15–1:30	**LUNCH BREAK—On Your Own** Lunch With Mentors for Graduate Students in the Gold Room (Rm. 203), Memorial Union (Organized by Marlene Cole and Rebecca Hess)				
AFTERNOON * * * * * **Poster Topics:** (April 26, 2001) 8:00AM–5:30PM 1. Landscape Characterization And Pattern Analysis 2. Scaling: Methods And Case Studies 3. Land-Use Change and Urban Ecology 4. Landscape Pattern and Ecosystem Processes	1:30–2:30	**Plenary Address by Dr. Nancy B. Grimm and Dr. Charles L. Redman** Ventana (Rm. 226), Memorial Union				
	2:30–2:45	**COFFEE BREAK**				
	2:45–3:00 3:00–3:15 3:15–3:30 3:30–3:45 3:45–4:00	*Special Session:* Top 10 List For Landscape Ecology (III) Chair: Jianguo (Jingle) Wu	Scale Effects In Landscape Analysis Chair: Richard Sutton	Vegetation Pattern And Plant-Environment Relationships Chair: Mark Dixon	Land-Use And Land-Cover Change: Pattern And Process (I) Chair: Morgan Grove	
	4:00–4:15	**COFFEE BREAK**				
	4:15–4:30 4:30–4:45 4:45–5:00 5:00–5:15 5:15–5:30	*Special Session:* Scaling Issues Related to Ecological and Hydrological Landscape Analyses Co-chairs: Bruce Jones and Iris Goodman	*Special Session:* Pollinators In Heterogeneous and Dynamic Landscapes Chair: Nancy McIntyre	Landscape Pattern and Species Invasion and Disease Spread Chair: Cindy Huebner	Land-Use and Land-Cover Change: Pattern and Process (II) Chair: Tamara Shapiro	
EVENING	5:30–6:30	**U.S.–IALE General Business Meeting** Open to All Members Ventana (Rm. 226) Memorial Union				
	7:00–9:30	**NASA–MSU Awards Dinner** Gold Room (Rm. 203), Memorial Union				
	9:00–11:00	**Student Social** Bandersnatch Brew Pub, 125 E. 5th Street, Tempe, 480.966.4438 (Organized by Marlene Cole and Rebecca Hess)				

APRIL 27, 2001, FRIDAY

4/27/01	TIME	EVENTS				
MORNING No poster session on April 27, 2001	8:00–12:00	**Registration** Outside of the Arizona Ballroom (Rm. 207), Memorial Union				
	7:00–8:15	**Landscape Ecology Editorial Board Meeting** Rincon Room (Rm. 225), Memorial Union				
	8:30–9:30	**Plenary Address by Dr. Orie L. Loucks** Ventana Room (Rm. 226), Memorial Union				
	9:30–9:45	**COFFEE BREAK**				
		Concurrent Session #1 Pima (Rm. 218)	Concurrent Session #2 Cochise (Rm. 212)	Concurrent Session #3 Alumni (Rm. 202)	Concurrent Session #4 Mohave (Rm. 222)	Concurrent Session #5 La Paz (Rm. 223)
	9:45–10:00 10:00–10:15 10:15–10:30 10:30–10:45 10:45–11:00	Landscape Pattern Analysis: Theory and Methods (I) Chair: X. Ben Wu	*Special Session:* Assessing Current and Future Regional Vulnerabilities (I) Chair: Betsy R. Smith	Pattern and Process in Urban Landscapes (I) Chair: Mark J. McDonnell	Landscape Pattern and Ecosystem Processes (I) Chair: Jiquan Chen	*Workshop*: The Decline Of Agricultural Landscapes in the Phoenix Metropolitan Area Chair: Laura Musacchio
	11:00–11:15	**COFFEE BREAK**				
	11:15–11:30 11:30–11:45 11:45–12:00 12:00–12:15	Landscape Pattern Analysis: Theory and Methods (II) Chair: X. Ben Wu	*Special Session:* Assessing Current and Future Regional Vulnerabilities (II) Chair: Betsy Smith	Pattern and Process in Urban Landscapes (II) Chair: Mark J. McDonnell	Landscape Pattern and Ecosystem Processes (II) Chair: Jiquan Chen	*Workshop*: The Equity of Regional Open-Space Conservation and Restoration Projects in the Phoenix Metropolitan Area Chair: Laura Musacchio
	12:15	**LUNCH BREAK—On Your Own** **Silent Book Auction** Outside of the Arizona Ballroom (Rm. 207), Memorial Union				
	1:00	**2001 U.S.–IALE Election: Ballot Box Closes at 1:00 PM** The ballot box is located at the registration table in the hallway next to Arizona Ballroom				
AFTERNOON	1:00–5:00	**Half-Day Field Trips** Place of Departure: Buses will be leaving from the dropoff area south of the College of Business and the Memorial Union (see map on page XX)				
EVENING	6:00–7:00	**Banquet Reception** Location: Tempe Mission Palms Hotel, 60 E. 5th Street, Tempe				
	7:00–9:30	**Banquet** Election Results, Awards, Food, and Banquet Address by **Dr. Katherine Crewe** Location: Tempe Mission Palms Hotel, 60 E. 5th Street, Tempe				

APRIL 28, 2001, SATURDAY

4/28/01	TIME	EVENTS				
MORNING * * * * *	8:00–12:00	**Registration** Outside of the Arizona Ballroom (Rm. 207), Memorial Union				
	7:00–8:00	**U.S.–IALE Executive Committee Meeting** Rincon Room (Rm. 225), Memorial Union				
	8:30–9:30	**Plenary Address by Professor Anne Spirn** Ventana Room (Rm. 226), Memorial Union				
	9:30–9:45	**COFFEE BREAK**				
Poster Session:		Concurrent Session #1 Ventana (Rm. 226)	Concurrent Session #2 Cochise (Rm. 212)	Concurrent Session #3 Alumni (Rm. 202)	Concurrent Session #4 Mohave (Rm. 222)	Concurrent Session #5 La Paz (Rm. 223)
Place: Arizona Ballroom (Rm. 207)	9:45–10:00	*Special Session:* Complexity Theory and Ecological Applications (I) Co-chairs: Darrel Jenerette and Jianguo Wu			Landscape-Scale Ecological Assessment (I) Chair: Kevin McGarigal	Landscape Pattern and Biodiversity Conservation (I) Chair: Paul C. Hellmund
	10:00–10:15		*Special Session:* Landscape Ecology Comes To Town: Applied Urban Landscape Ecology (I) Chair: Jack Ahern	Landscape Pattern and Species Distribution (I) Chair: Marlene B. Cole		
Set-up: 7:30AM–8:00AM	10:15–10:30					
Duration: 8:00AM–5:30PM	10:30–10:45					
Author Available: 11:00AM–12:15PM 4:00PM–5:30PM	10:45–11:00					
	11:00–11:15	**COFFEE BREAK**				
Poster Topics: see below	11:15–11:30	*Special Session:* Complexity Theory and Ecological Applications (II) Co-chairs: Darrel Jenerette and Jianguo Wu	*Special Session:* Landscape Ecology Comes To Town (II) Chair: Jack Ahern	Landscape Pattern and Species Distribution (II) Chair: Marlene B. Cole	Landscape-Scale Ecological Assessment (II) Chair: Kevin McGarigal	Landscape Pattern and Biodiversity Conservation (II) Chair: Paul C. Hellmund
	11:30–11:45					
	11:45–12:00					
	12:00–12:15					
	12:15–1:30	**LUNCH BREAK—Box lunches provided at the Maricopa Café, Second Floor of the Memorial Union**				
AFTERNOON * * * * *	1:30–1:45	*Special Session:* Premises and Problems With Spatial Analysis (I) Co-chairs: Marie-Jose Fortin and M. Miriti	*Special Session:* Pattern and Process In Aquatic Ecosystems (I) Co-chairs: Lisa Dent and E. Bennett	Disturbance and Vegetation Pattern and Dynamics (I) Chair: Louis Iverson	Land-Use Planning and Landscape Architecture (I) Chair: Frederick Steiner	Landscape Pattern and Population Processes (I) Chair: Henriette Jager
	1:45–2:00					
Poster Topics: (April 28, 2001)	2:00–2:15					
8:00AM–5:30PM	2:15–2:30					
	2:30–2:45	**COFFEE BREAK**				
1. Landscape Pattern and Population Dynamics and Species Distribution	2:45–3:00	*Special Session:* Premises and Problems With Spatial Analysis (II) Co-chairs: Marie-Jose Fortin and M. Miriti	*Special Session:* Pattern and Process In Aquatic Ecosystems (II) Co-chairs: Lisa Dent and E. Bennett	Disturbance and Vegetation Pattern and Dynamics (II) Chair: Janet Franklin	Land-Use Planning and Landscape Architecture (II) Chair: Frederick Steiner	Landscape Pattern and Population Processes (II) Chair: David Howerter
	3:00–3:15					
	3:15–3:30					
2. Landscape Conservation, Management and Design	3:30–3:45					
	3:45–4:00					
	4:00–4:15	**COFFEE BREAK**				
3. Vegetation Pattern and Plant-Environment Relationships	4:15–4:30	Land Use and Land Cover Change: Modeling Chair: Bryan C. Pijanowski	*Special Session:* Pattern and Process In Aquatic Ecosystems (III) Co-chairs: Lisa Dent and E. Bennett (*Summary and Discussion led by Dent and Bennett*)	Disturbance and Vegetation Pattern and Dynamics (III) Chair: Janet Franklin	Land-Use Planning and Landscape Architecture (III) Chair: Frederick Steiner	Landscape Pattern and Population Processes (III) Chair: David Howerter
	4:30–4:45					
4. Disturbance and Landscape Pattern Interactions	4:45–5:00					
	5:00–5:15					
	5:15–5:30					
EVENING		*** Please do not forget the **full-day field trip to Grand Canyon** tomorrow (April 29)!				

REGISTRATION

PATTERN PROCESS SCALE & HIERARCHY: Interactions in Human-Dominated and Natural Landscapes

Registration Information

REGISTRATION information

Welcome to the 16th Annual Symposium of the U.S. Regional Chapter of the International Association of Landscape Ecology at the Memorial Union. On behalf of the students, faculty, and staff of Arizona State University, we thank you for choosing to come to the symposium. Please refer to the program summary on pages 3–6 for an overview of the presentations and events. Maps and information about the Memorial Union are found on pages 14–16.

Registration

The registration table is located in front of the Arizona Ballroom (Rm. 207), on the second floor of the Memorial Union. Please see the program summary for hours of operation. Once you arrive in Tempe, please visit the registration table to pick up your symposium packet. If you pre-ordered a t-shirt, banquet ticket, and/or visitor parking stickers, these items will be available for pick up at the registration table. On-site requests for t-shirts, banquet tickets, field trips, and visitor parking stickers will be filled based on the availability of these items at the time of the symposium.

Registration Information

Pre-Registration rates until Monday, March 5, 2001:
IALE Member Pre-Registration, $200*
Non-member Pre-Registration, $250*
Student Pre-Registration, $105*
One-day registration, $80*
One-day student registration, $40

Monday, March 5, 2001:
- Member Regular Registration, $245*
- Non-member Regular Registration, $300*
- Student Regular Registration, $145*
- One-day registration, $100*
- One-day student registration, $50*

*NOTE:
Pre-registration will start in December 2000 and close on Monday, March 5, 2001. The registration forms must be postmarked or faxed by Monday, March 5, 2001 in order to qualify for pre-registration rates. Subsequent registrations will be charged as regular registration.

Student rates are available to full-time students enrolled for degrees or diplomas at a university. A photocopy of a current student identification card must accompany the registration form in order to qualify for the reduced student rate.

Conference Refund Policy

You may obtain a refund of the registration fee (minus a $50 cancellation fee) by submitting a written request to Dr. Laura Musacchio by Monday, March 26 (mail or fax only). No refunds will be made after this date. Refunds will be issued after the symposium.

Payment Information

All needed information and forms will be provided according to the payment options that you request. All the funds should be in U.S. dollar (US$). If you are using a check, we will only accept a check drawn on a US bank.

Payment types: credit card (Visa, Master Card), checks (U.S currency). Please make checks payable to the ASU.

T-Shirts with the U.S.–IALE 2001 logo

Large and X-large sizes are available. Two colors are available cactus green or cobblestone. If you pre-ordered your t-shirt, please pick it up at the registration table.

T-shirts will be sold on-site based on availability. Please check at the registration table.

U.S.–IALE 2001 Travel Information

Phoenix Sky Harbor International Airport is a 10-minute drive from the Arizona State University campus, the Memorial Union, and the hotels in Tempe. Free shuttle service from the airport is provided by the Holiday Inn and Twin Palms Hotel. In addition, taxis and shuttles services are available. Please contact your hotel for more details.

U.S.–IALE 2001 Hotel Accommodations

Several hotels are within walking distance of the Memorial Union at Arizona State University:

Holiday Inn–Tempe/ASU
915 S. Apache Blvd.
Tempe, AZ 85281

- $106 per night, single/double, plus tax.
- The block of rooms is listed under "ECO."
- Two blocks from the Memorial Union at ASU.
- Complementary shuttle to/from Sky Harbor Airport.

Twin Palms Hotel
1.800.367.0835 or 480.967.9431
225 E. Apache Blvd.
Tempe, AZ 85281

- $95 per night, single/double, plus tax.
- 1 block from the Memorial Union at ASU.
- The block of rooms is listed under "ECO."
- Complementary shuttle to/from Sky Harbor Airport.

Marriott Courtyard Tempe–Downtown
1.800.835.6205 or 480.966.2800
602 S. Ash Avenue
Tempe, AZ 85281

- $79 per night, single/double, plus tax.
- The block of rooms is listed under "ECO."
- Six blocks from the Memorial Union at ASU.
- One block from Mill Avenue, the heart of Arizona State and Tempe's downtown.
- Complementary shuttle to/from Sky Harbor Airport.

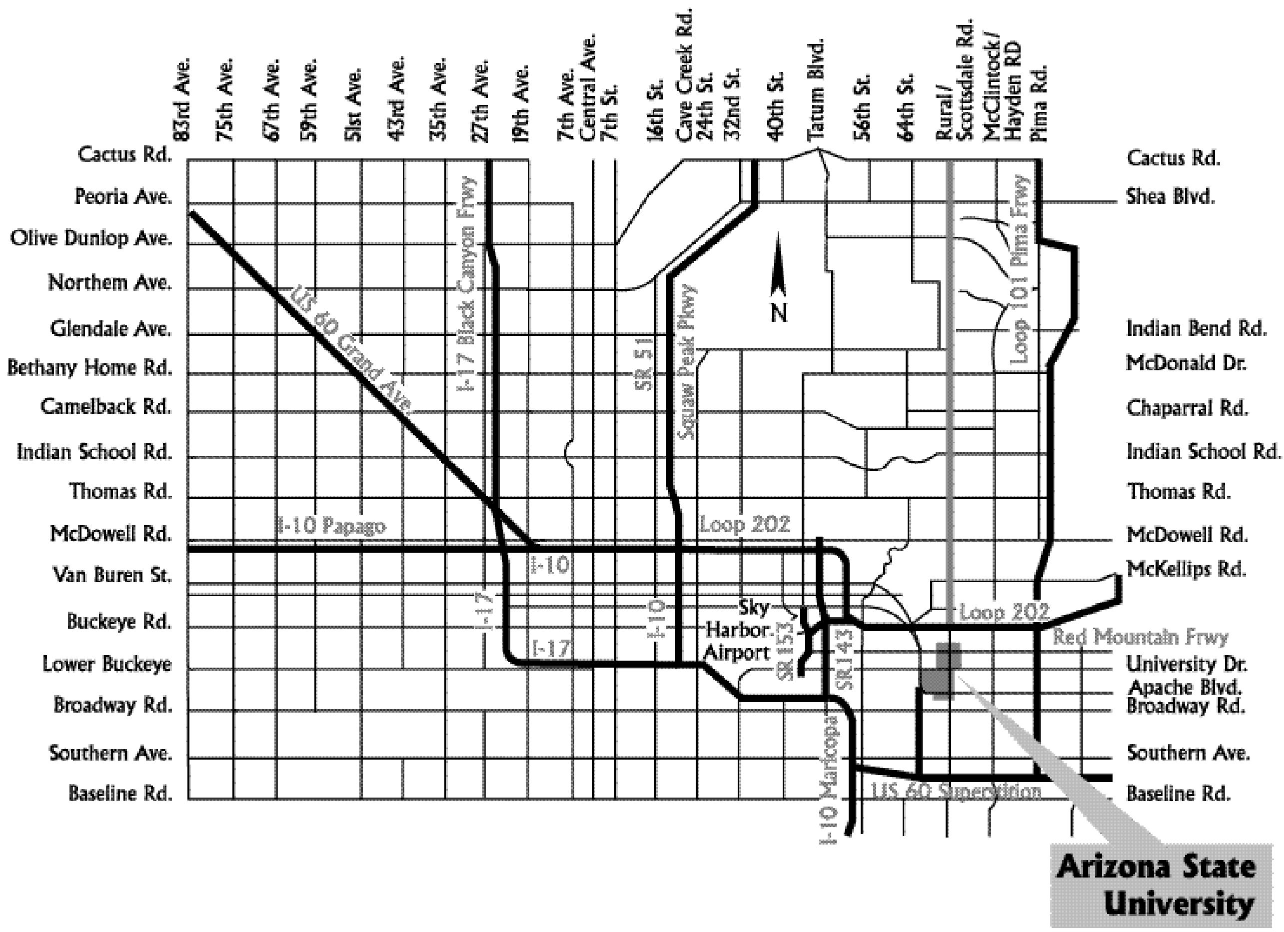
Notes:

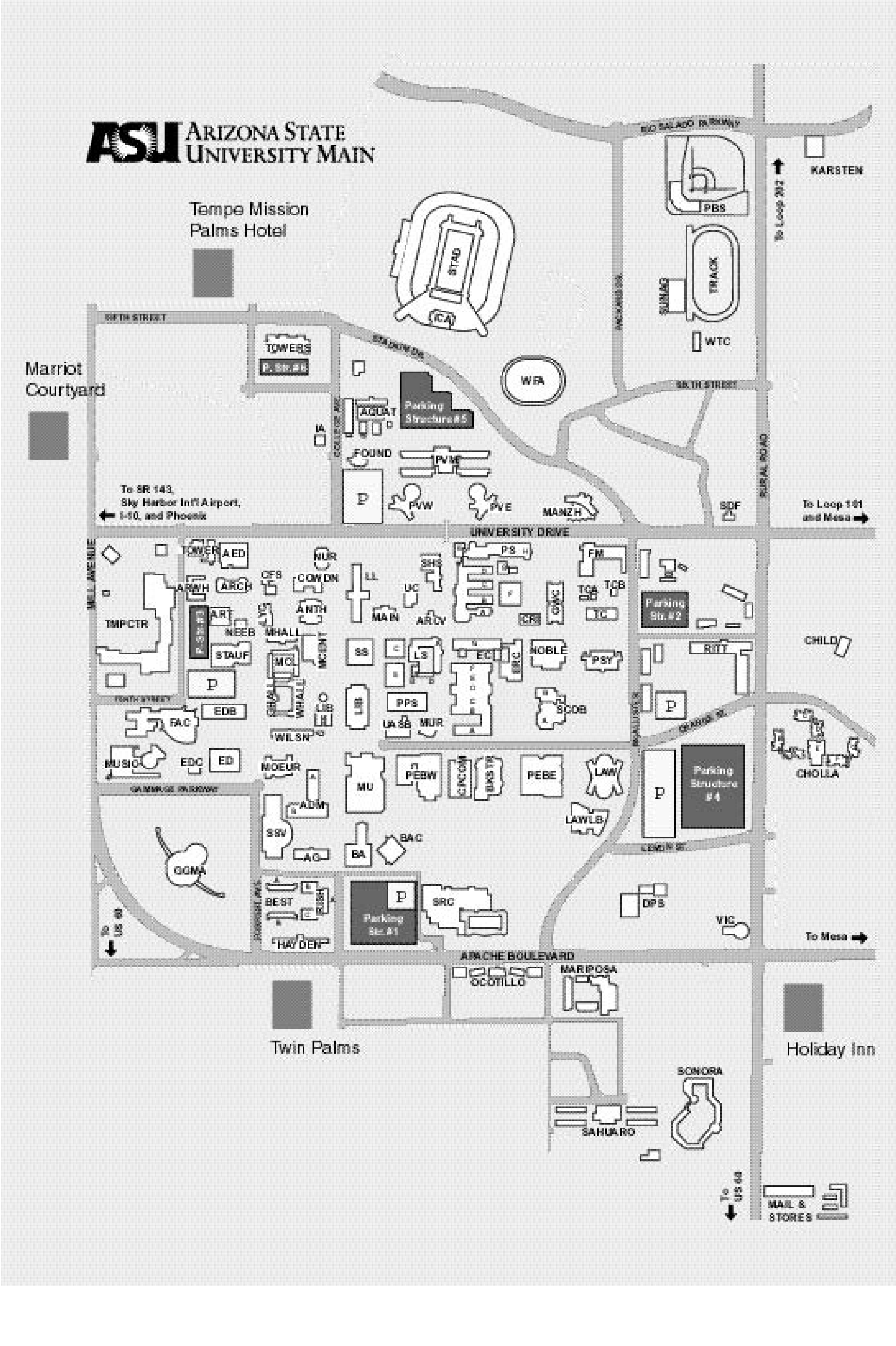
- Special hotel rates will be honored three days prior to and after the symposium (April 25–29, 2001).
- Reservations must be made by March 25, 2001 to secure the special conference rates for hotels.
- All reservations must be guaranteed via credit cards or cash deposits.
- Parking for hotel guests is free.

INFORMATION

Conference Information

LOCAL MAPS


83rd Ave.
75th Ave.
67th Ave.
59th Ave.
51st Ave.
43rd Ave.
35th Ave.
27th Ave.
19th Ave.
7th Ave.
Central Ave.
7th St.
16th St.
Cave Creek Rd.
24th St.
32nd St.
40th St.
Tatum Blvd.
56th St.
64th St.
Rural / Scottsdale Rd.
McClintock / Hayden RD
Pima Rd.
Cactus Rd.
Peoria Ave.
Olive Dunlop Ave.
Northern Ave.
Glendale Ave.
Bethany Home Rd.
Camelback Rd.
Indian School Rd.
Thomas Rd.
McDowell Rd.
Van Buren St.
Buckeye Rd.
Lower Buckeye
Broadway Rd.
Southern Ave.
Baseline Rd.
Cactus Rd.
Shea Blvd.
Indian Bend Rd.
McDonald Dr.
Chaparral Rd.
Indian School Rd.
Thomas Rd.
McDowell Rd.
McKellips Rd.
University Dr.
Apache Blvd.
Broadway Rd.
Southern Ave.
Baseline Rd.
US 60 Grand Ave.
I-17 Black Canyon Frwy
SR 51
Squaw Peak Pkwy
Loop 101 Pima Frwy
N
I-10 Papago
Loop 202
I-10
I-17
I-10
I-17
Sky Harbor Airport
SR 153
SR 143
Loop 202
Red Mountain Frwy
I-10 Maricopa
US 60 Superstition
Arizona State University


ASU ARIZONA STATE UNIVERSITY MAIN
Tempe Mission Palms Hotel
Marriot Courtyard
Twin Palms
Holiday Inn
KARSTEN
PBS
TRACK
SUNAG
WTC
STAD
ICA
WFA
TOWERS
Parking Structure #5
AQUAT
FOUND
PVM
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PVE
MANZH
SDF
To SR 143, Sky Harbor Int'l Airport, I-10, and Phoenix
To Loop 101 and Mesa
To Loop 202
UNIVERSITY DRIVE
APACHE BOULEVARD
TMPCTR
TOWER
AED
NUR
CFS
CONDN
LL
SHS
PS
FM
TCA
TCB
Parking Str. #2
ARWH
ARCH
ANTH
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MAIN
ARCV
CRB
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ART
NEEB
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STAUF
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NOBLE
PSY
RITT
CHILD
EDB
FAC
LIB
PPS
SCOB
UASB
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PEBW
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Parking Structure #4
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GGMA
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BAC
LAWLB
BEST
HAYDEN
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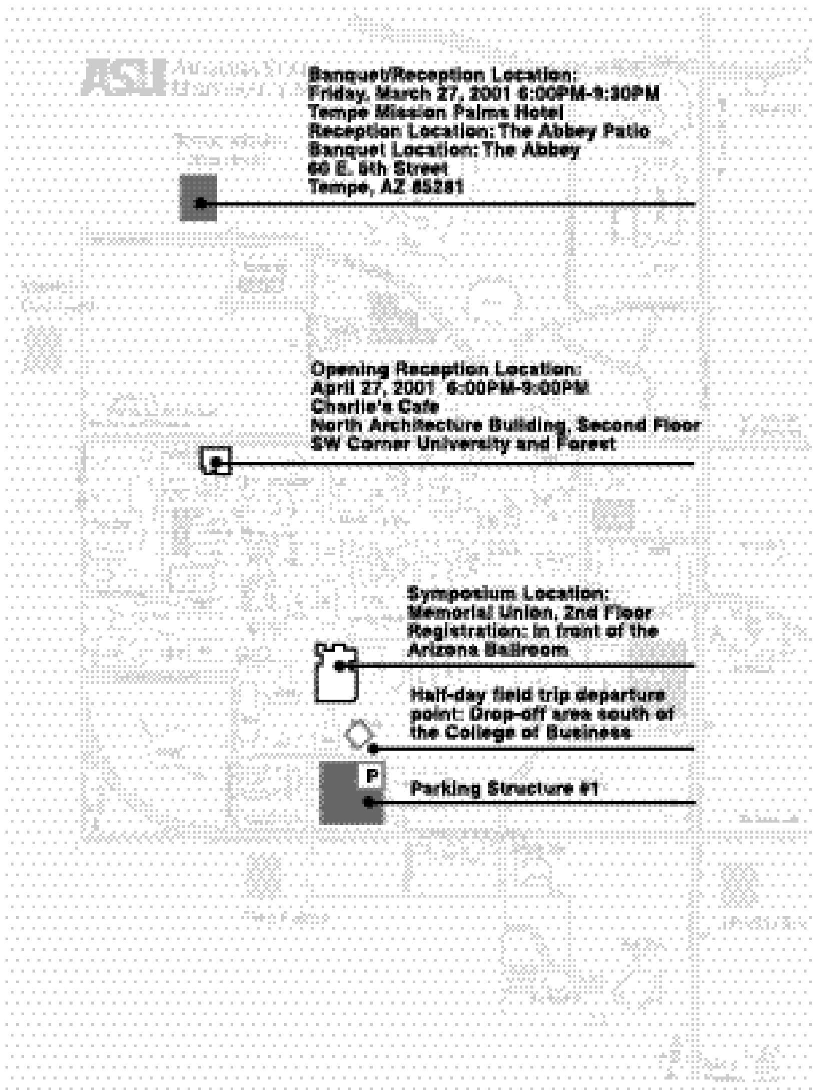
To Mesa
MARIPOSA
OCOTILLO
SONORA
SAHUARO
MAIL & STORES
To US 60


Banquet/Reception Location:
Friday, March 27, 2001 6:00PM-9:30PM
Tempe Mission Palms Hotel
Reception Location: The Abbey Patio
Banquet Location: The Abbey
60 E. 5th Street
Tempe, AZ 85281
Opening Reception Location:
April 27, 2001 6:00PM-9:00PM
Charlie's Cafe
North Architecture Building, Second Floor
SW Corner University and Forest
Symposium Location:
Memorial Union, 2nd Floor
Registration: In front of the
Arizona Ballroom
Half-day field trip departure
point: Drop-off area south of
the College of Business
P
Parking Structure #1

maps & information

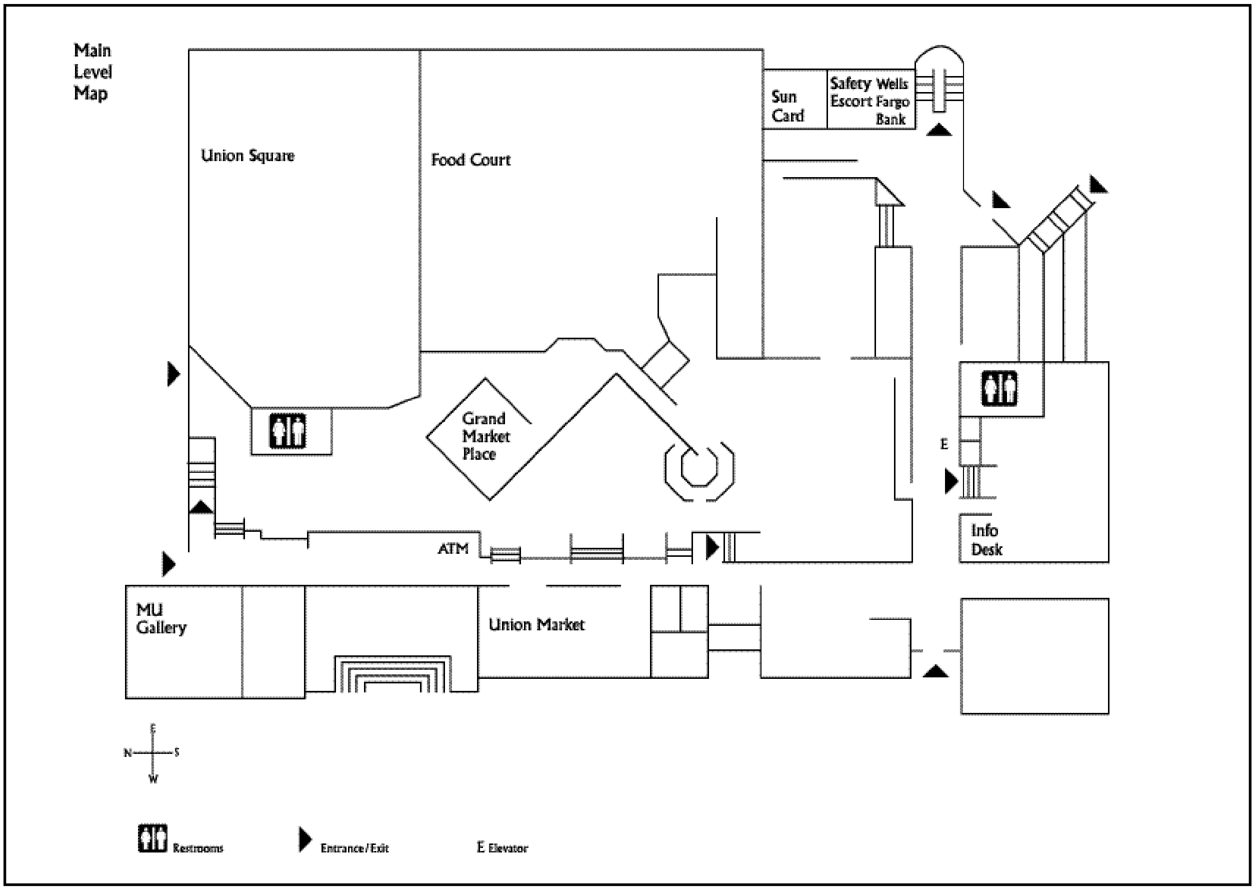
Memorial Union Business Hours
Monday 6:30 AM–12:00 AM
Tuesday 6:30 AM–12:00 AM
Wednesday 6:30 AM–12:00 AM
Thursday 6:30 AM–12:00 AM
Friday 6:30 AM–11:00 PM
Saturday 7:00 AM–11:00 PM
Sunday 10:00 AM–11:00 PM

Memorial Union Business Directory

Business	Location	Telephone
ATMs	MU Lower Level and Main Level	
Arizona State Savings and Credit Union	MU Lower Level	480.965.4428
Burger King	MU Lower Level	480.965.3518
Child & Family Services	MU Lower Level	480.965.9616
Chick-fil-A Restaurant	MU Main Level	
Community Service Program	MU Third Level	
Credit Union (AZ State Savings)	MU Lower Level	480.965.4428
Follett's Gift Shop	MU Lower Level	480.965.9156
Gourmet Grounds	MU Main Level	
Hoodlums New & Used Records	MU Lower Level	480.727.8733
Information Desk	MU Main Level	480.965.5728
Jamba Juice	MU Lower Level	480.727.7130
Lost & Found	MU Main Level	480.965.5728
Maricopa Café	MU Second Level	
MU Copy Center	MU Lower Level	480.965.7251
On the Go Salads	MU Main Level	
Pizza Hut	MU Main Level	480.965.4444
Schlotzsky's Deli	MU Lower Level	480.965.3717
Sodexho-Marriott Catering	MU 162	480.965.6508
Sodexho-Marriot Education Services	MU 135	480.965.3464
Sport's Cutters, Inc.	MU Lower Level	480.965.7222
STA Travel	MU Lower Level	480.965.9410
Student Legal Services	MU Third Level	480.965.6307
Student Regent Office	MU Third Level	480.965.2707
Sub Connection	MU Main Level	
Sun Card Office	MU Main Level	480.965.2737
The Picture Place	MU Lower Level	480.965.4322
Union Market	MU Main Level	480.965.1110
U.S. Post Office	MU Lower Level	480.965.7447
Wells Fargo Bank	MU Main Level	

Business Hours of Restaurants in the Memorial Union

Jamba Juice	
Monday–Thursday	7:00 AM–7:00 PM
Friday	7:00 AM–5:00 PM
Saturday	10:00 AM–3:00 PM
Burger King	
Monday–Thursday	6:30 AM–9:00 PM
Friday	6:30 AM–7:00 PM
Saturday	10:00 AM–6:00 PM
Sunday	11:00 AM–6:00 PM
Schlotzsky's	
Monday–Friday	8:00 AM–5:00 PM
Saturday	10:00 AM–3:00 PM
Chick-fil-A	
Monday–Thursday	9:00 AM–7:00 PM
Friday	9:00 AM–3:00 PM
Gourmet Grounds	
Monday–Thursday	7:00 AM–4:30 PM
Friday	7:00 AM–3:30 PM
Maricopa Café	
Monday–Friday	11:00 AM–2:00 PM
On the Go	
Monday–Thursday	10:00 AM–2:00 PM
Friday	10:00 AM–1:00 PM
Pretzelmania	
Monday–Thursday	6:30 AM–10:00 PM
Friday	6:30 AM–7:00 PM
Saturday	9:00 AM–5:00 PM
Sunday	10:00 AM–5:00 PM
Pizza Hut	
Monday–Thursday	10:00 AM–7:00 PM
Friday	10:00 AM–3:00 PM
Sub Connection	
Monday–Thursday	10:00 AM–7:00 PM
Friday	10:00 AM–3:00 PM
Taco Bell	
Monday–Thursday	9:00 AM–8:00 PM
Friday	9:00 AM–6:00 PM
Saturday	10:00 AM–4:00 PM
Union Market	
Monday–Thursday	6:30 AM–10:00 PM
Friday	6:30 AM–7:00 PM
Saturday	9:00 AM–6:00 PM
Sunday	10:00 AM–5:00 PM


Main
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Map
Union Square
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Escort
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Fargo
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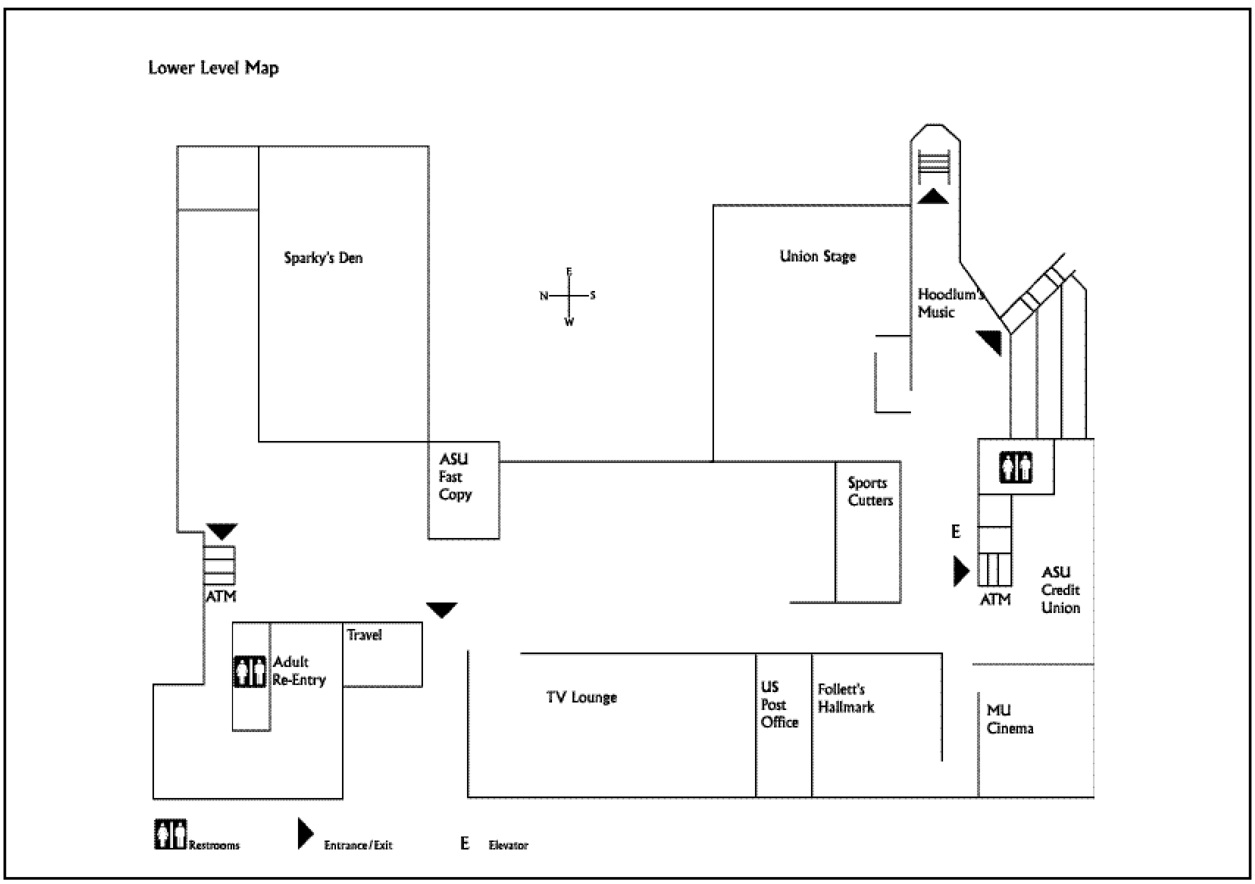
E Elevator


Lower Level Map
Sparky's Den
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Union Stage
Hoodlum's
Music
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Adult
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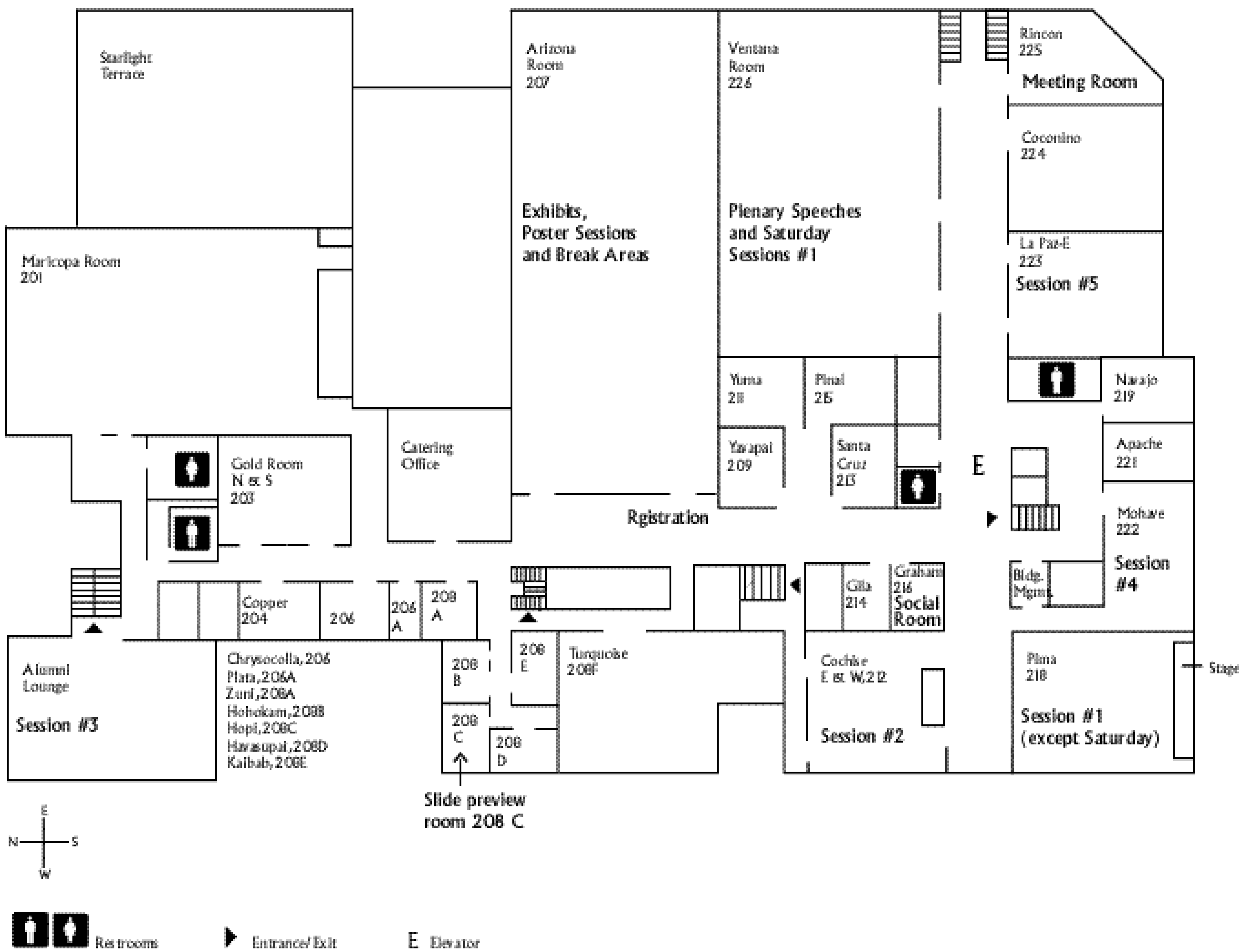
Office
Follett's
Hallmark
MU
Cinema
Restrooms
Entrance/Exit
E Elevator

Upper Level Map



Visitor Parking at the Memorial Union

Visitors to the ASU campus can use one of the visitor parking lots. We have made parking reservations in Parking Structure #1 for those symposium attendees who paid for parking by April 2. Parking Structure #1 is located at the corner of Lemon Street and Normal Street, which is directly south of the Memorial Union and the College of Business and is west of the Student Recreation Center. Please refer to the ASU campus map in your tote bag for more information. Please pick up your validation stamps at the IALE Symposium registration table in front of the Arizona Ballroom, second floor of the Memorial Union.

A list of other visitor parking lots is provided for your convenience: Lot 8, Lot 42, Lot 44, and Lot 51. The visitor lots are VERY busy during the morning and afternoon hours, so please keep in mind that space is limited and is available on a first-come-first-serve basis.

Notes for Visitor Parking

- Reservations are held for one-half hour before the designated entry time of 8 AM, to one half hour after the designated entry time. The spaces will then be released to the general public.
- All guests with a reservation need to check in with the Visitor Lot Cashier upon entering the lot and alert the cashier as to what conference or event they are attending.
- If the "Lot Full / Reservations Only" sign is out, a space has been reserved for the symposium attendees with parking reservations

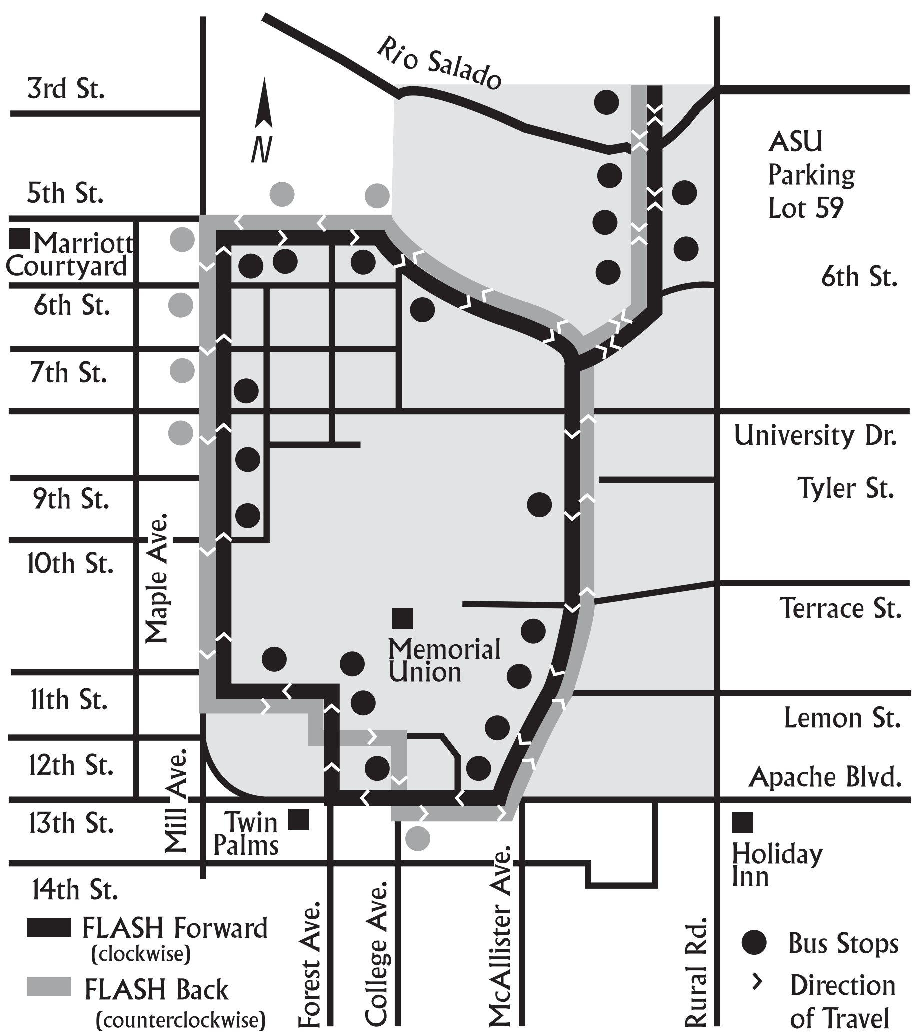
Arizona State University has two campus bus routes that are free for public use: (1) Flash Lite on Mill and (2) Flash Back and Forward.

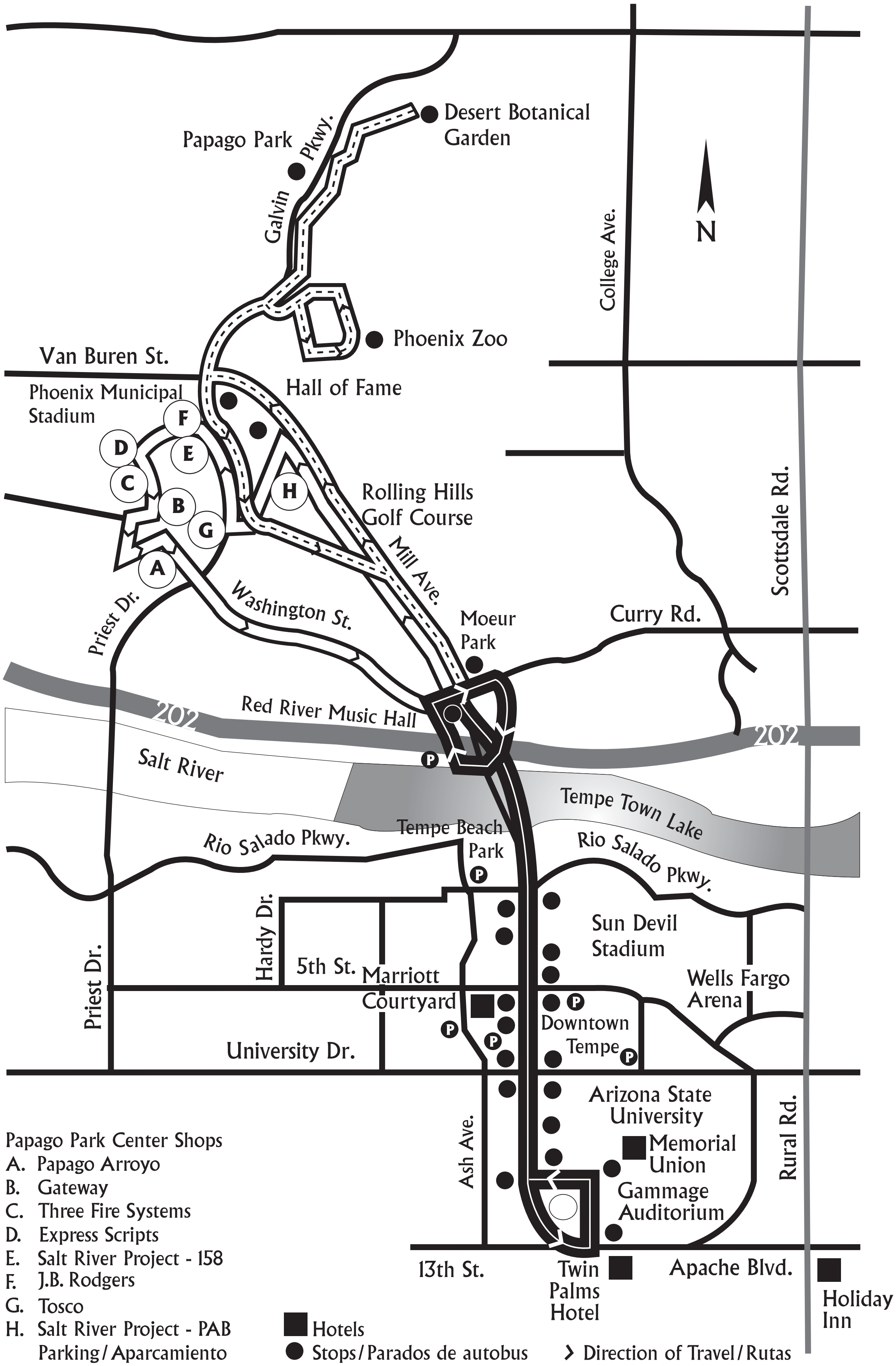
Flash Lite on Mill

This bus route connects the campus with downtown Tempe along Mill Avenue. Buses run on a 15-minute schedule. For those of you staying at the Marriott Courtyard, bus stops are located along Mill Ave., which is one block east of the hotel. On the Saturday and Sunday, the bus route is extended to the Desert Botanical Gardens and the Phoenix Zoo.

Flash Back and Forward

This bus route circles the campus and downtown Tempe in a counterclockwise (Flash Back) or clockwise (Flash Forward) direction. Bus stops are located throughout campus, including on Mill Avenue and Apache Boulevard.





Papago Park Center Shops
A. Papago Arroyo
B. Gateway
C. Three Fire Systems
D. Express Scripts
E. Salt River Project - 158
F. J.B. Rodgers
G. Tosco
H. Salt River Project - PAB
Parking/Aparcamiento

Hotels
Stops/Parados de autobus
Direction of Travel/Rutas

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We recognize the generous support and dedication of the following Arizona State University employees

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Department of Life Sciences and College of Arts and Sciences, ASU West
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Special thanks to the following Arizona State University faculty (in alphabetical order)

Dr. Jonathan Fink, Vice Provost for Research
Dr. Paul Gabriel, School of Planning and Landscape Architecture
Dr. Nancy Grimm, Department of Biology and CAP LTER
Dr. Mary Kihl, Herberger Center for Design Excellence
Dean John Meunier, College of Architecture and Environmental Design
Dr. Charles Redman, Center for Environmental Studies and CAP LTER
Dr. Frederick Steiner, School of Planning and Landscape Architecture

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Field Trip Leaders

Dr. Ramon Arrowsmith, Dr. Katherine Crewe, Professor Joseph Ewan, Dr. Nancy Grimm, Bruce Swanson, Jim Burke, John David, Jennifer Edmonds, John Roach

Gallery Exhibits

Dr. Katherine Crewe, Professor Laurel McSherry, Professor Rebecca Ewan, Professor Ignacio San Martin, Dr. Frederick Steiner, Professor Melissa Niederhelman

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Patrick Zollner	North Central Research Station, Rhinelander, Wisconsin
Bob Gardner	Appalachian Laboratory, Frostburg, Maryland
Bruce Milne	University of New Mexico, Albuquerque, New Mexico

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Sam Riffell	Michigan State University
Russell Watkins	3001, Inc.
Jianguo (Jingle) Wu	Arizona State University

NASA–MSU Professional Enhancement Awards Committee

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Carla Dombroski	Michigan State University
Garik Gutman	NASA
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Monica Kwasnik	Michigan State University

EVENT information

Opening Reception

The College of Architecture and Environmental Design will be hosting the opening reception from 6:00 PM to 9:00 PM on April 25. The reception will be held in Charlie's Café on the second floor of the Architecture North Building (AED), which is located in the northwestern quadrant of the campus on the southwest corner of University Avenue and Forest Avenue. A courtesy bus will run from 5:30 PM to 9:30 PM starting from the parking lot of the Holiday Inn, then proceeding to the parking lots of the Twin Palms Hotel and the Marriott Courtyard, and finally arriving at the Architecture North Building. A lecture entitled "Landscape Planning—A History of Ideas" by Dr. Carl Steinitz of the Graduate School of Design will be held in in the basement of the Architecture North Building (AED 60) at 4:45 PM. The faculty of the School of Planning and Landscape Architecture will be showing their creative works in an exhibit called "Sustainability" in the College of Architecture Gallery in the Architecture South Building (ARCH), April 25–26.

Lunch with a Mentor

During the lunch break on Thursday, April 26, students who have signed up for the Lunch with a Mentor Event will meet their mentors to converse over lunch at the Gold Room. This event has been organized by Marlene B. Cole and Rebecca Hess (U.S.–IALE Students Representatives) and is sponsored by the symposium.

NASA–MSU Award Dinner

Dr. Jianguo (Jack) Liu is arranging a dinner get-together for NASA–MSU awardees and leading landscape ecologists. The dinner will be held on the evening of Thursday, April 26 (7:00 PM–9:30 PM) in the Gold Room of the Memorial Union.

Student Social

A student get-together is scheduled from 9:30 PM to 11:00 PM on Thursday, April 26, at Bandersnatch Brew Pub, 125 E. 5th Street, in Tempe (480.966.4438). This pay-your-own-way event has been organized by Marlene B. Cole and Rebecca Hess (U.S.–IALE Students Representatives).

Silent Book Auction

The US Chapter of IALE makes a number of travel grants available to foreign colleagues so they can attend our annual meeting. An important source of funds for the Foreign Scholar Travel Award is proceeds from the silent book auction. The books are generously donated by the publishers that join us at the conference.

This year's Silent Book Auction will take place on the 2nd floor, outside of the Arizona Ball Room (Rm. 207), Memorial Union, 12:15 PM–1:30 PM on Friday, April 27, 2001.

Banquet

The banquet will be held at the elegant Tempe Mission Palms Hotel on April 27, which is located three blocks north of the ASU campus at the corner of Mill Avenue and 5th Street in downtown Tempe. The opening reception will be held at the Abbey Patio with the banquet at the Abbey. Two entrees will be available: herb marinated, free-range chicken or citrus grilled atlantic salmon. Vegetarian meals will be available on request. A courtesy bus will run from 5:00 PM to 10:00 PM starting from the parking lot of the Holiday Inn then proceeding to the parking lots of the Twin Palms and Marriott Courtyard, and finally arriving at the Tempe Mission Palms Hotel.

U.S.–IALE 2001 Best Student Paper / Poster Award

U.S.–IALE annually presents an award to a student for the outstanding oral paper or poster given at the Society's annual meeting. The winner of the award will have their travel expenses to the next U.S.–IALE annual meeting paid, and will receive a plaque commemorating the award. The objective criteria by which the presentation is judged, each with equal weight, include significance of ideas, creativity, quality of methodology, validity of results, and clarity of presentation. U.S.–IALE Awards Committee Chair is Dr. Eric Gustafson (email: ericgus@newnorth.net).

U.S.–IALE Business Meeting

The annual U.S.–IALE public business meeting will be held from 5:30 PM to 6:30 PM on April 26 (Thursday) in the Ventana Room (Rm. 226) of the Memorial Union. All IALE members and colleagues are welcome to attend.

U.S.–IALE Foreign Scholar Travel Award

We thank the U.S. EPA for its generous financial support of this year's Foreign Scholar Travel Award Program. The six recipients of the Foreign Scholar Travel Award (FSTA) will receive a personal check from U.S.–IALE for $1,000 at the U.S.–IALE 2001 as well as a waiver of registration fees. The awards will be given at the banquet on the evening of April 27 (Friday). The FSTA committee is composed of Peter August (Committee Chair), University of Rhode

Island; John Bissonette, Utah State University; Sam Riffell, Michigan State University; Russell Watkins, 3001, Inc.; and Jianguo Wu, Arizona State University.

Available Meeting Rooms

Slide Preview Room

A slide preview room will be available in the Hopi Room (Rm. 208C). A slide projector and slide carousels will be available.

Social Room

Looking for a place to relax? The Graham Room (Rm. 216) is available throughout the symposium.

Meeting Room

The Rincon Room is available for ad-hoc meetings during the symposium. Please go to registration table for the schedule of availability

FIELD TRIPS

Half-Day Field Trips
Friday, April 25
1:00 PM–5:00 PM

Buses will be leaving from the dropoff area south of the College of Business and the Memorial Union (see map on page 12). Box lunches can be picked up at the Ventana Room starting at noon.

From the Town to the Country: Conducting Stream Biogeochemistry along an Urban-Rural Gradient

Field trip leaders: Dr. Nancy Grimm, John Roach, and Jennifer Edmonds; Stream Laboratory, Department of Biology, Arizona State University

Stream biogeochemistry is heavily influenced by the physical structure of the stream channel. The urbanization of the Phoenix metropolitan area has resulted in extensive modification of exiting stream channels, the construction of artificial lakes and streams, and the creation of an extensive network of canals. However, many of the streams in the surrounding desert remain comparatively pristine. We will visit a variety of streams along this urban-rural gradient that differ in their hydrology and geomorphology. We hope that they will spark a discussion of natural and human landforms and their influence on the flow of water and the cycling of nutrients in fluvial systems.

Desert Preservation in the City of Phoenix
Field trip leaders: Jim Burke, City of Phoenix Parks, Recreation and Library Department; Professor Joseph Ewan, School of Planning and Landscape Architecture, Arizona State University; and Bruce Swanson, City of Phoenix Parks, Recreation and Library Department

The tour will focus on open space preservation efforts within the city of Phoenix. The tour will begin with visits to historically significant sites that have preserved Sonoran desert lands within what has become the six largest city in the nation. The tour will visit South Mountain Park, the largest municipal park in the country, and the North Mountains, home to the most popular trail in the country with more than 2 million visitors a year.

The tour will also visit the most recent effort to continue this tradition of preservation, the Sonoran Preserve. The master plan for this 21,500-acre project represents a departure from previous planning efforts. The most significant difference being that the Sonoran Preserve Master Plan attempts to develop a system that would function biologically while providing the public with a needed recreational resource. The Sonoran Preserve Master Plan was recognized by the American Society of Landscape Architects with a Presidential Award for Analysis and Planning. Jim and Joe, co-authors of the master plan will discuss the planning process, which includes on-going partnership with university planners, landscape architects, and ecologists.

Urbanization, Landscape, and Geologic History along the Salt River, Eastern Maricopa County
Field trip leader: Dr. Rámon Arrowsmith, Department of Geology, Arizona State University

This field trip will follow the Salt River from Arizona State University east into the Superstition Mountains and include several stops to discuss the changing uses of the river landscape from Hohokam, Hispanic, and Anglo irrigation to landfills and urban lakes as well as the classic landforms along the river including terraces, pediments, and channels. The last few million years of development of the Salt River is well recorded in the positions of these landforms, their relative ages, and related channel and overbank deposits.

Early Farming Experiments in the Phoenix Metropolitan Area
Field trip leader: Dr. Katherine Crewe, School of Planning and Landscape Architecture, Arizona State University

Farmlands around Phoenix have witnessed critical developments over the centuries, from the early Hohokam canals to the agricultural boom in citrus and cotton after the completion of the Roosevelt Dam in 1911. The area has provided a setting for a number of significant farming settlements, as well as important farm research. In this tour, we will visit some remains of these early farming communities, focusing on the towns of Chandler, Laveen, and Litchfield in the attempt to reconstruct a vanishing way of life.

Tres Rios Constructed Wetlands Demonstration Project
Field trip leader: John David, Landscape Ecology and Modeling Laboratory, Arizona State University West

Beginning in the early 1900s with the damming of the Salt River, the once verdant perennial river gradually became a dry riverbed whose primary inflow was from agricultural and storm runoff, and the discharge from the metropolitan Phoenix waste water treatment plant.

By the early 1990s a number of the valley's cities and various government agencies looked for solutions to bring the discharged water to meet or exceed the new water quality standards then being proposed. One alternative approach to the traditional engineering solutions was the use of constructed wetlands to polish the initially treated water.

The Tres Rios constructed wetlands project was designed to test and demonstrate the effectiveness of constructing wetlands to further polish the treated effluent coming from the 91st Avenue Waste Water Treatment Plant. When completed, the full-scale 800-acre wetland project will treat the entire 150 million gallons of water a day of effluent released from the plant. The project site is situated near the confluence of the Salt, Gila, and Agua Fria Rivers. It supports approximately 12 acres of wetlands, whose continuous outflow further provides necessary resources to maintain an additional mile of riparian habitat along the Salt River.

On this tour we will visit the Cobble site which compared lined and unlined basins to determine the amount of water loss through infiltration, and the Hayfield site which compared differing deep-zone configurations to determine which configuration (many and narrow, or few and wide) is optimum from the standpoint of both water quality improvement and increased habitat value. In addition, we will walk a riparian trail that is supported by the project's outflow, and view a 10-minute information video covering the highlights of the project.

Full-Day Field Trip
Sunday, April 29, 2001
6:30 AM–9:00 pm
Grand Canyon via Sedona
Departure: The coach bus will stop at each hotel to pick up passengers at these times: Marriott Courtyard, 6:30 AM; Twin Palms, 6:45 AM; Holiday Inn, 7:00 AM
Arrival back at Tempe: approximately 9:00 PM

Due to numerous requests, we have arranged a field trip to the South Rim of the Grand Canyon via the spectacular red rock country of Sedona. The trip is definitely a full day, but you will see some of the most scenic areas of Arizona. The route to the South Rim will pass through five biomes: Arizona Upland Sonora Desertscrub, Interior Chaparral, Juniper-Pinyon Woodland, Petran Montane Conifer Forest, and Great Basin Desertscrub. You will stop in Sedona for a coffee break and continue to the South Rim via Oak Creek Canyon and Flagstaff. You will spend several hours at the South Rim before heading back to Phoenix. A professional guide will provide narration during the trip. Snacks and drinks will be provided.

MUSEUMS at ASU

Arizona State University Art Museum
Free Admission
Hours of Operation: Tuesday 10:00 AM–9:00 PM
Wednesday—-Saturday 10:00 AM—- 5:00 PM
Sunday 1:00 PM–5:00 PM
480.965.ARTS

Description
The ASU Art Museum's permanent collection contains over 8,500 objects including works by Georgia O'Keeffe, Edward Hopper, Winslow Homer, James McNeill Whistler, Rufino Tamayo, Diego Rivera and Sue Coe. Three student-run art galleries display engaging exhibitions in all media and provide students with hands-on gallery experience.

Special exhibits
Rhasphody: Selections from the Valley Collection
The Wayfarer's Journey: A Film Installation by Gita Farid
Contemporary Art Furniture

Robert S. Dietz Museum of Geology
Free Admission
Located in the Physical Sciences Complex, F-Wing
Open Monday through Friday 9:00 AM–12:00 noon

THEATER AND DRAMATIC PRODUCTIONS at ASU

Enrico IV
Lyceum Theatre
April 13–14, 17–21, 22*+, 25–28, 29*
7:30 PM, *2 PM
*indicates signed performance
$14 General, $12 Faculty/Staff/Seniors, $10 Students
For tickets, call the Fine Arts Box Office at 480.965.6447.

Flora, the Red Menace
Evelyn Smith Music Theatre
April 25, 27, 28, 28,* 29, 29*
7:30 PM, * 2 PM
$14 General, $12 Faculty/Staff/Seniors, $10 Students
For tickets, call the Fine Arts Box Office at 480.965.6447.

MUSIC at ASU
ASU African Drum Ensemble Concert
7:30 p.m., Lawn at Forest Mall and Gammage Parkway or Katzin Concert Hall

SCHEDULE

Presentation Schedule

- Plenary Speakers
- Wednesday, April 25
- Thursday, April 26
  - Plenary Session
  - Morning Sessions (I am)
  - Afternoon Sessions (I pm)
  - Poster Session #1
- Friday, April 27
  - Plenary Session
  - Morning Sessions (II am)
  - Field Trips
  - Banquet
- Saturday, April 28
  - Plenary Session
  - Morning Sessions (III am)
  - Afternoon Sessions (III pm)
  - Poster Session #2
- Sunday, April 29
  - Full-Day Field Trip

Dr. Steward A. Pickett
Director of Baltimore Long-Term Ecological Research Project
Institute of Ecosystem Studies, Millbrook, New York, USA

Time: 8:45 am–9:45 am, April 26 (Thursday) 2001
Location: Ventana Room (Rm. 226), Memorial Union

The Landscape Paradigm in Ecology: Heterogeneity, Hierarchy, and Humans

Abstract

Using disparate examples of research projects that I have been involved in highlights key aspects of a framework for landscape ecology. The attempt to extract the similarities from these examples shows the ubiquity of heterogeneity, exposes some of its functional features, and helps to show the role of humans in creating and responding to heterogeneous urban and wild systems. A framework that can accommodate such a wide variety of studies recognizes 1) the kinds, frequency and configuration of elements of heterogeneity, 2) that heterogeneity is nested and scalable, 3) that determining the nature and control of flux is key to understanding heterogeneity, and 4) that a human ecosystem model can accommodate the range of individual and institutional processes in understanding ecosystems. Such a framework may serve landscape ecology well, and help inform other disciplines about the important insights of landscape ecology.

Dr. Steward T. A. Pickett received a B.S. from the University of Kentucky in 1972 and a Ph.D in plant ecology in 1977 from the University of Illinois at Urbana, Champaign. He served on the faculty of Rutgers University until 1987 and then joined the staff of the Institute of Ecosystem Studies where he currently holds the rank of Senior Scientist. His research interests encompass both conceptual and empirical studies of vegetation dynamics and natural disturbance, focusing on the mechanisms of post-agricultural vegetation development, and the role of disturbance-generated heterogeneity in the vegetation dynamics in primary forest. Studies focusing on the dynamics of ecological landscapes include experiments on the function of forest edges, the role of patchiness in diversity and productivity in the Negev Desert, and the structure and dynamics of cities as ecological systems. This last interest has led to his serving as the Director of the Baltimore Ecosystem Study, one of two urban Long-Term Ecological Research sites supported by the U.S. National Science Foundation.

Dr. Pickett has coedited five books, including the classic, *The Ecology of Patch Dynamics and Natural Disturbance* (1985, with P.S. White), *Ecological Heterogeneity* (1991, with J. Kolasa), and *Humans As Components of Ecosystems* (1993, with M.J. McDonnell). His approximately 110 scientific papers range from concerns with the structure of ecological theory, to the application of ecology to conservation, to the development of ecological approaches for studying urban areas. Dr. Pickett was elected a Fellow of the American Association for the Advancement of Science in 1992, and of the American Academy of Arts and Sciences in 1993. His contributions to the development and application of the profession of ecology include service as the inaugural Vice President for Science, Chairperson of the Membership Committee, and a member of the Council of the Ecological Society of America. He has also served on the Council of the International Association for Vegetation Science, the Science Advisory Board of the National Center for Ecological Synthesis and Analysis, the Biology Advisory Committee of the National Science Foundation, and the Board of Defenders of Wildlife.

Dr. Charles L. Redman and Dr. Nancy B. Grimm
Co-Directors of the Central Arizona-Phoenix Long-Term Ecological Research Project
Arizona State University, Tempe, Arizona, USA

Time 1:30 pm–2:30 pm, April 26 (Thursday), 2001
Location Ventana Room (Rm. 226), Memorial Union

Pattern and Process in the Human-Dominated Landscape of Central Arizona

Abstract
The Central Arizona-Phoenix Long-Term Ecological Research (CAP LTER) project is a multifaceted study aimed at answering the question, "How does the pattern of development of the city alter ecological conditions of the city and its surrounding environment, and vice versa?" Central to answering this question is understanding how land-use change is driven by societal decisions, how these decisions alter ecological pattern and process, and how changes in ecological conditions further influence human decision making. Of the 24 sites funded under the nationwide LTER program, Phoenix and Baltimore are the only two established specifically to study urban ecosystems. The rationale for the study of human-dominated systems is three-pronged. First, humans dominate earth's ecosystems; therefore, humans must be integrated into models for a complete understanding of ecological systems. Second, development of these more realistic models for ecological systems will lead to greater success in finding solutions to environmental problems. Third, although the study of ecological phenomena in urban environments is not a new area of science, the concept of the city as an ecosystem is a relatively new one for the field of ecology. Studying cities as ecosystems within new paradigms of ecosystem science will both raise the collective consciousness of ecologists about urban ecosystems and contribute to the further development of concepts that apply to all ecosystems. We will present background information on the Central Arizona–Phoenix landscape, results from the first three years of CAP LTER research, and a conceptual basis for integration of social and ecological systems.

Dr. Nancy B. Grimm (Ph.D. 1985, Arizona State University) is Professor of Biology at Arizona State University and Co-Director of the Central Arizona-Phoenix Long-Term Ecological Research (CAP LTER) project, a study of land-use change and ecological processes in the Phoenix metropolis and itssurroundings. She has published more than 60 articles on such diverse topics as the biogeochemistry of nitrogen in streams and rivers, the effects of natural and human-induced disturbances on stream communities and ecosystems, urban ecological systems, and interactions between linked ecosystems, such as rivers and groundwaters, watersheds and riparian zones. She has served on advisory panels and review teams for the National Science Foundation, the EPA, and the DOE, on editorial boards (including Ecology, Ecological Monographs, and Ecosystems), as president of the North American Benthological Society, and as chair of the Science Advisory Board for the National Center for Ecological Analysis and Synthesis.

Dr. Charles L. Redman is director of the ASU Center for Environmental Studies, and is the Virginia M. Ullman Professor of Natural History and the Environment. Redman is trained as an archaeologist and has published eight books and numerous scholarly articles on his fielwork in the Near East, Mediterranean and the Southwest US. He is also founding member of the Southwest Center for Education and the Natural Environment (SCENE), an officer of the state chapter of The Nature Conservancy, and an executive board member of the Governor's Commission on Groundwater Management. Dr. Redman has served as principal investigator or co-principal investigator on 35 research grants from federal, state, and private agencies, totaling over $24 million. Three years ago he began co-directing the Central Arizona-Phoenix Long-Term Ecological Project, and he is also co-directing the recent expansion of this urban ecological research to include an innovative interdisciplinary Ph.D. program (IGERT) sponsored by the National Science Foundation. He received his B.A. from Harvard University, and his M.A. and Ph.D. degrees in anthropology from the University of Chicago.

Professor Orie L. Loucks
Eminent Scholar of Ecosystem Ecology
Department of Zoology, Miami University, Oxford, Ohio, USA

Time: 8:30 am–9:30 am, April 27 (Friday), 2001
Location: Ventana Room (Rm. 226), Memorial Union

Influencing the Social and Political Metabolism of Landscapes

Abstract

This paper assumes that we know about the natural processes of landscapes, including hydrologic interactions, carbon capture, secondary production, population and metapopulation dynamics, perturbation processes, and ecological succession. Beyond that, we've learned much in recent years about human-generated processes that overlay natural landscapes, including land clearing, abandonment, fragmentation and recovery, conversion to commercial uses, reservoir development, irrigation, chemical enrichment of land and water, deposition of stressors, and introduction of exotic species. A further level of understanding is taking shape now. Here we need to consider how local to regional organizations, public and private, use policies or decision making to influence the above processes. The result is a social and political integration of processes, a kind of metabolism, that is different for each landscape. Our economic and policy surveys on landscapes in the greater Columbus area of Central Ohio have sought to estimate the willingness of people to pay for good stream water quality and biodiversity in the face of impending urban sprawl from Columbus into the Big Darby Creek watershed. We found the institutional influence is net-like, as well as hierarchical, capable of influencing pattern and process in both the natural and human-dominated system. Although essentially homeorhetic, however, the dynamics of this landscape system are capable of being redirected by human institutions. A second case study will illustrate why we believe financial institutions, such as the national capital markets, also can be enlisted to change human influence on the metabolism of landscapes.

Dr. Orie Loucks holds the position of Ohio Eminent Scholar in Applied Ecosystem Studies and Professor of Zoology at Miami University, Oxford, Ohio. His training includes B.Sc.F. and M.Sc. F. degrees in forestry from the University of Toronto (1953 and 1955, respectively), and a Ph.D. in botany from the University of Wisconsin-Madison in 1960. He began his career in 1955 as a Research Officer for the Department of Forestry in Canada and joined the Department of Botany at the University of Wisconsin in 1962, teaching advanced courses in ecology. From 1969 to 1973, he headed an interdisciplinary watershed study of the Lake Wingra basin, as part of the U.S. contribution to the International Biological Program. From 1976 to 1978, he served as Director of the Center of Biotic Systems in the Institute for Environmental Studies, University of Wisconsin, as well as Professor of Botany. He also headed a $3 million interdisciplinary study of environmental impacts from a large coal-fired generating station on the Wisconsin River in Central Wisconsin. In 1978, he joined The Institute of Ecology (TIE) in Indianapolis as Science Director and headed a series of studies concerning the regional effects of air pollutants and acidic deposition on Midwest ecosystems. In 1983, Dr. Loucks became Director of the Holcomb Research Institute at Butler University in Indianapolis. From 1986 to 1991, he headed a major inter-institutional study of pollutant effects on oak-hickory forests and soils of the Ohio Valley region.

Beginning in 1990, Dr. Loucks chaired a Miami faculty study group linking the business school with the science departments, seeking a common understanding of sustainable development for undergraduate teaching. This initiative has now become the Center for Sustainable Systems Studies. In the mid-1980s, Dr. Loucks was a member of the National Academy of Sciences Board on Water Science and Technology, and was U.S. Co-chair of the joint NRC–NAS/Royal Society of Canada study reviewing the 1978 Great Lakes Water Quality Agreement. He was a member of the Science Advisory Board, International Joint Commission from 1991 to 1995. From 1995 to 1997, he chaired the U.S. Vegetation Classification Panel of the Ecological Society of America and was a member of the AAAS Annual Meeting Program Committee. Dr. Loucks's public service and conservation interests are reflected in his work during the 1960s and 70s on the Board of Trustees of the Wisconsin Chapter of The Nature Conservancy, as a member of the National Board of Governors of The Nature Conservancy from 1984 to 1994, and as a recent member of the Ohio Chapter Board of Trustees. He also serves on the Cincinnati Museum's Edge of Appalachia Advisory Committee and the Three Valleys Conservation Trust. He was honored in 1994 with the Distinguished Service Award of the American Institute of Biological Science, and this year is the recipient of the National Wildlife Federation's Conservation Achievement Award in Science.

Dr. Katherine Crewe
School of Planning and Landscape Architecture
Arizona State University, Tempe, Arizona, USA

Time: 8:40 pm–9:30 pm, April 27 (Friday), 2001
Location: Tempe Mission Palms Hotel, 60 E. 5th Street, Tempe

The Origins Of Phoenix Farming

Abstract
The area around Phoenix has been settled by many different farming communities over the years, from both within the country and without. Each community has brought its own customary farm practices, but adapted these to arid desert conditions. Using historic slides, this presentation traces the development of early farming, dating back from the Hohokam Indians, and including the early white settlers; then later groups following the opening of the Roosevelt Canal, growing the area's chief crops of alfalfa, cotton, and citrus, but also cultivating exotic ventures such as ostrich and date farming, or specializing in cut flowers or sugar beets.

Dr. Crewe was born in South Africa, but has lived in the United States for 20 years. After taking a Masters in Landscape Architecture at the University of California, Berkeley, she practiced as a landscape architect on the east coast of the United States, then, in 1997 graduated with a Ph.D. in Landscape Architecture and Planning from the University of Massachusetts, Amherst. She is currently an assistant professor in the School of Planning and Landscape Architecture at Arizona State University

Professor Anne Whiston Spirn
School of Architecture and Planning
MIT, Cambridge, Massachusetts, USA

Time: 8:30 am–9:30 am, April 28 (Saturday), 2001
Location: Ventana Room (Rm. 226), Memorial Union

Watersheds, History, Landscape Planning and Community Development: Reflections on Fifteen Years of the West Philadelphia Landscape Project

Abstract
This paper describes the West Philadelphia Landscape Project as a laboratory for developing and testing theories of urban landscape change, planning, and management since 1987. It relates how processes of development, settlement, migration, and disinvestment have interacted with natural processes, such as water flow, to produce landscapes of poverty. It summarizes discoveries (such as the high correlation in many inner-city neighborhoods between vacant land and buried floodplains) and projects (such as the transformation of low-lying vacant land into a landscape amenity and stormwater detention facility, thereby rebuilding a neighborhood, reducing combined sewer overflows, and improving regional water quality). The paper summarizes the results of this research-in-action, sets that work within the context of broader issues in urban and environmental policy, and reflects on lessons for the theory and practice of landscape ecology and landscape planning and management.

Anne Whiston Spirn is Professor of Landscape Architecture and Planning at MIT. She received an A.B. from Harvard University and a M.L.A. from the University of Pennsylvania. Before coming to MIT, Spirn taught at the University of Pennsylvania and Harvard. Prior to teaching, Spirn worked at Wallace McHarg Roberts & Todd on diverse projects, including plans for Woodlands New Community in Houston, the Toronto Central Waterfront, and a comprehensive plan for Sanibel, Florida. Her first book, The Granite Garden: Urban Nature and Human Design (Basic Books 1984), won the President's Award of Excellence from the American Society of Landscape Architects. The Language of Landscape (Yale 1998) extends the ideas presented in The Granite Garden and argues that the language of landscape exists with its own grammar and metaphors. Since 1984, she has worked in inner-city neighborhoods on landscape planning and community design and development. She is director of the West Philadelphia Landscape Project, a program that integrates teaching, research, and community service, which has been featured in professional journals, newspaper articles, national radio and television broadcasts, and international conferences and symposia. WPLP was recognized as a model project by the White House Millennium Council in 1999.

April 25

Morning

10:00–12:00 Organizational Meeting for Student Workers, Rincon Room (Rm. 225), Memorial Union

Afternoon

1:00–5:00 Registration
Second Floor, Memorial Union, Arizona State University, outside of the Arizona Ballroom (Rm. 207)

1:00–6:00 Slide Preview / Computer Presentation
Preview Room 208 C, Memorial Union (35mm slide projector and computer projector available)

1:00–5:30 U.S.–IALE Executive Committee Meeting
Rincon Room (Rm. 225), Memorial Union

4:45 A Non–IALE Event
ASU School of Planning and Landscape Architecture Seminar
"Landscape Planning—A History of Ideas" by Dr. Carl Steinitz, Harvard University
Location: College of Architecture and Environmental Design, Arizona State University, AED 60 (North Building)

Evening

6:00–6:05 Welcome by Dr. Laura Musacchio (Program Coordinator) and Dr. Jianguo Wu (Program Chair)

6:05–6:15 Welcome by the Dean of the College of Architecture and Environmental Design, Dr. John Meunier

6:15–9:00 Welcome Mixer
Charlie's Café, AED 2nd Floor (North Building), College of Architecture and Environmental Design, Arizona State University

THURSDAY

April 26 8:15 to 9:45 plenary session

Chair Dr. Jianguo (Jingle) Wu, Arizona State University
Location Ventana Room (Rm. 226), Memorial Union

8:15–8:20	Opening Remarks by Program Chair, Dr. Jianguo (Jingle) Wu
8:20–8:30	Welcome Remarks by Vice Provost for Research, ASU, Dr. Jonathan Fink
8:30–8:40	Welcome Address by President of U.S.–IALE, Dr. Virginia Dale
8:40–8:45	Welcome Remarks by Program Coordinator, Dr. Laura Musacchio
8:45–9:45	Plenary Address by Dr. Steward A. Pickett, Institute of Ecosystem Studies, Millbrook, NY 12545, USA: The Landscape Paradigm in Ecology: Heterogeneity, Hierarchy, and Humans
9:45–10:00	COFFEE BREA

April 26 10:00 to 12:15 session #1

Special Session (1 AM-1):
Top 10 List for Landscape Ecology in the New Century
Chairperson: Jianguo (Jingle) Wu, Arizona State University.
Location: Pima Room (Rm. 218), Memorial Union

10:00–10:15 Wu, Jianguo. Department of Life Sciences, Arizona State University West, Phoenix, AZ 85069, USA. **Top 10 List for Landscape Ecology in the Twenty-First Century: Introduction**.

10:15–10:30 Naveh, Zev. Technion, Israel Institute of Technology, Haifa, Israel. **Naveh's Top 10 List for Landscape Ecology in the Twenty-First Century.**

10:30–10:45 Forman, Richard T. T. Harvard University, Graduate School of Design, Cambridge, MA 02138, USA. **Impact Opportunities for Landscape Ecology in the Twenty-Aughts.**

10:45–11:00 Farina, Almo. Faculty of Environmental Sciences, the Urbino University, Urbino, Italy. **Landscape Ecology Acting in the Real World, Priorities and Strategies.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Barrett, Gary W. and Terry L. Barrett. Institute of Ecology, University of Georgia, Athens, GA 30602, USA. **Landscape Ecology in the Twenty-First Century: From Youth to Maturity.**

11:30–11:45 Ahern, Jack. Department of Landscape Architecture and Regional Planning, University of Massachusetts, Amherst, MA 01003, USA. **Full Circle: Challenges for the Integration of the Science and the Application of Landscape Ecology.**

11:45–12:00 Baker, William L. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. **Landscape Ecology in the Twenty-First Century: A View from the Rocky Mountains.**

12:00–12:15 King, Anthony W. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6335, USA. **Top Ten Challenges for Landscape Ecology: A Middle-Number Systems Perspective.**

April 26 10:00 to 12:15 session #2

Regular Session (1 AM-2)
Landscape Mapping and Characterization: Methods and Applications
Chairperson: Pong Gong, University of California, Berkeley.
Location: Cochise Room (Rm. 212), Memorial Union

10:00–10:15 Gong,[1] P., Y. Sheng,[1] B. Xu,[1] L. Wang,[1] G. S. Biging,[1] Y. Wang,[2] Y.-P. Hsieh,[3] [1]Center for Assessment and Monitoring of Forest and Environmental Resources, University of California, Berkeley, CA 94720, USA; [2]Department of Geological Sciences, Florida State University, Tallahassee, FL 32306, USA; [3]Wetland Ecology, Center for Water Quality, Florida A&M University, Tallahassee, FL 32307, USA. **Photo-Ecometrics for Landscape Characterization.**

10:15–10:30 Rollins, Matthew and Robert Keane. Fire Sciences Laboratory, Rocky Mountain Research Station, United States Forest Service, Missoula, MT 59807, USA. **Remote Sensing and Gradient Modeling for Ecosystem Management**.

10:30–10:45 Arge,[1] Lars, Jeff Chase,[1] Laura Toma,[1,*] Jeffrey Vitter,[1] Rajiv Wickremesinghe,[1] Pat Halpin,[2] and Dean Urban.[2] [1]Levine Science Research Center, Computer Science Department, Duke University, Durham, NC 27708, USA; [2]Nicholas School of the Environment, Duke University, Durham, NC 27708, USA. **Digital Terrain Analysis for Massive Grids.**

10:45–11:00 Kupfer,[1] John and Scott Franklin.[2] [1]Department of Geography and Regional Development, University of Arizona, Tucson, AZ 85721, USA; [2]Department of Biology, University of Memphis, Memphis, TN 38152, USA. **Evaluation of an Ecological Land Type Classification System, Natchez Trace State Forest, Western Tennessee, USA.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Hargrove, William W. and Forrest M. Hoffman. Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA. **Multivariate Ecoregions of the United States: A Statistical Delineation.**

11:30–11:45 Hoffman, Robin. Faculty of Landscape Architecture, SUNY College of Environmental Science and Forestry, Syracuse, NY 13210, USA. **Application of Computer Visualizations in the Investigation of Alternate Forest Management Practices.**

11:45–12:00 Song, B,[1] P. Zollner,[2] D. J. Mladenoff,[1] Eric Gustafson,[2] H. S. He,[3] and V. C. Radeloff.[1]ß [1]Department of Forest Ecology and Management, University of Wisconsin, Madison, WI 53706, USA. [2]North Central Research Station, 5985 Highway K, Rhinelander, WI, USA. [3]School of Natural Resources, University of Missouri, Columbia, MO, USA. **3-D Visualization of Management Alternatives on the Chequamegon National Forest.**

12:00–12:15 Bolliger,[1] Janine, Erik V. Nordheim,[2] and David J. Mladenoff.[3] [1]Department of Forest Ecology and Management, University of Wisconsin, Madison, WI, 53706, USA; [2]Department of Statistics and Department of Forest Ecology and Management, University of Wisconsin, Madison, WI, 53706, USA; [3]Department of Forest Ecology and Management, University of Wisconsin, Madison, WI, 53706, USA. **A Probabilistic and Spatially Explicit Method to Assign Individual Tree Species to Ambiguously Identified Trees in Historical Land Office Surveys.**

* Indicates author who will present paper when other than initial author.

April 26 10:00 to 12:15 session #3

Special Session (1 AM-3)
Landscape Fire Succession Modeling
Chairpersons: Robert Keane, USDA Forest Service, Rocky Mountain Research Station; and Sandra Lavorel, Centre d'Ecologie Fonctionnelle & Evolutive (CEFE), Centre National de la Recherche Scientifique (CNRS)
Location: Alumni Room (Rm. 202), Memorial Union

10:00–10:15 Keane, R.E. and R. Parsons. USDA Forest Service Fire Sciences Laboratory, Missoula, MT 59807, USA. **Limitations of the Simulation Approach to Estimate Historical Range and Variation of Landscape Patch Dynamics.**

10:15–10:30 Chew, Jimmie D. USDA Forest Service, Rocky Mountain Research Station, Missoula, MT 59807, USA. **Integrating the Simulation of Disturbance Processes at Landscape Scales.**

10:30–10:45 Li, Chao. Northern Forestry Centre, Canadian Forest Service, Edmonton, Alberta, Canada T6H 3S5. **Landscape Structure Based Simulation of Natural Fire Regimes.**

10:45–11:00 Yemshanov, Dennis and Ajith H. Perera. Ontario Forest Research Institute, 1235 Queen St. E., Sault Ste. Marie, Ontario, Canada P6A 2E5. **Modelling Boreal Forest Landcover Dynamics After Fire Disturbance: A Markovian Approach.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Andison, David W. Bandaloop Landscape-Ecosystem Services, 3426 Main Ave., Belcarra, British Columbia, Canada V3H 4R3. **Practical Science Using the LANDMINE Landscape Fire Simulation Model.**

11:30–11:45 McGarigal,[1] Kevin, William Romme,[2] Edward Roworth,[1] and Michele Crist[1]. [1]Department of Natural Resources Conservation, University of Massachusetts, Amherst, MA 01003, USA; [2]Biology Department, Fort Lewis College, Durango, CO 81301, USA. **Rocky Mountain Landscape Simulator (RMLANDS): Characterizing the Expected Range of Variation in Landscape Structure and Fsunction.**

11:45–12:00 McKenzie, Donald, Amy E. Hessl, Susan Prichard, and David L. Peterson. Cascadia Field Station, P.O. Box 352100, University of Washington, Seattle, WA 98195, USA. **Linking Multi-Scale Empirical Approaches to Process-Based Models of Fire and Succession.**

12:00–12:15 Keane,[1] R.E. and S. Lavorel.[2] USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. P.O. Box 8089, Missoula, MT 59807, USA; [2]Centre d'Ecologie Fonctionnelle & Evolutive (CEFE), Centre National de la Recherche Scientifique (CNRS), UPR 9056, 1919 Route de Mende, 34293 Montpellier Cedex 05, France. **A Classification of Landscape Fire Succession Models: Presentation and Discussion.**

April 26 10:00 to 12:15 session #4

Regular Session (1 AM-4)
Landscape Management: Approaches and Practices
Chairperson Patrick A. Zollner. USDA Forest Service, North Central Research Station,
Location: Mohave Room (Rm. 222), Memorial Union

10:00–10:15 Zollner,[1] Patrick A., Eric J. Gustafson,[1] S. He Hong,[2] and David J. Mladenoff.[3] [1]USDA Forest Service, North Central Research Station, Rhinelander, WI 54501, USA; [2]University of Missouri, Department of Forestry, Columbia, MO 65211, USA; [3]University of Wisconsin Madison, Department of Forest Ecology and Management, Madison, WI 53706, USA. **Modeling the Influence of Dynamic Zoning on Forest Composition in the Northern Lake States.**

10:15–10:30 Adair, William A. and John A. Bissonette. USGS Utah Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, Utah State University, 5210 Old Main Hill, Logan, UT 84322-5210, USA. **Spatially Explicit Models and Landscape Planning: A Case Study with the Endangered Newfoundland Marten (*Martes americana atrata*).**

10:30–10:45 Nielsen, Clayton K. and Alan Woolf. Cooperative Wildlife Research Laboratory and Department of Zoology, Southern Illinois University at Carbondale, Mailcode 6504, Carbondale, IL 62901, USA. **Considering Landscape Physiognomy in Studies of Habitat Use-Availability.**

10:45–11:00 Green, Glen M. and Laura A. Carlson.* Center for the Study of Institutions, Population, and Environmental Change (CIPEC), Indiana University, Bloomington, IN 47408, USA. **Control of Forest Distribution by Bio-Geophysical and Social/Institutional Factors: Does Conservation Management Make a Difference?**

11:00–11:15 COFFEE BREAK

11:15–11:30 Haire, Sandra L. USGS Biological Resources Division, Fort Collins, CO 80525, USA. **Landscape Ecology as an Integrative Science: An Application in the Greater Yellowstone Ecosystem.**

11:30–11:45 Poiani,[1] Karen, Kent Gilges,[2] Ayn Shlisky,[1] and Jeff Hardesty.[3] [1]The Nature Conservancy, Department of Natural Resources, Cornell University, Ithaca, NY 14853, USA; [2]The Forest Bank, Center for Compatible Economic Development, The Nature Conservancy, Rochester, NY 14604, USA; [3]The Nature Conservancy, Department of Botany, University of Florida, Gainesville, FL 32611, USA. **Compatible Forest Management, Conservation, and Landscape Ecology: A Forest Management Network.**

11:45–12:00 Brooks, Kerry and Michael Bishopp. GIS and Simulation Laboratory, Interdisciplinary Design Institute and Department of Horticulture and Landscape Architecture, Washington State University–Spokane, Spokane, WA 99202, USA. **Evaluating Conflicts and Costs Associated with Proposed Landscape-Based Salmon Habitat Protection Measures.**

12:00–12:15 Tanizaki, K. F. and R. P. F. Pedrosa. Ecology Sector/DBAV/ Universidade do Estado do Rio de Janeiro, São Francisco Xavier, 524/PHLC sala220, Maracanã, Rio de Janeiro; Brazil. **Establishing Priorities for Conservation and Management in the Atlantic Coastal Forests: Case Study of Rio de Janeiro State, Brazil.**

April 26 1:30 to 2:30 planery session

Chair: Dr. Jianguo (Jingle) Wu, Arizona State University
Location: Ventana Room (Rm. 226), Memorial Union

1:30–2:30 Plenary Address by Dr. Charles L. Redman and Dr. Nancy B. Grimm, Arizona State University, Tempe, AZ 85287, USA:
Pattern and Process in the Human-Dominated Landscape of Central Arizona

2:30–2:45 COFFEE BREAK

April 26 2:45 to 5:30 session #1

Special Session (1 PM-1)
Top 10 List for Landscape Ecology in the New Century
(continued from morning session)
Chairperson: Jianguo (Jingle) Wu, Arizona State University
Location: Pima Room (Rm. 218), Memorial Union

2:45–3:00 Mladenoff, David J. Department of Forest Ecology and Management, University of Wisconsin, Madison, WI 54706, USA. **Challenges for Landscape Ecology.**

3:00–3:15 Dale, Virginia H. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6036, USA. **Top Ten Landscape Ecology Issues for the Next Millennium.**

3:15–3:30 Wiens, John A. National Center for Ecological Analysis and Synthesis, University of California Santa Barbara, Santa Barbara, CA 93101 and Department of Biology, Colorado State University, Fort Collins, CO 80523. **Looking Ahead by Looking Back: What Are the Central Issues of Landscape Ecology?**

3:30–3:45 Wu, Jianguo (Conveyor). Department of Life Sciences, Arizona State University West, Phoenix, AZ 85069, USA. **Top 10 Lists for Landscape Ecology from M. Anthrop, R. J. Hobbs, S. A. Levin, Arthur S. Lieberman, R. V. O'Neill and M. G. Turner.**

3:45–4:00 Questions for all speakers

4:00–4:15 COFFEE BREAK

April 26 2:45 to 4:15 session #2

Regular Session (1 PM-2)
Scale Effects in Landscape Analysis
Chairperson: Richard Sutton, Agronomy and Horticulture, University of Nebraska–Lincoln
Location: Cochise Room (Rm. 212), Memorial Union

2:45–3:00 Sutton, Richard K. Agronomy and Horticulture, University of Nebraska–Lincoln, Lincoln, NE 68583-0724, USA. **Effects of Grain, Extent, and Scale in a Hierarchical Test on Mystery, Legibility, and Preference in Rural Landscapes.**

3:00–3:15 Qi, Ye. Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94720-3310, USA. **Estimating Species Richness by Family: Does Scale Matter?**

3:15–3:30 Schulte, Lisa A. and David M. Mladenoff. Department of Forest Ecology and Management, University of Wisconsin, Madison, WI 53706, USA. **Effect of Scale on the Study of Pattern and Process in a Historical Landscape.**

3:30–3:45 Thompson, Craig M. and Kevin McGarigal. Department of Natural Resource Conservation, University of Massachusetts, Amherst, MA 01003-4210, USA. **Effects of Scale on Bald Eagle (Haliaeetus leucocephalus) Habitat Selection along the Lower Hudson River.**

3:45–4:00 Xu, Ming, Qinghua Guo and Ye Qi. Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94720, USA. **Detecting Spatial Patterns in a Young Ponderosa Pine Plantation Using 0.5m Resolution Digital Imagery**.

4:00–4:15 COFFEE BREAK

April 26 2:45 to 4:15 session #3

Regular Session (1 PM-3)
Vegetation Pattern and Plant-Environment Relationships
Chairperson: Mark Dixon, Department of Zoology, University of Wisconsin
Location: Alumni Room (Rm. 202), Memorial Union

2:45–3:00 Dixon, Mark and Monica Turner. Department of Zoology, University of Wisconsin, Madison, WI 53706, USA. **Modeling the Effects of Flow Variation on Recruitment Dynamics of Riparian Trees.**

3:00–3:15 Hess,[1] Rebecca S. and Thomas A. Spies.[2] [1]Department of Forest Science, Oregon State University, Corvallis, OR 97331, USA; [2]USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR 97331, USA. **Snag and Down Wood Patterns in Forests of the Coast Range of Oregon.**

3:15–3:30 Lookingbill, Todd, Kenneth Pierce, and Dean Urban. Nicholas School of the Environment, Duke University, Durham, NC 27708, USA. **Temperature in Montane Systems: Testing DEM–Derived Proxies with Field Data.**

3:30–3:45 McDonald,[1] Robert I., Robert K. Peet,[2] and Dean L. Urban.[3] [1]Nicholas School of the Environment, P.O. Box 90328, Duke University, Durham, NC 27708, USA; [2]Department of Biology, P.O. Box 3280, University of North Carolina, Chapel Hill, NC 27599, USA; [3]Nicholas School of the Environment, P.O. Box 90328, Duke University, Durham, NC 27708, USA. **Landscape Impacts on Oak Decline and Red Maple Increase.**

3:45–4:00 Bunn,[1] Andrew G., Dean L. Urban,[2] Lisa J. Graumlich.[1] [1]Mountain Research Center, Montana State University, P.O. Box 173490, Bozeman, MT 59717-3490, USA; [2]Nicholas School of the Environment, Duke University, Durham, NC 27708, USA. **Fine Scale Variability in the Physical and Biotic Templates of Three Alpine Treelines.**

4:00–4:15 COFFEE BREAK

April 26 2:45 to 5:30 session #4

Regular Session (1 PM-4)
Land-Use and Land-Cover Change: Pattern and Process
Chairpersons: J. Morgan Grove, USDA Forest Service (2:45–4:00 pm); and Tamara Shapiro, Department of Landscape Architecture, Rutgers University (4:15–5:30 pm).
Location: Mohave Room (Rm. 222), Memorial Union

2:45–3:00 Shapiro, Tamara,[1] Emily W.B. Russell,[2] and Jean Marie Hartman.[3] [1]Department of Landscape Architecture, Rutgers University, New Brunswick, NJ 08901, USA; [2]Department of Geologic Sciences, Rutgers University, Newark, NJ 07102, USA; and [3]Department of Landscape Architecture, Rutgers University, New Brunswick, NJ 08901, USA. **Forces of Environmental Change in the Hackensack Meadowlands: A Historic Analysis.**

3:00–3:15 McConnell, William J. Indiana University, Bloomington, IN 47405, USA. **Human-Environment Relations in Madagascar: The Importance of Spatial and Temporal Perspective.**

3:15–3:30 Binford,[1] M.W., C. Leslie,[2] R. Britts,[1] G. Barnes,[2] H. L. Gholz,[3] S.E. Smith.[2] [1]Department of Geography, University of Florida, Gainesville, FL 32611, USA; [2]Geomatics Program, Department of Civil Engineering, University of Florida, Gainesville, FL 32611, USA; [3]School of Forest Resources and Conservation, University of Florida, Gainesville, FL 32611, USA. **Decadal-Scale Spatial Dynamics of Land Cover, Land Ownership, Land Management in Industrial and Non-Industrial Forests in the Southeastern Coastal Plain Region of the U.S.**

3:30–3:45 Lioubimtseva, Elena. Department of Geography and Planning, Grand Valley State University, Allendale, MI 49401, USA. **Monitoring Changes in Arid Landscapes of Central Asia.**

3:45–4:00 Hockner,[1] Tom, Jim Newman,[2] Jeffrey Jones,[3] Mark Brown,[4] Joseph Delfino,[5] Michael Binford.[6] [1]Department of Urban and Regional Planning, University of Florida, Gainesville, FL 32611, USA; [2]Pandion Systems, Inc., Gainesville, FL 32611, USA; [3]East Central Florida Regional Planning Council, Maitland, FL 32751, USA; [4]Department of Environmental Engineering, University of Florida, Gainesville, FL 32611, USA; [5]Department of Environmental Engineering, University of Florida, Gainesville, FL 32611, USA; [6]Department of Geography, University of Florida, Gainesville, FL 32611, USA. **Assessing Impacts of Incremental Landscape Changes on the Wekiva River Ecosystem: A Dynamic Urban Ecology Model.**

4:00–4:15 COFFEE BREAK

4:15–4:30 Nagendra, Harini, Jane Southworth, and Catherine M. Tucker. Center for Study of Institutions, Population, and Environmental Change, Indiana University, Bloomington, IN 47408, USA. **Using Landscape Metrics to Interpret Trajectories of Land-Cover Change: A Case Study in Western Honduras.**

4:30–4:45 Nugranad[1] Jarunee, Peter August,[2] Daniel Civco,[3] Y. Q. Wang.[2] [1]Remote Sensing Division, National Research Council of Thailand, 196 Paholyothin Road, Chatuchak, Bangkok 10900, Thailand; [2]Department of Natural Resources Science, University of Rhode Island, Kingston, RI 02881, USA; [3]Department of Natural Resources Management and Engineering, University of Connecticut, Storrs, CT 06269, USA. **Biophysical and Socio-Economic Correlates of Land Cover in the Mae Taeng Watershed of Northern Thailand.**

4:45–5:00 Batistella,[1] Mateus and Fabio de Castro.[2] [1]Indiana University–ACT, Bloomington, IN 47405, USA; [2]NEPAM–UNICAMP, Campinas, SP 13081-970, Brazil. **Institutional Design and Landscape Fragmentation: A Comparative Study of Rural Colonization Projects in the Brazilian Amazon.**

5:00–5:15 Fernandez, Luis E. School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109-1115, USA. **Modeling the Agents of Tropical Deforestation: Integrating Social Survey Data into Spatial Models of Land-Use Change on the Atlantic Coast of Nicaragua (1959–1996).**

5:15–5:30 Zebisch,[1] Marc, Hartmut Kenneweg,[1] Valentina Krysanova,[2] and Frank Wechsung.[2] [1]Institute for Landscape Development, Technical University Berlin, Germany; [2]Potsdam Institute for Climate Impact Research, Germany. **Landscape Responses to External Driving Forces in Brandenburg, Germany**.

April 26 4:15 to 5:30 session #5

Special Session (1 PM-5)
Scaling Issues Related to Ecological and Hydrological Landscape Analyses
Chairperson: Bruce Jones and Iris Goodman. U.S. Environmental Protection Agency, Landscape Ecology Branch
Location: Pima Room (Rm. 218), Memorial Union

4:15–4:30 Berk,[1] Richard, Jan de Leeuw,[1] Richard Ambrose,[2] and Cindy Lin.[2] [1]Department of Statistics, University of California, Los Angeles, CA 90095-1554, USA; [2]Department of Environmental Science and Engineering, School of Public Health, University of California, Los Angeles, CA 90095-1554, USA. **Multilevel Statistical Modeling for Generalizing from Case Studies.**

4:30–4:45 Mueller, Felix and Ernst-Walter Reiche. Ecology Center, University of Kiel, Schauenburgerstrasse 112, D 24118 Kiel, Germany. **Ecological Gradients as Hierarchical Indicators of Ecosystem and Landscape Integrity.**

4:45–5:00 Chen, Grace F. Department of Geography, University of Iowa, Iowa City, IA 52242, USA. **Relating Landscape Patterns to Hydrological Processes in a Watershed Hierarchy**.

5:00–5:15 Jennings, David B. and S. Taylor Jarnagin.* U.S. Environmental Protection Agency, NERL/LEB, Environmental Photographic Interpretation Center, Reston, VA 20192, USA. **Impervious Surfaces and Streamflow Discharge: A Historical Remote Sensing Perspective in a Northern Virginia Subwatershed.**

5:15–5:30 Cardille,[1] Jeffrey A., Jonathan A. Foley,[1] Marcos Heil Costa.[2] Center for Sustainability and the Global Environment, University of Wisconsin, Madison, WI 53706, USA; [2]Department of Agricultural Engineering, Federal University of Viçosa, Viçosa, MG, Brazil. **Scaling Down Successfully: A New Method For Integrating Census and Satellite Data**

April 26 4:15 to 5:30 session #6

Special Session (1 PM-6)
Pollinators in Heterogeneous and Dynamic Landscapes
Chairperson: Nancy McIntyre, Department of Biological Sciences, Texas Tech University
Location: Cochise Room (Rm. 212), Memorial Union

4:15–4:30 McIntyre,[1] Nancy and Mark Hostetler.[2] [1]Department of Biological Sciences, Texas Tech University, Box 43131, Lubbock, TX 79409-3131, USA; [2]Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611-0430, USA. **Effects of Urban Land Use on Pollinator Communities in a Desert Metropolis.**

4:30–4:45 Turner,[1] S. J. and A.R. Johnson.[2] [1]The Department of Biological Sciences, St. Cloud State University, St. Cloud, MN 56301 USA; [2]The Department of Environmental Toxicology, Clemson University, 509 Westinghouse Road, Pendleton, SC 29670, USA. **Fragmented Native Populations in Agricultural Landscapes: The Case of an Orchid and Its Pollinators.**

4:45–5:00 Reed, Catherine C. Entomology Department, University of Minnesota, St. Paul, MN 55108, USA. **Native Bee Species Persistence and Recolonization on Midwestern Prairie Fragments.**

5:00–5:15 Waser, Nickolas M. Department of Biology, University of California, Riverside CA 92521, USA. **Isolation and Low Density: Two Effects of Fragmentation on Plant Populations, and Their Implications for Pollination by Animals.**

5:15–5:30 Silbernagel,[1] Janet and T. F. H. Allen.[2] [1]Department of Landscape Architecture, University of Wisconsin, Madison, WI 53706, USA; [2]Department of Botany, University of Wisconsin, Madison, WI 53706, USA. **Negotiating the Cultural Landscape as a Bumblebee: Complex Foraging Behavior and Levels of Organization.**

April 26 4:15 to 5:30 session #7

Regular Session (I PM-7)
Landscape Pattern and Species Invasion and Disease Spread
Chairperson: Cindy Huebner, USDA Forest Service, Northeastern Research Station
Location: Alumni Room (Rm. 202), Memorial Union

4:15–4:30 Huebner, Cynthia D. USDA Forest Service, Northeastern Research Station, Morgantown, WV 26505, USA. **Invasive Plant Species in Eastern Oak-Hickory Forests: Actual and Potential Landscape Impacts.**

4:30–4:45 Glenn, Susan. Forest Sciences Department, University of British Columbia, Vancouver, British Columbia, Canada V4K 3C9. **Responses of Grassland/Forest Boundaries to Surprising Changes in Climate in Central British Columbia, Canada.**

4:45–5:00 Hatfield, Colleen A. Department of Ecology, Evolution and Natural Resources, Rutgers University, New Brunswick, NJ 08901, USA. **Discontinuities in Habitat Features Inhibit the Spread of Exotic Species.**

5:00–5:15 Bickel,[1] Kathryn A., Laura C. Philips,[2] and Dean L. Urban.[3] [1]Nicholas School of the Environment, Duke University, P.O. Box 90328, Durham, NC 27708-0328, USA; [2]Department of Biology, University of North Carolina at Chapel Hill, P.O. Box 3280, Chapel Hill, NC 27599, USA; [3]Nicholas School of the Environment, Duke University, P.O. Box 90328, Durham, NC 27708-0328, USA. **Land Use, Disturbance, and the Spread of Non-Native Plant Species in a Piedmont Forest Ecosystem.**

5:15–5:30 Nicholson,[1] Matthew and Thomas Mather.[2] [1]Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, IL 62901, USA; [2]Center for Vector-Borne Disease, University of Rhode Island, Kingston, RI 02881, USA. **Spatial and Temporal Trends in Deer Tick Abundance: Implications for Human Lyme Disease Risk.**

POSTER session April 26 8:00 to 5:30

Place: Arizona Ballroom (Rm. 207), Memorial Union
Set-up time: 7:30 am–8:00 am
Duration: 8:00 am–5:30 pm
Author available for questions: 11:00 am–12:15 pm and 4:00 pm–5:30 pm

Landscape Characterization and Pattern Analysis

P#1-1 Camelo-de-Castro, Ernesto. Department of Plant Biology, Arizona State University, Tempe, AZ 85287, USA. **Landsat MSS and TM Data Preparation for Vegetation Cover Change Analysis: Evaluation on a Cerrado Environment in Mato Grosso, Brazil.**

P#1-2 Chen, Jiquan,[1] Eugenie Euskirchen,[1] Tom Hayes,[2] Siyan Ma,[1] Treneice Marshall,[1] and Sari Saunders.[1] [1]School of Forestry & Wood Products, Michigan Technological University, Houghton, MI 49931, USA; [2]University of California, Berkley, CA 94720, USA. **Are Edge Effects More Pronounced at Edges?**

P#1-3 Chen, Yufu, Ming Dong. Institute of Botany, Chinese Academy of Sciences, Beijing 100093, P.R. China. **Quantifying Spatial Pattern of a Sandy Landscape in Northern China by Lacunarity Analysis.**

P#1-4 da Costa Gurgel, Helen, Nelson Jesus Ferreira. Instituto Nacional de Pesquisas Espaciais (INPE), Caixa Postal 515-12201-097, São José dos Campos, SP, Brazil. **Spatial and Temporal Variability of NDVI over Brazil and Its Connections with the Climate.**

P#1-5 Helmer, E. H., Olga Ramos, Tania del Mar Lopez, Maya Quiñones and Wilmari Diaz. International Institute of Tropical Forestry, USDA Forest Service, P.O. Box 25000, Río Piedras, Puerto Rico, USA. **Mapping Forest Type and Land Use of a Biodiversity Hotspot.**

P#1-6 Hudak,[1] Andrew, Janet Ohmann,[1] Matt Gregory,[1] Melinda Moeur,[1] Michael Lefsky,[2] and Warren Cohen.[1] [1]Pacific Northwest Research Station, U.S. Forest Service; [2]Department of Forest Science, College of Forestry, Oregon State University, Richardson Hall 321, Corvallis, OR 97331-5752, USA. **Comparison of Two Methods to Map Forest Structure from Inventory Plot and Environmental Data in Western Oregon.**

P#1-7 Kirkpatrick,[1] Lee Anne and John F. Weishampel.[2] [1]Liberal Studies Program, University of Central Florida, Orlando, FL 32816-2368, USA; [2]Department of Biology, University of Central Florida, Orlando, FL 32816-2368, USA. **Quantifying Structure in Volumetric Neutral Landscapes.**

P#1-8 Townsend, Philip A., Robert A. Chastain, Brian R. Sturtevant, and Steven W. Seagle. Appalachian Laboratory, University of Maryland Center for Environmental Science, 301 Braddock Road, Frostburg, MD 21532, USA. **Characterization of Forest Vertical Structure for Landscape Studies.**

P#1-9 Wu,[1] X. Ben and Daniel Z. Sui.[2] [1]Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843, USA; [2]Department of Geography, Texas A&M University, College Station, TX 77843, USA. **Exploring Urban Residential Segregation Using a Lacunarity-Based Measure.**

Scaling: Methods and Case Studies

P#1-10 Bossenbroek,[1] Jonathan M., Helene H. Wagner,[1] Michelle M. Hawks,[1] John A. Wiens,[2] Beatrice Van Horne.[1] [1]Biology Department, Colorado State University, Ft. Collins, CO 80523, USA; [2]National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101-3351, USA. **Scale Dependency from Colorado to Kansas: How the Environment and the Beetles Come Together.**

P#1-11 Hawks, Michelle M., Helene H. Wagnar, Jonathan M. Bossenbroek, John A. Wiens, and Beatrice Van Horne. Department of Biology, Colorado State University, Fort Collins, CO 80521, USA. **Multi-Scale Analysis of Butterflies Response to Environmental Factors Using Causal Modeling.**

P#1-12 Li,[1] Harbin, Zhengquan Wang,[2] and Carl C. Trettin.[1] [1]USDA Forest Service, Southern Research Station, Charleston, SC 29414, USA; [2]College of Forest Resources and Environment, Northeast Forestry University, Harbin, Heilongjiang 150040, P.R. China. **Scaling Up Carbon Estimates in Peat Soils: Sources and Consequences of Uncertainty.**

P#1-13 Ohmann,[1] Janet L. and Matthew J. Gregory.[2] [1]USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR 97330, USA; [2]Department of Forest Science, Oregon State University, Corvallis, OR 97330, USA. **Alternative Approaches for Scaling Up Fine-Resolution, Mapped Vegetation Data for Regional Analysis.**

P#1-14 Schooley,[1] Robert L. and John A. Wiens.[1,2] [1]Department of Biology, Colorado State University, Fort Collins, CO 80523, USA; [2]National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101, USA. **Predicting the Distribution and Abundance of a Habitat Specialist: Grain Size and Spatial Effects.**

P#1-15 Wagner, Helene H.,[1] Jonathan M. Bossenbroek,[1] Michelle M. Hawks,[1] Beatrice Van Horne,[1] and John A. Wiens.[2] [1]Department of Biology, Colorado State University, Fort Collins, CO 80523, USA; [2]National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101, USA. **Spatial Covariance in Plant Communities: An Integration of Variogram Modeling, Multi-Scale Ordination and the Testing for Assembly Rules.**

P#1-16 Wiens,[1] John A., Helene H. Wagner,[2] Michelle M. Hawks,[2] Jonathan M. Bossenbroek,[2] and Beatrice Van Horne.[2] [1]National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101, USA; [2]Department of Biology, Colorado State University, Fort Collins, CO 80523, USA. **Changes in the Structure of Grassland-Dominated Landscapes along a Precipitation and Productivity Gradient in the Central Plains.**

P#1-17 Wu, Jianguo. Department of Life Sciences, Arizona State University West, Phoenix, AZ 85069, USA. **Effects of Changing Grain Size and Extent in Landscape Characterization and Pattern Analysis: Generalities and Idiosyncrasies.**

Land-Use Change and Urban Ecology

P#1-18 Alberti,[1,2] Marina, Derek Booth,[3] Kristina Hill,[4] John Marzluff,[5] Stefan Coe,[1,2] Roarke Donnelly,[5] Vivek Shandas,[1,2] and Daniele Spirandelli.[2,4] [1]Department of Urban Design and Planning, University of Washington, Seattle, WA 98195, USA; [2]Urban Ecology Research Lab, University of Washington, Seattle, WA 98195, USA; [3]Department of Civil and Environmental Engineering, University of Washington, Seattle, WA 98195, USA; [4]Department of Landscape Architecture, University of Washington, Seattle, WA 98195, USA; [5]College of Forest Resources, University of Washington, Seattle, WA 98195, USA. **The Impacts of Urban Patterns on Ecosystem Dynamics.**

P#1-19 Berling-Wolff, Sheryl,[12] and Jianguo Wu.[2] [1]Department of Plant Biology, Arizona State University, Tempe, AZ 85287, USA; [2]Landscape and Systems Ecology Lab, Arizona State University West, Phoenix, AZ 85069, USA. **Simulating Urban Growth in the Phoenix Metropolitan Region: Relating Pattern to Process.**

P#1-20 Chen, Chang-Jui. Department of Landscape, Chinese Culture University, 100, 2F, 125, Chung-Hua Rd., Sec.2, Taipei, Taiwan. **Landscape Spatial Patterns of Three Kinds of Irrigation Areas in Taoyuan Terrace, Taiwan.**

P#1-21 Clagget,[1] Peter, Michael Strager.[2] [1]Canaan Valley Institute, Valley Forge, Pennsylvania 19482-0964, USA; [2]West Virginia University, Morgantown, WV 26506-6108, USA. **An Interactive GIS Landscape Change and Analysis Tool.**

P#1-22 Fisher, Christopher T. Archaeological Research Institute, Department of Anthropology, Arizona State University, Tempe, AZ 85287, USA. **2000 Years of Landscape Change in the Lake Pátzcuaro Basin, Michoacán, Mexico.**

P#1-23 Gomide, Marcia,[1] Vladmir Luft,[2] Mônica Serrão.[3] [1]Núcleo de Estudos de Saúde Coletiva, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil; [2]CREP, Visconde do Rio Branco, Minas Gerais, Brasil; [3]SENAC, CEAD, Rio de Janeiro, Brasil. **From Tropical Forest to Eroded Lands: The Cost of the Natural Landscape in the Urbanization Process.**

P#1-24 Gomide,[1] Marcia, Roberto Medronho,[1] and Heinrich Haasenack.[2] [1]Núcleo de Estudos de Saúde Coletiva - NESC/UFRJ/ Rio de Janeiro, Brasil; [2]Departamento de Ecologia/UFRGS/Porto Alegre, Brasil. **Precarious Urbanization and Transmission of the Hepatitis A in a Poor Area of Rio de Janeiro, Brazil.**

P#1-25 Jaiteh,[1] Malanding S., Paul V. Desanker,[2] and Jiquan Chen.[3] [1]Center for International Earth Science Information Network (CIESIN), Columbia University, P.O. Box 1000, The Palisades, NY 10964, USA; [2]Department of Environmental Science, University of Virginia, Clark Hall, Charlottesville, VA 22903, USA; [3]School of Forestry and Wood Products, Michigan Technological University, 1400 Townsend Drive, Houghton MI 49931, USA. **Land Use and Landscape Patterns in Miombo Ecosystems.**

P#1-26 Alberti,[2] Marina, Erik Botsford,[1] and Alex Cohen.[1,2] [1]Department of Urban Design and Planning, University of Washington, Seattle, WA 98195, USA; [2]Urban Ecology Research Lab, University of Washington, Seattle, WA 98195, USA. **Quantifying Urban Ecological Gradients in the Puget Sound Region.**

P#1-27 Mauz, Kathryn. Arid Lands Resource Sciences, Office of Arid Lands Studies, University of Arizona, Tucson, AZ 85719, USA. **Quantifying Land-Cover Change on the Catalina Piedmont, Tucson, Arizona, 1984–1998: Application of Remote Sensing and GIS Analysis Techniques.**

P#1-28 Wimberly, Michael C. and Janet L. Ohmann. USDA Forest Service Pacific Northwest Research Station, Corvallis, OR 97331, USA. **Spatial Patterns of Forest Landscape Change in the Oregon Coast Range between 1936 and 1996.**

P#1-29 Zhang, Jiahua and Hiroshi Kanzawa. Atmospheric Environment Division, National Institute for Environmental Studies, Tsukuba, Japan. **Landscape Dynamics in Typical Ecological Regions of China Based on Remote Sensing and GIS.**

Landscape Pattern and Ecosystem Processes

P#1-30 Charpentier,[1,2] M, C. Wigand,[2] R. McKinney,[2] M. Chintala,[2] G. Thursby,[2] and J. Kiddon.[2] [1]OAO Corporation, 27 Tarzwell Drive, Narragansett, RI 02882, USA; [2]EPA, NHEERL, 27 Tarzwell Drive, Narragansett, RI 02882, USA. **A Geographic Information System (GIS) Analysis of Water Transit through Watersheds of Subestuaries in Narragansett Bay, Rhode Island.**

P#1-31 Paul,[1] John F., Randy L. Comeleo,[2] Jane Copeland.[3] [1]U.S. Environmental Protection Agency, Narragansett, RI 02882, USA; [2]OAO Corporation, Corvallis, OR 97333 USA; 3OAO Corporation, Narragansett, RI 02882, USA. **Landscape Structure and Estuarine Condition in the Mid-Atlantic Region of the United States: I. Developing Quantitative Relationships.**

P#1-32 Hollister,[1] Jeff W., John F. Paul,[2] Jane Copeland,[3] Randy L. Comeleo,[4] Mike Charpentier,[3] Peter V. August,[1] Mark Brush.[5] [1]University of Rhode Island, Department of Natural Resources Science, Kingston, RI, 02881, USA; [2]U.S. Environmental Protection Agency, Atlantic Ecology Division, Narragansett, RI 02882, USA; [3]OAO Corporation, Narragansett, RI 02882, USA; [4]OAO Corporation, Corvallis, OR 97333, USA; [5]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI 02882, USA. **Landscape Structure and Estuarine Condition in the Mid-Atlantic Region of the United States: II. Assessing the Accuracy of the National Land Cover Dataset at Multiple Extents.**

P#1-33 Koerner, Brenda A. and Jeffrey M. Klopatek. Department of Plant Biology, Arizona State University, Tempe, AZ 85287, USA. **Anthropogenic and Natural CO2 Efflux in an Arid Urban Environment: Pattern and Processes.**

P#1-34 Lin,[1,3] Yu-Pin, Tsun-Kuo Chang,[2] Tung-po Teng,[3] and Chen-Fa Wu.[1] [1]Department of Landscape Architecture, Chinese Culture University, Taipei, Taiwan 11114; [2]Graduate Institute of Agricultural Engineering, National Taiwan University, Taipei, Taiwan 10617; [3]Department of Geography, Chinese Culture University, Taipei, Taiwan, 11114. **A Study of Landscape Diversity and Soil Heavy Metal Pollution in an Agricultural Landscape.**

P#1-35 Jenerette,[1,2] G. Darrel, Matthew A. Luck,[1,2] Jianguo Wu,[1] Nancy B. Grimm,[2] Diane Hope,[3] and Weixing Zhu.[4] [1]Landscape and Systems Ecology Lab, Arizona State University West, Phoenix, AZ 85069, USA; [2]Department of Biology, Arizona State University, Tempe, AZ 85287, USA; [3]Center for Environmental Studies, Arizona State University, Tempe, AZ 85287, USA; [4]Department of Biological Sciences, Binghamton University—SUNY, Binghamton, NY 13902, USA. **Linking Spatial Pattern of Soil Organic Matter to Ecological Processes in an Urban Landscape.**

P#1-36 Tueller,[1] Paul T., Michael Limb[2] and Jianguo Wu.[3] [1]Department of Environmental and Resource Sciences, University of Nevada Reno, Reno, NV 89512, USA; [2]Bureau of Land Management, Klamath Falls, OR 97603, USA; [3]Landscape and Systems Ecology Lab, Arizona State University West, Phoenix, AZ 85069, USA. **Landscape Pattern and Ecosystem Attributes on a Western Nevada Rangeland Ecosystem.**

P#1-37 Wu, Wanli. School of Natural Resource Sciences, University of Nebraska-Lincoln, Lincoln, NE 68583, USA. **Scales and Processes of Flow Regime, Hydrologic Connectivity, and Riverine Landscape Patterns on Braided River Floodplains.**

P#-38 David,[1] John (EBo) and Jianguo (Jingle) Wu. [1]Department of Plant Biology, Arizona State University, Tempe, AZ 85287, USA; [2]Department of Life Sciences, Arizona State University West, Phoenix, AZ 85069, USA. **Toward Developing a Hierarchical Patch Dynamics Modeling Platform.**

FRIDAY

April 27 8:30 to 9:30 plenary session

Chair: Dr. Jianguo (Jingle) Wu, Arizona State University.
Location: Ventana Room (Rm. 226), Memorial Union

8:30–9:30	Plenary Address by Dr. Orie L. Loucks, Department of Zoology, Miami University, Oxford, OH 45056, USA. **Influencing the Social and Political Metabolism of Landscapes**
9:30–9:45	COFFEE BREAK

April 27 9:45 to 12:15 session #1

Regular Session (11 AM-1)
Landscape Pattern Analysis: Theory and Methods
Chairperson: X. Ben Wu, Texas A&M University
Location: Pima Room (Rm. 218), Memorial Union

9:45–10:00 Ludwig, John. CSIRO Sustainable Ecosystems, PMB 44, Winnellie, Darwin, Australia 0822. **Monitoring Landscape Health: A New Resource Retention Index Based on Remote Sensing.**

10:00–10:15 Hay,[1] G.J., P. Dubé,[1] D.J. Marceau,[1] A. Bouchard.[2] [1]Geocomputing Laboratory, Department of Geography, University of Montreal, Montreal, Quebec, Canada H3C 3J7; [2]IRBV, University of Montreal, Jardin Botanique de Montreal, Montreal, Quebec, Canada H1X 2B2. **Scale-Space for Landscape Ecologists: A Novel Approach for Defining Multi-Scale Landscape Structure in High-Resolution Imagery.**

10:15–10:30 Blaschke, Thomas. Department of Geography and Geoinformation, University of Salzburg, Hellbrunner Str. 34 A-5020 Salzburg, Austria. **Hierarchical Patch Dynamics and Object-Oriented Image Analysis: Multi-Scale Exploration of a Cultural Landscape.**

10:30–10:45 He,[1] Hong S., Stephen J. Ventura,[2] and David J. Mladenoff.[3] [1]School of Natural Resources, University of Missouri-Columbia, Columbia, MO 65211, USA; [2]Land Information & Computer Graphic Facilities, University of Wisconsin, Madison, WI 53706, USA; [3]Department of Forest Ecology & Management, University of Wisconsin, Madison, WI 53706, USA. **Effects of GIS Aggregation Approaches on Landscape Patterns Using Landsat TM Satellite Imagery.**

10:45–11:00 Lin,[1,2] Yu-Pin, Tung-po Teng,[2] and Chen-Fa Wu.[1] [1]Department of Landscape Architecture Chinese Culture University, Taipei, Taiwan 11114; [2]Department of Geography, Chinese Culture University, Taipei, Taiwan 11114. **Spatial Continuity and Fragmentation Analysis of Vegetation Landscape at Lugiakan Conservation Area in Taiwan.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Guo, Qinghua, Wei Luo,* Ye Qi. Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94704, USA. **Semivariance Techniques in Point Pattern Analysis: A Comparison with Ripley K.**

11:30–11:45 de-Camino-Beck, Tomas and Arturo Sanchez-Azofeifa. Earth and Atmospheric Science Department, University of Alberta, Edmonton Alberta, Canada T6G 2E3. **A Critical Review of Landscape Fragmentation Measures Using Cellular Automata.**

11:45–12:00 Bert, Daniel G. and Kathryn Freemark. Ottawa-Carleton Institute of Biology, Carleton University, Ottawa, Ontario, Canada K1S 5B6 (DGB); National Wildlife Research Centre, Environment Canada, 100 Gamelin Blvd., Hull, Quebec, Canada K1A 0H3 (KEF). **Nested Species Subsets in a Regional Context: Effects of Landscape Structure, Scale and Error.**

12:00–12:15 Tinker,[1] Daniel B., William H. Romme,[2] and Don G. Despain.[3] [1]Department of Geosciences and Natural Resources Management, Western Carolina University, Cullowhee, NC 28723, USA; [2]Biology Department, Fort Lewis College, Durango, CO 81301, USA; [3]USGS, Department of Biology, Montana State University, Bozeman, MT 59717, USA. **Historic Range of Variability in Landscape Structure in Subalpine Forests of the Greater Yellowstone Area.**

Special Session (11 AM-2)
Assessing Current and Future Regional Vulnerabilities
Chairperson: Elizabeth R. Smith, U.S. Environmental Protection Agency
Location: Cochise Room (Rm. 212), Memorial Union

9:45–10:00 Smith,[1] Elizabeth R., R.V. O'Neill,[2] K. Bruce Jones,[3] James D. Wickham,[1] and Kurt H. Riitters.[4] [1]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Research Triangle Park, NC 27711, USA; [2]Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN 37830 USA; [3]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Las Vegas, NV 89119, USA; [4]USDA Forest Service, Forest Health Monitoring Program, Research Triangle Park, NC 27709, USA. **A Strategy for Assessing Current and Future Regional Vulnerabilities.**

10:00–10:15 Tankersley Jr.,[1] Roger D., Kenneth H. Orvis,[2] and Elizabeth R. Smith.[3] [1]Tennessee Valley Authority, Norris, TN 37828, USA; [2]Department of Geography, University of Tennessee, Knoxville, TN 37996, USA; [3]U.S. EPA Office of Research and Development, Research Triangle Park, NC 27711, USA. **The Geography of Migration: A Landscape View of Stopover Habitats and Pathways in the Eastern United States.**

10:15–10:30 Riitters,[1] Kurt, Jim Wickham,[2] Bob O'Neill,[3] and Bruce Jones.[4] [1]US Forest Service, Research Triangle Park, NC 27709, USA; [2]U.S. EPA, Research Triangle Park, NC 27709, USA; [3]Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN 37830, USA; [4]U.S. EPA, Las Vegas, NV, 89173, USA. **Modeling the Risk of Forest Fragmentation in the Mid-Atlantic Region.**

10:30–10:45 Wickham,[1] J., E. Smith,[1] R. O'Neill,[2] T.Wade,[1] K. Riitters,[3] K. Jones.[4] [1]National Exposure Research Laboratory, EPA, RTP, NC 27711, USA; [2]Oak Ridge National Laboratory, Oak Ridge, TN 37830, USA; [3]Forest Health Monitoring Unit, Forest Service, RTP, NC 27709, USA. [4]National Exposure Research Laboratory, EPA, Las Vegas, NV 89119, USA. **Propagating Nutrient Export Risk Across Watersheds.**

10:45–11:00 Jackson,[1] Laura, Sandra Bird,[2*] Ronald Matheny,[3] Robert V. O'Neill,[4] Denis White,[5] Kristen Boesch,[6] and Jodi Koviach.[6] [1]US EPA, National Health and Environmental Effects Laboratory, Research Triangle Park, NC, 27711, [2]U.S. EPA, National Exposure Research Laboratory, Athens, GA 30605-2700, USA; [3]U.S. EPA, National Exposure Research Laboratory, Research Triangle Park, NC 27711, USA; [4]Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN 37830, USA; [5]U.S. EPA, National Health and Environmental Effects Laboratory, Corvallis, OR 97333-4902, USA; [6]University Of North Carolina, Dept. of City and Regional Planning, CB 3140, Chapel Hill, NC 27599-3140, USA. **Projecting Ecological Vulnerability to Land-Use Change across the Mid-Atlantic Region.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Hess, George. Forestry Department, North Carolina State University, Raleigh NC 27695-8002, USA. **Measuring Suburban Sprawl.**

11:30–11:45 Wainger, Lisa A. and Dennis M. King. University of Maryland, Center for Environmental Science, CBL, Solomons, MD 20688, USA. **Linking Environmental Indicators to Socio-Economic Indicators to Communicate Trade-Offs.**

11:45–12:00 Tran,[1] Liem T., C. Gregory Knight,[1,2] Robert V. O'Neill,[3] Elizabeth R. Smith,[4] Kurt H. Riitters,[5] and James Wickham.[4] [1]Center for Integrated Regional Assessment, the Pennsylvania State University, University Park, PA 16802, USA; [2]Department of Geography, Pennsylvania State University, University Park, PA 16802, USA; [3]Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN 37830, USA; [4]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Research Triangle Park, NC 27711, USA; [5]U.S. Department of Agriculture, Forest Service, Forest Health Monitoring Program, Research Triangle Park, NC 27711, USA. **Fuzzy Decision Analysis for Integrated Environmental Vulnerability Assessment of the Mid-Atlantic Region.**

April 27 9:45 to 12:15 session #3

Regular Session (11 AM-3)
Pattern and Process in Urban Landscapes
Chairperson: Mark J. McDonnell, University of Melbourne, Victoria
Location: Alumni Room (Rm. 202), Memorial Union

9:45–10:00 McDonnell, Mark J. and Kirsten Parris. Australian Research Centre for Urban Ecology, Royal Botanic Gardens Melbourne, c/o Botany School, University of Melbourne, Victoria, 3010, Australia. **Creation of a Human Dominated Landscape (Melbourne) Has Increased the Breeding Range of Grey-Headed Flying Foxes (Pteropus poliocephalus) in Australia.**

10:00–10:15 Theobald, David M. Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO 80523, USA; and The Nature Conservancy's Smith Fellowship Program. **Quantitative Measures of the Urban-Rural Gradient.**

10:15–10:30 Cadenasso,[1] M.L., S.T.A. Pickett,[1] and W.C. Zipperer.[2] [1]Institute of Ecosystem Studies, Millbrook, NY 12545, USA; [2]USDA Forest Service, Syracuse, NY 13210, USA. **Spatial Heterogeneity in an Urban Watershed: Baltimore, Maryland.**

10:30–10:45 Lister,[1] Tonya, Rachel Riemann,[1] Mike Hoppus,[1] and Wayne Zipperer.[2] [1]USDA Forest Service, Northeastern Research Station, 11 Campus Boulevard, Suite 200, Newtown Square, PA 19073, USA; [2]USDA Forest Service, SUNY College of Environmental Science and Forestry, 5 Moon Library, Syracuse, NY 13210, USA. **Changes in Land-Use Patterns and Forest Fragmentation over 50 Years in the Baltimore Area and Their Effects on Forest Composition and Structure.**

10:45–11:00 Grove,[1] J. Morgan and Ann P. Kinzig.[2] [1]USDA Forest Service, 705 Spear Street, South Burlington, VT 05403, USA; [2]Department of Biology, Arizona State University, Tempe, AZ 85287, USA. **Synthesis of Social and Ecological Approaches for the Spatial Analyses of Human Ecosystems, with Examples from Phoenix, Arizona, and Baltimore, Maryland.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Decker,[1] E. H., B. T. Milne,[1] F. A. Smith,[1] and S. M. Elliott.[2] [1]Department of Biology, University of New Mexico, Albuquerque, NM 87131, USA; [2]Division of Earth and Environmental Sciences, Los Alamos National Laboratory, Los Alamos, NM 87545, USA. **General Patterns in the Spatial Structure of Urban Networks.**

11:30–11:45 Mehaffey, Megan H., Maliha S. Nash, Tim G. Wade, and Curt M. Edmonds. U.S. Environmental Protection Agency, Las Vegas, NV 89119, USA. **New York City Water Supply: A 25 Year Landscape Analysis of the Catskill/Delaware Watersheds.**

11:45–12:00 Noorizan, Mohamed. Department of Landscape Architecture, Faculty of Design and Architecture, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia. **The Revitalisation of Malaysian Urban Landscapes.**

12:00–12:15 Cancelled

April 27 9:45 to 12:00 session #4

Regular Session (II AM-4)
Landscape Pattern and Ecosystem Processes
Chairperson: Jiquan Chen, Michigan Tech University
Location: Mohave Room (Rm. 222), Memorial Union

9:45–10:00 Euskirchen, Eugenie,[1] Jiquan Chen,[1] Harbin Li,[2] and Eric Gustafson.[3] [1]Michigan Technological University, Houghton, MI 49931, USA; [2]USDA Forest Service Center for Forested Wetlands Research, Charleston, SC 29414, USA; [3]USDA Forestry Sciences Laboratory, Rhinelander, WI 54501, USA. **Modelling Net Carbon across a Hypothetical Landscape Under Alternative Harvesting Strategies.**

10:00–10:15 Sturtevant, Brian R., Steven W. Seagle, and Philip Townsend. Appalachian Laboratory, University of Maryland Center for Environmental Science, 301 Braddock Road, Frostburg, MD 21532, USA. **Comparing Terrain-Based Models of Forest Productivity in Western Maryland: Extending to Regional Scales.**

10:15–10:30 Pennington, Deana D. Department of Geosciences, Oregon State University, Corvallis, OR 97331, USA. **Spatiotemporal Analysis of Landscape Structure, Function, and Change in the Western Cascades of Oregon**.

10:30–10:45 Tang, Jianwu, Ming Xu, and Ye Qi. Department of Environmental Science, Policy, and Management, University of California, 135 Giannini Hall Berkeley, CA 94720-3312, USA. **The Impact of Forest Thinning on Soil Respiration.**

10:45–11:00 Bennett, Elena and Stephen R. Carpenter. Center for Limnology, 680 N. Park St., Madison, WI 53706, USA. **Phosphorus Distribution along an Urban-Rural Gradient.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Zheng, Daolan and Stephen D. Prince. Department of Geography, University of Maryland, College Park, MD 20742, USA. **Grid Net Primary Production Estimates in Finland and Sweden at 1 km and 0.5 Degree Cell Sizes**.

11:30–11:45 Kerkhoff, Andrew J., Scott N. Martens, and Bruce T. Milne. Department of Biology, University of New Mexico, Albuquerque, NM 87131, USA. **Landscape Ecohydrology and Patterns of Tree Cover in Semi-Arid Woodlands.**

11:45–12:00 Krysanova, Valentina and Frank Wechsung. Potsdam Institute for Climate Impact Research, P.O. Box 601203, Telegrafenberg, 14412 Potsdam, Germany. **West-European Trends in Agriculture and Their Impact on Ecohydrological Processes: A Modelling Study in the State of Brandenburg.**

April 27 9:45 to 12:15 session #5

Special Session (11 AM-5)
Workshop: The Decline of Agricultural Landscapes in the Phoenix Metropolitan Area
Chairperson: Laura Musacchio, Arizona State University
Co-Organizers: Frederick Steiner, Arizona State University; Katherine Crewe, Arizona State University; and Jeff Schmid, USDA–Natural Resources Conservation Service
Location: La Paz Room (Rm. 223), Memorial Union

9:45–11:00 Workshop activities

11:00–11:15 COFFEE BREAK

April 27 11:15 to 12:15 session #6

Special Session (11AM-6)
Workshop: The Equity of Regional Open-Space Conservation and Restoration Projects in the Phoenix Metropolitan Area: Is a Planning Framework Needed?
Chairperson: Laura Musacchio, Arizona State University
Co-Organizers: Joseph Ewan, Arizona State University; Ruth Yabes, Arizona State University
Location: La Paz Room (Rm. 223), Memorial Union

11:15–12:15 Workshop Activities

April 27 1:00 to 5:00 Field trips

1:00–5:00	Half-Day Field Trips Buses for the half-day field trips will be leaving from the dropoff area south of the College of Business building near the corner of Lemon Street and Normal Street.

April 27 6:00 to 9:30 Banquet

Chair: Virginia Dale
Location: Tempe Mission Palms Hotel, 60 E. 5th Street, Tempe

6:00–7:00	Banquet Reception
7:00–8:00	Banquet Dinner
8:00–8:10	Eric Gustafson: Award Committee Announcement
8:10–8:20	Pete August: Foreign Scholar Travel Awards Announcement
8:20–8:30	Jack Lou: NASA–MSU Professional Enhancement Awards Announcement
8:30–8:40	Virginia Dale: Election Results
8:40–9:30	Banquet Address: (Introduction to the speaker by Dr. Laura Musacchio) Dr. Katherine Crewe: **The Origins of Phoenix Farming**

SATURDAY

April 28 8:30 to 9:30 plenary session

Chair: Laura Musacchio, Arizona State University
Location: Ventana Room (Rm. 226), Memorial Union

8:30–9:30	Plenary Address by Professor Anne W. Spirn **Watersheds, History, Landscape Planning, and Community Development: Reflections on 15 Years of the West Philadelphia Landscape Project**
9:30–9:45	COFFEE BREAK

April 28 9:45 to 12:15 session #1

Special Session (III AM-I)
Complexity Theory and Ecological Applications
Chairpersons: Darrel Jenerette, Arizona State University; Jianguo Wu, Arizona State University.
Location: Ventana Room A (Rm. 226), Memorial Union

9:45–10:00 Jenerette,[1,2] G. Darrel, Jianguo Wu,[1] Nancy B. Grimm.[2] [1]Dept. of Life Sciences, Arizona State University West, Phoenix, AZ 85069, USA; [2]Department of Biology, Arizona State University, Tempe, AZ 85287, USA. **Spatial Nitrogen Dynamics and Self-Organization.**

10:00–10:15 Stein, D. L. Department of Physics, University of Arizona, Tucson, AZ 85721, USA. **Spin Glasses, Disorder, and Complexity.**

10:15–10:30 Bascompte, Jordi. Estación Biológica de Doñana, CSIC, Sevilla, Spain. **Complex Systems and Habitat Loss.**

10:30–10:45 Keitt, Timothy H. Department of Ecology and Evolution, State Univeristy of New York at Stony Brook, Stony Brook, NY 11794, USA. **Statistical Mechanics of a Continent-Wide Biological Survey.**

10:45–11:00 Müller, Felix. Ecology Center, University of Kiel, Schauenburgerstrasse 112, D 24118 Kiel, Germany. **Ecosystem Synergetics: Applying Systems Theoretical Concepts to Ecosystem and Landscape Development.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Li, Bai-Lian. Department of Biology, University of New Mexico, Albuquerque, NM 87131, USA. **Spatiotemporal Complexity of Nonlinear Ecological Interactions.**

11:30–11:45 With,[1] Kimberly A. and Anthony W. King.[2] [1]Division of Biology, Kansas State University, Manhattan, KS 66506, USA; [2]Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA. **The Effect of Landscape Structure on Critical Biodiversity.**

11:45–12:00 Restrepo, Carla, Bruce T. Milne,* D. Bader, W. Pockman, and A. Kerkhoff. Department of Biology, University of New Mexico, Albuquerque, NM 871131, USA. **Variation in Vegetation Growth Rates: Implications for the Evolution of Semi-Arid Landscapes.**

12:00–12:15 Washington-Allen,[1,2] Robert A., Neil E. West,[1] R. Douglas Ramsey,[3] and Carolyn T. Hunsaker.[4] [1]Department of Rangeland Resources, Utah State University, Logan, UT 84322, USA; [2]Environmental Sciences Division, Oak Ridge National Laboratory, MS 6407, Oak Ridge, TN 37831, USA; [3]Remote Sensing/GIS Laboratory and Department of Geography and Earth Resources, Utah State University, Logan, UT 84322, USA; [4]USDA Forest Service, Pacific Southwest Research Laboratory, Fresno, CA 93710, USA. **A Dynamical Systems Perspective on Being Dried, Eaten, and Burned: What Is a Semi-Arid Landscape To Do?**

Special Session (III AM-2)
Landscape Ecology Comes to Town: An Exploration of Concepts, Issues, Strategies and Case Studies of Applied Urban Landscape Ecology.
Chairperson: Jack Ahern, University of Massachusetts
Location: Cochise Room (Rm. 212), Memorial Union

9:45–10:00 Cancelled

10:00–10:15 Yokohari, Makoto, Takashi Watanabe, and Takashi Hirohara. University of Tsukuba, Tsukuba, Ibaraki, 305-8573, Japan. **Restoring Ecological Relationships between Urban and Rural Landscapes: A New Ecological Planning Concept for Asian Mega-Cities.**

10:15–10:30 Condon, Patrick and Sara Muir. University of British Columbia, Landscape Architecture, 387 MCML Bldg. 2357 Main Mall, Vancouver, British Columbia, Canada V6T 1Z4. **The Headwaters Sustainable Community for 13,000: The East Clayton Neighborhood Concept Plan.**

10:30–10:45 Tjallingii, Sybrand P. Alterra, Green World Research, P.O. Box 476700 AA Wageningen, The Netherlands. **Carrying Structures of the Urban Landscape.**

10:45–11:00 Woodward, Joan and Kyle Brown. Department of Landscape Architecture, California State Polytechnic University, Pomona, CA 91768. **Patterns of Perseverance: Thirty Years of Ecological Planning in Los Angeles.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Snep, Robbert. Department of Landscape Ecology, Alterra, Green World Research, 6700 AA Wageningen, The Netherlands. **Modelling and Planning Nature and Biodiversity in Cities: The (Urban) Landscape Ecological Approach.**

11:30–11:45 Ahern, Jack. Department of Landscape Architecture and Regional Planning, University of Massachusetts 109 Hills North, Amherst, MA 01003, USA. **Future Landscape Scenarios in Urban Watershed Planning.**

11:45–12:00 Questions/Session Summary

April 28 9:45 to 12:15 session #3

Regular Session (III AM-3)
Landscape Pattern and Species Distribution
Chairperson: Marlene B. Cole, Rutgers University
Location: Alumni Room (Rm. 202), Memorial Union

9:45–10:00 Cancelled

10:00–10:15 Cole, Marlene B. and Richard G. Lathrop. Department of Ecology, Evolution and Natural Resources, Rutgers University, 14 College Farm Road, New Brunswick, NJ 08901, USA. **Spatial Relationships of Environmental and Sonar Backscatter-Derived Variables to Fish Abundance Data in the New York Bight.**

10:15–10:30 Krawchuk, Meg and Phil Taylor. Biology Department, ACWERN, Acadia University, Wolfville, Nova Scotia, Canada B0P 1X0. **The Relative Importance of Habitat Structure Changes within a Nested Hierarchy of Spatial Scales for Three Species of Insects.**

10:30-10:45 Aukema, Juliann E. Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, AZ 85719, USA. **Mistletoe Distribution at Multiple Scales: Patterns, Processes, and Mechanisms.**

10:45–11:00 Hoffman,[1] Aaron L. and John A. Wiens.[2] [1]Department of Biology, Colorado State University, Fort Collins, CO 80523, USA; [2]Department of Biology and Graduate Degree Program in Ecology, Colorado State University, Fort Collins, CO 80523, USA. **The Use of Semivariance Analysis for Scale Detection in Beetle Diversity and Landscape Properties on the Shortgrass Steppe of Colorado.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Tyler,[1] Marnie W., Don McKenzie,[1] and David L. Peterson.[2] [1]College of Forest Resources, University of Washington, Seattle, WA 98195, USA; [2]USGS Forest and Rangeland Ecosystem Science Center, Cascadia Field Station, University of Washington. **Effects of Human Land Use on Landscape Structure on the Western Olympic Peninsula, Washington, U.S.A.**

11:30–11:45 Giladi, Itamar, Michael Bokamper, and H. Ronald Pulliam. Institute of Ecology, The University of Georgia, Athens, GA 30602, USA. Distribution, Dispersal, and Habitat Suitability of *Hexastylis Arifolia* in a Mosaic Landscape.

11:45–12:00 Fairbanks,[1] Dean H.K., and Albert S. van Jaarsveld. Conservation Planning Unit, Department of Zoology and Entomology, University of Pretoria, Pretoria 0002, South Africa. **Human-Ecosystem Co-Evolution: Avian Diversity and Structure within African Land Transformation Systems.**

12:00–12:15 Cancelled

April 28 9:45 to 12:00 session #4

Regular Session (III AM-4)
Landscape-Scale Ecological Assessment
Chairperson: Kevin McGarigal, University of Massachusetts
Location: Mohave Room (Rm. 222), Memorial Union

9:45–10:00 McGarigal, Kevin, Scott Jackson, Brad Compton, Kasey Rolih, Ede Ene, Kirstin Seleen, and Curt Griffin. Department of Natural Resources Conservation, University of Massachusetts, Amherst, MA 01003, USA. **Biodiversity Assessment: A Coarse-Filtered Landscape Ecological Approach.**

10:00–10:15 Smith,[1] Jonathan, James D. Wickham,[1] Douglas Norton,[2] Tim G. Wade,[3] and K. Bruce Jones.[3] [1]U.S. Environmental Protection Agency, Landscape Characterization Branch (MD-56), Research Triangle Park, NC 27711, USA; [2]U.S. Environmental Protection Agency, Office of Water, 1200 Pennsylvania Ave. NW, Washington DC, 20460, USA; [3]U.S. Environmental Protection Agency, Landscape Ecology Branch, P.O. Box 93478, Las Vegas, NV 89193, USA. **Utilization of Landscape Indicators to Model Water Quality.**

10:15–10:30 Kepner,[1] W. G., S. N. Miller,[2] M. Hernandez,[2] R. C. Miller,[2] D. C. Goodrich,[2] C. M. Edmonds,[1] F. K. Devonald,[3] L. Li,[4] and P. Miller.[2] [1]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Las Vegas, NV, USA; [2]USDA–Agricultural Research Service, Southwest Watershed Research Center, Tucson, AZ, USA; [3]U.S. Environmental Protection Agency, National Center for Environmental Research, Washington, D.C., USA; [4]University of New Mexico, Department of Biology, Albuquerque, NM 87131, USA. **An Evaluation of Hydrologic Response to 25 Years of Landscape Change in a Semi-Arid Watershed.**

10:30–10:45 Richey, David J. Department of Landscape Architecture, University of Oregon, Eugene, OR 97403-5247, USA. **Design and Prioritized Implementation of Woody Riparian Buffers for Increasing Effective Shade in Agricultural Landscapes of the Willamette River Valley, Oregon.**

10:45–11:00 Desimone, Steven M., Brian L. Cosentino, Joseph B. Buchanan, D. John Pierce, and Timothy Quinn. Washington Department of Fish and Wildlife, 600 Capitol Way North, Olympia, WA 98501, USA. **Riparian Buffers as Habitat for Northern Goshawks: A Spatial Assessment at Three Scales on Managed Forest Landscapes in Western Washington.**

11:00-11:15 COFFEE BREAK

11:15–11:30 Baker,[1] Matthew E., Michael J. Wiley,[1] and Paul W. Seelbach.[2] [1]School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109-1115, USA; [2]Institute for Fisheries Research, Michigan Department of Natural Resources, Ann Arbor, MI 48109, USA. **Predicting Spatial Variation in Riparian Hydrology and Forest Composition across Lower Michigan.**

11:30–11:45 Hayman, Alicia A. and Hans Schreier. Institute for Resources and Environment, May Pen, Clarendon, Jamaica W.I. **The Effects of Land-Use Practices on Water Quality and Quantity in the Hope River Watershed, Jamaica.**

11:45–12:00 Cancelled

April 28 9:45 to 12:00 session #5

Regular Session (III AM-5)
Landscape Pattern and Biodiversity Conservation
Chairperson: Paul C. Hellmund, Colorado State University
Location: La Paz Room (Rm. 223), Memorial Union

9:45–10:00 Hellmund,[1] Paul Cawood, Theresa Tiehen,[2] and Raymond Sperger.[3] [1]Landscape Architecture Program, Colorado State University, Fort Collins, CO 80523, USA; [2]Colorado Department of Transportation, Aurora CO 80011, USA; [3]South Platte Park, South Suburban Park and Recreation District, Littleton, CO 80121, USA. **Wildlife, a Highway, and Community-Based Conservation: A Case Study on Denver Urbanizing Fringe.**

10:00–10:15 Weber, Whitney L., John L. Roseberry, and Alan Woolf. Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, IL 62901, USA. **Contribution of the Conservation Reserve Program to General Landscape Structure in Illinois.**

10:15–10:30 Meegan,[1] Rebecca P., David S. Maehr,[1] and Thomas S. Hoctor.[2] [1]Department of Forestry, University of Kentucky, Lexington, KY 40546-0073, USA; [2]Department of Landscape Architecture, University of Florida, Gainesville, FL 32611-5704, USA. **Recovering the Florida Panther through Regional Conservation Planning.**

10:30–10:45 Beazley, Karen F., Tamaini V. Snaith, and Peter J. Austin-Smith, Jr. School for Resource and Environmental Studies, Dalhousie University, Halifax, Nova Scotia, Canada B3H 3J5. **Delineating Critical Habitat for Viable Populations of Focal Species: An Example from Nova Scotia.**

10:45–11:00 Sanchez-Azofeifa,[1] G. Arturo, Gretchen Daily,[2] and Paul Ehrlich.[3] [1]Earth and Atmospheric Sciences Department, University of Alberta, Edmonton, Alberta, Canada T6G 2E3; [2]Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA 94305-5020, USA; [3]Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA 94305-5020, USA. **Isolation of National Parks in the Tropics.**

11:00–11:15 COFFEE BREAK

11:15–11:30 Tole, L. Center for Development Studies, University of Glasgow, Glasgow, U.K. **Habitat Loss and Anthropogenic Disturbance in Jamaica's Hellshire Hills Region.**

11:30–11:45 Liu,[1] Jianguo, Marc Linderman,[1] Zhiyun Ouyang,[2] Li An,[1] Jian Yang,[3] and Hemin Zhang.[3] [1]Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan, USA; [2]Department of Systems Ecology, Chinese Academy of Sciences, Beijing, China; [3]China Center for Giant Panda Research and Conservation, Sichuan Province, China. **Panda Habitat Pattern and Process across Space and Time: Integrating Landscape Ecology with Human Demography, Behavior, and Socioeconomics at Multiple Scales.**

11:45–12:00 Metzger, Jean Paul. Department of Ecology, University of Sao Paulo, Rua do Matao 321, trv. 14, 05508-900, Sao Paulo, Brazil. **Effects of Deforestation Pattern and Private Nature Reserves on the Forest Conservation in Agricultural Areas of the Brazilian Amazon.**

12:15–1:30 Lunch Break

Special Session (III PM-I)
Premises and Problems with Spatial Analysis
Chairpersons: Marie-Jose Fortin, Simon Fraser University; Maria Miriti, SUNY at Stony Brook
Location: Ventana Room A (Rm. 226), Memorial Union

1:30–1:45 Fortin, Marie-José,[1] Mathieu Philibert,[2] Tarmo Remme,[1] and Ferenc Csillag.[3] [1]School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6; Department of Geography, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6; [3]Department of Geography, University of Toronto, Mississauga, Ontario, Canada L5L 1C6. **Sensitivity Analysis of Boundary Detection on Spatial Features of Heterogeneous Landscape.**

1:45–2:00 Dale,[1] M.R.T., M.-J. Fortin,[2] and P. Legendre.[3] [1]Department of Biological Sciences, University of Alberta, Edmonton, Canada T6G 2E9. [2]School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6; [3]Département de sciences biologiques, Université de Montréal, Montréal, Canada H3C 3J7. **Accounting for Spatial Autocorrelation in Statistical Tests of Landscape Characteristics.**

2:00–2:15 Li,[1] Harbin and Jianguo Wu.[2] [1]USDA Forest Service Southern Research Station, Charleston, SC 29414, USA; [2]Landscape and Systems Ecology Lab, Arizona State University West, Phoenix, AZ 85069, USA. **Landscape Analysis with Pattern Indices: Problems and Solutions.**

2:15–2:30 Miriti, Maria. Department of Ecology and Evolution SUNY at Stony Brook Stony Brook NY 11794, USA. **What Can Distort the Identification of Landscape Spatial Pattern?**

2:30–2:45 COFFEE BREAK

2:45–3:00 Urban, Dean L. Nicholas School of the Environment, Duke University, Durham, NC 27708, USA. **Extending Community Ecological Analyses to Landscape Scales.**

3:00–3:15 Anthony,[1] J. A. and G. A. Bradshaw.[2] [1]Department of Fisheries and Wildlife, 104 Nash Hall, Oregon State University, Corvallis, OR 97331, USA; [2]USDA Forest Service, PNW Research and Rogue-Siskiyou National Forest, Applegate Ranger District, Jacksonville, OR 97530-9341, USA. **Wavelet Analysis as an Approach to Investigate the Reciprocal Relationship between Ecological Pattern and Process.**

3:15–3:30 Hughes, Josie, Andrew Fall, Marie-Josee Fortin, and Ken Lertzman. School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6. **Predicting the Effect of Pattern on Congregative Dispersal: A Comparison of Landscape Indices.**

3:30–3:45 Questions/Session Summary

4:00–4:15 COFFEE BREAK

April 28 1:30 to 5:15 session #2

Special Session (III PM-2)
Pattern and Process in Aquatic Ecosystems: How Patches and Networks affect Ecosystem Function
Chairpersons: Lisa Dent and Elena M. Bennett, University of Wisconsin
Location: Cochise Room (Rm. 212), Memorial Union

1:30–1:45 Fisher, Stuart G., Julia Henry, John Schade, and Jill Welter. Department of Biology, Arizona State University, Tempe, AZ 85287, USA. **Challenges of Applying the Concepts and Approaches of Landscape Ecology to Running Waters.**

1:45–2:00 Henry, Julia C., S. G. Fisher, J. D. Schade, and J. R. Welter. Department of Biology, Arizona State University, Tempe AZ 85287, USA. **Periphyton-Sandbar Edge Interactions in an Arid-Land Stream.**

2:00–2:15 Schade, John D., Stuart G. Fisher, Julia C. Henry, and Jill, R. Welter. Department of Biology, Arizona State University, Tempe, AZ 85287, USA. **Hydrologic and Nutrient Exchange between Stream and Riparian Zone in an Arid-Land Watershed.**

2:15–2:30 Welter, Jill R., Stuart G. Fisher, Julia C. Henry, and John D. Schade. Department of Biology, Arizona State University, Tempe, AZ 85287, USA. **Nutrient Transport and Processing in the Uplands and Intermittent Drainage Network: Linking Terrestrial and Aquatic Ecosystems.**

2:30–2:45 COFFEE BREAK

2:45–3:00 Weller, Donald E., Thomas E. Jordan, and David L. Correll. Smithsonian Environmental Research Center, Edgewater, MD 21037, USA. **Effects of Riparian Buffer Configuration on Nutrient Inputs to Streams.**

3:00–3:15 Findlay,[1] Stuart, Nina Caraco,[1] Jonathon Cole,[1] William Nieder,[2] and David Strayer.[1] [1]Institute of Ecosystem Studies, P.O. Box AB, Millbrook, NY 12545, USA; [2]Hudson River National Estuarine Research Reserve, Annandale, NY 12504, USA. **Functioning of Submersed Vegetation Patches in the Tidal Freshwater Hudson River.**

3:15–3:30 Johnson, Lucinda B. Natural Resources Research Institute, University of Minnesota, Duluth, MN 55811 USA. **Influence of Landscape Versus Local Scale Factors on Wood in Low Gradient Streams.**

3:30–3:45 Swanson,[1] Frederick J., Sherri L. Johnson,[2] Kai U. Snyder,[3] and Steven A. Acker.[4] [1]USDA Forest Service, Forestry Sciences Lab, Corvallis, OR 97331, USA; [2]Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331, USA; 3E&S Environmental, 2162 NW Fillmore Ave, Corvallis, OR 97330, USA; [4]National Park Service, 909 First Ave, Seattle, WA 98104, USA. **Disturbance of Aquatic and Riparian Systems in a Mountain River Network.**

3:45–4:00 Pringle, Catherine, Elizabeth Anderson, Effie Greathouse, and James March. Institute of Ecology, University of Georgia, Athens, GA 30606, USA. **How Do Different Spatial Patterns of Disturbance along Stream Networks Affect Ecosystem Function?**

4:00–4:15 COFFEE BREAK

4:15–4:30 Kratz,[1] Tim K., Thomas R. Hrabik,[1] John J. Magnuson,[1] and Katherine E. Webster.[1,2] [1]Center for Limnology, University of Wisconsin, Madison, WI 53706, USA; [2]Wisconsin Department of Natural Resources, 1350 Femrite Dr., Monona, WI 53716, USA. **The Role of Landscape Position in Lake Structure and Dynamics.**

4:30–4:45 Bradshaw,[1] Gay A. and Marie-Josèe Fortin.[2] [1]National Centre for Ecological Analysis and Synthesis and USDA, Forest Service, Santa Barbara, CA 93101, USA; [2]School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6. **Considerations of Landscape Heterogeneity Effects on Scaling and Monitoring of Aquatic Networks.**

4:45–5:15 Summary and Discussion to be led by Lisa Dent and Elena M. Bennett

April 28 1:30 to 5:00 session #3

Regular Session (III PM-3)
Disturbance and Vegetation Pattern and Dynamics
Chairperson: Louis Iverson, USDA Forest Service, Northeastern Research Station (1:30 pm–2:30 pm); Janet Franklin, San Diego State University (2:45 pm–5:00 pm)
Location: Alumni Room (Rm. 202), Memorial Union

1:30–1:45 Franklin, Janet. Department of Geography, San Diego State University, San Diego, CA 92182-4493, USA. **Simulating the Effects of Altered Fire Regimes on Plant Succession in the Shrublands and Forests of Southern California Using LANDIS.**

1:45–2:00 Howe, Elisabeth Bartlett and William L. Baker. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. **Disturbance Interactions and Severe Blowdown in a Rocky Mountain Subalpine Forest Landscape.**

2:00–2:15 Ehle, Donna S. and William L. Baker. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. **Influence of the Spatial Distribution of Pre-European Disturbance Events on Ponderosa Pine Age Structure in Rocky Mountain National Park, USA.**

2:15–2:30 Lindemann, Jeremiah D. and William L. Baker. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. **GIS Analysis of Factors Influencing Blowdown in a Rocky Mountain Landscape.**

2:30–2:45 COFFEE BREAK

2:45–3:00 Iverson, Louis R. and Todd F. Hutchinson. USDA Forest Service, Northeastern Research Station, Delaware, OH 43015, USA. **The Effects of Prescribed Fire on Soil Temperature and Moisture, Litter Consumption, and Sapling Topkill across a Forested Landscape in Ohio.**

3:00–3:15 Beaty, R. Matthew and Alan H. Taylor. Department of Geography, Pennsylvania State University, University Park, PA 16802, USA. **Stand and Landscape Scale Variablity of Fire Effects and Vegetation Dynamics in a Mixed Conifer Forest Landscape, Southern Cascades, California.**

3:15–3:30 Cancelled

3:30–3:45 Wilmer, Henry. The Wilderness Society, Center for Landscape Analysis, 1424 4th Ave. Suite 816, Seattle, WA 98101, USA. **Effects of Fire and Logging on Landscape Structure in the Greater Yellowstone Ecosystem.**

3:45–4:00 Andison, David W. Bandaloop Landscape-Ecosystem Services, 3426 Main Ave., Vancouver, British Columbia, Canada V3H 4R3. **Fire in Riparian Zones: The Perfect Hierarchical Model.**

4:00–4:15 COFFEE BREAK

4:15–4:30 Skinner,[1] Carl N. and Scott L. Stephens.[2] [1]U.S. Forest Service, Pacific Southwest Research Station, 2400 Washington Ave., Redding, CA 96001, USA; [2]College of Natural Resources, Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA, USA. **Changes in Fire Regimes in Mixed Conifer Forests of the Sierra San Pedro Martir, Baja California, Mexico.**

4:30–4:45 Franklin,[1] Scott, Amy Webbeking,[1] and John Kupfer.[2] [1]Department of Biology, University of Memphis, Memphis, TN 38152, USA; [2]Department of Geography and Regional Development, University of Arizona, Tucson, AZ 85721, USA. **The Effects of Landscape Structure on Plant Regeneration Patterns in Shifting Cultivation Fields Near Indian Church, Belize.**

4:45–5:00 Cancelled

April 28 1:30 to 5:15 session #4

Regular Session (III PM-4)
Land-Use Planning and Landscape Architecture
Chairperson: Frederick Steiner, Arizona State University
Location: Mohave Room (Rm. 222), Memorial Union

1:30–1:45 Dalton, Deborah W. Division of Landscape Architecture, University of Oklahoma, Norman, OK 73019, USA. **Eco-Revelatory Design: A Cautionary Tale of Two Designs in the City.**

1:45–2:00 Kosek, Sandra E. and Joan Iverson Nassauer. Department of Landscape Architecture, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109, USA. **Scale Influences on the Perception of Landscapes Designed for Ecological Function.**

2:00–2:15 Cancelled

2:15–2:30 Nassauer, Joan Iverson and Robert C Corry.* School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109-1115, USA. **A GIS-Based Spatial Model of Cultural Landscape Preferences for Altrenative Agricultural Landscape Scenarios.**

2:30–2:45 COFFEE BREAK

2:45–3:00 Harris, Virginia. Department of Agricultural and Consumer Economics, University of Illinois Urbana-Champaign, Urbana, IL 61801, USA. **Using Remote Sensing Data to Estimate the Value of Open Space in the Chicago Metropolitan Area.**

3:00–3:15 Swaffield, Simon R. Environmental Management and Design Division, Lincoln University, Canterbury, New Zealand. **Society, Culture and Landscape Ecology: Connections and Tensions.**

3:15–3:30 Willems, Geert P.A., Wim G. M. van der Knaap, and Catharinus F. Jaarsma.* Department of Environmental Sciences, Land Use Planning Group, Wageningen University, Generaal Foulkesweg 13, 6703 BJ Wageningen, The Netherlands. **Planning within Heterogeneous Landscapes: Confronting the Patterns of Movement and Processes in Time and Space of Man and Animal.**

3:30–3:45 Skabelund, Lee R. Department of Landscape Architecture, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061, USA. **Grounding Community Planning/Design with an Understanding of Site and Landscape Ecology: Learning from the Brown Farm Park Master Planning Process—Blacksburg, Virginia.**

3:45–4:00 Ewan,[1] Joseph M. and James P. Burke.[2] [1]School of Planning and Landscape Architecture, Arizona State University, Tempe, AZ 85287, USA; [2]Parks, Recreation and Library Department, City of Phoenix, Phoenix, AZ, USA. **The Sonoran Preserve Master Plan: Integration of Landscape Ecology with the Design and Planning of Open Space.**

4:00–4:15 COFFEE BREAK

4:15–4:30 Mouat,[1] David, Carl Steinitz,[2] Robert Anderson,[3] Hector Arias,[4] Scott Bassett,[2] Mary Cablk,[1] Michael Flaxman,[2] Tomas Goode,[5] Robert Lozar,[6] Thomas Mattock, III,[5] Winifred Rose,[6] Richard Peiser,[2] and Allan Shearer.[2] [1]Desert Research Institute, Reno, NV 89512, USA; [2]Department of Landscape Architecture, Harvard University, Cambridge, MA 02138, USA; [3]Environmental Division, U.S. Army Training and Doctrine Command, Fort Monroe, VA 23651, USA; [4]Gabinete de Estudios Ambientales, A.C., Hermosillo, Sonora, Mexico; [5]Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721; [6]U.S. Army Construction Engineering Research Laboratory, Champaign, IL 61862, USA. **Alternative Futures of the Upper San Pedro River Watershed, Arizona and Sonora: Politics of Landscape Change.**

4:30–4:45 Steinitz,[1] Carl, David Mouat,[2] Robert Anderson,[3] Hector Arias,[4] Scott Bassett,[1] Mary Cablk,[2] Micahel Flaxman,[1] Tomas Goode,[5] Robert Lozar,[6] Thomas Maddock, III,[5] Winifred Rose,[6] Richard Peiser,[1] and Allan Shearer[1]. [1]Department of Landscape Architecture, Harvard University, Cambridge, MA 02138, USA; [2]Desert Research Institute, Reno, NV 89512, USA; [3]Environmental Division, U.S. Army Training and Doctrine Command, Fort Monroe, VA 23651, USA; [4]Gabinete de Estudios Ambientales, A.C., Hermosillo, Mexico; [5]Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721, USA; [6]U.S. Army Construction and Engineering Research Laboratory, P.O. Box 9005, Champaign, IL 61826, USA. **Alternative Futures of the Upper San Pedro River Watershed, Arizona and Sonora: A Modeling Approach.**

4:45–5:00 Mohamed, AbuBakr AbdelAziz. Crop, Soil, and Water Sciences Division, International Rice Research Institute, P.O. Box 3127, MCPO1271 Makati City, Philippines. **Modeling Spatial Heterogeneity for Planning Land Use in Rainfed Environment.**

5:00–5:15 Ismail, Nafeesa Ahmed and AbuBakr AbdelAziz Mohamed. Crop, Soil, and Water Sciences Division, International Rice Research Institute, P.O. Box 3127, MCPO1271 Makati City, Philippines. **Farm Aggregation and Scaling for Land-Use Planning: Methodology and Application.**

April 28 1:30 to 5:15 session #5

Regular Session (III PM-5)
Landscape Pattern and Population Processes
Chairpersons: Henriette Jager, Oak Ridge National Laboratory (1:30 pm–2:30 pm); David Howerter, Institute for Wetland and Waterfowl Research, Ducks Unlimited Canada (2:45 pm–5:00 pm)
Location: La Paz Room (Rm. 223), Memorial Union

1:30–1:45 Jager,[1] Henriette, Jim Chandler,[2] Ken Lepla,[2] Annett Sullivan,[1] Webb Van Winkle.[3] [1]Oak Ridge National Laboratory, Oak Ridge, TN 37830, USA, [2]Idaho Power Co., Boise, ID, USA; [3]Environmental Consultant, Boise, ID, USA. **A Simulation Study of How Dams Influence White Sturgeon Populations at Three Spatial Scales.**

1:45–2:00 Lee,[1] Pey-Yi and Tom Scott.[1,2] [1]Department of Earth Sciences, University of California, Riverside, CA 92521, USA; [2]Department of Environmental Science, Policy, and Management. University of California, Berkeley, CA 94720, USA. **Hierarchical Pattern of Spatial Structure of Loggerhead Shrike at Different Scales.**

2:00–2:15 Springborn,[1] Elizabeth G. and David S. Maehr.[2] [1]Departments of Animal Science and Forestry, University of Kentucky, Lexington, KY 40503, USA; [2]Department of Forestry, University of Kentucky, Lexington, KY 40503, USA. **Conduits, Filters, and Barriers to Elk Movement in a Heterogeneous Landscape in Eastern Kentucky.**

2:15–2:30 McPherson, A. Michelle and Philip D. Taylor. ACWERN, Department of Biology, Acadia University, Wolfville, Nova Scotia, Canada B0P 1X0. **Effects of Landscape Change and Forest Regeneration on Peatland Dragonflies (Odonata) in Western Newfoundland.**

2:30–2:45 COFFEE BREAK

2:45–3:00 Howerter,[1,2] David, Jay J. Rotella,[2] James H. Devries,[1] Robert B. Emery,[1] Brian L. Joynt,[1] Llwellyn M. Armstrong,[1] and Michael G. Anderson.[1] [1]Institute for Wetland and Waterfowl Research, Ducks Unlimited Canada, Stonewall, Manitoba, Canada R0C 2Z0; 2Department of Ecology, Montana State University, Bozeman, MT 59717, USA. **Landscape Attributes Predict Hatching Rates: Effects of Classification and Scale.**

3:00–3:15 Smith,[1] Eric L. and Drew McMahan.[2] [1]Forest Health Technology Enterprise Team, USDA Forest Service, Fort Collins, CO 80526, USA; [2]Intecs International, Fort Collins, CO 80526, USA. **An Integrated System to Model and Display Bark Beetle and Management Impacts on a Forest Landscape.**

3:15–3:30 Frank, Karin. Department of Ecological Modelling, UFZ—Centre for Environmental Research Leipzig-Halle, D-04301 Leipzig, Germany. **An Index for Assessing Habitat Networks from the Perspective of Metapopulation Viability.**

3:30–3:45 Brandwine, Shlomo. Life Sciences Department, Ben-Gurion University of the Negev, Israel. **Binding Ideas in the Response of Populations to the Dynamics of Landscape Mosaics.**

3:45–4:00 Guo, Linhai Larry, John Morrison, and John Marthick. Environmental Research Institute, University of Wollongong, NSW 2522, Australia. **Multi-Scale Analysis of Landscape Connectivity in Kangaroo Valley, NSW Southeastern Australia in the Context of Landscape Ecology.**

4:00–4:15 COFFEE BREAK

4:15–4:30 Tluk V. Toschanowitz,[1] Katharina, Timothy J. Roper,[2] Karin Frank.[3] [1]Institute of Environmental Systems Research, University of Osnabrueck, D-49076 Osnabrueck, Germany; [2]School of Biological Sciences, University of Sussex, Brighton BN1 9QG, Great Britain; [3]Department of Ecological Modelling, UFZ-Centre for Environmental Research Leipzig-Halle, D-04318 Leipzig, Germany. **Assessing the Effect of Traffic on Different Hierarchical Levels of Population Ecology: Lessons from an Individual-Based Model.**

4:30–4:45 Gruber,[1] Bernd, Klaus Henle,[1] Karin Frank.[2] [1]Department of Conservation Biology and Natural Resources, UFZ–Centre for Environmental Research Leipzig-Halle, D-04318 Leipzig, Germany; [2]Deparment of Ecological Modelling, UFZ–Centre for Environmental Research Leipzig-Halle, D-04318 Leipzig, Germany. **Movement Models as Tools for Analyzing the Effect of Landscape Structure on Population Processes.**

4:45–5:00 Wilkerson, Cynthia R. Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Fl 32611, USA. **Isolated Temporary Wetlands as Prey Refugia for Anuran Communities.**

5:00–5:15 Foltete, Jean-Christophe and Didier Josselin. THEMA, 32 rue Megevand, 25030 Besancon Cedex, France. **Using Spatio-Temporal Co-Occurrence Matrices to Delineate Spatial Patterns about Vole Swarming.**

April 28 to 4:15–5:30 session #6

Regular Session (III PM-6)
Land-Use and Land-Cover Change: Modeling
Chairperson: Bryan C. Pijanowski, Michigan State University
Location: Ventana Room A (Rm. 226), Memorial Union

4:15–4:30 Pijanowski, Bryan C. College of Natural Science, Michigan State University, East Lansing, MI 48824, USA. **Can a Neural-Network–Based Land-Use Change Model Generalize across Space and Time? An Application of the Land Transformation Model for the Twin Cities and Detroit Metropolitan Areas.**

4:30–4:45 Meretsky,[1] Vicky, Tom Evans,[2] Eduardo Brondizio,[3] Cynthia Croissant,[2] and Dawn Parker.[4] [1]School of Public and Environmental Affairs, Indiana University, Bloomington, IN 47405, USA; [2]Department of Geography, Indiana University, Bloomington, IN 47405, USA; [3]Department of Anthropology, Indiana University, Bloomington, IN 47405, USA; [4]Center for the Study of Institutions, Population and Environmental Change, Indiana University, Bloomington, IN 47405, USA. **Characterizing Landscape Composition and Pattern: Cross-Site Comparison of Social and Biophysical Factors.**

4:45–5:00 Alberti,[1,2] Marina and Paul Waddell.[1,3] [1]Department of Urban Design and Planning, University of Washington, Seattle, WA 98195, USA; [2]Urban Ecology Research Lab, University of Washington, Seattle, WA 98195, USA; [3]Daniel J. Evans School of Public Affairs, University of Washington, Seattle, WA 98195, USA. **Urbansim: An Integrated Urban Development and Land-Cover Change Model.**

5:00–5:15 Obbink, Marion (M.H.) and Jan (J.G.P.W.) Clevers. Centre for Geo-Information, Wageningen University and Research, Wageningen, The Netherlands. **Aggregate Sets: A New Hierarchical Approach to Link Change Processes and Complex Spatial Patterns.**

5:15–5:30 Fritsch,[1] Uta, Daniel Katzenmaier,[1] and Axel Bronstert.[2] [1]Potsdam Institute for Climate Impact Research, Potsdam, Germany; [2]Institute for Geo-ecology, University of Potsdam, Potsdam, Germany. **Land-Use Scenarios for Flood Risk Assessment Studies.**

POSTER session April 28 8:00 to 5:30

Place: Arizona Ballroom (Rm. 207), Memorial Union
Set-up time: 7:30 AM–8:00 AM
Duration: 8:00 AM–5:30 PM
Authors available for questions: 11:00 AM–12:15 PM and 4:00 PM–5:30 PM

Landscape Pattern and Population Dynamics and Species Distribution

P#1-1 Baum,[1] Kristen A., William L. Rubink,[2] and Robert N. Coulson[1]. [1]Department of Entomology, Texas A&M University, College Station, TX 77843, USA; [2]Beneficial Insects Research Unit, Agricultural Research Service, United States Department of Agriculture, Weslaco, TX, USA. **Habitat Associations of Feral Honey Bees and Non-Apis Pollinators in South Texas.**

P#1-2 Butaye, Jan, Hans Jacquemyn, and Martin Hermy. Department of Land and Water Management, University of Leuven, Vital Decosterstraat 102, B-3000 Leuven, Belgium. **Differential Colonization Causing Non-Random Forest Plant Species Community Structure in a Fragmented Agricultural Landscape.**

P#1-3 Henebry, Geoffrey, Brian Putz, and James Merchant. Center for Advanced Land Management Information Technologies (CALMIT), University of Nebraska, Lincoln, NE 68588-0517, USA. **Modeling Herpetile Range Distributions from Species Occurrences and Landscape Variables.**

P#1-4 Jacquemyn, Hans, Jan Butaye, and Martin Hermy. Department of Land and Water Management, University of Leuven, Vital Decosterstraat 102, B-3000 Leuven, Belgium. **Spatio-Temporal Effects of Forest Fragmentation on Plant Species Composition in Mixed Deciduous Forest Patches.**

P#1-5 Katti, Madhusudan and Eyal Shochat. Central Arizona-Phoenix Long-Term Ecological Research Project and Center for Environmental Studies, Arizona State University, Tempe, AZ 85287, USA. **Phoenix or Tucson: Does Landscape Determine Where Abert's Towhees Choose To Live?**

P#1-6 Laurent,[1] E.J. and Bruce Kingsbury. Center for Reptile and Ampibian Conservation and Management and the Department of Biology, Indiana-Purdue University, Fort Wayne, IN 46805-1499, USA; [1]Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI 48824-1222, USA. **Validation and Nullification of a Predictive Model for Habitat Context: The Effects of Location and Landcover Classification.**

P#1-7 Pinto,[1] M. A., K. Baum,[1] W. Rubink,[2] S. Johnston,[1] R. N. Coulson.[1] [1]Knowledge Engineering Laboratory, Department of Entomology, Texas A&M University, College Station, TX, USA; [2]USDA / ARS, Weslaco, TX, USA. **Spatial and Temporal Patterns of Mitochondrial DNA in Feral Honey Bees: Impact of Africanization.**

P#1-8 Seagle, Steven W., Brian R. Sturtevant, Robert A. Chastain, and Philip A. Townsend. Appalachian Laboratory, University of Maryland Center for Environmental Science, Frostburg, MD 21532, USA. **Spatial Variation of Forest-Floor Litter Invertebrates in Topographically Diverse Landscapes.**

P#1-9 Stralberg, Diana, Nadav Nur, and Hildie Spautz. Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, CA 94970, USA. **Landscape-Level Influences on Breeding Songbirds in San Francisco Bay Tidal Marshes.**

P#1-10 Wunneburger,[1] D. F., R. N. Coulson,[2] S. T. O'Keefe,[2] and S. B. Vinson.[2] [1]GeoInformatics Studio, College of Architecture, Texas A&M University, College Station, TX 77843, USA; [2]Knowledge Engineering Laboratory, Department of Entomology, Texas A&M University, College Station, TX 77843, USA. **Hazard and Risk Rating Post Oak Savanna Landscapes for the Red Imported Fire Ant.**

Landscape Conservation, Management and Design

P#1-11 Anderson, Linda and Theodore Eisenman. Landscape Architecture Department, Cornell University, Ithaca, NY 14853, USA. **Conceptual Vision for Integrating Wetland Restoration and Tourism Development at the Montezuma Wetlands Complex in New York State.**

P#1-12 Bestelmeyer,[1] Brandon, Joel Brown,[1] Kris Havstad,[1] Robert Alexander,[2] George Chavez,[3] and Jeffrey Herrick.[1] [1]USDA–ARS Jornada Experimental Range, New Mexico State University, Las Cruces, NM, 88003, USA; [2]Bureau of Land Management, 1474 Rodeo Rd., Santa Fe, NM 87502, USA; [3]USDA Natural Resources Conservation Service, 6200 Jefferson, Albuquerque, NM 87109, USA. **An Integrated Approach to Managing Landscape Pattern and Dynamics in Southern New Mexico**.

P#1-13 DeFee II, Buren B., Douglas Wunneburger. Department of Landscape Architecture and Urban Planning, Texas A&M University, College Station, TX 77840, USA. **Integrating Stakeholder Concerns into Open Space Planning Decisions.**

P#1-14 Drummond,[1] Mark A., Raymond D. Watts,[2] Roger Compton.[3] [1]USGS, MESC, 4512 McMurry Ave., Fort Collins, CO 80525, USA; [2]USGS/CIRA, Colorado State Univ. Foothills Campus, Fort Collins, Colorado 80523, USA; [3]USGS, RMMC, P.O. Box 25046, MS516, Denver, CO 80225, USA. **Temporal Effects of Human Influence on Rural Landscape Pattern and Wildlife Habitat in Teton County, Wyoming.**

P#1-15 Flamm,[1] R. O., Alexander Smith,[1] Suzanne Tarr,[1] Susan Jacobson,[2] and Sampreethi Aipanjiguly.[2] [1]Florida Marine Research Institute, Department of Environmental Protection, St. Petersburg, FL, USA;. [2]Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL, USA. **Manatee "Places" In and Around Tampa Bay, Florida.**

P#1-16 Fraser, John. Science Development and Technology Branch Ontario Ministry of Natural Resources, Peterborough, Ontario, Canada K9J 8M5. **Landscape Ecology Approaches to the Protection of Natural Heritage Features and the Sustainable Management of Mineral Aggregate Resources, Oak Ridges Moraine, Ontario Canada.**

P#1-17 Harden,[1] Charles and Matthew Nicholson.[2] [1]Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, Illinois 62901-6504, USA; [2]Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, Illinois 62901-6504, USA. **Impacts of Human Development on Deer Herd Management in the Ex-Urban Landscape.**

P#1-18 Johnson, Alan R. and Karen M. Eisenreich. Department of Environmental Toxicology, Clemson University, Pendleton, SC 29670, USA. **Integrating Landscape Ecology into Ecological Risk Assessment.**

P#1-19 Ng, Evelyn. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. **Environmental Policies for Solar Energy Use in a Closed Micro-Business System.**

P#1-20 Paranjape, Anagha. School of Planning and Landscape Architecture, Arizona State University, Tempe, AZ 85287, USA. **Adaptation of Visual Resource Management (VRM) Systems for the Visual Quality Assessment of Urban-Natural Landscapes.**

P#1-21 Rubino, Matt J., Terri J. King, and George R. Hess. Forestry Department, North Carolina State University, Raleigh, NC 27695-8002, USA. **A Focal Species Approach to Wildlife Planning.**

P#1-22 Sun-Kee Hong,[1] In-Ju Song,[2] Eun-Kyong Lee,[1] Do-Won Lee,[3] and Ji-Hae Shin.[2] [1]Environmental Planning Institute, Seoul National University, Seoul 151-742, Korea; [2]Seoul Development Institute, Seoul 100-250, Korea; [3]Graduate School of Environmental Studies, Seoul National University, Seoul 151-742, Korea. **Changes in Landscape Pattern and Their Effects on Ecosystem Functions in the Seoul Area: Guidelines for Urban Landscape Conservation and Ecological Planning.**

P#1-23 Vanucchi-Hartung, Jamie. Department of Landscape Architecture, Cornell University, Ithaca, NY 14850, USA. **Landscapes, Process and Time: Past and Future in the Present.**

P#1-24 Yamashita, Sampei. Department of Civil Engineering, Kyushu Sangyo University, Fukuoka, Japan. **Attractiveness of a Wooded River Landscape and Changes in Its Colors in the Daytime.**

Vegetation Pattern and Plant-Environment Relationships

P#1-25 Allen,[1] Thomas and John Kupfer.[2] [1]Department of Political Science and Geography, Old Dominion University, Norfolk, VA 23529, USA; [2]Department of Geography and Regional Development, University of Arizona, Tucson, AZ 85721, USA. **Scales of Pattern and Process in Fraser Fir Forest Disturbance and Fegeneration, Great Smoky Mountains, USA.**

P#1-26 Bean, David A. and Greg H. R. Henry. Department of Geography, University of British Columbia, Vancouver, British Columbia, Canada V6T 1Z2. **The Spatial Pattern of Vegetation in a High Arctic Oasis.**

P#1-27 Hooten,[1] Mevin B., David R. Larsen,[2] and Christopher K. Wikle.[2] [1]Department of Forestry, University of Missouri, Columbia, MO 65211, USA; [2]Department of Forestry, University of Missouri, Columbia, MO 65211, USA. **Modeling and Mapping the Distribution of Legumes in the Missouri Ozarks: A Bayesian Approach.**

P#1-28 Zhang, Huayong. Center of Eco-Environmental Sciences and Institute of Botany, Chinese Academy of Sciences, Beijing, P. R. China. **Vegetation Pattern and Climatic Conditions: A Statistical Thermodynamics Theory.**

P#1-29 Ki-Hwan Cho[1], Do-Soon Cho,[1] and Sun-Kee Hong.[2] [1]Department of Environmental Sciences, The Catholic University of Korea, Puchon, Korea; [2]Environmental Planning Institute, Seoul National University, Seoul, Korea. **Landscape Ecological Functions of Mountain Ridges between a Bioreserve and Its Neighboring Forest in the Kwangnung Area, Korea.**

P#1-30 Marshall, Treneice and Jiquan Chen. School of Forestry and Wood Products, Michigan Technological University, Houghton, MI 49931, USA. **Contribution of Wetland Ecotones on Vascular Plant Diversity within a Northern Hardwood Landscape.**

P#1-31 Mast,[1] Joy N. and Lawrence E. Stevens,[2] [1]Department of Geography and Public Planning, Northern Arizona University, Flagstaff, AZ 86011, USA; [2]Department of Biological Sciences, Northern Arizona University, Flagstaff, AZ 86011, USA. **Dendroecological Study of Black Cottonwood Dynamics along Regulated and Unregulated Rivers in British Columbia.**

P#1-32 Pierce, Kenneth B., Todd Lookingbill, and Dean Urban. Nicholas School of the Environment, Duke University, Durham, NC 27708, USA. **An Assessment of Proximate Climate Variables and Their Relative Impact of Vegetation Patterns in Montane Systems.**

P#1-33 Powell,[1] Scott L., Andrew J. Hansen,[1] and Rick L. Lawrence.[2] [1]Ecology Department, Montana State University, Bozeman, MT 59717, USA; [2]Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717, USA. **Monitoring Forest Response to Past and Future Global Change in the Greater Yellowstone Ecosystem.**

Disturbance and Landscape Pattern Interactions

P#1-34 Fleming,[1] Richard A. and Jean-Noël Candau.[2] [1]Great Lakes Forest Research Centre, Canadian Forest Service, Sault Ste. Marie, Ontario, Canada P6A 5M7; [2]Ontario Forest Research Institute, Ontario Ministry of Natural Resources, Sault Ste. Marie, Ontario, Canada P6A 5N5. **Pattern and Process in the Interaction of Spruce Budworm and Wildfire Disturbance Regimes at Landscape Scales.**

P#1-35 Kashian,[1] Daniel M. and Monica G. Turner.[2] [1]Departments of Zoology and Forest Ecology and Management, University of Wisconsin, Madison, WI 53706, USA; [2]Department of Zoology, University of Wisconsin, Madison, WI 53706, USA. **The Persistence of Landscape Legacies Following Catastrophic Fire in Yellowstone National Park.**

P#1-36 Peters, D. P. C. Jornada Experimental Range, Las Cruces, NM 88003, USA. **Landscape-Scale Consequences of Small-Scale Disturbances at a Grassland-Shrubland Ecotone.**

P#1-37 Schoennagel,[1] Tania, Monica G. Turner,[2] and William H. Romme.[3] [1]Depts.of Botany and Zoology, University of Wisconsin, Madison, WI, USA; [2]Dept. of Zoology, University of Wisconsin, Madison, WI, USA; [3]Dept. of Biology, Fort Lewis College, Durango, CO, USA. **Spatial and Temporal Influences of Fire Regimes on Initial Pathways of Succession Across the Yellowstone Landscape.**

P#1-38 Wolf, Joy J. Department of Geography, University of Wisconsin—Parkside, Kenosha, WI 53141, USA. **Effects of Prescribed Burning as a Control for Exotic Invasion in Rocky Mountain National Park Grasslands.**

Field trip April 29 Full-Day

Grand Canyon via Sedona

Pickup at the hotels by the bus:

6:30 am Holiday Inn
6:45 am Twin Palms Hotel
7:00 am Marriott Courtyard

Arrival back at Tempe: approximately 9:00 pm

Due to numerous requests, we have arranged a field trip to the South Rim of the Grand Canyon via the spectacular red rock country of Sedona. The trip will definitely take up a full day, and will include some of the most scenic areas of Arizona. The route to the South Rim will pass through five biomes: Arizona Upland Sonora Desertscrub, Interior Chaparral, Juniper-Pinyon Woodland, Petran Montane Conifer Forest, and Great Basin Desertscrub. We will stop in Sedona for a coffee break and continue to the South Rim via Oak Creek Canyon and Flagstaff. We will spend several hours at the South Rim before heading back to Phoenix. A professional guide will provide narration during the trip.

l Indicates author who will present paper when presentation is to be made by an author other than the first listed.

ABSTRACTS

PATTERN PROCESS SCALE & HIERARCHY:
Interactions in Human-Dominated and Natural Landscapes

Abstracts
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Adair, William A. and John A. Bissonette. USGS Utah Cooperative Fish and Wildlife Research Unit, Department of Fisheries and Wildlife, Utah State University, 5210 Old Main Hill, Logan, UT 84322-5210, USA. **Spatially Explicit Models and Landscape Planning: A Case Study with the Endangered Newfoundland Marten (Martes americana atrata).**

Wildlife ecologists have long recognized that for most wildlife species, habitat quality depends on both the quantity of resources and their spatial configuration. However, few wildlife habitat models have attempted a spatially-explicit approach to assessing habitat quality, and only a handful of these have been used for landscape planning. Because 1) Newfoundland marten favor old growth forests and avoid openings and 2) spatial configuration is the most flexible aspect of timber harvest planning in western Newfoundland, the Newfoundland marten provides an ideal case study for examining the costs and benefits associated with spatially explicit modelling. We developed a suite of spatially explicit models that assess habitat quality by directly linking den sites with foraging patches, thereby mimicking the marten's habitat selection process. We compared these spatially explicit models with conventional aspatial models in terms of 1) their ability to accurately depict Newfoundland marten habitat quality at several scales and 2) their utility as decision-making tools for landscape planners. We conclude with guidelines for determining when spatially explicit modeling is a requirement for effective decision making.

Ahern, Jack. Department of Landscape Architecture and Regional Planning, University of Massachusetts, Amherst, MA 01003, USA. **Full Circle: Challenges for the Integration of the Science and the Application of Landscape Ecology.**

From its beginnings in Europe, landscape ecology has held the promise to fully and seamlessly integrate ecological science with applications in landscape planning, design, and management. The reality has been one of mixed success. While significant progress has been made in articulating first principles and fundamental theories, few widely-accepted successes can be cited as model applications of landscape ecology. The promise remains to be more fully realized. The following questions are useful to frame, to lead, and to integrate future investigations and applications:

What are the main knowledge gaps which limit the effective application of landscape ecology in planning, design, and management of landscapes? Can these gaps be addressed through empirical research?

Which adaptive strategies are appropriate to gain new knowledge through application? Can monitoring protocols be established to collect and analyze long-term data from decisions made?

How can the methods of case study-based research be formalized to articulate and document knowledge gained through application (and comparative applications)? Can the scope of these case studies be focused on accepted indicators of landscape structure, function, and change?

What is the appropriate pedagogy to inspire and support a fuller integration of landscape ecological science and application? What is the role of the universities? Of IALE? Of other agencies or entities?

Ahern, Jack. Department of Landscape Architecture and Regional Planning, University of Massachusetts 109 Hills North, Amherst, MA 01003, USA.
Future Landscape Scenarios in Urban Watershed Planning.

A fundamental precept of landscape ecology is the reciprocal interrelationship of landscape pattern and process. Much research has explored this dynamic with respect to flows of energy, materials, and movement of species across heterogeneous rural and agricultural landscapes. Less work has been done with respect to these flows, and other flows which are prevalent in human-dominated urban environments. Future landscape scenarios engage the landscape pattern/process dynamic over time into the future. As planning activities, they make assumptions and proposals which define trajectories of landscape change based on best-available knowledge and data. Scenarios are most useful to inform comparative discussion among stakeholders and decision makers regarding planning and policy decisions. This paper reviews several contemporary approaches to alternative future landscapes and proposes a method for the application of scenarios in urban watershed planning.

Alberti,[1,2] Marina and Paul Waddell.[1,3] [1]Department of Urban Design and Planning, University of Washington, Seattle, WA 98195, USA; [2]Urban Ecology Research Lab, University of Washington, Seattle, WA 98195, USA; [3]Daniel J. Evans School of Public Affairs, University of Washington, Seattle, WA 98195, USA. **Urbansim: An Integrated Urban Development and Land-Cover Change Model.**

This paper presents an integrated strategy to model the urban development and land cover change dynamics in the Central Puget Sound Region. This project is part of the Puget Sound Regional Integrated Synthesis Model (PRISM)—an interdisciplinary initiative at the University of Washington that aims to develop a dynamic and integrated understanding of the environmental and human systems in the Puget Sound. We focus on UrbanSim, a new software architecture for spatial simulation to develop a behaviorally integrated model for operational use by policymakers and planners faced with the complex trade-offs between urban growth and preserving ecological conditions. This paper presents the specifications of the urban development and land–cover-change models and discusses the status of the implementation and empirical application of these models to the Puget Sound region. We build on several modeling traditions—urban economics, landscape ecology, and complex system science—each offering different perspective on modeling urban dynamics. We choose to link human and ecological processes through a spatially explicit representation of the land. Our hybrid model structure combines a microsimulation of actor choices (location, housing, travel, and land development) and a spatially-explicit, grid-based model structure that represents the dynamics inherent in land-use and land-cover change.

Alberti,[1,2] Marina, Derek Booth,[3] Kristina Hill,[4] John Marzluff,[5] Stefan Coe,[1,2] Roarke Donnelly,[5] Vivek Shandas,[1,2] and Daniele Spirandelli.[2,4] [1]Department of Urban Design and Planning, University of Washington, Seattle, WA 98195, USA; [2]Urban Ecology Research Lab, University of Washington, Seattle, WA 98195, USA; [3]Department of Civil and Environmental Engineering, University of Washington, Seattle, WA 98195, USA; [4]Department of Landscape Architecture, University of Washington, Seattle, WA 98195, USA; [5]College of Forest Resources, University of Washington, Seattle, WA 98195, USA. **The Impacts of Urban Patterns on Ecosystem Dynamics.**

Consideration of urban patterns is critical to the successful use of ecological research in urban planning and design. Urban ecology does not yet have an established, proven set of pattern metrics to describe urban landscape patterns. To study the relationship between urban patterns and ecological conditions we need to describe these patterns quantitatively. We examine across a broad range of scales, several pattern metrics which we hypothesize are linked to ecological processes in urbanizing landscapes. We select metrics to quantify urban form, land-use intensity, land-cover heterogeneity, and land-cover connectivity. We seek correlations with two biological metrics: (a) nest predation rates of corvid bird species (crows, ravens) on songbird species, and (b) aquatic macroinvertebrate biodiversity (measured using the Index of Biotic Integrity, or IBI). Using data on bird communities and aquatic macroinvertebrates we test formal hypotheses about what factors determine and maintain an urban gradient in the Puget Sound region. We investigate three categories of hypotheses: (1) relationships between urban patterns and various spatial pattern metrics, (2) relationships between spatial scale (defined first as resolution and then as a real extent) and the correlation between a pattern metric and an ecological variable, and (3) relationships between spatial pattern metrics (each defining one aspect of an urban-rural gradient) and an ecological variable. Together, these allow us to address both the direct relationship between urban pattern and ecological conditions and the sensitivity of pattern measurements to measurement scale..

Alberti,[1,2] Marina, Erik Botsford,[1] and Alex Cohen.[1,2] [1]Department of Urban Design and Planning, University of Washington, Seattle, WA 98195, USA; [2]Urban Ecology Research Lab, University of Washington, Seattle, WA 98195, USA. **Quantifying Urban Ecological Gradients in the Puget Sound Region.**

Ecologists have suggested that ecological conditions in urbanizing landscapes can be described by a complex urban-to-rural gradient (McDonnell and Pickett, 1990). The gradient paradigm offers a useful framework to test hypotheses on the impacts of urban development on ecological processes. These studies, however, tend to simplify the actual urban structure into monocentric agglomerations characterized by concentric rings of development surrounding a dense core. The assumption of gradient analysis is that the overall urban exposure changes predictably with distance from the urban core. Due to such simplification, current gradient studies fail to capture the effects of alternative urban development patterns on ecological processes. In this poster we argue that urban-to-rural gradients cannot be represented by the distance from the urban core. Rather, we suggest, they can best be described using a series of pattern metrics that link urban development to ecological conditions. Based on an analysis of land-use and land-cover patterns in the Seattle metropolitan area, we propose a strategy to quantify urban patterns. We examine the behavior of various pattern metrics and propose a set of metrics useful to test formal hypotheses on the relationships between urban patterns and ecological disturbances. Finally, we discuss the implications of our empirical study for gradient analysis of metropolitan areas and for future urban ecological research.

Allen,[1] Thomas and John Kupfer.[2] [1]Department of Political Science and Geography, Old Dominion University, Norfolk, VA 23529, USA; [2]Department of Geography and Regional Development, University of Arizona, Tucson, AZ 85721, USA. **Scales of Pattern and Process in Fraser Fir Forest Disturbance and Fegeneration, Great Smoky Mountains, USA.**

Southern Appalachian Spruce-Fir (*Picea-Abies*) forests have undergone widespread damage and mortality since the introduction of the balsam woolly adelgid in the 1950s. We integrated field observations, topoclimatic models, and 1988-1998 satellite imagery to analyze spatial and temporal patterns of Fraser fir and spruce-fir ecosystems in Great Smoky Mountains National Park. Spectral changes in Landsat TM digital data were statistically modeled by topographic variables. Change vector analysis (CVA) and spherical geometry were applied at multiple scales: individual sites, local ridges, and east-west across the study area. Meaningful relationships were found between elevation and spectral change within and between sites. CVA vectors revealed differential spectral evidence of mortality and regeneration pathways. Geographic variations of these vectors also detail the scale of east-west and finer scale patterns suggesting upslope progression of fir mortality. The application of CVA provided the ability to summarize variation in spectral changes in space and time and to ascribe these to forest mortality and regeneration.

Anderson, Linda and Theodore Eisenman. Landscape Architecture Department, Cornell University, Ithaca, NY 14853, USA. **Conceptual Vision for Integrating Wetland Restoration and Tourism Development at the Montezuma Wetlands Complex in New York State.**

This landscape design proposal creates a conceptual vision for the 50,000+ acre Montezuma Wetlands Complex (MWC) that seeks to enhance habitat integrity and accommodate visitors. The MWC is a major stopover on the Atlantic migratory flyway in upstate New York. The draining of wetlands during construction of the Erie Canal, subsequent muckland farming, and the development of a major interstate highway have profoundly modified the MWC landscape. Plans are now being developed to restore the area to a wetland condition and manage it for wildlife habitat. The reversion of agricultural fields to wetlands will greatly reduce the county and municipal tax base. Consequently, local communities have expressed interest in developing tourism to support the economy. Our analysis and interventions seek to integrate the restoration of wetland habitat with the development of ecologically sensitive tourism. Through spatial analysis, our inquiry focused on restoring and enhancing patch diversity and connectivity in a fragmented landscape, exploring edge dynamics, and creating interior space conditions. Design interventions include project areas that interpret ecological processes at different temporal and geographic scales, including geologic and human-induced landscape transformation, engineered wetlands serving as a stopover for millions of migratory birds, and various stages of wetland succession. Proposals also include the creation of a new visitor center acting as a gateway into the entire complex.

Andison, David W. Bandaloop Landscape-Ecosystem Services, 3426 Main Ave., Vancouver, British Columbia, Canada V3H 4R3. **Fire in Riparian Zones: The Perfect Hierarchical Model.**

As we get our hands dirty with the natural disturbance model of forest management in the boreal forest, things are not as clear-cut as we hoped. For instance, riparian zones are particularly sensitive areas both socially and ecologically. Ironically, our improving understanding of how fire affects these special areas is not making the task of managing them sustainably any easier. At landscape scales, there is evidence that fires burn through riparian zones on a regular basis. Fires form edges more often than expected at creeks and rivers, but not significantly so. At intermediate scales, we begin to see more subtle shifts in fire severity across riparian zones, but again, not commonly so. Survival of individuals increases through riparian zones for selected combinations of vegetation types and topography, but the majority of riparian zones burn as often, and as hot as, the adjacent upland forests. At stand scales, fire controls forest invasion, maintains lower vegetation communities, keeps fuel-loads low, changes the temperature profile of the aquatic system, and creates snags and woody debris. Finally, at the micro-site scale, fire is a chemical process that exposes mineral soil without compaction, converts and transports nutrients, and creates a new hydrological balance. Understanding and accepting that these functions are "natural" is difficult enough, but using all of this new knowledge to design a management strategy which maintains the integrity of the system is another, much more difficult mission. Ultimately, the difficulty lies in our inability to think, plan, manage, and monitor in a hierarchical manner.

Andison, David W. Bandaloop Landscape-Ecosystem Services, 3426 Main Ave., Belcarra, British Columbia, Canada V3H 4R3. **Practical Science Using the LANDMINE Landscape Fire Simulation Model.**

Despite all the talk about "natural range of variability," examples of exactly what that entails are few and far between. We are universally having difficulty grasping the potential implications of embracing variability in land management. LANDMINE is a stochastic, landscape disturbance model that was designed to fill this void. The cellular automaton spread algorithm in LANDMINE allows disturbances such as forest fires to be calibrated for shape as well as amount, spacing, and sizes of residual islands. Disturbance sizes and frequencies are selected stochastically from cumulative functions derived from empirical data. Stochastic ignition probabilities are based on spatial ignition tendencies. Vital attribute species responses to disturbance drive successional shifts on individual pixels. Although not a proper fire behavior model, LANDMINE can use topography, fuel-types, and even wind direction to spread fires according to observed or hypothesized burning tendencies. The transparent, conceptual simplicity of LANDMINE has proven valuable for practical applications over the past several years. The most obvious application has been to run the model several hundred times to capture a temporal range of variation in patterns. For instance, Weldwood of Canada Ltd. has used LANDMINE output to establish multi-scalar seral-stage ranges for long-term planning. The model has also been used to test the ability of different management scenarios to create more "natural" landscape patterns. Not surprisingly, the most powerful application of the model so far has been to demonstrate how, and in what way, natural landscapes have been (and will continue to be) dynamic.

Anthony,[1] J. A. and G. A. Bradshaw.[2] [1]Department of Fisheries and Wildlife, 104 Nash Hall, Oregon State University, Corvallis, OR 97331, USA; [2]USDA Forest Service, PNW Research and Rogue-Siskiyou National Forest, Applegate Ranger District, Jacksonville, OR 97530-9341, USA. **Wavelet Analysis as an Approach to Investigate the Reciprocal Relationship between Ecological Pattern and Process.**

Two-dimensional wavelet analysis characterizes complex ecological data to increase our comprehension of the reciprocal relationship between pattern and process across scales. Integrating individual features at one scale as a texture at multiple scales translates ecological patterns as a multi-dimensional volume. Visualizing complex relationships as a space-time volume captures a closer approximation of the way ecological relationships exist in nature—nonlinear, multi-scalar, and uncertain. As a pattern analysis method that accommodates and preserves non-stationarity, wavelet analysis provides novel visualization and analytical capabilities for increased insight into the interactions between multi-scalar pattern (heterogeneity) and sampling design. Wavelet analysis is presented as an analytical and modeling tool for optimizing sampling efficiency and accuracy, such as in the context of designing large-scale monitoring plans. Effective monitoring must involve sampling designs sufficiently detailed to detect ecologically significant patterns at multiple scales, yet logistically tractable and resource-efficient for sustained execution. For this reason, methods that help optimize these objectives and contribute to the design of more efficient sampling prior to implementation are important for successful large-scale monitoring. We present an approach that uses two-dimensional wavelet analysis in tandem with simulation modeling to select optimal sampling designs for large-scale spatio-temporal ecological phenomena. The sampling properties and behavior of wavelet analysis are described and illustrated in a comparison of spatio-temporal patterns in species range data and statistical simulations of varying distributions to emulate natural patterns.

Antrop, Marc. Department of Geography, University of Ghent, Belgium.
Top 10 list for landscape ecology. (Conveyed by J. Wu)

1. Search for norms or standards for the landscape metrics.
The use of indices is becoming increasingly important in environmental assessment and policy making. Unlike the more "technical" environmental compartments such as air, water, soil toxicity, and noise, no numerical standards or norms are available for indicators related to landscape and ecology. Many indicators about the technical compartments are legally regulated, which is not the case for landscape indicators. Landscape metrics are numerical indicators that are widely used for descriptive and comparative purposes, but are difficult to be used as standards in a legal assessment procedure. It might be worthwhile to focus some fundamental research upon this.

2. Integrate or link landscape metrics (indices) to holism.
Many landscape metrics try to describe properties of the landscape that are surpassing the characteristics of the composing elements. Some of these properties have clearly a holistic meaning, such as the ones dealing with complexity, diversity, heterogeneity, and order. They might offer a possibility to bridge the experimental-scientific method of research with the phenomenological-humanistic methods. As both approaches are used in the study of landscape, this can only broaden and enforce the understanding of landscape and the practical application of the results coming from it.

3. Design and apply integrated monitoring at the landscape level.
The speed and magnitude of landscape change is still increasing and general inventory data are rapidly becoming out of date. Many actions in spatial and environmental planning are interfering with each other and have no or a poor follow-up in many cases. Monitoring programs focus on a specific issue, such as biodiversity assessed by the occurrence of some indicator species or the measurement or immissions by sampling networks. Interaction with other processes in the landscape as well as the landscape structures are seldom integrated. Integrated monitoring at the landscape level is multifunctional and is more appropriate to understanding the driving forces, pressures, state, impact-

response model (DPSIR).

4. Consider man as a particular species.
Man should be regarded as a particular species because of the way he interacts with the environment and the magnitude of his impact upon the creation and change of the landscape. His behavior is hardly predictable and billions act simultaneously but in a largely non-concerted manner, resulting in a rather chaotic pressure and impact upon the environment. An important aspect in understanding man's behavior in relation to the landscape is the way he is valuing the land and the landscape, as well as the elements it contains. Values of landscape (and elements) are not absolute, but are assigned and affected by culture. Values may change in time and this affects the way the land is used and thus how the landscape will be (re)shaped. The success of programs to sustain landscape ecological functioning depends upon how important humans, as individual and as society, consider them to be. Also, most valuing by humans in the past resulted in the creation of unique cultural landscapes that are considered of ecological importance today, such as the enclosed hedgerow landscapes. Understanding the way man evaluates the landscape might offer new opportunities to implement the results of landscape ecological research.

5. Give more attention to the quality of the data generally provided for spatial analysis and use in a GIS.
Spatial analysis and the use of GIS has become extremely important in landscape ecological research. More and more geographical map data are available, and much of these are secondary data derived from other data sets or digitized or interpreted from analogue data. Data from different scale, accuracy, precision, and quality are often combined, affecting the outcome in various but not always transparent ways. Little information is given about the quality of the data used (for example, in scientific publications) and the metadata accompanying the data sets is rare and not always complete. Critical data evaluation should become more important in the reporting of scientific research, in particular when dealing with spatial and dynamical issues.

6. Apply theories from landscape ecology to other domains of landscape research and translate the results from landscape ecological research for planning and policy making.
Fundamental research and theory are important in landscape ecology, and the research is organized accordingly. This makes landscape ecology a strong academic discipline (although it is not always recognized as such). Many results are considered too abstract and theoretical for many planners and policy makers, whodeal with the landscape in a more practical sense, and thus are important in the changing and shaping of the landscape as well. Landscape ecologists should make more efforts to translate their theories, concepts, and results for practical applications and link them to the concepts and theories used in spatial (physical) planning and environmental planning.

7. Broaden the research for landscape perception.
"Landscape" differs from "land" by its holistic character that implies a perceptive dimension. Landscape always includes the scenery as well. The visual aspect is emphasized here and other forms of landscape sensing receive less attention. Recent research by acoustics is achieved in the field of soundscapes for example. However, these researchers have no background in landscape research. Landscape ecology as a transdisciplinary discipline should try to embrace these new fields of research as well and set up links to broaden and integrate its concepts with those in the field of environmental psychology, sociology, acoustics, etc.

8. Apply landscape ecology in dynamic and chaotic landscapes.
Much landscape ecological research is focussing upon specific landscape types (wetland, riparian landscapes, deserts, mountains, forests, etc). Recently interest in the complex and dynamical (sub)urban landscapes has been increasing, as well as the impact of urban sprawl upon the countryside. However, really chaotic and extremely dynamical landscapes, such as the ones formed by large industrial complexes, third world urbanization and war and zones of conflict are rarely studied. Of course, many practical difficulties exist, but many opportunities to see the landscape functioning in extreme situations are missed as well. Thinking about a methodology to study such landscapes might be a first step.

9. Set up a common language.
English has become the common international language in landscape ecology as in most other sciences. For non-native English speaking researchers this is clearly a handicap to express the results of their work. The problem in landscape research is particularly important as the concept of landscape has also a perceptive, cultural, and social dimension. In many languages there is no one-to-one translation for "landscape" as well as for many related concepts, such as "(geographical) space," environment, "scale," etc. For example, in many languages, "landscape" has an intimate connotation of the "beauty" or "(symbolic) value" of the perceived or imagined land. Associations are made often with "home land" and "heritage." In the common use of the word "landscape" no association is made with a hierarchical structured system or a scale of complexity of organization. The multiple meanings of the term "landscape" and related terms is the most important factor in misunderstandings among scientists.

10. Stimulate education and training in landscape ecology.
Landscape ecology is still marginal in educational programs, in particular in higher education. However, landscape as a central holistic concept for many different research disciplines offers many opportunities to initiate and train young future researchers in transdisciplinary working in a broad field of applications. A base course of landscape ecology ("thinking landscape ecology") might be essential before any later specialization in (one of the branches) of landscape ecology that is added to any other more traditional and recognized discipline.

Arge,[1] Lars, Jeff Chase,[1] Laura Toma,[1] Jeffrey Vitter,[1] Rajiv Wickremesinghe,[1] Pat Halpin,[2] and Dean Urban.[2] [1]Levine Science Research Center, Computer Science Department, Duke University, Durham, NC 27708, USA; [2]Nicholas School of the Environment, Duke University, Durham, NC 27708, USA.

Digital Terrain Analysis for Massive Grids.

Analysis of digital elevation models (DEMs) is central to a range of applications concerned with the effects of topography on hydrologic flow and soil water accumulation. Topographic convergence indices, in particular, have been shown to be useful predictors of soil water content, erosion potential, and plant species distribution. As applications target increasingly larger geographic regions, however, the calculations involved in these indices become computationally infeasible using conventional data-processing approaches; these indices are well beyond the capabilities of commercially available software. Here we present a new computational approach based on external memory algorithms, which scale efficiently to problems involving very large datasets. We focus on an algorithm for the computationally demanding intermediate steps in computing a topographic convergence index. Our program accepts as input a DEM, which it fills to remove depressions and from which it then computes flow directions and flow accumulation, delineates watersheds, and computes the topographic convergence index. The algorithm is capable of processing study areas (grids) several orders of magnitude larger than conventional processing algorithms. Similar approaches can be applied to related processing tasks for landscape-scale digital datasets.

Aukema, Juliann E. Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, AZ 85719, USA. Mistletoe Distribution at **Multiple Scales: Patterns, Processes, and Mechanisms.**

The desert mistletoe, *Phoradendron californicum*, is a distinctive feature of the Sonoran desert landscape. This plant parasite provides important resources for native birds and is primarily dispersed by Phainopeplas (*Phainopepla nitens*). The distribution of mistletoes is determined by the distribution of their host plants and by the behavior of their avian dispersers, which create patches of mistletoe and respond to it. Studying this type of interaction in the landscape makes one simultaneously aware of the scales, heterogeneity, and patches that are important for parasite, hosts, and animal dispersers. Because I am studying the interaction of very different organisms, I examined processes of pathogen transmission at multiple scales ranging from single trees to thousands of hectares. I examined mistletoe and host distributions, seed deposition, and Phainopepla behavior throughout the Santa Rita Experimental Range, a Sonoran Desert site that has been heavily impacted by grazing. I used different analytical tools for optimum exploration at different scales. I used a geostatistical approach at the largest scales to examine the variance in mistletoe prevalence and host characteristics across the Range. At the intermediate scale, I analyzed patterns of infection, seed deposition, and bird movement using maximum likelihood. Data in this analysis was derived from tree-by-tree mapping using GPS. At the small scale of trees, I linked mechanisms of phainopepla behavior to processes of seed dispersal. I summarize by describing how results obtained at lower scales and inspected using "fine-filter" analytical approaches, provide the mechanisms that generate patterns at larger scales detected by "coarse-filter" analysis.

Baker, William L. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. **Landscape Ecology in the Twenty-First Century: A View from the Rocky Mountains.**

Landscape ecologists in two decades have developed a body of theory and empirical findings that has reshaped ecology and influenced many other disciplines, yet significant challenges remain. Twenty-first century landscapes will be more developed and humanized than are landscapes today, because of continuing population growth and expansion of the global economy. In the Rocky Mountains, for example, a rising population is creating distinct problems in landscapes dominated by urbanization, energy development, logging and grazing, agriculture, recreation, and wildlands. Landscapes characterized by sustainability have not yet emerged, because of continuing population growth and because the region remains under the influence of shifting global and national forces and priorities (e.g., shift to natural gas as an energy source, expanding urban and ex-urban development). A continuing boom-and-bust economy leaves landscape legacies that constrain future options. New theory and principles are needed, tailored to particular kinds of landscapes, to absorb population growth and economic development while maintaining critical landscape functions and future options. In fossil-fuel energy landscapes, for example, there is a need for new models for development that will minimize short-term adverse impacts and facilitate restoration of landscape structure and function after resource depletion. Logging landscapes can be re-designed to minimize adverse effects of fragmentation while harvesting continues. Landscape ecology will remain important during the twenty-first century if it can provide practical solutions as well as new theory relevant to the short-term pattern of land transformations accompanying growth with the long-term goal of transitioning to landscapes of sustainability.

Baker,[1] Matthew E., Michael J. Wiley,[1] and Paul W. Seelbach.[2] [1]School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109-1115, USA; [2]Institute for Fisheries Research, Michigan Department of Natural Resources, Ann Arbor, MI 48109, USA. **Predicting Spatial Variation in Riparian Hydrology and Forest Composition across Lower Michigan.**

In recent years, researchers and resource managers have emphasized the importance of riparian areas in aquatic ecology and watershed management. However, ecological assessment of riparian areas can be complicated by underlying spatial variation in riparian ecosystem dynamics that alter the impact of land-use changes on aquatic systems. We modeled various hydrologic processes that help determine the ecological potential of riparian areas and mediate flux between terrestrial and aquatic systems. The models were then validated using an extensive survey of riparian plant community composition from 96 locations across Lower Michigan. We found that relatively simple, GIS-based models reflecting fairly complex hydrologic processes, such as shallow groundwater movement and river flooding, explained a large portion of the variation in riparian character and forest composition. Because such models provide insight into the spatial variation of riparian conditions and their hydrologic function, they provide an important context for interpreting the influence of landscape alteration on rivers, as well as a useful predictive tool for managers interested in riparian assessment and restoration.

Barrett, Gary W. and Terry L. Barrett. Institute of Ecology, University of Georgia, Athens, GA 30602, USA. **Landscape Ecology in the Twenty-First Century: From Youth to Maturity.**

Odum in his classic article "The Strategy of Ecosystem Development" (Science, 1969, 164: 262-270) contrasted trends in the development of ecosystems between early developmental stages and mature stages; these same trends (attributes) likely have relevance for landscape development as well. For example, there is evidence that the human population will reach carrying capacity conditions during the 21st century (see Barrett and Odum, 2000, BioScience, 50: 363-368 for a review of this trend). This trend suggests that society will have matured from a young seral stage of human development, identified by high growth with emphasis on production, to a more mature stage of human (societal) development, hopefully characterized by sustainability and quality-of-life attributes. Ten strategies are presented suggesting how to more effectively plan for and reside within this evolving stage of landscape maturation. These strategies include landscape/global planning, ecological literacy, metalandscape diversity, and integrative research and outreach programs.

Bascompte, Jordi. Estación Biológica de Doñana, CSIC, Sevilla, Spain.
Complex Systems and Habitat Loss.

Habitat loss is considered the main cause of biodiversity decline. Despite its potential consequences, a comprehensive framework aimed at understanding and predicting the consequences of habitat loss for populations and communities is still in its infancy. In this talk I will first introduce a mean-field model based on the metapopulation paradigm. This kind of models predicts the existence of an extinction threshold once a critical amount of habitat has been destroyed. I will proceed by asking how such an extinction threshold is modified when we introduce (1) spatial structure and (2) a web of trophic interactions with other species. In relation to spatial structure, I will show the existence of critical values of destruction related to percolation where some landscape indices show abrupt transitions. By incorporating metapopulation dynamics within these landscape models, I will explore the effect of such non-linear landscape changes on metapopulation abundance. I will also consider how spatial correlation in the patterns of destruction modifies the extinction threshold. In relation to the second point, I will consider how the complexity of the web and the existence of direct and indirect interactions among species are important for determining metapopulation occupancy and the extinction thresholds.

Batistella,[1] Mateus and Fabio de Castro.[2] [1]Indiana University–ACT, Bloomington, IN 47405, USA; [2]NEPAM–UNICAMP, Campinas, SP 13081-970, Brazil. **Institutional Design and Landscape Fragmentation: A Comparative Study of Rural Colonization Projects in the Brazilian Amazon.**

Government-sponsored projects of rural settlement are among the key processes leading to landscape change in the Brazilian Amazon. Despite their primary goal of providing land for small farmers, their establishment brings along a complex social structure, including other actors, such as loggers and extractivists. The diversity of situations involving different actors, biophysical features, and institutional designs directly affect the structure of incentives, creating a mosaic of land-cover trajectories and landscape patterns. This paper addresses the influence of different architectures of colonization and institutional designs upon landscape fragmentation in the State of Rondônia (Western Amazon), where development projects have been routine over the last twenty years. We carry out a comparative analysis of two adjacent settlement projects established in the early 80s encompassing approximately 3,000 sq. km. The settlements differ in terms of lots allocation and land tenure arrangement. Vale do Anari was based on private properties placed along an orthogonal road network, following the standard design of colonization in the Amazon (often referred to as a "fishbone" pattern). Machadinho Oeste took topography into account for lot allocation, and its design included sixteen forest reserves housing local rubber tappers. Landscape structure indices were calculated, using multi-temporal LANDSAT TM image classifications, dated 1988, 1994, and 1998. The results show higher deforestation rates and forest fragmentation in Vale do Anari. We discuss the accountability of these different settlement designs in affecting landscape fragmentation, which is useful to evaluate new strategies resulted from the establishment of colonization projects in the Amazon.

Baum,[1] Kristen A., William L. Rubink,[2] and Robert N. Coulson[1]. [1]Department of Entomology, Texas A&M University, College Station, TX 77843, USA; [2]Beneficial Insects Research Unit, Agricultural Research Service, United States Department of Agriculture, Weslaco, TX, USA. **Habitat Associations of Feral Honey Bees and Non-Apis Pollinators in South Texas.**

Interactions between native pollinators, especially bees, and introduced honey bees (Apis mellifera) have been the center of much concern due to potential impacts on the pollination of native plants. The recent decline in managed honey bee colonies and the arrival of Africanized honey bees have extended these concerns to agricultural and urban landscapes. We studied feral honeybees and non-Apis pollinators on the Welder Wildlife Refuge in San Patricio County, Texas, where Africanized honeybees were first recorded in 1993. Our objective was to compare the habitat associations of honeybees and non-Apis pollinators. We used aerial pitfall traps baited with honey and a honeybee attractant to compare foraging activity in different habitats. Because the honeybees could not recruit to the traps, they provided an estimate of how many honeybees were scouting for resources in a specific area. Forty traps were randomly distributed across the landscape by placing a 50-meter grid over the study area and then randomly selecting grid cells for sampling. Traps were run for three-week intervals, and all collected bees were identified to genus. Preliminary analyses showed Lasioglossum were the most common bees. Bees belonging to other genera were scarce, including honeybees. However, additional data showed a dramatic increase in honeybee numbers when resources were scarce. The grassland habitat supported the largest abundance and diversity of non-Apis bees and the greatest number of honeybees. Additional analyses should provide further insight into habitat associations of honeybees and non-Apis pollinators.

Bean, David A., and Greg H.R. Henry. Department of Geography, University of British Columbia, Vancouver, BC, Canada, V6T 1Z2. **The Spatial Pattern of Vegetation in a High Arctic Oasis.**

Environmental changes resulting from global warming are predicted to be most intense at high latitudes, and this has considerable implications for the distribution of vegetation in the High Arctic. The relationships among plant community structure, diversity, vegetation phenology, and abiotic factors, including snowmelt pattern, temperature, soil moisture, and soil nutrients, are being studied at the Alexandra Fiord lowland (78° 53' N, 75° 55' W), a high arctic oasis on the east coast of Ellesmere Island, Canada. Digital aerial photographs were used to map the vegetation and the pattern of snowmelt. At each of 28 sampling points, vegetation was surveyed, soil was sampled, temperature was recorded by dataloggers, and phenological observations were made on four plant species throughout one growing season. A geographic information system is being used to analyze the data from the discrete sampling points and relate it to the observed distribution of plant communities. From these data are anticipated insights on the spatial interrelationships between vegetation and the abiotic environment with a view to improving predictions of vegetation response to climate change in this region.

Beaty, R. Matthew and Alan H. Taylor. Department of Geography, The Pennsylvania State University, University Park, PA 16802, USA. **Stand and Landscape Scale Variablity of Fire Effects and Vegetation Dynamics in a Mixed Conifer Forest Landscape, Southern Cascades, California.**

Fire is an important force that shapes landscape diversity by influencing vegetation composition and structure at multiple scales. We examined stand and landscape scale patterns of fire effects on vegetation in a mixed-conifer forest landscape. Fire regimes (i.e., return interval, season, extent, rotation, severity) were reconstructed with dendroecology. Repeat areal photography (1941 and 1993) and stand structural analysis was used to determine patterns of fire effects and successional changes since fire suppression. Slope aspect, potential soil moisture, forest composition, and fire regime parameters in our study area covary. Median composite and point fire return intervals were shorter on ponderosa pine dominated, south-facing slopes (9 years, 19 years), intermediate on mixed species, west-facing slopes (14–17 years, 34–37 years), and longest on white fir dominated, north-facing slopes (34 years, 54 years). Fire severity also varied by species composition, slope aspect, and slope position. At the landscape scale, differences in fire return interval and severity promoted fine-grained vegetation patterns on south-facing slopes and coarse-grained patterns on north-facing slopes. At the stand level, variable fire regimes created vegetation structures ranging from even-aged, monospecific stands of white fir to multi-aged, multi-species stands dominated by pines. Fire frequency declined dramatically after 1905, and stands have infilled with fire intolerant species. This study suggests compositional and structural diversity within the mixed conifer zone is related to spatial variation in fire regimes. Fire suppression has homogenized fire regimes with the apparent result of homogenizing vegetation composition and structure at both stand and landscape scales.

Beazley, Karen F., Tamaini V. Snaith, and Peter J. Austin-Smith, Jr. School for Resource and Environmental Studies, Dalhousie University, Halifax, N.S. B3H 3J5. Canada. **Delineating Critical Habitat for Viable Populations of Focal Species: An Example From Nova Scotia.**

Landscape planning and management decisions should incorporate key ecological processes and the associated spatial patterns, particularly as development pressures increase upon a limited land base. In Nova Scotia, several species are in decline and at risk of extirpation due to habitat conversion, degradation, and fragmentation. Thus, to conserve these species it is important to understand the ecological process of population viability over time, as well as the spatial patterns (size and configuration) of critical habitat on the landscape. Selection and delineation of critical habitat includes considerations of viable population size, density, home-range area, dispersal patterns, and habitat characteristics. The habitat requirements of viable populations of lynx (*Lynx canadensis*), American moose (*Alces alces*), American marten (*Martes americana*), and river otter (*Lontra canadensis*) help to define key landscape-level parameters in Nova Scotia. Geographic Information System (ArcInfo; ArcView) analyses of various land-cover and forest-inventory data sets are used to select and delineate appropriate habitat, including both core and connectivity zones. If sufficient habitat for these species is conserved, it should go a long way toward maintaining viable populations of many species in Nova Scotia. Population viability of species over time is a key ecological process and is intimately bound up with the landscape. Critical spatial patterns for the survival and evolution of focal species should be understood, delineated, and maintained.

Bennett, Elena and Stephen R. Carpenter. Center for Limnology, 680 N. Park St., Madison, WI 53706. **Phosphorus distribution along an urban-rural gradient.**

Phosphorus (P) is a key pollutant causing lake eutrophication, a critical problem for freshwater resources in the United States. P is accumulating in upland soils of many watersheds around the world, increasing the potential P runoff to surface waters. However, we know little about the spatial pattern of P accumulation, the causes of this pattern, or its effects on P runoff to surface waters. We hypothesized that, at the watershed scale, changes in P accumulation and storage may be best understood along a gradient from urban to rural land uses. Our urban-rural gradient is not represented by a linear transect; instead, we used a functional gradient definition based driving time to the urban center and population density to map the urban-rural gradient across Dane County, Wisconsin. We examined soil P concentrations at over 500 sites along this gradient to determine the spatial arrangement of hot spots of P accumulation and the land management factors driving the relationship between hot spots and location. We found that, while the mean soil test P values were similar across the gradient (mean of 43 ± 22 ppm in urban areas and 74 ± 51 ppm in rural areas), the variation increased significantly along the gradient from urban to rural sites. Current land use (e.g., agricultural or residential) and house age ($r2=0.25$, $p<0.000$) rather than land-use history or fertilizer application rates ($r2=0.064$, $p<0.001$), appears to be the dominant factor influencing this relationship.

Berk,[1] Richard, Jan de Leeuw,[1] Richard Ambrose,[2] and Cindy Lin.[2]
[1]Department of Statistics, University of California, Los Angeles, CA 90095-1554, USA; [2] Department of Environmental Science and Engineering, School of Public Health, University of California, Los Angeles, CA 90095-1554, USA. **Multilevel Statistical Modeling for Generalizing from Case Studies.**

Case studies, which are the bread and butter of environmental research, are too often faced with a very difficult "So what?" criticism: just because certain findings apply to a given study site does not necessarily mean that they apply to others. Yet, the goal of such research commonly is to arrive at broadly relevant conclusions. In this paper, we employ a generalization of multilevel statistical modeling to consider the degree to which one can draw credible conclusions across a set of case study sites. Multilevel modeling allows one, within a regression analysis framework, explicitly to consider how statistical summaries vary systematically over a set of sites. As a result, the degree to which findings can be applied beyond a single site is addressed directly. Our contribution is to provide a generalization of multilevel modeling, and the necessary software, so that one may work with the generalized linear model and include such features as spatial and temporal dependence, inherently nonlinear relationships, and latent variables. For example, outcomes can be categorical, and sites closer to one another in space may be treated systematically as more alike. The emphasis in our paper is on technique, with the data used as an illustration. The data come from a Regional Environmental and Monitoring Assessment Program (R-EMAP) project, US EPA Region 9, undertaken in conjunction with UCLA Environmental Science and Engineering Program. The research is a spatially intensive stream bioassessment monitoring study for Calleguas Creek Watershed, Ventura County, California. The effort includes sampling of riparian habitat and streams for two seasons between 1999-2000. Data are collected at 70 sites. Field assessment in the watershed includes water quality, physical habitat assessments (e.g., measures and/or visual estimates of channel cross-sectional dimensions, substrate, fish cover, bank characteristics, and riparian vegetation structure), and benthic and fish community sampling. The project seeks to assess the current ecological condition of coastal Southern California streams and to examine the impacts of land use on water quality and aquatic ecosystem integrity.

Berling-Wolff, Sheryl[1,2] and Jianguo Wu.[2] [1]Department of Plant Biology, Arizona State University, Tempe, AZ 85287, USA; [2]Landscape and Systems Ecology Lab, Arizona State University West, Phoenix, AZ 85069, USA.
Simulating Urban Growth in the Phoenix Metropolitan Region: Relating Pattern to Process.

In order to project future urban growth, it is necessary to identify the predominant factors and processes that drive urbanization. In the past decades, many urban growth models have been developed, but few offer any ecological or social explanations. In this presentation, we describe a spatially explicit urban growth model that is used to simulate the historical land-use change and its social and ecological driving forces in the Phoenix metropolitan area. The Phoenix urban growth model is a modified version of HILT, a rule-based urban growth mode originally developed for the San Francisco Bay Area. The modeling framework is a modified cellular automaton that applies growth rules and allows for self-modification during execution of controlling variables. Using land use and other data collected for the Phoenix area, existing growth rules have been selectively modified, and new rules added to help examine key ecological and social factors that affect urbanization. FRAGSTATS, a landscape analysis package, is used to compute landscape indices to compare simulated and empirically mapped land-use patterns. Preliminary results show that there are relatively few factors that have significantly influenced the urban growth in the Phoenix metropolitan region. These include growth/density values, land ownership, and dispersal growth that is so elusive to model and significantly contributes to landscape fragmentation.

Bert, Daniel G. and Kathryn Freemark. Ottawa-Carleton Institute of Biology, Carleton University, Ottawa, Ontario, Canada K1S 5B6 (DGB); National Wildlife Research Centre, Environment Canada, 100 Gamelin Blvd., Hull, Quebec, Canada K1A 0H3 (KEF). **Nested Species Subsets in a Regional Context: Effects of Landscape Structure, Scale and Error.**

When species compositions for sites with low species richness are largely proper subsets of compositions for sites with higher species richness, the distributional pattern of species across sites is structurally nested. To date, the application of nested subset analysis has primarily focused on extensions of the theory of island biogeography, while largely ignoring explicitly spatial and landscape scale factors that potentially contribute to the generation of this class of non-random pattern. In this study, two separate designs were used to compare the effects of patch size, isolation, landscape structure, and scale on species specific and assemblage level nestedness patterns. We used a dataset comprising a total of 144 forest fragments with complete bird surveys in the form of presence/absence data in a 125 km square region and representing a gradient of decreasing forest cover and increasing fragmentation. Nestedness varied greatly across ranking variables for both patch clusters and landscapes and increased with scale. Individual forest bird responses differed for landscapes ranked by independent measures of forest composition and configuration and also varied with scale. In general, only a small proportion of species was significantly nested. Because measurement error led to increases in statistical ties between sites for a given ranking variable, effect size and absolute nestedness scores declined with increasing error. Nested subset analysis may help identify species likely to exhibit threshold responses to landscape structure in a study region, which could lead to coarse scale rules for more detailed modeling in conservation management.

Bestelmeyer,[1] Brandon, Joel Brown,[1] Kris Havstad,[1] Robert Alexander,[2] George Chavez,[3] and Jeffrey Herrick.[1] [1]USDA–ARS Jornada Experimental Range, New Mexico State University, Las Cruces, NM, 88003, USA; [2]Bureau of Land Management, 1474 Rodeo Rd., Santa Fe, NM 87502, USA; [3]USDA Natural Resources Conservation Service, 6200 Jefferson, Albuquerque, NM 87109, USA. **An Integrated Approach to Managing Landscape Pattern and Dynamics in Southern New Mexico.**

The ecological site concept of the USDA Natural Resource Conservation Service provides a hierarchical framework for classifying and distinguishing landscape units that differ in the processes that determine plant and animal community dynamics within units and that determine interactions among units. Ecological sites are based upon important differences in landscape position and inherent soil properties as defined by the responses of dominant plant species to variation in climate and management. Dominant plants, in turn, regulate several ecosystem attributes including dynamic soil properties. State-and-transition models are used to represent theories about the positive feedbacks between plant populations and ecosystem processes and the causes of irreversible changes in plant and animal composition. An understanding of these causes is needed to avoid ecosystem degradation, to fairly evaluate and manage instances of degradation, and to promote remediation. Here, we describe our ongoing efforts to improve the ecological site classification system for the Chihuahuan Desert of southern New Mexico by integrating current approaches to community and landscape ecology with the historical perspectives and practical experiences of land managers and ranchers. Our approach emphasizes an increased understanding of patterns of dispersal, establishment, and growth of dominant plants along landscape and climatic gradients.

Bickel,[1] Kathryn A., Laura C. Philips,[2] and Dean L. Urban.[3] [1]Nicholas School of the Environment, Duke University, P.O. Box 90328, Durham, NC 27708-0328, USA; [2]Department of Biology, University of North Carolina at Chapel Hill, P.O. Box 3280, Chapel Hill, NC 27599, USA; [3]Nicholas School of the Environment, Duke University, P.O. Box 90328, Durham, NC 27708-0328, USA. **Land Use, Disturbance, and the Spread of Non-Native Plant Species in a Piedmont Forest Ecosystem.**

Non-native plant species are increasingly invading forest ecosystems and creating considerable ecological problems by altering ecosystem structure and function. A number of explanations for this trend have been offered, one of which pinpoints the interaction between habitat alteration from land use and the opportunistic life histories of invading species. This study investigates the hypothesis that land use and natural disturbance mediate the spread of non-native plants in forests of the Piedmont region of North Carolina. The Piedmont is characterized by a long history of widespread habitat alteration resulting from agricultural practices in the early part of the twentieth century. Pine forests have since regenerated on abandoned agricultural fields and are now actively managed for timber. Piedmont forests are undergoing additional modifications in response to increasing development pressures. Forests in this region are therefore continually subjected to alteration and fragmentation. This study takes advantage of a unique set of permanent sampling plots in Duke Forest, a 3,250 hectare private research forest, to measure changes in herbaceous communities over the past twenty-five years. Changes in native and non-native species richness and composition are related to environmental, topographic, and land-use variables. Land-use variables include the proximity of sites to roads and streams and the density of neighboring development and vegetation cover. Our findings indicate that proximity to streams and surrounding vegetation densities are important variables in explaining changes in herbaceous communities of the Piedmont.

Binford,[1] M.W., C. Leslie,[2] R. Britts,[1] G. Barnes,[2] H. L. Gholz,[3] S.E. Smith.[2] [1]Department of Geography, University of Florida, Gainesville, FL 32611, USA; [2]Geomatics Program, Department of Civil Engineering, University of Florida, Gainesville, FL 32611, USA; [3]School of Forest Resources and Conservation, University of Florida, Gainesville, FL 32611, USA. **Decadal-Scale Spatial Dynamics of Land Cover, Land Ownership, Land Management in Industrial and Non-Industrial Forests in the Southeastern Coastal Plain Region of**

Urban, agricultural, and plantation forestry landscapes are all dominated by human activities, and each has its own temporal and spatial dynamics. We are studying how climate variability and land ownership and management practices have altered forested ecosystems in the southeastern United States between 1975 and 2000, using an integrated approach of satellite remote sensing, in situ measurement of ecosystem processes, and compilation of land-record archives to define land-ownership patterns. Our focus is on private and state-owned industrial and non-industrial forests. Small (14.4 km x 14.4 km) sample areas are being studied intensively to determine the spatial and temporal patterns of changing land cover, land ownership, and management practices. Land-cover change processes are estimated with remote sensing methods calibrated by long-term (20+ years) ecosystem measurements. This paper describes how spatial patterns, measured by various landscape indices, have changed over the period of study and outlines specific hypotheses that explain the influence of land ownership, natural environmental variation, and their interactions. Preliminary results suggest that the size of the land parcel, but not land ownership, is a good predictor of land-cover change patterns. Large parcels, whether owned by private individuals, commercial forestry companies, or holding companies, are managed as industrial forests and have shown specific patterns as they have been clear-cut and regrown over 25 years. The transfer of land from one commercial enterprise to another, with some conversion from commercial to private ownership (urban development), were the predominant changes in the later part of the time period.

Blaschke, Thomas. Department of Geography and Geoinformation, University of Salzburg, Hellbrunner Str. 34 A-5020 Salzburg, Austria. **Hierarchical Patch Dynamics and Object-Oriented Image Analysis: Multi-Scale Exploration of a Cultural**

Hierarchical patch dynamics (HPD) has been suggested as a conceptual framework for research into landscapes, which incorporates the issues of heterogeneity, scale, connectivity, and non-linearity. Due to theoretical and technological short-comings, much traditional landscape monitoring has been limited to uni-spatial snapshots of the continuums of landscape and to a focus on the pixel as a surrogate for landscape process or pattern. In this paper, the hierarchical patch dynamics framework is juxtaposed with the concept of a multiscalar methodology of image segmentation. It is argued that segmentation-based methods of object-oriented image processing will overcome some limitations of the pixel-centred approach and allow for the integration of semantic rules within the classification process. The fractal net evolution approach is introduced which uses a local mutual best-fit heuristics to find the least heterogeneous merge in a local vicinity, following the gradient of the best-fit. The potential of this approach is illustrated by reporting on an ongoing research program in a traditional cultural European landscape dominated by extensive grazing over centuries and undergoing recent changes. The concept of multiscalar segmentation is applied to a classification of different types of meadows and pastures according to their texture. Some pastures exhibit characteristic textures while they show at the same time similar reflection values per pixel in an infrared aerial photography. It is argued that the exploration and understanding of these spatial patterns opens new ways to explore and understand changes of the driving processes and will enable landscape planners to design grazing schemes to preserve the cultural landscape.

Bolliger,[1] Janine, Erik V. Nordheim,[2] and David J. Mladenoff.[3] [1]Department of Forest Ecology and Management, University of Wisconsin, Madison, WI, 53706, USA; [2]Department of Statistics and Department of Forest Ecology and Management, University of Wisconsin, Madison, WI, 53706, USA; [3]Department of Forest Ecology and Management, University of Wisconsin, Madison, WI, 53706, USA. **A Probabilistic and Spatially Explicit Method to Assign Individual Tree Species to Ambiguously Identified Trees in Historical Land Office Surveys.**

U.S. General Land Office Surveys, which were conducted in the nineteenth century, have been widely used to answer questions regarding vegetation patterns prior to European settlement. However, the surveyor's expertise and care was inconsistent. One of the most widespread problems includes ambiguous trees, i.e., surveyors naming a tree by its genus (e.g., pine) instead of the species (e.g., jack pine). The proportions of these ambiguous trees can be quite large, and make qualitative and quantitative vegetation descriptions difficult. Thus, our goal was to find a method to identify ambiguous trees to the most likely species present. Since the effort should not only satisfy mapping purposes but also be of potential use for quantitative vegetation analysis, this method is solely based on neighboring trees of the same genus as the ambiguous tree rather than using environmental envelopes as in previous efforts. Within different scenarios of radii (500m to 3,000m) the proportions of trees identified to species were calculated. These proportions were then used to identify ambiguous trees of the genus Pinus and Betula to the species level within the respective radius. The method performance was tested in three study areas. A random selection of trees originally identified to species was artificially categorized as ambiguous. The artificially as ambiguous categorized trees and trees originally identified to species by the surveyors were then statistically compared. Results show that the larger the radius, the more trees are accounted for. The method performance, however, is best using radii smaller than 1000m.

Bossenbroek,[1] Jonathan M., Helene H. Wagner,[1] Michelle M. Hawks,[1] John A. Wiens,[2] Beatrice Van Horne.[1] [1]Biology Department, Colorado State University, Ft. Collins, CO 80523, USA; [2]National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101-3351, USA. **Scale Dependency from Colorado to Kansas: How the Environment and the Beetles Come Together.**

The response of a species to landscape structure is scale dependent. Scaling is often conducted by simple aggregation, which ignores gradients and potential threshold responses. Our objective is to determine if scale dependencies of organisms in relation to the environment are constant across a regional moisture gradient. We sampled beetle communities at five grassland sites ranging from the shortgrass steppe of the Pawnee National Grassland in eastern Colorado to the tallgrass prairie of the Konza LTER in eastern Kansas. At each site, 2-km transects were sampled at 50-m intervals for beetle community composition. Soil, vegetation, and temperature data were also collected along these transects. We used moving window analysis and multi-scale ordination to analyze the patterns of scale dependencies of beetle community composition as they relate to the environment. Our results show that these scaling properties differ in a predictable way as one moves from the shortgrass steppe to the tallgrass prairie. We conclude that scaling properties of beetle communities depend on the environmental conditions in which they are set.

Bradshaw,[1] Gay A. and Marie-Josèe Fortin.[2] [1]National Centre for Ecological Analysis and Synthesis and USDA, Forest Service, Santa Barbara, CA 93101, USA; [2]School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6. **Considerations of Landscape Heterogeneity Effects on Scaling and Monitoring of Aquatic Networks.**

Given the increasing rate of landscape change, researchers have realized that managing natural resources sustainably requires knowledge about ecosystems over more than one temporal and spatial scale. Monitoring ecosystem integrity implies sampling over long periods of time and space to identify any significant changes. Nonetheless, there remain aspects related to scaling which limit the ability to detect landscape change with a maximal amount of inference. While successive analyses can be used to estimate errors, it is not clear how spatial reorganization resulting from scaling has diluted the signal of the processes embodied within the observed patterns. This is of particular import for the case of aquatic networks such as streams.To achieve a maximal amount of inference, it is first necessary to match three scales: spatial heterogeneity, the scales of the ecological processes creating landscape heterogeneity, and the spatial and temporal resolutions of the image used in the analysis. We discuss the relationship between scale of spatial pattern, image analysis, and scale of process and how their interactions affect large-scale monitoring quality for the case of aquatic networks. We assert that the interactions between pattern and process need to be considered explicitly when designing large-scale monitoring to accurately describe ecological change. This study and others further support the suggestion that monitoring be coupled with spatio-temporal models to elucidate the mapping from pattern to process across scales. It is stressed that future research efforts be directed to understanding the characterization of space-time relationships implicit in pattern and that we move beyond the space-time duality approach to analysis.

Brandwine, Shlomo. Life Sciences Department, Ben-Gurion University of the Negev, Israel. **Binding Ideas in the Response of Populations to the Dynamics of Landscape Mosaics.**

The Jewish National Fund started approximately 10 years ago to construct ground disturbance in different parts of the arid and semi-arid areas of Israel. Those structures act as traps for water and the resources that it carries. This activity changes the natural landscape into a human-controlled landscape composed of two patch types: patches and patches enriched with water and resources. Those changes invoke the question of how the creation of new patches affects the population dynamics of inhabitant species? This question is a part of a much wider topic in landscape ecology involving the relationships between landscape dynamics and population dynamics.

I used a Field Experimental Model System (FEMS), which entails two patches, 10m by 5m each. I irrigate one of the FEMS patches to create a new patch enriched with an additional 50mm water above the natural rainfall regime. I used a states and transitions matrix-model to analyze the population dynamics of four species of non-flying invertebrates inhabiting the FEMS. I hypothesized that the population response of species differentiating by evolutionary strategies will have a bell shape function. I found that an R-selected species mainly responds to changes in the amount of resources in the patches and its population density increases due to the increase in survival rate. On the other extreme, a K-selected species has demonstrated little response to the treatment overall. Two other species with intermediate characteristics have demonstrated a mixed response, which includes both an increase in survival rate and an increase in migration rate that were correlated to the amount of water in the patches and the relative amount of water between them. These results indicate a matching rule between the spatio-temporal activity scale of the individuals and the scale of the newly created patches.

Brooks, Kerry and Michael Bishopp. GIS and Simulation Laboratory, Interdisciplinary Design Institute and Department of Horticulture and Landscape Architecture, Washington State University–Spokane, Spokane, WA 99202, USA. **Evaluating Conflicts and Costs Associated with Proposed Landscape-Based Salmon Habitat Protection Measures.**

This project examines the implications of land use and management policies proposed by the National Marine Fisheries Service to protect and restore stream and associated uplands habitat for endangered salmon species. Focusing particularly on proposed stream buffer zones, we examine the conflicts between current land-use patterns and desired habitat configurations. In addition, we estimate the costs of achieving these habitat conditions under differing sub-watershed development conditions. We employ Geographic Information Systems (GIS) and ancillary technologies to study a sample of sub-watersheds in the Puget Sound (Washington USA) Basin, stratified by Scheuler's watershed "degradation" categories. Using information on hydrological features, habitat/land cover, parcelization and other data, we analyze the current status of habitat in these sample watersheds, focusing particularly on the proposed stream buffer areas. We then compare proposed buffers and current and desired habitats with parcel and ownership patterns to assess the costs and feasibility of implementing proposed protection measures. Further, we analyze costs for restoration of habitats to desired conditions as they vary amongst the watershed degradation categories. These analyses highlight "conflicts and costs." They provide a basis for suggestions regarding the proposed policies in terms of the extent of current-use conflicts with the desired conditions, and the costs of meeting these conditions. Examination of suggested buffer sizes in relation to parcelization patterns facilitates development of suggestions regarding the "takings" aspects of the proposed policies. Overall, this project develops a basis and methodology for discussing the potential and problems of implementing these habitat protection and enhancement measures.

Bunn,[1] Andrew G., Dean L. Urban,[2] Lisa J. Graumlich.[1] [1]Mountain Research Center, Montana State University, P.O. Box 173490, Bozeman, MT 59717-3490, USA; [2]Nicholas School of the Environment, Duke University, Durham, NC 27708, USA. **Fine-Scale Variability in the Physical and Biotic Templates of Three Alpine Treelines.**

Previous and ongoing research into landscape modeling of ecotones indicates the need to account for fine scale drivers. Understanding the patterns at fine spatial scales is a critical step if we are to derive models of biotic process at alpine timberline. We mapped three focus plots at sub-meter scales to capture demographic mechanisms and environmental constraints at the upper treeline ecotone in the Eastern Sierra Nevada. The focus of the sampling was to account for variability in the physical environment as it affects seedling establishment and tree growth. Foxtail pine (*Pinus balfouriana*) terminates at tree line as upright individuals while whitebark pine (*P. albicaulis*) persists as krumholtz. These two conifers provide for comparisons between environmental constraints and life history strategy. We characterized the physical template to account for differences in topography, soil depth, and soil moisture. We mapped the location of each tree on the landscape. We post-processed the data and performed a multivariate exploration of physical and demographic processes leading to treeline dynamics. We use these data to develop hypotheses about spatial heterogeneity and hierarchical structure as it affects the translations of information across scales in different mountain landscapes. We also ask how we can scale these patterns to an extremely heterogeneous landscape dominated by conifer species with strikingly different life history strategies.

Butaye, Jan, Hans Jacquemyn, and Martin Hermy. Department of Land and Water Management, University of Leuven, Vital Decosterstraat 102, B-3000 Leuven, Belgium. **Differential Colonization Causing Non-Random Forest Plant Species Community Structure in a Fragmented Agricultural Landscape.**

The biotas of fragmented habitats often have been found to exhibit non-random patterns of species composition. An example of such non-random distribution pattern is a nested subset pattern. At both the community and the individual species level we investigated whether a nested community pattern could be found in 84 isolated recent forest fragments. Next the hypothesis that nestedness was generated by isolation and differential colonization was tested. Alternative hypotheses formulated in the past, such as nested habitats and patch area dependent species relaxation, were verified. Individual species colonization probabilities were derived with a logistic regression analysis. Species occurrence in suitable target patches was related with the degree of isolation from occupied source patches. Habitat suitability of each target patch was determined with a habitat space model based on the actual species composition. Albeit the stochastic factor involved in the colonization proces, we found at both levels that the observed non-random community structure resulted primarily from different colonization probabilities and isolation. At the individual species level the degree of nestedness is highly correlated with isolation sensitivity. Based on the results we recommend the use of colonization probabilities to quantify effects of isolation in heterogeneous landscapes. Although migration rates may be superior to study migration within homogeneous forest systems, the consciousness of the importance of geographic isolation on species composition forces us to change our perception on forest conservation and to integrate landscape planning into conservation efforts.

Cadenasso,[1] M.L., S.T.A. Pickett,[1] and W.C. Zipperer.[2] [1]Institute of Ecosystem Studies, Millbrook, NY 12545, USA; [2]USDA Forest Service, Syracuse, NY 13210, USA. **Spatial Heterogeneity in an Urban Watershed: Baltimore, Maryland.**

A guiding question of the Baltimore Ecosystem Study, Long-Term Ecological Research (LTER), is: "How do the spatial structure of socio-economic, ecological, and physical factors in an urban area relate to one another and how do they change through time." A first step to address this question is to define socio-economic, ecological, and physical patches within the study area. This presentation will demonstrate an approach we are using to describe, delimit, and quantify ecological patches in four regions of the Gwynns Falls Watershed, Baltimore, MD. The four regions span the gradient of urbanization present in the watershed. Specifically, we have focused on 1) how can structural patches, based on ecological factors, be described, delimited, and quantified? and 2) how does patchiness of ecological factors differ among the four regions? Digital air photos of submeter resolution, taken during the leaf on season of 1999, were used in an ArcView system to create a data layer of delimited patches. The ecological patches were described hierarchically by three broad categories: forests, open areas, and built structures. Forests are further resolved into patch types based on canopy size. The open area patches represent combinations of non-forest and non-built areas. Patches of built structures are described using a matrix of the type and density of built structures and the types and densities of associated vegetation. We will compare the frequency distributions of patch types in the four regions as well as the degree of spatial heterogeneity that is found in these regions.

Camelo-de-Castro, Ernesto. Department of Plant Biology, Arizona State University, Tempe, AZ 85287, USA. **Landsat MSS and TM Data Preparation for Vegetation Cover Change Analysis: Evaluation on a Cerrado Environment in Mato Grosso, Brazil.**

The main objective of this work is to evaluate the preparation of two Landsat images, of different dates and resolution, for a vegetation cover change analysis. The data tested is comprised of an MSS scene from August 1986 and a TM scene from August 1992, which were obtained from the Tropical Rain Forest Information Center / Basic Science and Remote Sensing Initiative (TRFIC/BSRSI) at Michigan State University. The steps necessary to prepare the data to be used in this kind of analysis are described and discussed, particularly with regards to issues such as quality of metadata, the radiometric and atmosphere correction, geometric correction and scale definition for the analysis. The results show that, with certain precautions, a combination of NDVI and Change Detection techniques can be used to perform vegetation change analysis using the two different scaled images. A reclassification process is also described with the intention of producing a map of land cover suitable for the evaluation of the vegetation change, in case that a vegetation map is not available. The major achievement of this study is a demonstration of how to control for the resolution in the analysis of vegetation cover change using regular quality MSS and TM images.

Canzonieri, Carmela. Faculty of Environmental Studies, York University, 355 Lumbers Building, 4700 Keele Street, Toronto Ontario, Canada M3J 1P3.
Reinforcing the Ecological Structure to Artificial Infrastructure Ratio in Suburban/Rural Landscapes.

This paper looks at the relationship between the pattern of an ecosystem upholding its ecological structure and the scale of the artificial infrastructure imposed upon it. When the difference in scale is substantial, for example a small vegetation patch and an isolated road in a desert, chances are that the ecosystem might escape the effects of the infrastructure, or in a opposite example, that a far ranging ecological structure might be not significantly affected by an infrastructure of a much lower scale. When the scale of the artificial infrastructure is similar to that of the ecological structure, conflicts start to occur at higher and higher frequencies. The effect of a standard infrastructure is then different over different landscapes. This paper presents a case of applied landcape ecology in which the primary goal is to set up concomitant measures to reinforce the ecological-structure/artificial-infrastructure ratio within the ecosystem rather than to manage for harvesting of resources. This paper looks at 1) the effects of arbitrarily placed infrastructure over the functions of components and over the larger ecological processes, 2) mechanisms that have a positive influence on the strength of the system, and 3) a spatial scenario capable of reinforcing ecological structure by reducing redundant infrastructure while accommodating a necessary level of it. Key issues are road effects, connectivity, network, ecological structure to artificial infrastructure ratio, and strategic infrastructure downsizing.

Cardille,[1] Jeffrey A., Jonathan A. Foley,[1] Marcos Heil Costa.[2] Center for Sustainability and the Global Environment, University of Wisconsin, Madison, WI 53706, USA; [2]Department of Agricultural Engineering, Federal University of Viçosa, Viçosa, MG, Brazil. **Scaling Down Successfully: A New Method For Integrating Census and Satellite Data.**

As part of our effort to develop long-term, historical datasets of land cover in the Amazon River basin, we have developed a new method for merging satellite-based imagery and ground-based agricultural census information. This method allows us to scale down polygon-based census data by simultaneously considering satellite-based land-cover data for the same area. We began by developing a spatially explicit agricultural census data set for each of the countries in the basin and produced a new map of county-level agricultural activity for the mid-1990s. We then developed a new technique to merge this census map with satellite-based land-cover classifications and produced a new, 5-minute (9 km) gridded data set with attributes of both the census and satellite data. The method uses regression trees to represent the statistical relationship between the county-level agriculture density data and the categories of the relatively fine-grain satellite classification. We then used this relationship to determine the most likely agriculture density in each cell of a regular grid of intermediate spatial scale. The net result is a fused map that preserves the overall amounts of agriculture, distributed with the finer spatial scale of the satellite imagery. We believe that this method is a generally applicable approach to problems of scaling down data in a way that is consistent with other information sources. This presentation will introduce the problem, the regression tree method, and criteria for selecting among candidate solutions.

Charpentier,[1,2] M, C. Wigand,[2] R. McKinney,[2] M. Chintala,[2] G. Thursby,[2] and J. Kiddon.[2] [1]OAO Corporation, 27 Tarzwell Drive, Narragansett, RI 02882, USA; [2]EPA, NHEERL, 27 Tarzwell Drive, Narragansett, RI 02882, USA. **A Geographic Information System (GIS) Analysis of Water Transit Through Watersheds of Subestuaries in Narragansett Bay, Rhode**

A watershed approach was used to examine the integrity of 10 salt marshes of similar geomorphology and hydrology in Narragansett Bay, Rhode Island. The integrity of salt marshes is described as the capability of a salt marsh to provide key ecosystem services, including water quality maintenance, wildlife habitat, food production, erosion control, and recreation/cultural use. Indicators of these services are being developed from measures of ecosystem structure and function in marshes of varying anthropogenic stress based on watershed land use (i.e., percent residential, industrial, agricultural, and natural lands). As part of this study, a GIS analysis was utilized to examine patterns of water transit and how various natural lands act as nutrient sinks. A topographic model for each watershed was developed which integrated the surface hydrology of the respective watershed. Using the topographic model, a surface flow network was determined for each watershed. The surface flow network models the surface flow of water for all locations in each watershed. Land-use information was then draped over the surface flow network so that the contribution of flow from any particular land-use type could be determined for any location in the watershed. Summary values of the contribution of flow from land-use types was determined at several sampling locations within each watershed for comparison to field measurements. By adjusting the surface-flow network such that flow was intercepted by natural lands, it was possible to examine the effects of natural lands acting as sinks for nutrients.

Chen, Chang-Jui. Department of Landscape, Chinese Culture University, 100, 2F, 125, Chung-Hua Rd., Sec.2, Taipei, Taiwan. **Landscape Spatial Patterns of Three Kinds of Irrigation Areas in Taoyuan Terrace, Taiwan.**

The agricultural landscape is a mosaic of natural and human-managed patches that vary in size, shape, and arrangement. Therefore, the analysis of landscape spatial patterns is an important component of understanding ecological dynamics. Traditional paddy farming villages in Asia used to have various important parts to play among urban, rural, and natural areas. Those paddy fields with waterway networks and hedgerows among farming villages were functioning as: 1) habitat of species, 2) ecological networks for traveling among urban, rural, and natural areas, 3) buffer zones that repress human influences flowing from cities into natural areas, 4) flood control, water quality improving, and revitalizing groundwater. However, as urbanization and industrialization advances, biodiversity existing there has been largely damaged, and ecological orders among urban, rural, and natural areas are also about to collapse. The focus of the first part of this paper is to research and analyze the change of culture landscape of the Taoyuan terrace in Taiwan and to find out the special agricultural development mode and social formation of three kinds of irrigation areas before 1980s. The focus of the second part of this paper is to analyze the landscape ecology structure change complexity and diversity of landscape elements in composition, structure, and function over three kinds irrigation areas of the Taoyuan Terrace in Taiwan during urbanization and industrialization processes in the last two decades by using landscape ecology theorem and geographic information system (GIS). Due to the need of special geographical environment and irrigation, the type and size of irrigation pond and waterway form the typical agriculture ecological and geographical landscape of Taoyuan Terrace before the 1980s. Throughout the individual period (1982–1988–1994), G.I.S. data study of the areas of rice field in the three kinds of irrigation areas of Taoyuan Terrace rapidly decreased due to urbanization and industrialization. This study establishes a set of systematic research methods and theorems from landscape ecology—including various spatial pattern indices, such as fractal dimension, fragmentation, diversity, dominance, evenness index of landscapes, and shape index in combination with characteristics of patches, such as total numbers, mean size, size ranges, corrected perimeter-area ratio, compactness, patch elongation index, grain shape index, and patch edge. These were then used to detect and analyze the changes of landscape elements, classifications, and the relative arrangement of patch type within landscape mosaic over the study period. Finally, this study proposes sustainable development strategies that will cater to future changes.

Chen, Grace F. Department of Geography, University of Iowa, Iowa City, IA 52242, USA. **Relating Landscape Patterns to Hydrological Processes in a Watershed Hierarchy.**

A watershed-based approach is required to address the cumulative impacts of nonpoint source pollution that occurs across the landscape and to link the terrestrial and aquatic environments through hydrological cycles. According to the principles of hierarchy theory, which suggests that spatial patterns, processes, and their interactions vary with scale, relationships between land and water need to be discerned at characteristic scales. To explore the effects of scale on landscape properties, hydrological processes, and pattern-process interactions, an Iowa watershed encompassing some 11,000 km_2 is first decomposed into three hierarchical levels, within which various numbers of subwatersheds are contained, using GIS techniques. Watershed processes and landscape properties are then quantified for each subwatershed using hydrologic modeling and pattern analysis techniques. Based on the simulated results and chosen indices of landscape pattern, relationships between landscape patterns and hydrological processes are established at each hierarchical level. How dominant factors controlling pattern-process interactions change with scale and errors resulting from scaling are finally evaluated across the watershed hierarchy. This case study reinforces the importance of identifying characteristic scales for particular nonpoint source problems and exemplifies how the effects of scale on spatial patterns, processes, and their interactions can be explored through a hierarchically structured framework using GIS techniques and hierarchical ANOVAs.

Chen, Jiquan,[1] Eugenie Euskirchen,[1] Tom Hayes,[2] Siyan Ma,[1] Treneice Marshall,[1] and Sari Saunders.[1] [1]School of Forestry & Wood Products, Michigan Technological University, Houghton, MI 49931, USA; [2]University of California, Berkley, CA 94720, USA. **Are Edge Effects More Pronounced at Edges?**

Edges and areas-of-edge influence (AEI) created by natural or human-induced disturbance account for a large proportion of many landscapes. Vertical flows of materials and energy within the AEI differ from those within the same area prior to the disturbance. Some direct alterations related to edge creation include changes in light levels, precipitation, seed/pollen rains, deposition, and outgoing radiation. Horizontally, there will be a series of mixing processes because of the differences between the two adjacent communities (E_1 and E_2). These horizontal mixing processes are described by employing two differential equations based on the diffusion rate between the edge and the adjacent communities: $\Delta E_1/\Delta D_1 = K_1$, and $\Delta E_2/\Delta D_2 = K_2$, where D_1 and D_2 are distance from the edge in E_1 and E_2, respectively, and K_1 and K_2 are the diffusion rates. Through model simulations of varying K_1, K_2, E_1, and E_2, we found that edge influences do not always peak at edge (i.e., 0 distance). This phenomenon is further supported by field data of several empirical studies examining understory vegetation, stand structure, physical environment, litter, and other ecosystem processes (e.g., decomposition) at the edge and its adjacent communities. We emphasize that edge effects are a result of complex vertical and horizontal mixings. Depending on the variable of interest and timing of the event, various gradients between E_1 and E_2 can be predicted. In addition to the empirical-based edge studies, a more process-based approach is critical in terms of understanding the horizontal mixing processes associated with the AEI.

Chen, Yufu, Ming Dong. Institute of Botany, Chinese Academy of Sciences, Beijing 100093, P.R. China. Quantifying **Spatial Pattern of a Sandy Landscape in Northern China by Lacunarity Analysis.**

Quantifying spatial pattern is an important goal in landscape ecology because of the effects of spatial pattern on ecological processes. Lacunarity analysis, as a more general technique than fractal methods, was introduced to ecologists. In order to quantify the spatial pattern of the Mu Us sandy landscape of North China, two transects (both 5-km long) intersecting at a right angle were set to investigate plant cover percentages by contiguous 5m x 5m quadrats. Those with plant cover of 20%, representing the occurrence of mobile-sand sites along the transect, were chosen as habitats of interest. The lacunarity analysis was executed for the empirical data as well as simulated random sequences and simulated transects of all clustered at the extremes with the same percentage of occupied habitats of interest as the real transects. Both real transects exhibited higher lacunarity than random sequences, but far lower than simulated clustered transects, suggesting moderate clumping of mobile-sand sites along transects. The lacunarity curves for both real transects had distinct breaks in slope, implying a scale dependent heterogeneity of the sandy landscape. These breaks may suggest multi-scale dominant processes controlling the distribution of mobile-sand sites. The difference in shape of lacunarity curve between two empirical transects revealed anisotropy in spatial structure of mobile-sand sites. Lacunarity is sensitive to changes in landscape texture, which makes proliferating of detectable.

Chew, Jimmie D. USDA Forest Service, Rocky Mountain Research Station, Missoula, MT 59807, USA. **Integrating the Simulation of Disturbance Processes at Landscape Scales.**

A simulation system has been developed to provide for the interaction of fire and insect and disease disturbance processes within a spatial pattern of vegetation communities. The probability of disturbance process occurrence by individual plant communities is determined by using a combination of vegetation attributes, past processes and treatments, and the conditions and past processes of adjacent plant communities. The predicted probabilities are used to create multiple simulations that provide ArcView maps for the frequency of occurrence for both disturbance processes and vegetation attributes. Landscapes can be simulated in yearly or decade time steps. Vegetation input layers can be irregular polygons or uniform, rectangular polygons of a size specified by the user. Vegetation treatments can be scheduled. The system is being used in Region One of the USDA Forest Service for landscapes ranging from a few thousand acres to millions of acres. The system is one of a number of models currently being compared at a number of geographic locations across the United States in a Joint Fire Science study. The systems' behavior for predicting fire spread and intensity is compared to a large wildfire occurring in the summer of 2000 on the Bitterroot National Forest.

Clagget,[1] Peter, Michael Strager.[2] [1]Canaan Valley Institute, Valley Forge, Pennsylvania 19482-0964, USA; [2]West Virginia University, Morgantown, WV 26506-6108, USA. **An Interactive GIS Landscape Change and Analysis Tool.**

The Natural Resource Analysis Center at West Virginia University and the Canaan Valley Institute are developing an ArcView GIS extension to evaluate the impacts of landscape changes using indicators related to water quality, wildlife habitat, and overall landscape condition. Users of the extension will be able to interactively incorporate changes to the landscape to predict where changes might occur from urban expansion. This will be accomplished within the major components which include the ability to define a study area location, summarize existing landscape condition, perform landscape related water quality analysis, perform wildlife habitat analysis, and model the effects of land-use change. Land-use change may be implemented in one of two methods. The first method will be an interactive model of potential land development. The model is based on topography, existing development (urban or residential areas), and existing land uses. The user will have the ability to specify likelihood of conversion to developed land uses for different existing land uses, as well as restrictions to development such as zoning or parcel boundaries. The second method of specifying land-use change is actual delineation of changes using either on-screen digitizing and subsequent land-use reclassification within ArcView or incorporation of digital map data files from other sources. For example, a new digital map data might indicate the location of a proposed mine outline. This effort is expected to result in the development of improved methods that support policy development, community decision making, and agency implementation.

Cole, Marlene B. and Richard G. Lathrop. Department of Ecology, Evolution and Natural Resources, Rutgers University, 14 College Farm Road, New Brunswick, NJ 08901, USA. **Spatial Relationships of Environmental and Sonar Backscatter-Derived Variables to Fish Abundance Data in the New York Bight.**

We employed multivariate and spatial statistics to determine the relationships among fish abundance patterns and several physical characteristics of the New York Bight. With some three decades of research trawl sampling data for juvenile and adult summer flounder (*Paralychthys dentatus*) and silver hake (*Merluccius bilinearis*), we assessed the relationships among the fish abundance and spatial location, depth, and a concavity/convexity index based on depth. In addition, we analyzed fish abundance patterns in relation to backscatter from sidescan sonar, along with local and regional measures of heterogeneity and a bottom type classification based on sonar data, landform, and sediment type. Both life stages of the two species exhibited pronounced seasonal and interannual variability in abundance. In spring, adult summer flounder displayed statistically significant associations with the depressional bottom class while adult silver hake associated with the outcropping class. We ran a series of simple and partial Mantel tests to assess correlations in similarities of fish responses and the environmental variables among sample points. Mantel tests showed that autumn adult silver hake patterns exhibited a significant association with measures of regional (105,600 m2) heterogeneity, as measured by mean and variance of sonar backscatter, irrespective of spatial location. Regional measures of heterogeneity were more closely related to the fish data than were local area (400 m2) measures. This work contributes to efforts that attempt to identify and conserve essential fish habitat as mandated in the Sustainable Fisheries Act of 1996.

Condon, Patrick and Sara Muir. University of British Columbia, Landscape Architecture, 387 MCML Bldg. 2357 Main Mall, Vancouver, British Columbia, Canada V6T 1Z4. **The Headwaters Sustainable Community for 13,000: The East Clayton Neighborhood Concept Plan.**

The James Taylor Chair asserts: "The site is to the region what the cell is to the body." Just as the health of the human body is dependent on the individual cells within it, so too is the urban region dependent on the health of the individual sites that comprise it. Therefore, site and neighborhood design influence the ecological, social, and economic health of the region. The Headwaters Project heals the "cell" of the site in order to heal the "body" of the region. The plan for East Clayton demonstrates how sustainability principles can form the foundation for a more sustainable community design, and can, in turn, lead to a more sustainable region. The plan shows that we can virtually eliminate water pollution, and cut air pollution by over 40% (through reduced trip generation), simply by changing the way we design our neighborhoods. The Headwaters Project is an innovative blueprint for sustainable development, and it is now influencing the development of "lighter, greener, cheaper, smarter, and complete communities" throughout Cascadia's urban landscape. The project represents a model that may be appropriate for application in other urban, and urbanizing, environments.

Crewe , Katherine. School of Planning and Landscape Architecture, Arizona State University, Tempe, AZ, USA. **The Origins of Phoenix Farming.**

The area around Phoenix has been settled by many different farming communities over the years, from both within the country and without. Each community has brought its own customary farm practices, but adapted these to arid desert conditions. Using historic slides, this presentation traces the development of early farming, dating back from the Hohokam Indians, and including the early white settlers; then later groups following the opening of the Roosevelt Canal, growing the area's chief crops of alfalfa, cotton, and citrus, but also cultivating exotic ventures such as ostrich and date farming, or specializing in cut flowers or sugar beets.

da Costa Gurgel, Helen, Nelson Jesus Ferreira. Instituto Nacional de Pesquisas Espaciais (INPE), Caixa Postal 515-12201-097, São José dos Campos, SP, Brazil. **Spatial and Temporal Variability of NDVI over Brazil and Its Connections with the Climate.**

The dynamics of the vegetation affects the environment directly. Studies on these dynamics are necessary for the compression of the Global Changes that has reaching our planet in the last decades. Motivated by that problematical, this work intends to study the connections between NDVI (Normalized Difference Vegetation Index) and annual and interanual climatic variabilities over Brazil. For this purpose, NDVI and OLR (Outgoing Longwave Radiation) data, obtained from NOAA–AVHRR between January 1982 and December 1993, were analyzed. Principal Component Analysis (PCA) was the statistical tool used to accomplish this study. PCA was done at both NDVI and OLR data. The results of OLR data allow a climatic characterization in space and time of the main climatic systems that act on Brazil. It was observed that the first component represents the mean pattern of convective activity; second and fourth components are associated with the summer/winter and spring/autumn modes of the annual cycle; the third component shows the variations modulated by El Niño's events. The PCA of NDVI demonstrated the potentiality of this variable in characterizing the main features of vegetation that prevail in the Brazilian territory. In addition, annual and interannual variability of these vegetation groups related to the climatic variability (components 1, 2, and 3) was characterized. PCA also revealed the main "non-climatic" factors that disturbs NDVI, which are: the occurrence of burns, NOAA's satellites period delays, and the changes of NOAA's satellites 9 and 11 (components 4, 5, 6 and 10).

Dale, Virginia H. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6036, USA. **Top Ten Landscape Ecology Issues for the Next Millennium.**

The top ten landscape ecology issues for the next millennium are: (1) Land-use change – understanding the causes and implications of land-use and land-cover changes at local and regional scales; (2) Environmental changes – developing the ability to understand and predict effects of climate and other environmental changes at local and regional scales; (3) Data – developing the means to handle the large amounts of data that are becoming available; (4) Communication – developing the language, repertoire, and means to communicate what landscape ecology has to offer to decision makers, including individuals, private companies, environmental organizations, elected officials, and agency employees. (5) Models – using the best available technology to appropriately understand and predict key landscape processes. (6) Resource management – addressing how patterns in space and time affect resources and their management. (7) Scaling – developing and testing methods for translating information across scales. (8) Experiments – building a body of landscape experiments that use scientific methods to test ideas about landscape ecology. (9) Interdisciplinary research and approaches – building the firm bridges to other disciplines that are necessary to address landscape issues. (10) Sustainability – developing an understanding of what sustainability means for landscape ecology. This understanding will involve consideration of ecological, social, cultural, aesthetic, and economic components of sustainability over a region.

Dale,[1] M.R.T., M.-J. Fortin,[2] and P. Legendre.[3] [1]Department of Biological Sciences, University of Alberta, Edmonton, Canada T6G 2E9. 2School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6; [3]Département de sciences biologiques, Université de Montréal, Montréal, Canada H3C 3J7. **Accounting for Spatial Autocorrelation in Statistical Tests of Landscape**

In statistical testing and other quantitative assessments of ecological characteristics at the landscape scale, the presence of spatial autocorrelation in the data can have a large effect on the results and their interpretation. In this presentation, we briefly review this problem and then describe some of the approaches that can be used to solve it, concentrating on statistical analysis rather than on experimental or sampling design. Approaches include the deflation of the test statistic and the adjustment of the effective sample size. We will comment on these and on Monte Carlo and restricted randomization techniques. We will distinguish between tests where solutions to this problem are known and those for which solutions are yet to be found. The discussion will be illustrated with examples from simulation studies. Furthermore, using fire and boreal forest data at the landscape scale, we will compute the correlation between these spatially autocorrelated variables and compare the significance tests based on two different procedures.

Dalton, Deborah W. Division of Landscape Architecture, University of Oklahoma, Norman, OK 73019, USA. **Eco-Revelatory Design: A Cautionary Tale of Two Designs in the City.**

Between 1997 and 1999, the author was co-designer for two landscaping projects that emphasized a native plant palette and expressed visually the qualities of the local native landscape. Both projects were of such small scale that it was not possible to include ecological function as a workable goal. However, the designers believe that it is important to try to create expressions in the landscape that reflect or recall the native landscape of the area as a means of re-educating people about the native landscape. This more ecologically expressive approach represents a different aesthetic than is normally expected or accepted in urbanized settings, and carries with it a number of conflicts with typical cultural aesthetic values. The "Oklahoma Canyon Garden," used the canyon landscapes found in the state as a model for re-landscaping a two story deep 30' x 125' lightwell in the University of Oklahoma Library Plaza in Norman, Oklahoma. The other project, "Bluestem Stream," used the metaphor of a stream to create an undulating swath of native prairie plants and stone in a matrix of little bluestem grass on the Oklahoma City campus of the University of Oklahoma Health Sciences Center. While these two projects were installed, neither of them was completed totally as the designers originally intended. The proposed presentation, supported extensively by slides, will describe the projects, discuss some of their theoretical and philosophical underpinnings, and discuss the problems associated with trying to design in a more ecologically expressive way.

David,[1] John (EBo) and Jianguo (Jingle) Wu. [1]Department of Plant Biology, Arizona State University, Tempe, AZ 85287, USA; [2]Department of Life Sciences, Arizona State University West, Phoenix, AZ 85069, USA. **Toward Developing a Hierarchical Patch Dynamics Modeling Platform.**

Many of the ecological questions posed today are by their very nature multi-scale, interdisciplinary, and spatially extended. Historically, the effects of spatial pattern were often assumed to have little or no effect on the dynamics of ecological systems. In these instances problems were decomposed only vertically (as in hierarchy theory). In other cases, the importance of spatial relationships were recognized and the models were spatially explicit, but were "flat" to avoid the added complexity inherent in hierarchical models. The arbitrary separation of system complexity into these distinct camps was in part the motivation behind the integration of Hierarchy Theory with Patch Dynamics into Hierarchical Patch Dynamics. In addition to the theoretical and epistemological framework, there are numerous ways that sub-models can be represented that have profound consequences to model performance in terms of computational time, numerical stability, and error characteristics. We are developing a Hierarchical Patch Dynamics Modeling (HPDM) platform for integrating multi-scale heterogeneous models. As such, the HPDM platform is intended to function as a framework from which multi-sale ecological models can be developed and integrated in an efficient and coherent manner. Here we demonstrate how the HPDM platform works through a series of examples. These include: 1) a forest stem map simulator to be used in modeling fire risk assessment and the effects of fire reintroduction in Ponderosa Pine forests; 2) a simple model of land-use change utilizing ownership, domains of influence, and local rules; and 3) a model of native plant recruitment as a function of managed dam releases and water availability as indicated by global process indicators.

de-Camino-Beck, Tomas and Arturo Sanchez-Azofeifa. Earth and Atmospheric Science Department, University of Alberta, Edmonton Alberta, Canada T6G 2E3. **A Critical Review of Landscape Fragmentation Measures Using Cellular Automata.**

In the past, the behavior of landscape fragmentation measures have been analyzed using simulated neutral landscapes, with a small set of unrealistic random patterns that do not represent, in general, realistic landscapes. In this paper we argue, using four simulated landscapes created with cellular automata rules (anneal, ortho, blocks, and patches) plus random generated landscapes, that current measures used by the landscape ecology community are not enough to understand landscape fragmentation. Our results show that different types of landscapes, resulting from different dynamics expressed in the cellular automata rules, can have similar values in many measurements, leading to misinterpretation of how a fragmented landscape would appear in reality. Our results also indicate that percolation thresholds and total percolation values for non-random landscapes differ from theoretical values when compared against random generated maps, and that landscape measures do not have unique solutions as previously believed. We also show that values such as lacunarity, landscape division, spatial entropy, mass entropy, and percolation thresholds are more robust measures of landscape structure and fragmentation than the common used by the community (e.g. patch density and fractal dimension). In this paper, we suggest that non-random landscapes created with cellular automata can be used to establish a general landscape classification scheme to estimate critical values for landscape fragmentation. Finally, we suggest that a concise definition of landscape fragmentation, accounting for both temporal and spatial dynamics of land-use/cover and meta-population properties, must be established.

Decker,[1] E. H., B. T. Milne,[1] F. A. Smith,[1] and S. M. Elliott.[2] [1]Department of Biology, University of New Mexico, Albuquerque, NM 87131, USA; [2]Division of Earth and Environmental Sciences, Los Alamos National Laboratory, Los Alamos, NM 87545, USA. **General Patterns in the Spatial Structure of Urban Networks.**

Urban ecosystems are gaining attention as important sites for ecological research. While substantial modeling and fieldwork is being conducted on the ecology in cities, little is known about processes that govern the distribution of urban areas around the world, i.e., the ecology of cities. Here we analyze the spatial structure of inter-urban networks globally, using satellite, census, and traffic data. We examine size-specific, nearest neighbor distances; rank size distributions; and measures of spatial arrangement to quantify patterns of urban distribution. We then describe how these patterns are governed by ecological and energetic constraints on the flow of material and energy through and among urban areas. We find that hierarchic patterns of city distribution are general and global, which suggests that socioeconomic details are unnecessary for understanding macroscopic patterns of human settlements.

DeFee II, Buren B., Douglas Wunneburger. Department of Landscape Architecture and Urban Planning, Texas A&M University, College Station, TX 77840, USA. **Integrating Stakeholder Concerns into Open Space Planning Decisions.**

Substantial population growth in Texas is contributing to the spread of urban areas into the surrounding countryside. Two nearby major metropolitan areas, Houston and Austin, and one smaller metropolitan area within the COG, Bryan/College Station, provide centers for high growth potential within the counties under the jurisdiction of the Brazos Valley Council of Governments (BVCOG), a seven county regional planning organization located in central Texas. In preparation for urban growth into its rural areas, the Environmental Subcommittee of the BVCOG has called for the creation of an Open Space Plan. The first step in open-space planning is creating an inventory of land that is currently used as, or could be preserved as, open space. Several problems have been identified as central to this process: (1) Open space is poorly defined and largely dependent on local values. (2) Appearance of outside experts with answers to your problems will alienate many stakeholders within the COG. (3) A mechanism for delivering information is as important as the open-space inventory database itself. To address these issues as well as to develop the open-space inventory database, the GeoInformatics Studio is developing an Internet-based, open-space decision support system. This system will identify potential open-space areas through physical and ecological characteristics, yet include local citizen values when determining what areas to consider for conservation. Ultimately, the system will rank areas within the COG quantitatively for desirable open-space characteristics based upon existing resources, identified needs, and expressed local values.

Desimone, Steven M., Brian L. Cosentino, Joseph B. Buchanan, D. John Pierce, and Timothy Quinn. Washington Department of Fish and Wildlife, 600 Capitol Way North, Olympia, WA 98501, USA. **Riparian Buffers as Habitat for Northern Goshawks: A Spatial Assessment at Three Scales on Managed Forest Landscapes in Western Washington.**

Recent changes in State Forest Practices standards will result in wider riparian buffers along most streams in Washington. Although forest landowners hope to meet multiple species habitat requirements in the buffers, their value for most wildlife species is unknown. We wanted to assess whether riparian areas in managed forests will meet specific area thresholds of the Northern Goshawk (*Accipiter gentilis*) at three spatial scales: nest site, post-fledging family area (PFA), and home range. A spatially explicit model using a grid cell-based "moving window" assessment determined if threshold area amounts (75, 40, and 40% of 48 [nest], 170 [PFA], and 2200-ha [home range] "windows," respectively) occurred at each spatial scale. Using GIS-generated buffer widths (24.4, 30.5, and 39.0 m) that reflect a likely range of riparian protection, we mapped buffer areas on a randomly selected township of lowland forest in western Washington. Our results suggest the new riparian standards may be inadequate for goshawks because moderate (30.5-m) buffers and moderate stream density did not meet area thresholds at any of the spatial scales. Analysis using 39.0-m buffers indicated that thresholds were met for the two larger spatial scales on part of the moderate density landscape. Results from analyses in landscapes with higher and lower stream densities will be presented and discussed. Where area thresholds were not met, either increasing buffer width in localized areas, extending the length of harvest rotations, or parsimonious designation of adjacent uplands as goshawk habitat met area threshold goals.

Dixon, Mark and Monica Turner. Department of Zoology, University of Wisconsin, Madison, WI 53706, USA. **Modeling the Effects of Flow Variation on Recruitment Dynamics of Riparian Trees.**

Plant communities are influenced by the timing of disturbance relative to species-specific demographic processes. Using a combination of field sampling and simulation modeling, we examined the influence of temporal flow variation on the recruitment of riparian tree seedlings on Wisconsin River sandbars. Field data for 1997-2000 showed high variation in flows, seedling abundances, and species composition among years, with mid-summer flow pulses exerting strong influences on the composition and density of new germinants in 3 of the 4 years. Based on these results and data from the literature, we developed a rule-based model to link variation in river flow with annual seedling recruitment of riparian trees. Key relationships in the model include (i) the effect of water level and sandbar topography on dispersal and deposition of seeds and (ii) the importance of the timing of sandbar exposure/inundation relative to seed dispersal. We predict that strong recruitment years will be episodic and will occur when flows are low, stable, or declining during the growing season. For particular tree species, we predict that recruitment success in a given year will also be related to the timing of flows in relation to the dispersal phenology of that species. Possible uses of the model include projecting the impacts on riparian vegetation dynamics of flow regime changes due to regulation or climate change

Drummond,[1] Mark A., Raymond D. Watts,[2] Roger Compton.[3] [1] USGS, MESC, 4512 McMurry Ave., Fort Collins, CO 80525, USA; [2]USGS/CIRA, Colorado State Univ. Foothills Campus, Fort Collins, Colorado 80523, USA; [3]USGS, RMMC, P.O. Box 25046, MS516, Denver, CO 80225, USA. **Temporal Effects of Human Influence on Rural Landscape Pattern and Wildlife Habitat in Teton County, Wyoming.**

Fragmentation of wildlife habitat has been cited as the number-one strategic concern of Park Service, Fish and Wildlife Service, and Forest Service managers in the Greater Yellowstone Area (GYA). Comprehensive measurement of fragmentation in the GYA is, however, lacking—in part because of limitations of available geographic data and in part because of the lack of a consensus methodology for measuring fragmentation. Our study assessed the effect of various data sets (including maps of roads and clear-cuts) on the development of fragmentation maps and statistics, working in a study area between the Gros Ventre and Teton Wilderness Areas in Teton County, Wyoming. The quality and currency of road maps used in the analysis makes a discernible difference in the outcome, as does the seasonal opening and closing of National Forest roads. Our results indicate that comprehensive mapping and measurement of habitat fragmentation will be reliable only with a consistent, recent data set that is augmented with information about seasonal administrative closure of roads. Our results also suggest that traffic-density information for open roads will have a discernible effect on measures of fragmentation.

Ehle, Donna S. and William L. Baker. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. **Influence of the Spatial Distribution of Pre-European Disturbance Events on Ponderosa Pine Age Structure in Rocky Mountain National Park, USA.**

Supporters of historic stand structure restoration advocate fuel reduction to return ponderosa pine landscapes to a pre-European settlement state. We mapped and aged live and dead trees and mapped and dated fire scars in 9 plots in the ponderosa pine zone in Rocky Mountain National Park, USA. The historic ponderosa pine landscape in Rocky Mountain National Park was likely shaped by beetle epidemics and a mixture of fire regimes. Before European settlement, some stands were burned by crown fires, some stands were burned by surface fires that torched some trees, and some stands were burned by both crown and torching surface fires. Fire spread over the landscape was inferred from approximate death years of dead wood and germination years of live and standing dead trees. Crown fires led to simultaneous tree recruitment. Torching of trees during surface fires resulted in a patchy spatial distribution of mortality and resulting regeneration. Regeneration resulting from surface fires did not always occur at the locations of trees killed by the same fire and may represent areas favorable for regeneration in the absence of competing vegetation. Dating of dead wood in some plots allowed temporal reconstruction of pre-European stand-initiating and stand-replacing events. Missing cohorts (no dead wood) between these events may indicate beetle epidemics or other events that would cause wood to decay especially quickly. Results from this study indicate that temporal and spatial events that shaped pre-European ponderosa pine landscapes in Rocky Mountain National Park were more heterogeneous than previously thought.

Euskirchen, Eugenie,[1] Jiquan Chen,[1] Harbin Li,[2] and Eric Gustafson.[3]
[1]Michigan Technological University, Houghton, MI 49931, USA; [2]USDA Forest Service Center for Forested Wetlands Research, Charleston, SC 29414, USA; [3]USDA Forestry Sciences Laboratory, Rhinelander, WI 54501, USA.
Modelling Net Carbon across a Hypothetical Landscape Under Alternative Harvesting Strategies.

Forests have been considered as the major carbon sink within the global carbon sink. However, the amount of carbon sequestered by a fragmented landscape, which varies significantly in its composition and age structure, generally remains unknown to the scientific community. The temporal dynamics and spatial distribution of net ecosystem production (NEP) in a mosaic are dependent on patch type and its chronosequence in the landscape. In light of this, we have devised a model, LandNEP, to follow the change in NEP by patch type and chronosequence. Three different scenarios have been simulated within a 10,000 ha hypothetical landscape. Over a period of 300 simulation years, the biomass of the landscape ranged from 41,900 Mg to 102,200 Mg, and the cumulative area harvested ranged from 783,500 to 134,300 ha. Based on these scenarios, we are able to demonstrate that theoretically, timber harvest strategies requiring rotations at the time of a patch's maximum NEP will ultimately yield the greatest cumulative NEP value. These results suggest that carbon losses within a managed landscape could be mitigated by permitting the ecosystem to reach its maximum as a net carbon sink and harvesting timber directly at the point. Therefore, alternative management scenarios play a leading role in determining to what extent a landscape sequesters carbon.

Ewan,[1] Joseph M. and James P. Burke.[2] [1]School of Planning and Landscape Architecture, Arizona State University, Tempe, AZ 85287, USA; [2]Parks, Recreation and Library Department, City of Phoenix, Phoenix, AZ, USA.
The Sonoran Preserve Master Plan: Integration of Landscape Ecology with the Design and Planning of Open Space.

In Metropolitan Phoenix, Arizona, over an acre of open desert land is cleared for development every hour. *The Sonoran Preserve Master Plan* (1999) presents a vision for how 21,500 acres can be set aside for public open space and wildlife habitat within the city. This presentation addresses how both aesthetic and scientific perspectives informed the planning and design process for this urban preserve. Development of this plan differs from the city's prior open space planning efforts. The planning methods combine traditional planning and design techniques, such as inventory and analysis, with public input and landscape ecological theory. University contributions through research (wildlife and vegetation inventories, habitat suitability analysis, GIS modeling, and land value analysis) and collaborative planning practices (charrettes and symposia) helped integrate cultural and ecological needs and concerns into the plan. As a result of a planning process that embraced ecological landscape design, the Sonoran Preserve incorporates a diversity of desert biotic communities and landforms, and includes culturally significant features. It protects desert tortoise habitat and preserves undisturbed xeric-riparian corridors—both threatened and declining members of the regions natural ecology. It nearly doubles the amount of preserved desert land in the city and plays a significant role in the shaping of future urban form. *The Sonoran Preserve Master Plan* provides a model for reconciling human and non-human nature in the biggest city in the fastest growing county in the nation. More directly the plan provides important urban open space so future generations can, through direct contact, learn to love and respect a place of fragile beauty.

Fairbanks,[1] Dean H.K., and Albert S. van Jaarsveld. Conservation Planning Unit, Department of Zoology and Entomology, University of Pretoria, Pretoria 0002, South Africa. **Human-Ecosystem Co-Evolution: Avian Diversity and Structure within African Land Transformation Systems.**

Conservation is largely affected by socio-economic imperatives. Various levels of human landscape development represent a co-evolutionary process between a social system and an ecosystem. We examined the distribution and abundance of bird species across two southern African development gradients using bird census data in KwaZulu-Natal Province, South Africa. The region represents a gradient of African rural to Western first world commercial agriculture and urban land-use running from relatively undisturbed to highly developed and includes nature reserves, subsistence farming, commercial farming, exotic plantations, small holdings, and residential and industrial areas. In an effort to understand avian community temporal dynamics, pattern, and scale, it is instructive to consider these in a hierarchical fashion, from the broadest to the most localized. Broad environmental and landscape-scale pattern factors are examined as contributions to regional variation in assemble age composition, and the influences of physical environment, biotic factors, and human disturbance processes are explored. Different environmental factors assume varying degrees of importance among localities within a region, and landscape pattern or land-cover proportion are likely to be dominant in importance in a similar manner. The hypothesis that topographic, temperature, and moisture factors assume the greatest importance of explaining variation in bird diversity at coarser scales, and landscape pattern and land-cover proportion explains the remaining variation in diversity, based on the type of development model, in a hierarchically scaled manner is confirmed. The analysis places crucial questions on the roles of establishing isolated nature reserves and their ability to preserve bird diversity persistence in the developing landscape.

Farina, Almo. Faculty of Environmental Sciences, the Urbino University, Urbino, Italy. **Landscape Ecology Acting in the Real World, Priorities and Strategies.**

Acting in landscape ecology means to have an integrated vision of the real world and to understand better and deeper how ecosystems are functioning and how humans change the functions and behavior of the natural systems. After at least 20 years of impressive action in theoretical as well as in applied fields landscape ecology is now facing a dilemma to maintain an independent position inside the ecology by evolving new theories and practical tools or to restrict the action to the applied field with the risk to be incorporated into the plethora of reductionistic ecological approaches. I strongly believe that landscape ecology can and must pursue the challenge (1) to develop into an independent field. To achieve this goal (2) landscape ecology should contribute more to the integration between the different "environmental and economic sciences" according a common framework that is based on (3) System General Theory, (4) Environmental Complexity, (5) Hierarchy Theory, and (6) the Multiscalar Perception of Complexity. (7) Ecosystem approaches should be integrated with the landscape ecology approach in land evaluation, restoration procedures, and protection activity. (8) Field experiments that are actually rare and restricted to some categories of organisms should be expanded in space and time, from organisms to processes. (9) A new general theory on the mosaic should be developed. (10) Educational programs should be strongly encouraged and developed in academic curricula.

Fernandez, Luis E. School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109-1115, USA. **Modeling the Agents of Tropical Deforestation: Integrating Social Survey Data into Spatial Models of Land-Use Change on the Atlantic Coast of Nicaragua (1959–1996).**

Deforestation in Nicaragua is increasing primarily by economically marginalized peasant-colonist farmers using swidden agricultural practices. Efforts to study deforestation dynamics have primarily focused on modeling approaches that use remotely sensed data at regional scales. There have been few efforts that integrate household level social data with regional scale spatial models. I present results from an ongoing study that examines causes and patterns of deforestation using an integrative approach that combines spatial regression analysis, social science methodologies, and agent-based land-use modeling. The study focuses on the lowland forest region of Pearl Lagoon, Nicaragua. The objectives of this study are to 1) identify eco-physical and aggregate socio-economic variables and their effects on the pattern of land-use change using logistic regression analysis, 2) determine key peasant decision factors in land selection through social surveys and model key decision factors in an agent-based land-use change model, and 3) determine strengths and shortcomings of the these two approaches and develop a new integrative framework that combines the advantages of each. A main hypothesis of this study is that an integrated approach, which combines the power of remotely sensed data with the more culturally accurate community level data, provides more accurate results in multi-cultural developing regions with mobile ethnic populations. I present results of the regression analysis compared to, and integrated with, social data for Fonseca village in eastern Nicaragua. The study results describe regional historical land-use patterns and illustrate the value of including community level data into deforestation and land-use models.

Findlay,[1] Stuart, Nina Caraco,[1] Jonathon Cole,[1] William Nieder,[2] and David Strayer.[1] [1]Institute of Ecosystem Studies, P.O. Box AB, Millbrook, NY 12545, USA; [2]Hudson River National Estuarine Research Reserve, Annandale, NY 12504, USA. **Functioning of Submersed Vegetation Patches in the Tidal Freshwater Hudson River.**

Patches of submersed aquatic vegetation (SAV) are a conspicuous feature of most aquatic ecosystems and have been shown to serve a variety of quantitatively important functions ranging from habitat to sediment trapping. In the tidal freshwater Hudson River SAV can occupy as much as 20% of the river bottom area and plant biomass is as high as 500 g dry mass/m_2. In a 60 km stretch there are nearly 400 plant beds ranging in size from 20 to 1.2 million m_2. We have evaluated several of the ecological functions including primary productivity, sediment trapping, and habitat for invertebrates and fishes. We are exploring the extent to which patch characteristics or landscape variables help explain among-patch variability in these functions. Maintenance of super-saturated oxygen concentrations in the water column appear to be a simple function of patch size suggesting larger patches are buffered from exchange with the generally under-saturated water in the river main channel. In contrast, suspended sediment concentrations are higher in the patches than in the main channel and were not related to patch size. This suggests that even large patches are incapable of decreasing water velocities sufficiently to enhance sediment trapping. Our ability to extrapolate from site-specific studies to the whole ecosystem depends upon finding relationships between function and simple predictor variables such as patch size, shape, or landscape position. Such tools would also help efforts to manage and preserve these important habitats.

Fisher, Christopher T. Archaeological Research Institute, Department of Anthropology, Arizona State University, Tempe, AZ 85287, USA. **2000 Years of Landscape Change in the Lake Pátzcuaro Basin, Michoacán, Mexico.**

The "Columbus polemic" debate seeks the cause of modern degradation in the Americas by determining the sustainability of indigenous and European-style land-use. This paper reports on a program of landscape research examining socio-political processes underlying 2000 years of land-use within the Lake Pátzcuaro Basin, Michoacán, Mexico. First patterns of erosion and settlement are integrated identifying how and with what impact indigenous and Hispanic land-managers modified past landscapes. Second, the impact of Conquest is evaluated focusing on the unintended consequences of disease and landscape abandonment.

Fisher, Stuart G., Julia Henry, John Schade, and Jill Welter. Department of Biology, Arizona State University, Tempe, AZ 85287, USA. **Challenges of Applying the Concepts and Approaches of Landscape Ecology to Running Waters.**

Running water ecosystems can be better understood if they are viewed through the disciplinary eyes of landscape ecology; however, several decisions must first be made to define the domain of study and to properly frame research questions. Examples will be presented from studies of Sycamore Creek in Arizona, which has been studied for two decades, first as an ecosystem and more recently as a landscape. The first decision is whether to view the stream as one of many patches within a larger landscape or to resolve it as a landscape consisting of many patches. The latter approach has been used by stream ecologists. The second decision is to identify the scale(s) of the study and to be aware of the effect of scale on answers to research questions. Stream ecologists have traditionally decomposed streams based on geomorphology in a manner which is sometimes hierarchical. Scaling decisions will ultimately depend on the dimensional resolution of the system. The third decision therefore will determine whether the stream will be viewed as a one dimensional line, a planar surface, or a three dimensional whole. Intercalary fractal descriptions may also be useful, for example, in describing drainage networks. The fourth dimension, time, is required to reveal patterns of material movement, processing, and retention in the landscape and the disturbance regime which alters these dynamics.

Flamm,[1] R. O., Alexander Smith,[1] Suzanne Tarr,[1] Susan Jacobson,[2] and Sampreethi Aipanjiguly.[2] [1]Florida Marine Research Institute, Department of Environmental Protection, St. Petersburg, FL, USA;. [2]Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL, USA.
Manatee "Places" in and around Tampa Bay, Florida.

Effective stewardship of Florida's coastal landscape requires, in part, an understanding of the motivations behind human decisions and the consequences of those decisions on coastal landscape structure and function. This statement is particularly true within the context of boating and its affects on manatees (*Trichechus manatus*). Approximately 30% of the annual manatee mortality results from collisions with watercraft. Reducing this mortality is primarily relegated to government regulation. An alternative approach is behavior modification through outreach. We are comparing outreach's and regulation's influence on boater behavior and their significance to the coastal landscape. This involves (1) characterizing baseline activities, beliefs, and motivations of boaters in Tampa Bay, Florida; (2) distributing educational materials to boaters based on the results of the baseline characterization; and (3) evaluating the effectiveness of the materials in changing boater intent and consequently changing the spatial distribution of behaviors and their effects. We are at step two. Approximately 4,500 Florida-registered vessels were monitored. Of these, about 15% sped outside designated channels and over shallow seagrass beds at least once—areas frequented by manatees. Telephone surveys revealed significant knowledge gaps about manatees and confusion about boat speed zones and manatee harassment. Based on survey results, existing materials were modified, some retired, and others designed. Furthermore, an evaluation of outreach efforts revealed that some boaters were being missed, for example, those launching from private docks. Outreach efforts were modified to ensure that all boaters are reached. Implications of these results for managing coastal landscapes for manatee protection are discussed.

Fleming,[1] Richard A. and Jean-Noël Candau.[2] [1]Great Lakes Forest Research Centre, Canadian Forest Service, Sault Ste. Marie, Ontario, Canada P6A 5M7; [2]Ontario Forest Research Institute, Ontario Ministry of Natural Resources, Sault Ste. Marie, Ontario, Canada P6A 5N5. **Pattern and Process in the Interaction of Spruce Budworm and Wildfire Disturbance Regimes at Landscape Scales.**

The dominant natural disturbances in Canada's boreal forests are wildfire and outbreaks of spruce budworm, *Choristoneura fumiferana* (Clem.). Our research focuses on the spatial and temporal patterns of the interaction of these disturbance regimes at landscape scales and on some of the underlying ecological processes. As a prerequisite to developing models for forecasting, and as a baseline for future monitoring, we present early results from a retrospective analysis of Ontario's historical records over the past 60 years. These results begin to quantify the interaction between SBW outbreak and wildfire disturbance regimes. Spatiotemporal analyses suggest that fires burned less than 10 x 10^6 ha while SBW caused whole tree mortality within 33 x 10^6 ha. Within the 41 x 10^6 ha defoliated by SBW at least once since 1941, the proportion burnt was greatest in areas that suffered moderate frequencies (9–11 years) of SBW defoliation ($P=0.00021$). Randomization tests revealed that fires over 200 ha occurred 3–9 years after a SBW outbreak, more often than would be expected by chance alone ($P<0.05$), and that SBW outbreaks generally occurred less often than expected by chance alone ($P<0.05$), between one year before and 16 years after fire. This "time-window" of disproportionately high fire prevalence appears to have started longer after SBW outbreak and to have been wider in western than in eastern Ontario. Climatic explanations for such differences are investigated.

Foltete, Jean-Christophe and Didier Josselin. THEMA, 32 rue Megevand, 25030 Besancon Cedex, France. **Using Spatio-Temporal Co-Occurrence Matrices to Delineate Spatial Patterns about Vole Swarming.**

The goal of our research is to identify spatial patterns involving the vole swarming phenomenon. Because of this phenomenon's complexity, which evolves cyclicly, and whose ecological factors are not yet really explained, we are charged, in a multidisciplinary research team, with studying the relationship between landscape structure and the swarming score of rodents measured in space (at French communes scale) and time (every year). First, we describe the available data, their accuracy, their limits, and the spatial entities they are attached to. We also assume a few hypotheses from expert assessment and ecological observations. Two sets of different data are used in a supervised way: (1) from a vectorial map, the swarming scores described yearly for ten years for every French commune (this is our phenomenon to explain), (2) from raster images, the landscape characterization, described by land cover, slope, and elevation (these are the explicative variables). Then, we explain the involved methods. Our choice is to keep the different spatial structures within co-occurrence matrices, instead of computing synthetic indicators. We also cross two different approaches to build our knowledge: (i) using an automatic filtering algorithm in order to extract local spatio-temporal co-occurrence matrices about vole swarming and landscape structure, and (ii) upstream and downstream, exploring and validating delineated patterns by an Exploratory Data Spatial Analysis. We developed these methods in a freeware computational environment (Delphi and XlispStat). Finally, we show our results on a French set of communes (Doubs county) and discuss the involved methods efficiency in the landscape ecology research field.

Forman, Richard T. T. Harvard University, Graduate School of Design, Cambridge, MA 02138, USA. **Impact Opportunities for Landscape Ecology in the Twenty-Aughts.**

These fall into three bulging bins. (1) SIGNIFICANT LACUNAE in today's landscape ecology include: ecological flows across the land; adjacencies and neighborhood configurations; the matrix; stream/river corridor width and design; cluster of small patches versus a corridor; importance of plants and vegetation; ecologically optimum network forms; the roles of spatial patterns produced by nature, planning/design, and lack thereof. (2) NEW FRONTIERS evolve naturally from landscape ecology. "Spatially meshing nature and culture" seems still shrouded. However, "road ecology" emerges, including: traffic disturbance/noise effects on natural communities; the road-effect zone; development of theory; and meshing ecological flows/biological diversity with safe/efficient transport. (3) WE THE PEOPLE highlights how landscape ecologists might work. Ponder the transition from how we spend our time to how we got and get inspiration. Look beyond our colorful land-use-and-ownership models to see topographic variations, little-road systems, hedgerow habitats, groundwater flows, changing forms guiding our movement, and actual animal routes across heterogeneous land. Spend more time with colleagues in landscapes outside North America. Outline visions for the future, in addition to improvements for the present. Write rather than edit concise books on landscape ecology, its major areas and applications. Make sure that both solid long-half-life empirical insight and promising short-half-life quantitative models move forward arm-in-arm. Imagine the end of the aughts in landscape ecology.

Fortin, Marie-José,[1] Mathieu Philibert,[2] Tarmo Remme,[1] and Ferenc Csillag.[3] [1]School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6; Department of Geography, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6; [3]Department of Geography, University of Toronto, Mississauga, Ontario, Canada L5L 1C6. **Sensitivity Analysis of Boundary Detection on Spatial Features of Heterogeneous Landscape.**

Boundaries are inherent features of all landscapes. The definition, description, identification, and interpretation of boundaries, however, depend on (1) the context within which landscapes are analyzed, and (2) the data models and data types that are used to represent those landscapes. Most methods of handling boundaries are arbitrary in some fashion and are specific to certain applications and/or data types and they are usually based on some knowledge of landscape patterns and appropriately related spatial statistical models. To investigate the significance of boundaries, we compare local and global boundary detector algorithms in their ability to detect accurately the location of known boundaries from simulated landscapes as well as from remotely sensed data of boreal forest. With the simulated landscapes, we are specifically investigating the sensitivity of three landscape pattern parameters: degree of spatial autocorrelation, within patch mean, and within patch variance. It is found that the boundary detectors are sensitive to within patch variance. These findings contribute to the better understanding and the operational characterization of landscape spatial heterogeneity.

Frank, Karin. Department of Ecological Modelling, UFZ–Centre for Environmental Research Leipzig-Halle, D-04301 Leipzig, Germany. **An Index for Assessing Habitat Networks from the Perspective of Metapopulation Viability.**

Landscape fragmentation and habitat loss are common phenomena in human-dominated areas. They result in networks of remnant habitat patches with the well-known effect of an increased risk of species extinction. In this case, harmonizing humanity and nature means looking for activities that effectively counteract or at least do not further amplify this negative effect. This task, however, can only be met if tools are available that enable the relationship between the spatial structure of habitat networks and the viability of spatially structured populations or metapopulations to be uncovered. We present a simple landscape index for "Metapopulation Viability" that has been extracted from a spatially realistic metapopulation model. This index allows dissimilar habitat networks to be assessed, compared, and ranked according to their ability to maintain a viable metapopulation. Moreover, the effect of changes in the network structure can be assessed in a spatially differentiated way. By taking this information as a basis, land-use activities with the highest positive or the lowest negative effect can be identified. The predictive power and the practical value of the presented index are demonstrated for the Glanville Fritillary butterfly (*Melitaea cinxia*) system on the Aland Islands (SW Finland). Finally, some general conclusions concerning the benefits of extracting landscape indices from spatial population models are drawn. We show that a number of problems in the realm of decision support in conservation management (evaluating landscapes through the eyes of an ecological process, providing understanding, managing ecological uncertainty, and linking ecology and socioeconomy) are captured.

Franklin, Janet. Department of Geography, San Diego State University, San Diego, CA 92182-4493, USA. **Simulating the Effects of Altered Fire Regimes on Plant Succession in the Shrublands and Forests of Southern California Using LANDIS.**

A spatially explicit landscape model of disturbance and vegetation succession, LANDIS, was used to examine the effect of fire regime on succession in the plant communities of the southern California foothills and mountains. The model was tested using an artificial dataset representing an initial random distribution of six plant functional groups on an even-aged landscape. Three fire cycles, frequent (35 yr), moderate (70 yr), and infrequent (1,050 yr), were applied for 500 yr (ten replicates). These fire cycles were simulated within 7% of the intended values. Thus, LANDIS, originally developed for northern temperate forests, can be calibrated for the higher-frequency fire regime in this region. The infrequent fire regime resulted in an old landscape dominated by the shade tolerant functional groups while under the moderate and frequent fire regimes all functional groups persisted. The model is being modified to simulate fire-cued germination from a seed bank because "obligate seeders" form an important functional group in the region. It will then be applied to a dataset comprising 25 species and 11 landtypes (landscape site classes) developed for ~3900 sq. km of San Diego County. Landtypes were modeled by unsupervised clustering of climate and terrain variables. Maps of species occurrence by age class were developed using predictive models of species distributions combined with fire history data. I hypothesize that a 70-yr fire cycle will result in infrequent but high severity fires in the montane zone (where fire suppression has led to fuel build-up) causing a decline in low-elevation conifer species.

Franklin,[1] Scott, Amy Webbeking,[1] and John Kupfer.[2] [1]Department of Biology, University of Memphis, Memphis, TN 38152, USA; [2]Department of Geography and Regional Development, University of Arizona, Tucson, AZ 85721, USA. **The Effects of Landscape Structure on Plant Regeneration Patterns in Shifting Cultivation Fields Near Indian Church, Belize.**

Due to demographic and economic pressures, the predominantly forested matrix that characterized many areas of slash-and-burn agriculture is being replaced by a cultivated matrix with areas of younger forest in various stages of recovery. The more rapid turnover of plots and the altered spatial context of the fields and forests within the landscape may have ramifications for the long-term fate and restoration of tropical forests. For example, it could be hypothesized that the adjacency and diversity of seed sources for regeneration on fallow fields has been altered as a result of the changes in landscape structure, and this altered spatial context may subsequently influence the rate and trajectory of succession. We examined this hypothesis by collecting vegetation data from thirty-two milpas (slash-and-burn fields) that varied in their age (fallow > 3 years, fallow < 3 years, in use >3 years, in use < 3 years) and their distance to older forest (> 100 m or < 100 m). Species composition of both the woody and herbaceous strata were found to be significantly different between near and distant milpas. Further, Shannon's diversity index values for woody vegetation were greater in the milpas near old growth than distant milpas currently in use. One implication that could be drawn from these results is that regenerating fields marked by lower diversity may be less resilient and recover more slowly from cultivation because of greater soil leaching brought about by the less efficient uptake and cycling of soil resources (e.g., nitrogen).

Fraser, John. Science Development and Technology Branch Ontario Ministry of Natural Resources, Peterborough, Ontario, Canada K9J 8M5. **Landscape Ecology Approaches to the Protection of Natural Heritage Features and the Sustainable Management of Mineral Aggregate Resources, Oak Ridges Moraine, Ontario Canada.**

This paper outlines an ecological framework for the management of mineral aggregate resources for a portion of the Oak Ridges Moraine, in the rapidly urbanizing Greater Toronto Area (GTA) in Ontario, as part of an emerging resource management approach based on concepts of ecological sustainability, adaptive management, and multi-criteria decision making. The paper provides a comparative evaluation of three GIS based landscape ecology analysis programs, with respect to their effectiveness in quantifying landscape composition and structure. The programs are evaluated with respect to their effectiveness in deriving landscape parameters for simulated mineral aggegate extraction scenarios, and as the basis for the development of a decision suport system for aggregate resource management. Such an approach also supports the evaluation of alternate rehabilitation scenarios for extracted areas to emulate natural structural components of the moraine landscape and to develop strategies for the re-integration of fragmented landscape components.

Fritsch,[1] Uta, Daniel Katzenmaier,[1] and Axel Bronstert.[2] [1]Potsdam Institute for Climate Impact Research, Potsdam, Germany; [2]Institute for Geo-ecology, University of Potsdam, Potsdam, Germany. **Land-Use Scenarios for Flood Risk Assessment Studies.**

Land-use scenarios are an approved tool for studying the influence of possible changes on natural processes, such as flood generation. The model land-use change modelling kit (LUCK) provides a method for the spatial transformation of overall trends concerning land-use changes into spatially distributed land-use patterns. Making use of gridded spatial information on topography, soils and present land use, the technique takes the topology into account in a true position mode. The conversion is realized pixelwise, based on an evaluation of the site characteristics of each pixel as well as its neighborhood relationships. Both criteria form the potential of each pixel to become subject to changes. Three main land-use categories are considered within LUCK by different modules for urbanization, agricultural and forestal land-use changes. The results are altered land-use maps that can be used directly as an input for flood simulation with distributed hydrological models such as WaSiM-ETH. Study areas are three mesoscale tributaries of the Rhine basin in Germany that represent different characteristic land-use patterns with either dominantly urban, agricultural and forestal structure. Referring to these area types, different land-use trends with certain driving forces come into operation that are considered for the land-use scenario generation. The avails and the limits of the tool will be presented by applying the different tools to the three areas. The main focus is on the urbanization module, which has been validated for all three catchments on the dynamics of historical settlement development.

Giladi, Itamar, Michael Bokamper, and H. Ronald Pulliam. Institute of Ecology, The University of Georgia, Athens, GA 30602, USA.
Distribution, Dispersal, and Habitat Suitability of Hexastylis Arifolia in a Mosaic Landscape.

Understanding changes in the distribution of an organism requires information on its habitat requirements and dispersal capability in a landscape context. We are studying the distribution, habitat suitability, dispersal, and genetic structure of *Hexastylis arifolia*, a common myrmecochorous forest herb of the Southeastern US. The study is being done in Whitehall Forest, near Athens, Georgia, a mosaic of forest patches of different type, age, and successional stage. Major changes in the landscape in the last 60 years have been delineated using aerial photographs. In the study area, *Hexastylis arifolia* is found in a range of deciduous forest seral stages, but rarely further than 50 meters from patches that have been forested continuously for at least 60 years. This distribution pattern implies dispersal limitation, a hypothesis that is tested in this study. Direct observations of ants dispersing seeds indicate dispersal distances are typically 2m or less, but occasionally exceed 10 m. These direct measurements are compared to maximum likelihood estimations of dispersal curves based on the distribution of seedlings. The spatial scale of the genetic structure measured by allozyme variation is consistent with the observed dispersal distances. We assess habitat suitability by correlating distribution to environmental factors and by studying habitat-specific demography. We test our assessment of habitat suitability by introducing plants of various life stages into different habitat types and following their subsequent survival and reproduction. Our goal is to develop a model that uses field estimations of dispersal and habitat suitability to predict changes in the distribution of *Hexastylis arifolia* and to test these predictions with current distribution and historical changes in the landscape.

Glenn, Susan. Forest Sciences Department, University of British Columbia, Vancouver, British Columbia, Canada V4K 3C9. **Responses of Grassland/Forest Boundaries to Surprising Changes in Climate in Central British Columbia, Canada.**

The invasion of BC's grasslands by douglas-fir has been a concern for range managers and conservationists. Land managers dispute the relative effects of fire suppression and grazing regimes on tree encroachment. In addition, ecosystems at the limits of their ranges may be sensitive indicators of changes in climate that are difficult to detect statistically. I examined patterns of encroachment of douglas-fir in relation to climate records of the 1900s. There was no clear trend in average annual or growing season rainfall or temperature that corresponded to Douglas-fir establishment. Since 1934, the northern limit of grasslands in central British Columbia has had fewer hot/dry summers and more cool/wet summers than previously. This unexpected change in climate has reduced potential evaporation in this area. It is hypothesized that this change in climate extremes could reduce desiccation of tree seedlings and alter the natural fire regime. If seedling desiccation is a major factor limiting encroachment, then seedling survival should be most successful where shade from nearby trees protects the seedling. However, in a preliminary study in a relatively cool, wet summer, I found significantly higher proportions of seeds germinated and survived in open grassland areas than in areas shaded by trees. Small mammal consumption of seeds was reduced in open grasslands where there was less cover from predation for the voles and mice. The relaxation of the climatic constraint of high potential evaporation may have made the small mammal role in tree encroachment apparent.

Gomide, Marcia,[1] Vladmir Luft,[2] Mônica Serrão.[3] [1]Núcleo de Estudos de Saúde Coletiva, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brasil; [2]CREP, Visconde do Rio Branco, Minas Gerais, Brasil; [3]SENAC, CEAD, Rio de Janeiro, Brasil. **From Tropical Forest to Eroded Lands: The Cost of the Natural Landscape in the Urbanization Process.**

Presented here is the case of loss of hydric supplying and the agricultural productivity decurrent that resulted from the extreme modification in the landscape of the county of Viscone of Rio Branco, Minas Gerais State, Brazil. During the 1980s, the ground was worn out by the intense culture of coffee and sugar cane, causing a reduction in the harvests and a shift toward cattle production. By the 1990s, in extensive areas of the region, not even grass could germinate. Erosive processes had been installed, leading to the loss of the land. The clearing of the wooded areas at spring heads and near rivers led to the deposit of sediments in the stream-beds and to the decrease of the outflow. This modification in the landscape was so intense that today the estimate hydric supplying for the region is calculated in 10-year increments. Geo-morphological, archaeological, historical, and ecological studies have collected data from the last landscape and the current one, as well as from the urbanization processes. This information has made it possible to understand the context and to offer to the population a program of Ambiental Education, facilitated by the demand of some brackets of the society. As an incentive method, valuation, and approach of the community, didactic material was collected, telling the history of the region. Here, joining scientific data and popular knowledge—recovered through oral information—made possible its integration into regional history. The program hopes to collaborate in resetting the current landscape, as well as protecting the remaining original landscape, rescuing the value of the environment in the supported development of the region.

Gomide,[1] Marcia, Roberto Medronho,[1] and Heinrich Haasenack.[2] [1]Núcleo de Estudos de Saúde Coletiva - NESC/UFRJ/ Rio de Janeiro, Brasil; [2]Departamento de Ecologia/UFRGS/Porto Alegre, Brasil. **Precarious Urbanization and Transmission of the Hepatitis A in a Poor Area of Rio de Janeiro, Brazil.**

The modification and inadequate use of space causes environmental problems that may affect the population's health. The area of the study has a short drain extension, poor garbage collection, and inadequate water supply, leading part of the population to make use of incipient cesspools and hollow wells as an alternative water supply (creating precarious sanitation conditions). This situation favors the occurence of several waterborne diseases, such as hepatitis A, a viral etiological disease. There was an attempt to identify factors that could determine the occurence of hepatitis A through a group of environmental and socio-economic variables. Geographic Information Systems were used to identify the risk areas and logistic regression to identify the explanatory variables for the occurence of hepatitis A. Areas at higher risk for hepatitis A were identified as well as two decisive socio-economic factors for occurence: the family's average monthly income and the housewife's level of education. It is concluded that the occurence of hepatitis A is strongly influenced by environmental and socio-economic conditions, encouraging the adoption of educational programs and the implementation of socio-economic conditions to the level necessary for its appropriate control.

Gong,[1] P., Y. Sheng,[1] B. Xu,[1] L. Wang,[1] G. S. Biging,[1] Y. Wang,[2] Y.-P. Hsieh,[3] [1]Center for Assessment and Monitoring of Forest and Environmental Resources, University of California, Berkeley, CA 94720, USA; [2]Department of Geological Sciences, Florida State University, Tallahassee, FL 32306, USA; [3]Wetland Ecology, Center for Water Quality, Florida A&M University, Tallahassee, FL 32307, USA. **Photo-Ecometrics for Landscape Characterization.**

Our recent attempt toward the development of the field of photo-ecometrics has led to a number of new developments in digital photogrammetry and its applications. We advocate the use of a digital surface model (DSM) that contains the elevation of all surface features, such as buildings and trees, rather than a digital elevation model (DEM), which has been traditionally used only for the terrain. We illustrate in this presentation our methods for deriving DSMs and orthophotos generated with digital photogrammetry in landscape characterization. Using 1:40,000 aerial photographs as ground truth, we evaluated the potential of Landsat Thematic Mapper imagery in crown closure estimation of California's hardwood rangeland. Using 1:2,400 and 1:12,000 aerial photographs, we developed new image matching algorithms to extract tree crown morphology and tree heights for both broadleaf and conifer species in California. Using 1:12,000 aerial stereopairs acquired in the summers of 1970 and 1995 of a hilly savanna in California and scanned at 1,000 DPI, we derived DSMs and subsequently orthophotos for each year to measure gully encroachment. Using 1:23,000 aerial stereopairs acquired over a coastal marshland area in Florida in 1951 and 1997, we produced a digital orthophoto for each year.

Through measurement, we found that the lower boundaries of the salty sandy zones on the marshland displaced toward the land for approximately 3–10 m from 1951 to 1997. Since it was unlikely that the sand type had changed over the 46-year period, the only possible explanation is that either the annual average sea level or the evaporation rate or both have undergone change in this area, leading to a conclusion that climate had changed over the 46-year period. There is no doubt that aerial and digital photography are becoming more popular. Digital photogrammetry is a helpful tool for us to extract accurate DSM data from stereopairs. As high resolution data from airborne and spaceborne remote sensing become more and more available, DSMs can be easily obtained. DSMs allow us to study changes not only about topography but also about canopy closure and tree heights. The potential of DSMs opens many opportunities for improving the accuracy of landscape change monitoring.

Green, Glen M. and Laura A. Carlson.* Center for the Study of Institutions, Population, and Environmental Change (CIPEC), Indiana University, Bloomington, IN 47408, USA. **Control of Forest Distribution by bio-Geophysical and Social/Institutional Factors: Does Conservation Management Make a Difference?**

This paper analyzes the relative contributions of bio-geophysical and social/institutional factors in determining the distribution of forest. We examine landcover for Indiana from Landsat TM images and data gathered by surveys in the early 1800s. Topographic relief values were calculated from digital elevation models (DEM) and compared to landcover on private lands vs. lands managed by government agencies. Forest, which once covered 85% of Indiana, now covers 20%. Deciduous forest cover increases from 10% of flat land to more than 65% on slopes greater than 10%. While the aerial extent of land in Indiana drops off rapidly with increasing slope, the proportion of land under non-private management increases sharply with increasing relief. Land managed by government agencies makes up only about 4% of the state. Land managed by different agencies is distributed differently with respect to relief, with some agencies' holdings concentrated on flatter land and some on topographically steep terrain. Do institutions determine landcover, or do they simply inhabit particular kinds of lands—lands that would have the same land cover regardless of ownership and management? A test of proportions evaluates whether or not landcover under these government agencies is significantly different from privately managed lands at the same slope values. This analysis can be helpful in evaluating the types of habitats that are being preserved both on public and on private lands. This information can aid forest policymakers attempting to evaluate current conservation policies and craft new legislation to promote conservation of particularly threatened types of forest habitat.

Grove,[1] J. Morgan and Ann P. Kinzig.[2] [1]USDA Forest Service, 705 Spear Street, South Burlington, VT 05403, USA; [2]Department of Biology, Arizona State University, Tempe, AZ 85287, USA. **Synthesis of Social and Ecological Approaches for the Spatial Analyses of Human Ecosystems, with Examples from Phoenix, Arizona, and Baltimore, Maryland.**

Sometimes shared, but rarely fused, the social and ecological sciences have each developed with their own traditions and approaches to spatial analyses. For interdisciplinary research, however, it is increasingly necessary to synthesize these separate social and ecological approaches, particularly if we are to advance our understanding of the dynamics of human ecosystems. In this presentation, we review the major approaches traditionally taken towards spatial analysis in the social and ecological sciences. Based upon this brief review, we discuss some of the opportunities for greater interdisciplinary collaboration by highlighting some of the more promising integrative research questions concerning spatial patterns in human-dominated ecosystems, and offer a survey of some of the leading datasets and software that would be of practical use in this integrated analysis. Finally, we close with several examples comparing the Central Arizona Phoenix (CAP) and Baltimore Ecosystem Study (BES) projects with particular attention to the ecological and social core areas of the LTER Network in order to illustrate a synthetic approach to the spatial analyses of human ecosystems.

Gruber,[1] Bernd, Klaus Henle,[1] Karin Frank.[2] [1]Department of Conservation Biology and Natural Resources, UFZ–Centre for Environmental Research Leipzig-Halle, D-04318 Leipzig, Germany; [2]Deparment of Ecological Modelling, UFZ–Centre for Environmental Research Leipzig-Halle, D-04318 Leipzig, Germany. **Movement Models as Tools for Analyzing the Effect of Landscape Structure on Population Processes.**

Developing options for a sustainable land use requires a good understanding of the effect of landscape structure on ecological processes. But in order to fully understand the effect on population processes, for instance, the individuals' specific response to the landscape structure (e.g. movement behavior) has to be taken into account. Hence, tools for linking individual with population processes are needed. We present an individual-based, spatially explicit model that allows the individual probability of meeting a partner (and therefore the rate of fertilized females) to be assessed and analyzed in terms of the consequences of both different landscape structures and different (sex-specific) movement types. We demonstrate to what extent the movement type of a species influences the ranking order that results from comparing alternative landscape structures regarding their effect on the individual mating success and discuss the consequences for landscape evaluation and management. Finally, we show that a landscape index "Individual Mating Success" can be derived that contains the whole essence of the presented simulation model and provides a tool for analyzing a given landscape through the eyes of the considered species. This index only depends on the landscape structure and the movement rules and can directly be calculated, without having to resort to the underlying model itself. The presented model-based approach was tested and validated in a case study, using a long-term data set of a population of an arboreal Gecko (*Gehyra variegata*) in Australia.

Guo, Linhai Larry, John Morrison, and John Marthick. Environmental Research Institute, University of Wollongong, NSW 2522, Australia. **Multi-Scale Analysis of Landscape Connectivity in Kangaroo Valley, NSW Southeastern Australia in the Context of Landscape Ecology.**

A natural catchment (30 by 40 kilometres) delineated using WMS is used to test the assumption that landscape connectivity is a threshold phenomenon and its exact value of the threshold depends upon the spatial arrangement of habitat and the perceptions of organisms. The valley is characterized by rapid development by clearing forest for dairy and residential purpose since a century ago. The spatial arrangement of remnants is critical in nature and biodiversity conservation in the area. Based on the ecology and their connectivity requirements, critical threshold scales associated with abrupt changes in landscape connectivity for four State-wide listed species (each uses a different type of habitat based on vegetation) have been identified using GIS and simulation modeling. The suitable scale to investigate landscape connectivity for *Petrogale penicillata* is about 100 meter, and that for *Petaurus australis* is 400 meter, for *Tyto tenebricosa* is 800 meter, and for *Dasyornix brachypterus* is 1,000 meter. Consequently, specific high value remnants (keystone patches) were located for each species, which, if properly conserved or revegetated, can significantly increase the connectivity for those species. To test the effect of landscape composition and spatial arrangement on landscape connectivity, Modified Cluster Method (Saura and Martinex-Millaan, 2000) is used, which can separate the control of fragmentation and habitat abundance. Our results answered some key questions concerning local community in vegetation target setting: How much vegetation do I need? Where should they be left? How should they be arranged? These results could be easily integrated into the design guidelines for sustainable landscape.

Guo, Qinghua, Wei Luo,* Ye Qi. Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94704, USA.
Semivariance Techniques in Point Pattern Analysis: A Comparison with Ripley K.

Spatial point pattern analysis has always been an important issue in ecological analyses. Most popular point pattern analysis methods, such as Ripley K and TTLQV, assume that the spatial process is isotropic, which means the covariance of a pair of points depends only on the scalar distance between them. But in nature, isotropy is really an exception. And often, understanding the anisotropy nature of the spatial pattern is crucial in our understanding of ecological process behind. We propose to introduce semivariance technique into spatial point analysis. We found that the semivariance method can better describe the anisotropic and heterogeneous nature of spatial point patterns. We first simulated artificial point data to measure the effectiveness of this method and then applied it to the mangrove forest in the Los Haitises National Park. We compared the effectiveness of semi-variance method with results by Ripley K. Semivariance method proved to be able to not only detect spatial deviation from random distribution, but also can detect spatial variations along different directions (anisotropy). Ripley K was not able to detect anisotropy. In case of random distribution, the semivariogram exhibited a pure nugget effect; in regular distribution, it also had a similar pattern with a lower sill. In clustering distribution, the semivariogram exhibits a clear structure with the range corresponding to the average cluster size. The effects of the grid size used in semivariance calculation are discussed, and gaps (defined as low density area around patches) in the point pattern on the shape of semivariogram are investigated.

Haire, Sandra L. USGS Biological Resources Division, Fort Collins, CO 80525, USA. **Landscape Ecology as an Integrative Science: An Application in the Greater Yellowstone Ecosystem.**

Human activities change landscape patterns and processes, even in areas we are inclined to think of as "wild." How have our activities changed the look of the landscape, and what do we want the landscape to look like in the future? One way to explore these questions is to bring together knowledge of historical landscapes, plant and wildlife ecology, and cultural values to predict landscape change. These changes can be visualized in images that contain landscape elements that are predicted to vary with changes in ecosystem management and cultural influence. We attempt to integrate scientific knowledge and cultural value components in our study of the Jackson Valley, Wyoming, USA, where a long history of ungulate management is under scrutiny in a fascinating and controversial situation. Jackson bison and elk herds winter on the National Elk Refuge; attracted by the feedlines established in the early 1900's when high elk mortality roused public sympathy. Currently, ungulates are an economic resource for the area in terms of hunting and tourism, as well as a source of concern; feeding practices exacerbates the transmission of brucellosis. Of equal concern to ecologists is the alteration in vegetation patterns and underlying processes resulting from high ungulate population levels. This study uses a visual perspective as an integrative approach to aid management decisions in the Jackson Valley.

Harden,[1] Charles and Matthew Nicholson.[2] [1]Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, Illinois 62901-6504, USA; [2]Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, Illinois 62901-6504, USA. **Impacts of Human Development on Deer Herd Management in the Ex-Urban Landscape.**

Human developments in rural landscapes clearly have had negative impacts on many species. However, for some exploited species, rural development may actually have positive impacts by creating defacto refugia from hunting pressure. For instance, in Illinois, state regulations prohibit firearms hunting for white-tailed deer (Odocoileus virginianus) within 274 meters of any occupied structure without the permission of the occupant. Therefore, it is likely that exclusion of hunters from areas around rural structures may reduce hunter-caused mortality in exploited species. Moreover, as the amount of high quality habitat in juxtaposition to rural structures increases this effect may be enhanced. To investigate these questions, we examined the impacts of rural development on the distribution and success of deer hunters in Illinois. Specifically we measured the distribution of hunters through both aerial and ground surveys and then compared this distribution with that of rural developments. We also examined the quality of habitat within the presumed refugia created by the legal exclusion of hunters and how that impacted hunter success. Home density within deer habitat was not found to be significantly correlated with harvest efficiency. However, harvest efficiency was found to have a slight negative correlation with the percent of the exclusion areas consisting of deer habitat. Other contributing factors are also presented and discussed.

Hargrove, William W. and Forrest M. Hoffman. Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA. **Multivariate Ecoregions of the United States: A Statistical Delineation.**

A series of statistically-derived ecoregionalizations of the conterminous United States based on 25 environmental variables will be presented. Multivariate clustering based on high-resolution maps of elevation, temperature, precipitation, soil characteristics, and solar inputs at several specified levels of division result in a spectrum of objective ecoregion maps for the United States. Coarse divisions reflect intuitively-understood regional environmental differences, but fine divisions highlight local condition gradients, ecotones, and clines. Because the technique is quantitative, several valuable ecological derivatives can be generated. Principal Component Analysis (PCA) of ecoregion centroids after clustering forms the basis for a red-green-blue visualization which indicates the relative contribution of each PCA factor to the environment within that ecoregion. Similarity of any ecoregion to any other ecoregion can be quantified and displayed as a "representativeness" map. Borders between ecoregions can be characterized as gradual or sharp, or can be shown to change character along their length. The technique can also be applied simultaneously to multiple maps through time.

Harris, Virginia. Department of Agricultural and Consumer Economics, University of Illinois Urbana-Champaign, Urbana, IL 61801, USA. **Using Remote Sensing Data to Estimate the Value of Open Space in the Chicago Metropolitan Area.**

This study focuses on valuing the loss of open spaces that accompanies new residential development in urban fringe areas. Open space is valued for a number of reasons, including its views, recreational opportunities, and its role in maintaining water quality and species habitat. Public parks and forest preserves, private golf courses, and agricultural land are different types of open space, which may have different values for a community. This paper develops a model that estimates the value of open space in a community, allows policy simulations of alternative preservation strategies, and applies the model to a specific community in the United States. This study focuses on how different configurations of open space will affect property values on a community-wide basis; however, individual homeowners may be interested in how open space near their houses affects the value of their properties, which is also available from the analysis. Using data on assessed valuation of buildings and land for a community in the Chicago metropolitan region, the present value residents place on open space near their homes will be estimated. Different definitions of open space will be used in the analysis. One definition would limit open space to public land such as forest preserves or parks. Another definition will include privately owned land that is used for agricultural production. Information on the location of open space comes from remotely sensed data as well as other sources.

Hatfield, Colleen A. Department of Ecology, Evolution and Natural Resources, Rutgers University, New Brunswick, NJ 08901, USA.
Discontinuities in Habitat Features Inhibit the Spread of Exotic Species.

Stream and riparian habitats function as corridors for organisms to move through the environment. At the scale of the watershed, the configuration of streams provides a network of interconnected habitats that potentially determines habitat extent and accessibility for organisms dependent on the stream or riparian environment. The goals of this study were to examine the potential for stream and riparian habitats to function as corridors for exotic plants at the scale of the stream network. I examined how exotic species distribution varied with riparian plant community composition, position within the network, and the local environmental. The study stream network was a relatively undisturbed fourth order stream system in northern New Jersey where the riparian vegetation community was sampled along the main channel and all tributaries. Variation in stream gradient and channel morphology defined five different riparian vegetation types that were intermixed along the main channel and tributaries. Overall species diversity and exotic species richness varied by riparian vegetation type with four of the five vegetation types supporting exotic species. Most exotic species present in the riparian zone were also common in the adjacent upland hampering the ability to determine the source of initial introduction. However, distributions of exotic species were not continuous along the stream network, suggesting that riparian habitats do not function as continuous habitats. The non-continuous nature of the riparian vegetation types throughout the stream network appears to retard the spread of riparian-dependent exotic species.

Hawks, Michelle M., Helene H. Wagnar, Jonathan M. Bossenbroek, John A. Wiens, and Beatrice Van Horne. Department of Biology, Colorado State University, Fort Collins, CO 80521, USA. **Multi-Scale Analysis of Butterflies Response to Environmental Factors Using Causal Modeling.**

The scale we use to collect data on animal communities influences our ability to explain species distributions using environmental variables. Analysis of data at multiple scales can help identify which scales might be appropriate for further data collection and analysis. We collected butterfly community data along three 2-km transects at Konza Prairie LTER. Environmental data gathered along these transects included fire frequency, grazing treatments, vegetation composition, and plants flowering at time of survey. We analyzed these data by causal modeling of resemblance matrices at various scales. The explanatory power of the environmental variables changed with scale. Our analyses indicated the appropriate scales for data collection. We demonstrate how this approach can be used to determine the appropriate scale for a particular study.

Hay,[1] G.J., P. Dubé,[1] D.J. Marceau,[1] A. Bouchard.[2] [1]Geocomputing Laboratory, Department of Geography, University of Montreal, Montreal, Quebec, Canada H3C 3J7; 2IRBV, University of Montreal, Jardin Botanique de Montreal, Montreal, Quebec, Canada H1X 2B2. **Scale-Space for Landscape Ecologists: A Novel Approach for Defining Multi-Scale Landscape Structure in High-Resolution Imagery.**

In this paper we describe a novel approach based on scale-space theory for extracting multi-scale landscape structure within a high-resolution remote sensing scene. Analysis is performed on an IKONOS image (acquired in September, 2000) that represents a highly fragmented agro-forested landscape in the Haut St-Laurent region of south-western Québec. Scale-space originates from the computer vision community, where it was developed to analyze real-world structures with no *apriori* information about the scene being assessed. Its basic premise is that a multi-scale representation of a signal (such as a remote sensing image of a landscape) is an ordered set of derived signals showing structures at coarser scales that constitute simplifications of corresponding structures at finer scales. In practice, gaussian filters are applied to the image at a range of kernel sizes resulting in a scale-space cube, where each layer in the cube represents convolution at a specific scale. The primary objective of our study is to link structures at different scales in scale-space to higher-order objects, called "scale-space blobs," and to extract significant features based on their appearance and persistence over scales. Blob-like structures, which persist in scale-space, are likely candidates to correspond to significant structures in the image and thus in the landscape. Spatial statistics are used to describe the spatial heterogeneity of these emergent landscape structures, and 3-D tools have been developed (in IDL-interactive data language) to visualize and describe their multi-dimensional morphology. These patterns are then be related to their underlying processes in order to better understand the multi-scale dynamics of this landscape.

Hayman, Alicia A. and Hans Schreier. Institute for Resources and Environment, May Pen, Clarendon, Jamaica W.I. **The Effects of Land-Use Practices on Water Quality and Quantity in the Hope River Watershed, Jamaica.**

The need for an integrated approach to water resources management and the linking of water management to land use has been stressed in many fora in recent years. Since water sustains life, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. A study was conducted to determine the effects of land-use practices on water quality and quantity in the Hope River watershed, Jamaica. Geographical Information Systems was utilized to evaluate changes in land use over the decade 1989–1998, while Participatory Rural Appraisal was used to determine the local people's perceptions and practices. Water balances for the watershed and the reservoir were determined to better understand the limitations and scope for management options. The water quantity study revealed that there is high spatial and temporal variability in rainfall, which decreased from 250 mm monthly in 1933 to less than 150mm in the 1990s. Subsequently, the available water from runoff as well as peak flows have also decreased. There has been an increase of over 2° in temperature in the watershed over the study period. The water balance showed that the hydrological cycle is dominated by evapotranspiration, which is greater than rainfall for 75% of the year. At the Mona Reservoir, which receives water from the Hope River, there was a negative balance in storage for at least 1/3 of the decade. Water quality analysis showed that there is deterioration in both spatial and temporal dimensions. Not only have nutrients increased but conductivity, total dissolved solids, and fecal coliform levels have also risen. Fecal coliform levels exceed the maximum allowable limits for health and recreational use over 90% of the time. These all tend to increase downstream. GIS overlays showed a 55% increase in agriculture, 24% in settlements, and a decrease of 18% in forestland. Conversion of the land is of major concern as 85% of the land is on steep slopes of over 25°. A study of people's perceptions revealed that most problems stem from the current economic conditions. People's perceptions were different from those of the government but sometimes showed similarities with the scientific data. An integrated management framework is needed which involves all stakeholders with specific focus on pollution prevention, maximizing storage, and improving efficiency of water use.

He,[1] Hong S., Stephen J. Ventura,[2] and David J. Mladenoff.[3] [1]School of Natural Resources, University of Missouri-Columbia, Columbia, MO 65211, USA; [2]Land Information & Computer Graphic Facilities, University of Wisconsin, Madison, WI 53706, USA; [3]Department of Forest Ecology & Management, University of Wisconsin, Madison, WI 53706, USA. **Effects of GIS Aggregation Approaches on Landscape Patterns Using Landsat TM Satellite Imagery.**

Aggregations of raster data based on the majority rule have been typically used in landscape ecological studies. It is generally acknowledged that through the aggregation process 1) dominant classes increase in abundance, while minor classes decrease in abundance or even disappear; and 2) the spatial patterns are changed. In this paper, we examine an alternative, random rule-based aggregation and its effects on cover type abundance and landscape patterns using a classified TM imagery. We aggregated the image from 30 m to 990 m resolution, a range sufficient for most data aggregations. To assess the effects of data aggregation on spatial pattern, we use aggregation index (AI), fractal dimension (FD), and average patch size. Our study assures that the majority rule-based aggregation distorts cover type percent areas, with the most common and contagious classes and the least common and dispersed classes distorted the most, while the random rule-based aggregation maintains cover type proportions of all classes within this broad range (30-900 m). The two aggregation methods alter spatial patterns in opposite ways. Majority rule-based aggregation filters out minor classes and produces clumped landscapes, while random rule-based aggregation tends to make disaggregated spatial pattern. Overall, we find that with the classified TM satellite image, the random rule-based aggregation maintains spatial pattern better than the majority rule-based aggregation. A map from random rule-based aggregations appears to have finer resolutions than the one from majority rule-based aggregation, while the spatial resolution is actually the same.

Hellmund,[1] Paul Cawood, Theresa Tiehen,[2] and Raymond Sperger.[3] [1]Landscape Architecture Program, Colorado State University, Fort Collins, CO 80523, USA; [2]Colorado Department of Transportation, Aurora CO 80011, USA; [3]South Platte Park, South Suburban Park and Recreation District, Littleton, CO 80121, USA. **Wildlife, a Highway, and Community-Based Conservation: A Case Study on Denver Urbanizing Fringe.**

The community-based Chatfield Basin Conservation Network was concerned when it first heard that the Colorado Department of Transportation (CDOT) was considering widening rural US-85 through Douglas County, Colorado. Traffic volumes and safety concerns were increasing in one of the fastest growing counties in the United States. But, the Network was uncertain if expanding the road from two to four and six lanes could possibly create an impassable barrier for the area's abundant wildlife. The Network, a group of more than 75 public and private organizations, had already drafted a vision plan for an interconnected system of open space for the area's wildlife. While CDOT's mission required it look narrowly at areas adjacent to the highway, the Network was accustomed to looking at the broader landscape. Through funding from the Colorado Smart Growth program, the Network was able to carry out ecological and planning studies that complemented CDOT's work. (One of those studies suggested the utility for wildlife of having underpasses of various sizes, not just a few large ones.) CDOT and the Network found ways to plan collaboratively. For example, through wildlife tracking and other research, CDOT identified two major underpasses to redesign for wildlife movement. The Network has developed conservation strategies for protecting lands leading to those underpasses as well as smaller ones. Through such community collaboration, eventual changes to US-85 are more likely to make the future highway a better fit for wildlife and the larger landscape, because all of the major stakeholders took part in finding solutions.

Helmer, E. H., Olga Ramos, Tania del Mar Lopez, Maya Quiñones and Wilmari Diaz. International Institute of Tropical Forestry, USDA Forest Service, P.O. Box 25000, Río Piedras, Puerto Rico, USA. **Mapping Forest Type and Land Use of a Biodiversity Hotspot.**

Extinction risks may be among the world's highest for tropical island species because high species endemism combines with high proportions of habitat loss. Many tropical islands have complex topography, climate, and soils, and, as in other complex tropical areas, ecological zones change rapidly over small areas. The maps needed for sustainable management of the ecological diversity in these complex areas require finer spatial and class resolution than existing global- or subcontinental-scale maps provide. This study evaluated a stratified, supervised classification method for integrating Landsat TM imagery with ancillary data to map, for conservation planning, forest to the formation level across Puerto Rico. Caribbean islands are an important priority for biodiversity conservation, and Puerto Rico contains forest formations representative of many forests found in the region. Using data on elevation, climate, and geology, we mapped 18 forest formations, including an early successional stage of six formations. Overall, classifications stratified by geoclimatic zones worked well to map both land use and forest formations in Puerto Rico. Geology separated the unique forest formations developed on serpentine and karst substrates and information on climate distinguished semi-deciduous from evergreen forests. Using an elevation band in a submontane-montane classification zone allowed consistent distinction between 1) cloud forest formations and disturbed forest at lower elevations, and 2) dense-canopied submontane vs. lower montane wet forests. To facilitate use of the data in global-scale maps of forest cover, we also identified what class each forest formation falls into for two classification schemes used in global forest monitoring.

Henebry, Geoffrey, Brian Putz, and James Merchant. Center for Advanced Land Management Information Technologies (CALMIT), University of Nebraska, Lincoln, NE 68588-0517, USA. **Modeling Herpetile Range Distributions from Species Occurrences and Landscape Variables.**

In order to provide a transparent and durable modeling framework for the range distributions of vertebrate species, the Nebraska Gap Analysis project has used recursive partitioning to develop "objective" semi-empirical models. Recursive partitioning algorithms predict membership of individual cases in classes of a categorical dependent variable from measurements of one or several independent variables. The motivation for using this strategy is two-fold: the resulting trees of decision points and values that form the models are readily understandable, debatable, and tunable; and the non-parametric modeling handles the multimodality common to regional species occurrence data. Although the best-known recursive partitioning algorithm is CART (Classification and Regression Trees), we have used QUEST (Quick, Unbiased, and Efficient Statistical Trees), a recent improvement on CART which greatly speeds up searching of the data space and which is more robust in the face of categorical variables with many levels. State Museum voucher specimens collected in Nebraska since 1969 served for the occurrence data. Explanatory factors included land-cover class/vegetation alliance composition at multiple extents, surficial soils characteristics, climatic means, variance and extremes, and terrain data. A main result of the modeling effort was the importance of interannual climatic variability in establishing range limits for these ectotherms. The poster illustrates the modeling procedure, provides the model trees and resulting range distributions for several representative amphibian and reptiles species, and discusses the weaknesses and strengths of the framework.

Henry, Julia C., S. G. Fisher, J. D. Schade, and J. R. Welter. Department of Biology, Arizona State University, Tempe AZ 85287, USA. **Periphyton-Sandbar Edge Interactions in an Arid-Land Stream.**

Ecosystem ecologists are interested in the relationship between spatial patterns and ecosystem processes. Recent research in Sycamore Creek, a nitrogen limited desert stream, has focused on the influence of sandbars on nitrogen cycling. Sycamore Creek is unregulated and characterized by flash floods that rearrange alluvial material. Depending on the time since a flood event, sandy runs contain from 0 to >20 sandbars that vary in size, shape, and arrangement in the channel. Stream water flows downstream, enters sandbars along "inwelling" edges, and moves along flowpaths through the sandbar. Microbial processes occurring in the interstices of sandbars cause non-linear increases in nitrate along flowpaths, and high nitrate water re-enters the surface stream at sandbar termini or "outwelling" edges. We have observed distinct spatial patterns of different types of periphyton associated with sandbar inwelling and outwelling edges. This study was designed to answer the question "what causes upstream sandbar inwelling edges to be dominated by nitrogen fixing cyanobacteria and downstream outwelling edges to be dominated by non-fixing algae?" We hypothesized that algae grows preferentially at locations where high nitrate water outwells from sandbars while cyanobacteria, which can fix nitrogen from the atmosphere, inhabit inwelling edges with low nitrate concentrations. We tested the hypothesis descriptively (measuring hydrology, nutrients and periphyton biomass) and experimentally (periphyton transplants). In general, the hypothesis was supported by our results. Sandbars are important to stream nitrogen cycling because they influence the distribution of n-fixing (direct N input to stream) and non-fixing (which retain 60–98% of outwelling nitrate) periphyton along their edges.

Hess, George. Forestry Department, North Carolina State University, Raleigh NC 27695-8002, USA. **Measuring Suburban Sprawl.**

Between December 1999 and May 2000, articles about sprawl appeared in a several popular magazines, including *Time, US News and World Report, The New Yorker, Atlantic Monthly,* and *Sierra*. Search for "urban sprawl" on the World Wide Web and you will be inundated. Most of these articles and web sites focus on purported negative social, economic, and environmental effects of sprawl. Yet, in all of this, the term "sprawl" is rarely defined and quantified. In order to assess sprawl's ecological impacts, we must be able to define and measure it. I define sprawl from a landscape perspective, present a number of simple quantitative sprawl indexes based on US Census data for urbanized areas (e.g., population size, population density, road connectivity), and use these indexes to compare sprawl among the urbanized areas in the mid-Atlantic United States. The indexes will be used to develop quantitative profiles of urbanized areas with similar characteristics. The indexes will be useful for examining trends for a single urbanized area through time and comparing trends among urbanized areas at city, state, and regional scales. In the longer term, I will examine correlation among sprawl indexes and measures of environmental quality and degradation.

Hess,[1] Rebecca S. and Thomas A. Spies.[2] [1]Department of Forest Science, Oregon State University, Corvallis, OR 97331, USA; [2]USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR 97331, USA. **Snag and Down Wood Patterns in Forests of the Coast Range of Oregon.**

Dead trees are important to forest ecosystem function and biodiversity, and their distribution is sensitive to the history of wildfires and logging. Patterns of dead wood have been examined at stand scales but infrequently and cursorily at landscape and regional scales. In this study, we asked: 1) What is the amount and distribution of snags and down wood in the Coastal Province of Oregon? and 2) What is the relative importance of environment and forest history in explaining the regional patterns of dead wood? We compiled a series of regional plot databases to describe the current amount and distribution of dead wood. We used multivariate techniques to evaluate relationships between dead wood, environment, and history. We used the Gradient Nearest Neighbor approach to model the spatial patterns of dead wood across the Coastal Province. Dead wood levels were higher on some ownerships, and size distributions of down logs and snags were spatially highly variable. Both environment and stand history played a role in the abundance and distribution of dead wood, with higher dead wood levels found at lower elevations and in areas that had not experienced repeated fire events. Ecological relationships explaining dead wood patterns at stand scales also operate at regional scales but with greater variation. Regionally, dead wood amounts and piece sizes are sensitive to management history. Current forest management practices and continued fire suppression will likely diminish the amount of dead wood present on some ownerships and lessen the spatial variability and temporal pulses of wood inputs.

Hobbs, Richard J. School of Environmental Science, Murdoch University, Murdoch, WA 6150, Australia. **Top 5 research questions in landscape ecology. (Conveyed by J. Wu)**

1. How do we do rigourous research at the landscape level? Traditional balanced and replicated designs don't work, so how can we come up with a mix of observartion, experimentation, and modelling which will yield convincing results? Do we need a new protocol for investigations at the landscape level, including a new approach to using statistics?
2. How do we more effectively combine the heavily biophysical North American approach to landscape ecology with the more planning and socio-economic focus in Europe? Both are valid and useful, but both could be significantly strengthened by synergies between the two.
3. How do we develop a useful set of "vital landscape attributes" that can be monitored and used to determine directions and desirability of landscape change? Aronson and LeFloch started on this, but more needs to be done.
4. Can we put the GIS genie back in the bottle? GIS is a tool, but it needs useful questions to guide it. Too often GIS is done just because it's there. We need effective meshing of good landscape ecological questions with good GIS tools.
5. Understanding of how landscape patterns influence biotic use and movement requires detailed biological understanding of organisms. This requires basic ecological study of individual species, an endeavour which is increasingly difficult to fund. Without basic biological data, no amount of GIS work, metrics development, etc., will actually help much!

Hockner,[1] Tom, Jim Newman,[2] Jeffrey Jones,[3] Mark Brown,[4] Joseph Delfino,[5] Michael Binford.[6] [1]Department of Urban and Regional Planning, University of Florida, Gainesville, FL 32611, USA; [2]Pandion Systems, Inc., Gainesville, FL 32611, USA; [3]East Central Florida Regional Planning Council, Maitland, FL 32751, USA; [4]Department of Environmental Engineering, University of Florida, Gainesville, FL 32611, USA; [5]Department of Environmental Engineering, University of Florida, Gainesville, FL 32611, USA; [6]Department of Geography, University of Florida, Gainesville, FL 32611, USA.
Assessing Impacts of Incremental Landscape Changes on the Wekiva River Ecosystem: A Dynamic Urban Ecology Model.

The majority of a metropolitan area's future growth will take place beyond the existing urban edge, expanding into and altering rural areas and their ecosystems. Current development practices and permitting procedures interact with these systems on an incremental basis—that is, one development at a time. Their focus is on an individual site, with little if any consideration given to the larger area of which it is a part. Through this process, natural areas are subdivided, the pieces isolated, and ultimately, as a metropolitan area continues its expansion, the structure of ecosystems are fragmented to such a degree that their functional integrity is compromised. The environmental deterioration occurring from this process is one of the principal characteristics of urban development. Incorporating landscape ecology principles into the practice of urban and regional planning offers a promising approach for addressing this problem. In the Orlando Metropolitan Area, we are developing a spatially explicit impact model for the Wekiva River Protection Area, a 100,000-acre ecosystem on the edge of the urban area that contains a federally designated Wild and Scenic River and is facing enormous development pressures. The GIS-based model will incorporate information on the dynamic relationship between the ecosystem's structure and function, and will allow the ecosystem's reaction to incremental structural changes to be identified and quantified. By using GIS, the spatial and ecological consequences will be presented in ways that facilitate nonexpert (i.e., decision makers) understanding and participation in the planning process.

Hoffman, Robin. Faculty of Landscape Architecture, SUNY College of Environmental Science and Forestry, Syracuse, NY 13210, USA. **Application of Computer Visualizations in the Investigation of Alternate Forest Management Practices.**

Forest managers, forest owners, recreationists, and land-use planners all make decisions based, in part, on what they see when looking at the forest. Understanding and communicating basic stand dynamics can assist forest users to appreciate the changes that occur as a result of natural disturbances and human interventions. Information describing forest conditions is typically presented in tabular or graphic form (McGaughey 1997). While these communication tools are well suited for illustrating basic stand attributes, they do not provide images of a stand's visual characteristics, for example, form, color, and spatial dimensions. New technologies are being applied to visualization techniques; however, little is known about the efficacy of computer-generated images. This study investigates the validity and reliability of digital images generated by the USDA Forest Service Stand Visualization System (SVS) as surrogates for portraying forest scenes. The images produced, while abstract, provide a readily understood representation of stand conditions and help communicate forest management alternatives to a variety of audiences (McGaughey 1997). At each of 10 field visual qualities control points, biophysical characteristics were measured and used to generate SVS images. Respondents completed ratings of forest visual qualities from the computer-generated images. The survey results will be used to draw preliminary conclusions about the usefulness of these images as informational and educational tools. This additional "visual" information could assist managers and users in making better informed decisions about the appropriateness of a plan of action and improve their understanding of alternative forest management strategies; a series of images could illustrate temporal changes.

Hoffman,[1] Aaron L. and John A. Wiens.[2] [1]Department of Biology, Colorado State University, Fort Collins, CO 80523, USA; [2]Department of Biology and Graduate Degree Program in Ecology, Colorado State University, Fort Collins, CO 80523, USA. **The Use of Semivariance Analysis for Scale Detection in Beetle Diversity and Landscape Properties on the Shortgrass Steppe of Colorado.**

How do the relationships between organisms and environments vary with scale? How do patterns of beetle species richness relate to heterogeneity in vegetation? To answer these questions, we analyzed variation in the distribution of beetle species richness and vegetation coverage at multiple scales on the short-grass steppe of the Central Plains Experimental Range, Colorado, USA. Four 2-km transects were selected to traverse a gradient of habitat types. We systematically trapped beetles and performed vegetation surveys along each transect during the summer of 1998. We used semivariance analysis to assess similarity between the scales of variation in beetle species richness and vegetation attributes. Although semivariance analysis has been used to quantify the spatial heterogeneity of many organismal and environmental variables, there have been few attempts to use semivariance to relate spatial variance in species richness at a particular site to environmental features. Similarity between the scales of variation in beetle species richness and vegetation attributes may indicate ways in which beetles perceive and respond to habitat features. Overall, we found few instances in which semivariograms of beetle species richness were similar to those seen in vegetation coverage, although in some instances patterns of variability in beetle species richness coincided with those seen in bare ground coverage and shrub coverage. Overall, beetle species richness exhibited multiple scales of variability, whereas environmental variables appeared to vary at dissimilar scales.

Hollister,[1] Jeff W., John F. Paul,[2] Jane Copeland,[3] Randy L. Comeleo,[4] Mike Charpentier,[3] Peter V. August,[1] Mark Brush.[5] [1]University of Rhode Island, Department of Natural Resources Science, Kingston, RI, 02881, USA; [2]U.S. Environmental Protection Agency, Atlantic Ecology Division, Narragansett, RI 02882, USA; [3]OAO Corporation, Narragansett, RI 02882, USA; [4]OAO Corporation, Corvallis, OR 97333, USA; [5]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI 02882, USA. **Landscape Structure and Estuarine Condition in the Mid-Atlantic Region of the United States: II. Assessing the Accuracy of the National Land-Cover Dataset at Multiple Extents.**

It has been hypothesized that land-use and land-cover patterns are strongly correlated with estuarine condition. In order to effectively evaluate this hypothesis, we need accurate measures of landscape structure and an understanding of the functional scales of land-use/land-cover data. Robust site-specific accuracy assessment methods allow for fine-scale assessments of overall land-use/land-cover classification accuracy and also describe mis-classification error between classes; however, they provide little insight into the accuracy of the data at the broad spatial scales at which landscape structure is often measured. We have developed a method that addresses this shortcoming. We assessed the accuracy of the National Land Cover Dataset (NLCD) using photo-interpreted land-use/land-cover data from Rhode Island (RIGIS) and Massachusetts (MASS-GIS). Within randomly distributed areas, we were able to calculate Pearson and Spearman rank correlations between the classified (NLCD) and reference (RIGIS and MASS-GIS) data along a gradient of extents (30ha to 3000ha). Forest, water, urban, and agricultural lands were accurately depicted at extents greater than approximately 3,000 ha. Due to potentially non-unique spectral signatures and rarity, barren lands, wetlands, non-natural woody, and rangeland were consistently misclassified and the NLCD poorly depicted these at all extents. These analyses allow us to identify a minimum spatial extent by which we may reliably measure landscape structure. This method is not presented as a replacement for site-specific accuracy assessment but as an important additional source of information regarding the accuracy and utility of broad scale land-use/land-cover data.

Hooten,[1] Mevin B., David R. Larsen,[2] and Christopher K. Wikle.[2] [1]Department of Forestry, University of Missouri, Columbia, MO 65211, USA; [2]Department of Forestry, University of Missouri, Columbia, MO 65211, USA. **Modeling and Mapping the Distribution of Legumes in the Missouri Ozarks: A Bayesian Approach.**

Understory vegetation composition is an important factor influencing biodiversity, animal forage, nutrient dynamics, and other crucial processes in most forested ecosystems. This holds true for the Ozark highlands section of Southeast Missouri where most of the upland soils are highly weathered and underlying geology is quite variable. The topographic complexity of the area adds to the variation in quantity and quality of ecological niches defined by environmental characteristics such as: soil order, geology, slope, aspect, slope position, and landform. It has been documented that several of the 500+ plant species found in subsections within the Missouri Ozark highlands have fairly high correlations with these environmental variables. In these subsections, leguminous ground flora has been found to be highly abundant when compared to other forested ecosystems. Speculation suggests that this abundance may be due to the exploitation of a nutrient poor substrate by these nitrogen-fixing legumes. It is the purpose of this project to demonstrate a robust spatial modeling methodology that will describe abundance patterns for organisms on a landscape. This research is focused on spatially modeling relationships between certain understory legumes and the aforementioned terrain-derived and substrate defining variables. Using ground flora data collected as part of the MOFEP pre-treatment project, and a series of conditional spatial regression models within a hierarchical Bayesian framework it is possible to successfully model leguminous plant distributions on a landscape.

Howe, Elisabeth Bartlett and William L. Baker. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. **Disturbance Interactions and Severe Blowdown in a Rocky Mountain Subalpine Forest Landscape.**

Three major disturbances affect subalpine forests in the Rocky Mountains: blowdown, insect outbreaks, and fire. It is believed that these disturbances influence one another temporally and spatially, creating a mosaic of disturbance patches on the landscape. In 1997, a severe windstorm resulted in the blowdown of over 10,000 ha of trees in the Routt National Forest in northern Colorado. The Routt-Divide Blowdown provides a valuable opportunity to study spatial patterns and interactions among large disturbance events over time. The study area includes blowdown patches of varying size and severity and is defined by the watershed of the Middle Fork Elk River. A map of stand-origin dates was created from approximately 1500 trees in 80 stands. This map was then compared to a map of the 1997 blowdown patches to determine relationships between past disturbance events and the pattern of the blowdown. The watershed has experienced at least one major disturbance event (fire, wind, or insects) each century since the 1500s. The oldest stands occur at higher elevations and on north slopes. The topography has influenced the pattern of both fire and blowdown, with south-facing slopes more likely to burn. Human influences (primarily sheep grazing) in the last 120 years have contributed to small-scale variability in south-facing, lower elevation aspen stands. The pattern of past events on the landscape, among other factors, contributed to the pattern of the 1997 blowdown. Determining the spatial relationships between disturbance events may help to predict responses to future disturbances, both natural and human-caused.

Howerter,[1,2] David, Jay J. Rotella,[2] James H. Devries,[1] Robert B. Emery,[1] Brian L. Joynt,[1] Llwellyn M. Armstrong,[1] and Michael G. Anderson.[1] [1]Institute for Wetland and Waterfowl Research, Ducks Unlimited Canada, Stonewall, Manitoba, Canada R0C 2Z0; [2]Department of Ecology, Montana State University, Bozeman, MT 59717, USA. **Landscape attributes predict hatching rates: Effects of classification and scale.**

Habitat fragmentation resulting from agricultural activities often has been cited as a cause for reduced reproductive success of grassland-nesting birds including ducks. Understanding how habitat configurations affect demographic parameters is essential for making better decisions about habitat preservation and restoration. Equally important is an understanding of how habitat classifications and the scale at which landscape attributes are measured affects predictions of demographic rates. Using duck (*Anas spp.*) nesting data from 10 65-km^2 study areas (n = 4,862 nests) dispersed throughout the aspen (*Populus tremuloides*) parklands of south-central Canada, we built models to predict hatching rates using generalized linear mixed modeling techniques. Using a hierarchical approach, we constructed separate models using landscape metrics generated for three different habitat classification regimes and three different spatial extents. Akaike Information Criteria was used to select the most parsimonious models for each combination of spatial extent and classification. We then searched for an emergent model that included important variables from multiple extents and classifications. Habitat patch size, shape, and type were important predictors of hatching, as were distance from habitat edge, distance from nearest wetland, and distance from nearest farm sites. Selected models were fairly robust to changes in habitat classification, but very sensitive to changes in extent. Inclusion of variables from >1 spatial extent significantly improved our ability to predict hatching rate.

Hudak,[1] Andrew, Janet Ohmann,[1] Matt Gregory,[1] Melinda Moeur,[1] Michael Lefsky,[2] and Warren Cohen.[1] [1]Pacific Northwest Research Station, U.S. Forest Service; [2]Department of Forest Science, College of Forestry, Oregon State University, Richardson Hall 321, Corvallis, OR 97331-5752, USA.
Comparison of Two Methods to Map Forest Structure from Inventory Plot and Environmental Data in Western Oregon.

The Forest Service and other agencies maintain a national network of inventory plots where forest structural parameters are measured and monitored at roughly decadal intervals. Our objective was to produce contemporary, regional maps of forest structure from these data, for the benefit of forest managers. We summarized tree basal area, height, and density data at the species level for over 1,300 inventory plots systematically gridded across western Oregon at 1.7-5.5 km intervals. We also compiled continuous environmental data layers (climatic, topographic, geologic, and spectral) for the same region. We then used two methods, Gradient Nearest Neighbor (GNN) and Most Similar Neighbor (MSN), to relate the plot-level data on species and stand structure to the continuous environmental data extracted for the inventory plot locations. The similarity functions in GNN and MSN are based on canonical correlation analysis and canonical correspondence analysis, respectively. Both methods use nearest-neighbor imputation to predict the response variables at all inter-plot locations, based on their respective canonical relationships. Preliminary results with just basal area data indicated that GNN more accurately predicts at the species level than MSN. However, maps of predicted basal area indicated that GNN is biased towards errors of commission, while MSN is not. Previous studies, lead by Moeur, indicate that MSN may be more appropriate for structural data aggregated above the species level. We will therefore expand our comparison of these two models for predictive vegetation mapping to other structural variables, such as tree height and density.

Huebner, Cynthia D. USDA Forest Service, Northeastern Research Station, Morgantown, WV 26505, USA. **Invasive Plant Species in Eastern Oak-Hickory Forests: Actual and Potential Landscape Impacts.**

Are invasive plant species a threat to oak-hickory forests of the eastern United States? Invasive plant species are often characterized by early successional traits, including small seeds that are wind and animal dispersed, vegetative growth, and shade-intolerance, all of which enable the plants to take advantage of disturbed areas and spread rapidly. One may conclude that these traits do not lend themselves to easy invasion of a forest and the apparent low impact of invasive plant species on forests, compared to riparian and rangeland sites, may support this. However, oak-hickory forests are unique because their canopies are relatively open compared to other hardwood forests, and the native species respond well to openings caused by various disturbance types. In fact, management regimes to maintain oak-dominated forests include clear-cutting and fire, both of which may promote exotic invasion. Moreover, eastern forests may be described as patches within an urban and agricultural matrix; i.e., the sink of invasion is embedded in its source. While there are over 180 potential oak-hickory forest invaders, we found the following species of most concern: *Alliaria petiolata, Microstegium vimineum, Lonicera japonica, Celastris, orbiculatus, Rosa multiflora, L. maackii, L. tatarica, L. morrowii,* and *Ailanthus altissima*. I compared each species' traits (physical, reproductive, and physiological), competitive ability, control measures, and known impacts on succession and ecosystem processes. I then related the distribution of these species to patterns of forest fragmentation and land use. I used this information to predict future impacts of invasive plant species on oak-hickory forests.

Hughes, Josie, Andrew Fall, Marie-Josee Fortin, and Ken Lertzman. School of Resource and Environmental Management, Simon Fraser University, Burnaby, British Columbia, Canada V5A 1S6. **Predicting the Effect of Pattern on Congregative Dispersal: A Comparison of Landscape Indices.**

Recently, attention has been given to developing landscape indices to quantify spatial pattern. However, it is not well known which, if any, of these indices describe aspects of pattern relevant to organisms. One study has investigated the ability of landscape indices to predict the results of simple dispersal on fragmented old growth landscapes. However, many species follow more complicated dispersal rules, some of which may alter the effect of pattern. The relative success of indices may also depend on the range of patterns investigated. To explore these considerations, we examined relationships between a variety common and new landscape indices and the results of a simulation of pheremone mediated congregative dispersal, such as that of mountain pine beetles and other aggressive bark beetles. We used a simple fire model to generate forest landscape patterns, which allowed us to vary landscape composition (habitat/non-habitat) and configuration independently over a wide range, while still ensuring that the cohesion and size distribution of our patches remained within a natural range. We used a balanced multifactorial experimental design to test for effects of patch characteristics and percent habitat, with ten replicates of each pattern type to control for stochastic variation in pattern and dispersal success. We found that both composition and configuration affect beetle success. Connectivity indices that are insensitive to small patches and small changes in patch perimeter performed best. This result is consistent with the findings for simple dispersal on real landscapes, suggesting that the relative merit of landscape indices may be fairly robust to details of pattern and species.

Ismail, Nafeesa Ahmed and AbuBakr AbdelAziz Mohamed. Crop, Soil, and Water Sciences Division, International Rice Research Institute, P.O. Box 3127, MCPO1271 Makati City, Philippines. F**arm Aggregation and Scaling for Land-Use Planning: Methodology and Application.**

In integrating biophysical and socio-economic aspects for analysis of land-use problems, one is always confronted with the problem of combining data from different spatial scales. Land-use decisions involve choices on at least two spatial scales. At one level, the regional level (macro level), a policy maker is trying to decide what policy may bring about the desired developments. At the other level, the farm level (micro level), farmers have their own production decision problem. In order to solve the macro-level decision problem, the uncertainty about farm responses has to be reduced. Ideally this can be done by grouping individual farms and aggregating them to be able to estimate their responses. In land-use planning, scaling up analysis from farm level to regional level, is the source of the aggregation problem. Developing procedures for solving this problem is one of the main challenges in land-use planning and as yet unsolved in a satisfactory manner. This paper contributes to development and operationalisation of a farm grouping and mapping methodology for land-use planning and policy analysis. The paper comprises four sections. Section one gives a description of the problem. A methodology is developed and outlined in section two. Operationalisation of the methodology for the case of Amol sub-region in Mazandaran Province, Islamic Republic of Iran, is carried out and described in section three. Finally, strengths and limitations of the methodology are discussed in section four.

Iverson, Louis R. and Todd F. Hutchinson. USDA Forest Service, Northeastern Research Station, Delaware, OH 43015, USA. **The Effects of Prescribed Fire on Soil Temperature and Moisture, Litter Consumption, and Sapling Topkill across a Forested Landscape in**

We have studied the potential of prescribed fires to restore mixed oak communities in Ohio since 1996. Here, we document landscape trends in soil temperature and moisture, and quantify variations in fire intensity and sapling topkill resulting from such fires. Soil temperatures at 1 cm depth increased only an average of 9.3 C for a six-minute period during the fire, for minimal expected impacts. Following the fires, hourly sensing occurred on mesic and xeric sites for seven months. Biologically significant effects may have occurred, as the soils on burned sites were warmer and drier, especially on xeric sites. Maximum daily soil temperatures averaged 3.5-5.7 C (maximum of 13 C) higher on the burned xeric sites during the first 30 days; elevated temperatures lasted 155 days. In a second study, fire intensity was monitored over four years of spring burns (some sites burned 4x and some 2x), under various weather conditions, and spatially modeled. The relationship of fire temperature to topkill of saplings was also used to map patterns of topkill across the landscape. The output maps show two very different prescribed fires, depending on weather: when recent rainfall has occurred, only the steep south-facing slopes experience higher temperatures and sapling topkill rates; under drier conditions, a greater portion of the landscape, including north-facing slopes, had greater temperatures and topkill. Fire intensity in 1999 also was higher on sites that had burned only once previously as compared to sites burned each year, because of higher fuels. These studies show importance of spatial and temporal conditions on fire outcomes.

Jackson,[1] Laura, Sandra Bird,[2]* Ronald Matheny,[3] Robert V. O'Neill,[4] Denis White,[5] Kristen Boesch,[6] and Jodi Koviach.[6] [1]US EPA, National Health and Environmental Effects Laboratory, Research Triangle Park, NC, 27711, [2]U.S. EPA, National Exposure Research Laboratory, Athens, GA 30605-2700, USA; [3]U.S. EPA, National Exposure Research Laboratory, Research Triangle Park, NC 27711, USA; [4]Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN 37830, USA; [5]U.S. EPA, National Health and Environmental Effects Laboratory, Corvallis, OR 97333-4902, USA; [6]University Of North Carolina, Dept. of City and Regional Planning, CB 3140, Chapel Hill, NC 27599-3140, USA. **Projecting Ecological Vulnerability to Land-Use Change across the Mid-Atlantic Region.**

The EPA Office of Research and Development (ORD) is addressing the question, "Where will projected land-use change most threaten ecological resources in the mid-Atlantic region?" Research is progressing within a multiple-scale framework to identify 1) county aggregations and 2) specific watersheds where projected growth and land-use conversion pose significant threats to sensitive ecological resources. Five region-wide modeling techniques were developed in-house and with the Departments of Agriculture and Interior. Synthesis of these results identified multiple-county aggregations most likely to undergo significant land-use change. When overlaid with large-scale ecological resources of concern, these subregions illustrate community risk management priorities for EPA Regions II, III, and IV. They also provide the focus for more intensive research, serving as test areas for the application and integration of higher-resolution, spatially explicit models developed within ORD, EPA Program Offices, and the academic community. Collaborative application of these models under selected economic and policy scenarios will lead to local development profiles across a range of resolutions and certainty. ORD will use the detailed development profiles that emerge to drive exposure and effects models, arriving at ecological vulnerability profiles at the eight-digit watershed scale. Vulnerability profiles will include ecological resources directly displaced by land-use conversion, and those indirectly impacted by increased quantity and toxicity of runoff and air pollution. A significant component of this initiative is the analysis of multiple scales and variables at work in current models, and the potential for their integration. ORD has evaluated 22 existing models of land-use change and related environmental impacts in the publication, "Projecting Land-Use Change: A Summary of Models for Assessing the Effects of Community Growth and Change on Land-Use Patterns" (EPA publication number EPA/600/R-00/098). Final reports will be available for distribution in January 2001.

Jacquemyn, Hans, Jan Butaye, and Martin Hermy. Department of Land and Water Management, University of Leuven, Vital Decosterstraat 102, B-3000 Leuven, Belgium. **Spatio-Temporal Effects of Forest Fragmentation on Plant Species Composition in Mixed Deciduous Forest Patches.**

Islands and terrestrial habitat patches isolated by the development of the surrounding landscape traditionally have been studied in terms of species richness (alpha-diversity) whereas patterns of species composition (beta-diversity) have received far less attention. Predictable patterns of species composition may be produced by both local and regional processes, which restrict the community pool to some subset of the regional species pool. By linking information of the exact spatial relations among patches, differences in age and habitat using extensions of the classical Mantel test, we tested the hypothesis that for 241 small and isolated forest patches embedded in a hostile agricultural landscape among-patch variation in species composition can be attributed to 1) differences in inter-patch distance, 2) differences in age or habitat or 3) a complex interaction of spatial and temporal aspects of fragmentation. Disentangling the relative importance of both spatial and temporal factors of fragmentation is of upmost importance for the development of more comprehensive guidelines for afforestation and forest conservation. Our results clearly show that the regulation of community structure is not only internally generated, but external processes such as dispersal may be important features explaining community structure in small and isolated forest patches. Hence, consideration of explicit spatial relations among forest patches is necessary for understanding local ensembles of plants within patches. The general conclusion is that the goal of forest conservation is not to stop landscape change, not to try to conserve the status quo, but rather to ensure that populations continue to respond to landscape changes.

Jager,[1] Henriette, Jim Chandler,[2] Ken Lepla,[2] Annett Sullivan,[1] Webb Van Winkle.[3] [1]Oak Ridge National Laboratory, Oak Ridge, TN 37830, USA, [2]Idaho Power Co., Boise, ID, USA; [3]Environmental Consultant, Boise, ID, USA. **A Simulation Study of How Dams Influence White Sturgeon Populations at Three Spatial Scales.**

Most of the world's large rivers are fragmented by dams that provide benefits to society but have adverse effects on some fish populations. In order to study the spatial influences of dams on white sturgeon populations, we developed a hierarchy of models. These models revealed effects that operated at three different spatial scales: 1) the metapopulation scale that encompasses the whole river, 2) the population scale for populations that occupy river segments between dams, and 3) the individual scale that considers spatial heterogeneity within segments. At the metapopulation scale, dams alter metapopulation dynamics by blocking upstream movements between adjacent river segments. Simulations indicated that unbalanced migration had a negative effect on upstream populations. At the population scale, fragmentation has both quantitative and qualitative effects on fish habitat: 1) the overall amount of river habitat decreases and 2) the quality of habitat is altered because free-flowing habitat is converted to reservoir. For white sturgeon, we assumed that high flows were required for spawning and that episodic high mortality occurred in reservoirs with water quality problems. Simulated populations distributed among many, short river segments were more likely to reach local extinction, particularly when free-flowing habitat was eliminated, than those in fewer, long river segments. At the individual scale, our estimates of mortality associated with poor water quality in reservoirs depended strongly on model assumptions about the ability of white sturgeon to move to avoid local areas with anoxic water. We will now use the metapopulation model to compare management alternatives designed to reconnect subpopulations by translocation, upstream passage, or stocking.

Jaiteh,[1] Malanding S., Paul V. Desanker,[2] and Jiquan Chen.[3] [1]Center for International Earth Science Information Network (CIESIN), Columbia University, P.O. Box 1000, The Palisades, NY 10964, USA; [2]Department of Environmental Science, University of Virginia, Clark Hall, Charlottesville, VA 22903, USA; [3]School of Forestry and Wood Products, Michigan Technological University, 1400 Townsend Drive, Houghton MI 49931, USA. **Land Use and Landscape Patterns in Miombo Ecosystems.**

The Miombo, extending over 2.7 million km^2 is the most extensive dry woodland ecosystem in Africa. An estimated 55 million people are directly dependent of the ecosystems for settlement, cropland, grazing land and woodfuels. A combination of anthropogenic activities (land use) and natural disturbances (drought and wildfires) had resulted in a significant modification of extensive areas of the Miombo with direct influence on regional biological diversity, climate and biogeochemical processes. The objective of this study was to analyze how spatial characteristics had changed within agricultural and forested landscapes between 1984 and 1995. Land-cover maps derived from Landsat Thematic Mapper scenes of central Malawi acquired in 1984 and 1995 were used to characterize landscape change within shifting cultivation (extensive agriculture in forest) areas, permanent settlement (intensive agricultural matrix) areas and Protected National Park (Brachystegia woodland) areas. Fragmentation of woodland covers particularly closed woodland was greatest in shifting cultivation areas with mean patch size decreasing from 27 to 17ha. In permanent settlement areas, cropland area increased 52% compared to 14% and 7% in shifting cultivation and National Park areas, respectively. New cropland areas in the permanent settlement areas came from fallow land (wooded grassland and dambos). National Park area remained fairly unchanged with closed woodland area increasing by 4%, mainly from regeneration of open woodland. This study provided evidence that landscape patterning within the Miombo is directly influenced by the intensity of human use.

Jenerette,[1,2] G. Darrel, Jianguo Wu,[1] Nancy B. Grimm.[2] [1]Dept. of Life Sciences, Arizona State University West, Phoenix, AZ 85069, USA; [2]Department of Biology, Arizona State University, Tempe, AZ 85287, USA. **Spatial Nitrogen Dynamics and Self-Organization.**

Self-organizing complex systems generate a variety of behavioral patterns. Two contrasting types of organization, hierarchical and SOC, are commonly identified in ecological systems. Hierarchical organization is characterized by the creation of scale dependence; processes and patterns occur in specific scale domains. In contrast self-organized criticality (SOC) is characterized by scale invariance; system dynamics and patterns span all scales, there is no characteristic event or patch size. Here, we explicitly compare these two organizational structures, examining the conditions which promote their development and their effect on system functioning. A conceptual model is proposed that system organization, hierarchical or SOC, is mediated by environmental variability. In environments of high variability, hierarchical structure could be favored because it constrains system dynamics—it promotes metastability. In environments of low variability, fractal structure could provide a mechanism for generating novelty and promoting long-range coherence of the system. We explore the interactions of these differing system organizations by coupling a new ecosystem model that generates hierarchical structure with a simple fire model which generates self-organized critical behavior. The ecosystem model simulates the interactions of two vegetation functional groups, nitrogen fixers and non-fixers, as well as nitrogen dynamics. When initialized randomly, the model generates a dynamic spatial heterogeneity where vegetation types and nitrogen patterns form discrete clumps, hierarchical units. By coupling this model with a fire model that exhibits SOC, the interactions between these two organizational characteristics can be examined. Explicitly examining how model systems become organized will help us understand the functioning of real systems.

Jenerette,[1,2] G. Darrel, Matthew A. Luck,[1,2] Jianguo Wu,[1] Nancy B. Grimm,[2] Diane Hope,[3] and Weixing Zhu.[4] [1]Landscape and Systems Ecology Lab, Arizona State University West, Phoenix, AZ 85069, USA; [2]Department of Biology, Arizona State University, Tempe, AZ 85287, USA; [3]Center for Environmental Studies, Arizona State University, Tempe, AZ 85287, USA; [4]Department of Biological Sciences, Binghamton University—SUNY, Binghamton, NY 13902, USA. **Linking Spatial Pattern of Soil Organic Matter to Ecological Processes in an Urban Landscape.**

Soil organic matter (SOM) measurements were obtained from 200 sampling sites in central Arizona. The samples were distributed in a spatially stratified random design that encompassed an area of 6387 km^2. The study area includes the urbanized, suburbanized, and agricultural areas of metropolitan Phoenix and the surrounding native desert ecosystem. The objective of this study was to determine the spatial pattern of SOM content and then to scale-up the point measurements to generate a regional SOM estimate. We hypothesized that land cover would be an important factor explaining the variability of SOM content. In addition, we also hypothesized that the multiple stressors associated with urbanization would be manifested as an urban to wildland gradient in SOM content. Three alternative methods will be used to estimate regional SOM content. 1) We will use regression analysis to predict SOM content as a function of other spatially distributed variables. 2) We will estimate a patch specific SOM content by overlaying a classified TM satellite image with the sample locations, and generated a regional estimate by integrating field measures with remotely sensed data. 3) We will identified spatial correlations in the data and then interpolated with a Kriging algorithm. Preliminary results showed that patch type alone was not an adequate predictor of SOM content. A significant ($p<.05$) second-order spatial trend in SOM content was observed centered on the urbanized region. Understanding SOM patterns is a necessary first step in understanding the biogeochemical controls in this region.

Jennings, David B. and S. Taylor Jarnagin.* U.S. Environmental Protection Agency, NERL/LEB, Environmental Photographic Interpretation Center, Reston, VA 20192, USA. **Impervious Surfaces and Streamflow Discharge: A Historical Remote Sensing Perspective in a Northern Virginia Subwatershed.**

Impervious surfaces are a leading contributor to non-point-source water pollution in urban watersheds. These surfaces include such features as roads, parking lots, rooftops, and driveways. Aerial photography provides a historical vehicle for determining impervious surface growth and, with concurrent daily streamflow and precipitation records, allows the historical relationship of impervious surfaces and streamflow to be explored. Impervious surface area in the upper Accotink Creek subwatershed was mapped from six dates of geo-registered historical aerial photography ranging from 1949 to 1994. Impervious surface cover has grown from approximately 3% in 1949 to 33% in 1994. Analysis of historical concurrent daily mean streamflow and daily precipitation records (1948–1998) shows a statistically significant increase in normalized discharge rates (per 1 in. of precipitation) for precipitation events >= 0.25 in., while the amount of precipitation per event shows no statistically significant change over the same time period. Historical changes in streamflow in this basin appear to be related to increases in impervious surface cover as determined by aerial photography and not to changes in precipitation patterns. The use of historical remote sensing data to reveal changes in landscape characteristics shows promise as a tool in understanding long-term changes in ecosystem function. Notice: The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development (ORD), funded this research and approved this abstract as a basis for an oral presentation. The actual presentation has not been peer reviewed by EPA.

Johnson, Alan R. and Karen M. Eisenreich. Department of Environmental Toxicology, Clemson University, Pendleton, SC 29670, USA. **Integrating Landscape Ecology into Ecological Risk Assessment.**

Ecological risk assessment is a procedure for systematically evaluating the likelihood of harm or undesired effects resulting from environmental stressors. The stressors most commonly considered are chemical contaminants, but the approach can be extended to include non-chemical stressors, such as land-use changes, altered hydrology, invasive species, or anthropogenic climate change. The techniques and methods of ecological risk assessment have undergone substantial development since early applications in the 1980s. In the United States, substantive methodological guidance has been provided by the Environmental Protection Agency (EPA 1998). Although issues associated with spatial heterogeneity and spatiotemporal scales are clearly relevant to the ecological risk assessment process, they have received little systematic treatment. We review the EPA guidance, and identify several points at which a landscape perspective may be advantageous throughout the process. These include consideration of scale and spatial organization in the initial problem formulation, accounting for spatial heterogeneity in exposure characterization, extrapolation of laboratory or small-scale studies in the effects characterization, the selection of assessment and measurement endpoints, a spatial analysis of uncertainties, and the use of spatial visualization for risk communication.

Johnson, Lucinda B. Natural Resources Research Institute, University of Minnesota, Duluth, MN 55811 USA. **Influence of Landscape Versus Local Scale Factors on Wood in Low Gradient Streams.**

Ecosystem processes in streams are influenced by factors that operate over a large range of spatial and temporal scales. In streams, wood influences a variety of ecosystem processes by controlling some fundamental physical properties important to stream benthic and pelagic communities, including the flow regime, organic matter budgets, habitat structure. In low gradient, Midwestern streams, woos is scarce relative to forested streams studied intensively in the southeastern United States and the Pacific Northwest. Although scarce and highly mobile, wood plays an important role in structuring the aquatic invertebrate community. Wood abundance is best predicted by landscape features, while the number and size of debris dams is best predicted by a combination of local and landscape features, reflecting channel scale control over wood retention. Underlying hydrologic factors controlled by landform strongly influence the stability of woody structures. Landscape features that positively associated with wood abundance include link number (related to catchment size), low-density residential land use, and topographically heterogeneous catchments. These areas are associated with landscape characteristics that are not amenable to agricultural production. Debris accumulations also are associated with residential land use, but also are controlled by channel dimensions and the amount of open tree canopy. While wood abundance in small, forested streams is predominantly controlled by channel dimensions, wood in these Midwestern streams is largely source-controlled, with lesser control exhibited by the stream channel, since log dimensions are generally much smaller than channel widths. To fully understand factors controlling wood abundance, both local and landscape factors must be considered.

Kashian,[1] Daniel M. and Monica G. Turner.2 [1]Departments of Zoology and Forest Ecology and Management, University of Wisconsin, Madison, WI 53706, USA; 2Department of Zoology, University of Wisconsin, Madison, WI 53706, USA. **The Persistence of Landscape Legacies Following Catastrophic Fire in Yellowstone National Park.**

It is well known that landscape pattern is important for ecological processes, and thus understanding the factors controlling landscape pattern is crucial for predicting ecosystem dynamics and vegetation development in disturbance-prone landscapes. The 1988 fires in Yellowstone National Park created a complex spatial pattern of lodgepole pine (*Pinus contorta* var. *latifolia*) seedling stands of differing structures across the landscape, but the spatio-temporal dynamics of post-disturbance heterogeneity such as this are poorly understood. We examined the long-term development of patches (mature forest stands of varying age) that constitute the Yellowstone mosaic to understand the degree to which major disturbances determine landscape pattern. We combined empirical measurements of tree density and age structure for stands in four age classes (50–100 years, 125–175 years, 200–250 years, and 300–350 years) with aerial photo interpretation to construct a simulation model to predict changes in the post-1988 landscape pattern over the scale of centuries. Preliminary results indicate that dynamics of the landscape mosaic depend on (i) magnitudes and rates of change in stand structure, (ii) the relative proportion of stand density classes across the landscape, and (iii) the initial spatial arrangement of patches produced by the disturbance. Initially dissimilar patches within the mosaic tend to coalesce with time since disturbance due to stand-level processes such as self-thinning or colonization, but coalescence depends on the initial spatial arrangement and level of dissimilarity between of these patches. Thus, spatial heterogeneity of the landscape declines with time since disturbance despite the strong initial patterning imposed by the disturbance.

Katti, Madhusudan and Eyal Shochat. Central Arizona-Phoenix Long-Term Ecological Research Project and Center for Environmental Studies, Arizona State University, Tempe, AZ 85287, USA. **Phoenix or Tucson: Does Landscape Determine Where Abert's Towhees Choose To Live?**

Local species diversity in urban environments is influenced by the regional species pool, habitat diversity and productivity within the city, and landscape configuration. Studies on urban bird communities have focused more on habitat factors, but less on landscape structures, such as corridors, that influence species distribution. We studied the influence of riparian corridors on the distribution of Abert's Towhee (*Pipilo aberti*), a common resident of Arizona, in urban areas. Previous studies describe this species as common in residential habitats in Phoenix, but scarce in Tucson, though it is common in natural habitats surrounding both cities. An important difference between these cities is that several major riparian corridors cross-residential habitats in Phoenix, but not in Tucson. We tested the hypothesis that these riparian corridors influence the distribution and abundance of Abert's Towhee in Phoenix. We estimated Towhee abundance from point counts at 51 locations throughout the Phoenix area. We found that Towhees did not occupy all neighborhoods, and that their abundance decreased with distance from riparian corridor. This suggests that riparian corridors may facilitate Towhee dispersal into residential habitats, and that the lack of such corridors in Tucson may explain their absence. The lack of Towhees from neighborhoods far from riparian corridors may suggest landscape mediated source-sink population dynamics along a riparian-residential habitat gradient. We suggest that studies on residential habitat used by bird species need to incorporate appropriately large spatial scales and landscape elements, since data from only one city, regardless of size, may represent pseudoreplication.

Keane, R.E. and R. Parsons. USDA Forest Service Fire Sciences Laboratory, Missoula, MT 59807, USA. **Limitations of the Simulation Approach to Estimate Historical Range and Variation of Landscape Patch**

Landscape patterns in the western United States are shaped by the interaction of fire and succession, and conversely, these vegetation patterns influence fire dynamics and plant colonization processes. Historical landscape pattern dynamics can be used to assess current landscape conditions and to design spatial characteristics for management activities. Historical range and variability (HRV) of landscape composition and structure can be quantified from simulated chronosequences of landscape vegetation and used 1) to describe temporal landscape characteristics, 2) to develop baseline threshold values, and 3) to design treatment guidelines for ecosystem management. But, this simulation approach has many limitations. To demonstrate the advantages and disadvantages of this approach, we performed several experiments using the spatially explicit, multiple pathway model LANDSUM (a LANDscape SUccession Model) to simulate a suite of landscape pattern metrics for four landscapes in the Pacific Northwest of the United States. The experiments evaluated 1) the effect of landscape size on pattern metrics, 2) simulation time spans of 100, 500, and 1,000 years and intervals 5, 10, 25 and 50 years to determine optimal output generation parameters, 3) the effect of topography on landscape metrics, 4) the effect of landscape shape on pattern metrics, 5) the influence of initial conditions on landscape metrics output, and last, 6) the sensitivity of input fire probabilities and transition times on landscape pattern. Results of these simulation tests are presented along with recommendations for employing simulation techniques to quantify landscape pattern HRV for fire management considerations.

Keane,[1] R.E. and S. Lavorel.2 USDA Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory. P.O. Box 8089, Missoula, MT 59807, USA; 2Centre d'Ecologie Fonctionnelle & Evolutive (CEFE), Centre National de la Recherche Scientifique (CNRS), UPR 9056, 1919 Route de Mende, 34293 Montpellier Cedex 05, France. **A Classification of Landscape Fire Succession Models: Presentation and Discussion.**

This presentation will summarize the talks during the special session, and then present a classification and corresponding key for landscape fire succession models. Landscape fire succession models (LFSM) are those computer programs that simulate the processes of fire and succession in a spatial domain. The purpose of this classification is to support an ongoing model evaluation project sponsored by the Landscape Fire working Group (Group 2.2.2) of the Global Change and Terrestrial Ecosystems (GCTE) organization, an integral part of IGBP. This group is charged with exploring the interaction of fire and ecosystems at the landscape level to further understand this complex dynamic, and also to develop a strategy for incorporating fire into coarse scale DGVMs (Dynamic Global Vegetation Models coarsely simulate the migration of vegetation types across the globe as climate changes). We would like to solicit comments on the classification and promote a spirited discussion on the application of LFSM to coarse scale fire modeling.

Keitt, Timothy H. Department of Ecology and Evolution, State Univeristy of New York at Stony Brook, Stony Brook, NY 11794, USA. **Statistical Mechanics of a Continent-Wide Biological Survey.**

Ecologists, going back to Taylor, have long been interested in scaling phenomena. Motivated by recent studies of scaling in economic time series, I examine power-law scaling in population time series taken from the North American Breeding Bird Survey. For each species in the survey, I form a single time series by summing over all survey locations in a given year. I then estimate and remove from the time series the bias in these time series due to changes through time in the number and distribution of survey locations. I show that the standard deviation of population growth rates depends strongly on mean abundance and that this relationship is power-law with exponent 0.36+/-0.01. A null model for this relationship is that time series with higher means are sums of a greater number of independently fluctuating sub-populations. According to the central limit theorem, we should see an exponent of 1/2, i.e., much less variability in highly abundance species. Two modifications of the null model can account for the greater variability of highly abundant species. The first is an increase in the size of sub-populations with increasing total population size which results in fewer sub-populations and higher variability in abundant species. The second is spatial synchrony in local population growth rates leading to a smaller effective number of sub-populations. I show that both these phenomena are present in the survey data. The resulting model predicts a wide range of macroecological patterns reported in the literature and present in the survey data. I also discuss why some species deviate widely from the overall scaling law.

Kepner,[1] W. G., S. N. Miller,[2] M. Hernandez,[2] R. C. Miller,[2] D. C. Goodrich,[2] C. M. Edmonds,[1] F. K. Devonald,[3] L. Li,[4] and P. Miller.[2] [1]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Las Vegas, NV, USA; [2]USDA—Agricultural Research Service, Southwest Watershed Research Center, Tucson, AZ, USA; [3]U.S. Environmental Protection Agency, National Center for Environmental Research, Washington, D.C., USA; [4]University of New Mexico, Department of Biology, Albuquerque, NM 87131, USA. **An Evaluation of Hydrologic Response to 25 Years of Landscape Change in a Semi-Arid**

The assessment of land use and land cover is an extremely important activity for contemporary land management. A large body of current literature suggests that human land-use practices are the most important factor influencing natural resource management at multiple scales. During the past two decades important advances in the integration of remote imagery, computer processing, and spatial analysis technologies have allowed the examination of environmental change. Recently, changes have been documented over a period of approximately 25 years in a semi-arid watershed using a series of remotely sensed images. Landscape change analysis has been linked with distributed hydrologic models to evaluate consequences of land-cover change to hydrologic response. A landscape assessment tool using a geographic information system (GIS) has been developed that automates the parameterization of the Soil Water Assessment Tool (SWAT) hydrologic model. This tool was used to prepare parameter input files for the San Pedro Basin, a watershed originating in Sonora, Mexico and flowing into southeast Arizona which has undergone significant land-cover change. Runoff and sediment yield were simulated using this model. Simulation results for the San Pedro indicate that increasing urban and agricultural areas and the correlative decline of grasslands resulted in increased annual runoff volumes, flashier flood response, and decreased water quality due to sediment loading. These results demonstrate the usefulness of integrating landscape change analysis and distributed hydrologic models through the use of GIS for assessing watershed condition and the relative impacts of land-cover transitions on hydrologic response.

Kerkhoff, Andrew J., Scott N. Martens, and Bruce T. Milne. Department of Biology, University of New Mexico, Albuquerque, NM 87131, USA.
Landscape Ecohydrology and Patterns of Tree Cover in Semi-Arid Woodlands.

Ecologists have long assumed that water-limited vegetation systems exist in some sort of equilibrium with their climatic and soil environments. Extending this assumption to a landscape context leads to the hypothesis that vegetation patterns result from adjustments in canopy density to maintain this equilibrium along climate and soil gradients. Recent "ecohydrological" approaches provide optimality criteria for quantitatively describing the climate-soil-vegetation equilibrium. These theories are generally based on point models of water-balance, and have not been examined in the context of climate and soil gradients. We explore this approach to landscape ecohydrology using spatially explicit data on the climate, soils, and vegetation of pinyon-juniper woodlands of the Sevilleta LTER site. Specifically, we ask whether gradients in energy and water input, along with soil variation, can be used to predict patterns of tree density over a complex topographic landscape. While woodland trees are broadly constrained by drought stress (as measured by annual water deficit), local tree density bears a complex relationship to both intraseasonal and interannual variation in energy and water input, as well as to alternative optimality criteria.

Ki-Hwan Cho[1], Do-Soon Cho,[1] and Sun-Kee Hong.[2] [1]Department of Environmental Sciences, The Catholic University of Korea, Puchon, Korea; [2]Environmental Planning Institute, Seoul National University, Seoul, Korea.
Landscape Ecological Functions of Mountain Ridges between a Bioreserve and Its Neighboring Forest in the Kwangnung Area,

This study was carried out to assess the ecological structure and function of mountain ridges that are connected to the Kwangnung Natural Reserve Forest (KNRF). Three ridges were surveyed and divided into two categories: one includes A and B ridges that were regenerated forests in the neighborhood of KNRF, the other is C ridge that was within the KNRF (from core zone to managed zone). The forest to which these ridges belonged had a lobe shape. The decline of species richness with distance from KNRF (peninsular effect) for all tree layer species or herbaceous layer species on A and B ridges were not found. However, if the species that were appeared in C1-C11 (core zone quadrats) were considered only, there was a significant decrease in tree and herbaceous species richness on these ridges. This means that the neighborhood forest of KNRF plays a role of buffer zone. It also implies that the peninsular effect at landscape scale is related to the loss of interior habitats. Vegetation survey indicates that successional stages and community structures were different between inner and outer ridges. The results of a DCA ordination of quadrats in A and B ridges, axis 1 was significantly correlated with distance from KNRF, indicating that KNRF affects the regeneration of the neighboring forest. The regenerating species were different at different distances from KNRF. The bioreserve is important to biodiversity conservation as well as ecological management of the neighboring forest.

King, Anthony W. Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6335, USA. **Top Ten Challenges for Landscape Ecology: A Middle-Number Systems Perspective.**

My top ten challenges for the future of landscape ecology are a mix of the old and new. Ranging from the old and persistent challenge of defining the scientific scope of landscape ecology to newer challenges of considering landscapes as complex adaptive systems, I will touch on some familiar themes of scaling and hierarchical organization. A challenge unsolved remains a challenge no matter how familiar. I will also discuss some less familiar questions about system organization and our conceptualization of landscapes that I view as exciting challenges for the science of landscape ecology in the twenty-first century.

Kirkpatrick,[1] Lee Anne and John F. Weishampel.[2] [1]Liberal Studies Program, University of Central Florida, Orlando, FL 32816-2368, USA; [2]Department of Biology, University of Central Florida, Orlando, FL 32816-2368, USA.
Quantifying Structure in Volumetric Neutral Landscapes.

Though usually characterized as fractal planes, i.e., between one and two dimensions, certain natural land- or sea-scapes are better represented as fractal volumes, i.e., between two and three dimensions. For example, the architecture of a forest canopy, the distribution of plankton in an ocean column, or the below ground organization of ant burrows can be depicted as a fractal sponge with occupied areas and empty spaces. Recognizing that the quantification of spatial heterogeneity is essential to understanding the relationships between patterns and processes, ecologists have developed and evaluated a host of landscape indices (e.g., connectivity, patchiness, porosity, contagion, etc.) and analysis techniques (e.g., geostatistics, lacunarity, wavelet, fractal, etc.) for planar spatial patterns. For this study, we developed binary cubic counterparts (voxel) to the more familiar flat, crossword puzzle-like (pixel) neutral models to assist in characterizing the relationships between measured patterns and volumetric formations in natural systems. Model types included simple random, percolation gradient, patchy, and hierarchically organized structures. We generated numerous variations of these and assessed the ability of certain pattern metrics derived from the planar landscape analyses to discriminate among the structural models. These experiments provide a statistical benchmark for measuring pattern in complex volumetric formations.

Koerner, Brenda A. and Jeffrey M. Klopatek. Department of Plant Biology, Arizona State University, Tempe, AZ 85287, USA. **Anthropogenic and Natural CO2 Efflux in an Arid Urban Environment: Pattern and**

The effects of land-use change on deserts may have significant impacts on ranging from regional climate modification to being significant carbon exchange sites. Changing the biological structure of these ecosystems through agriculture and urbanization by subsidization with water and energy, significantly changes the carbon stocks and fluxes. We document sources of CO_2 emissions across the Phoenix, Arizona metropolitan region. The Phoenix region, composed of a diverse mosaic of patch types, is characterized by a CO_2 dome that peaks near the urban center. The concentrations are high, not just because of anthropogenic sources, but also due to the physical geography of the area. Humans and their automobiles provide a substantial amount of emissions, that we show using a GIS based approach. We have measured significant diurnal cycles related to emissions, meteorology, and vegetation interactions. Soil CO_2 efflux is controlled by vegetation type and watering regime. Ecosystems dominated by natural vegetation, during hot dry periods, experience minimal emissions. Conversely, human maintained vegetation (i.e. golf courses, irrigated agriculture, lawns) shows significant soil CO_2 efflux that is temperature and soil moisture dependent. We present a graphical portrayal of soil CO_2 emissions for the dominant land-use types in the metropolitan region and discuss how this relates to the portrayal of global carbon cycling.

Kosek, Sandra E. and Joan Iverson Nassauer. Department of Landscape Architecture, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109, USA. **Scale Influences on the Perception of Landscapes Designed for Ecological Function.**

Large-scale land-cover patterns are aggregations of smaller scale design decisions resulting from parcelization that rarely take note of the ecologically functional characteristics of the larger landscape upon which they are imposed. This results in a dichotomy, and typically a conflict, between the scale of land ownership and the scale of landscape ecological function. At the scale of land ownership, what each land owner perceives about the landscape affects their decisions about the management of their parcel. The different management practices implemented by many land owners at the scale of residential parcels can result in habitat fragmentation and other negative effects on the ecology of the landscape. We surveyed 325 environmental group members and other residents of Southeast Michigan to determine their responses to two scales of landscape designs: front yards (0.1 ha) and subdivisions up to 150 ha. Each scale included a range of design treatments that varied in ecological function. At the subdivision scale, design treatments characterized by the most beneficial ecological function, with less lawn area and more forest or prairie, were more attractive to both groups. In contrast, at the front yard scale, the most ecologically beneficial designs were not found to be as attractive as designs that were moderate or low in ecological benefits, both of which included larger mown lawn areas. This scale difference in perception of the most ecologically beneficial residential landscapes suggests that designs that include larger ecologically beneficial patches within the design of an entire subdivision have more widely recognized cultural value than small patches on individual homeowners' parcels.

Kratz,[1] Tim K., Thomas R. Hrabik,[1] John J. Magnuson,[1] and Katherine E. Webster.[1,2] [1]Center for Limnology, University of Wisconsin, Madison, WI 53706, USA; [2]Wisconsin Department of Natural Resources, 1350 Femrite Dr., Monona, WI 53716, USA. **The Role of Landscape Position in Lake Structure and Dynamics.**

Individual lakes in a lake district often share the same origin, sit on similar geologic material, experience the same weather, and share the same regional species pool. Yet, lakes within a lake district are known to differ substantially in such characteristics as size, water chemistry, biological community structure and species richness, and degree of among-year variability. In this paper we draw on two decades of research at the North Temperate Lakes Long Term Ecological Research site to demonstrate how the spatial position of lakes relative to the surrounding hydrologic system is an important determinant of many structural and dynamic attributes of the lakes. This landscape position concept, conceptually similar to, but differing in detail with, the river continuum concept, leads directly to an understanding of spatially explicit patterns of lake dynamics at the landscape scale. Lakes lower in the landscape tend to be larger, more ion-rich, more likely to have stream inflows and outflows, more stable chemically when subjected to droughts, and have greater species richness than lakes higher in the landscape. Greater species richness in lakes lower in the landscape is related to differences in both lake size and water chemistry. Interestingly, although stream connections offer a corridor for species movement and might thereby increase species richness in connected lakes, stream connectivity among lakes appears to have only a minor effect on species richness in our study lakes. Among year coherence in variability in pairs of lakes is also related to the similarity of the lake pairs with respect to landscape position.

Krawchuk, Meg and Phil Taylor. Biology Department, ACWERN, Acadia University, Wolfville, Nova Scotia, Canada B0P 1X0. **The Relative Importance of Habitat Structure Changes within a Nested Hierarchy of Spatial Scales for Three Species of Insects.**

The larvae of three dipterans develop within the leaves of the pitcher plant, providing naturally nested levels of scale including leaves within plants within clusters within bogs. A census of the three species was used to assess the influence of amount and configuration of habitat on distribution within this discrete hierarchy of spatial scales. In general, species responded to the amount of habitat at relatively fine (individual) spatial scales, and configuration of habitat at broader scales, though each responded at slightly different absolute scales. The study emphasizes that both amount and configuration of habitat are important determinants of organism distribution.

Krysanova, Valentina and Frank Wechsung. Potsdam Institute for Climate Impact Research, P.O. Box 601203, Telegrafenberg, 14412 Potsdam, Germany.
West-European Trends in Agriculture and Their Impact on Ecohydrological Processes: A Modelling Study in the State of

During the last decade a tendency towards deintensification of agricultural land occurred in the state of Brandenburg, Germany, as in whole Western Europe, caused by a saturated market for agricultural commodities, less public acceptance for a subsidised agricultural production, and environmental pollution. The expansion of the EU and policy changes described in the Agenda 2000 indicate that this tendency will remain. Two possible ways of deintensification are: 1) an increase in temporary set-aside within crop rotations (the main measure applied during the last decade in Brandenburg), and 2) creation of buffer zones along river courses (river corridors) by converting arable land inside them into grassland (permanent set-aside). In our simulation study we explored the impact of temporary and permanent set-aside on regional water balance and nitrogen leaching to groundwater in Brandenburg. Simulations were performed using the regional ecohydrological model SWIM, which integrates hydrological processes, crop/vegetation growth, erosion, and nutrient dynamics in soil and water. The model was used to simulate the consequences of land-use change scenarios on main components of the regional water balance and nitrogen leaching. While positive trends were found for water quality, two opposite tendencies were established by introducing temporary and permanent set-aside on water resources. The temporary set-aside increased runoff from the whole area up to 6.7% due to lower evapotranspiration and higher soil moisture in arable land, while the conversion of agricultural land within river corridors to meadows had an opposite effect on regional runoff (-6.9%) due to higher water retention and higher evapotranspiration.

Kupfer,[1] John and Scott Franklin.[2] [1]Department of Geography and Regional Development, University of Arizona, Tucson, AZ 85721, USA; [2]Department of Biology, University of Memphis, Memphis, TN 38152, USA. **Evaluation of an Ecological Land Type Classification System, Natchez Trace State Forest, Western Tennessee, USA.**

We incorporated data on forest type, soils and topography into a GIS-based ecological land classification system for Natchez Trace State Forest in western Tennessee. When land types derived for the classification were evaluated with respect to data on forest composition and environmental conditions collected in the field, we found that the variables used to derive the classes did influence floristic patterns but that the classes themselves imperfectly captured patterns of overstory community composition for a number of reasons. This underscores a continuing limitation to the use of land type systems for some areas; specifically, the process of delineating land type boundaries inherently introduces errors because of: (1) the difficulty in defining meaningful breakpoints between classes, (2) the dynamic nature of plant communities and the individualistic responses of species to environmental gradients, and (3) limitations introduced by the spatial and temporal scale of the data. Although there was a general concordance between the land types and the forest types, it was unlikely that the land types could be used reliably to predict the proportional occurrence or level of representation of a given tree species or forest type. Thus, while there may be some management uses for which a general relationship between land type and vegetation or other environmental variables is fine, there are uses for which it is inadequate because a detailed or specific characterization is needed. Land types thus provide a potentially valuable management tool, but their utility and successful implementation are dependent upon a recognition of their inherent limitations.

Laurent,[1] E.J. and Bruce Kingsbury. Center for Reptile and Ampibian Conservation and Management and the Department of Biology, Indiana-Purdue University, Fort Wayne, IN 46805-1499, USA; [1]Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI 48824-1222, USA. **Validation and Nullification of a Predictive Model for Habitat Context: The Effects of Location and Landcover**

Landscape context plays an important role in whether or not an individual will utilize a particular patch of habitat. Past studies have shown that the surrounding landscape mosaic may influence species presence and density in otherwise similar patches. At last year's meeting we presented a method for predicting the value of habitat context for the endangered copperbelly water snake (Nerodia erythrogaster neglecta) in Kentucky. The value of a patch was given as the weighted number, total area and total perimeter of all like classified patches correlated with copperbelly density within distances representing typical copperbelly movement patterns. This year we provide validation for our methods. Cluster analysis was employed to determine if patch values could be used to distinguish between four levels of copperbelly density using data not included in model development. While only 33% of the sites were correctly agglomerated into correct groups, 95% of the sites were agglomerated into groups within one density category of that observed, excluding 44% of the possible combinations. Also, 63% of the sites were correctly classified as having copperbellies present and 43% were correctly classified as not having copperbellies. The same methods failed to predict habitat context for copperbelly density in Illinois and the results for Indiana were opposite that of Kentucky and previous studies of copperbelly habitat relationships. Possible reasons for these failures include differences between state's wetland maps, including: age, resolution and methods of classification. We recommend greater coordination within regions for future mapping efforts.

Lee,[1] Pey-Yi and Tom Scott.[1,2] [1]Department of Earth Sciences, University of California, Riverside, CA 92521, USA; [2]Department of Environmental Science, Policy, and Management. University of California, Berkeley, CA 94720, USA.
Hierarchical Pattern of Spatial Structure of Loggerhead Shrike at Different Scales.

We analyzed the spatial dispersion of Loggerhead Shrikes at three different scales (local population, regional metapopulation, and continental geography population) to find out the hierarchical pattern of spatial structure. At local scale, the survey data of breeding shrike territories at San Clemente Island showed that nearest neighbor distances were closer than habitat model predicted. The shrikes breeding territories dispersed in clustered pattern. It suggests some degree of conspecific attraction for territory establishing in male loggerhead shrikes. Above local population level, the local population, instead of individual, dispersion was analyzed. For regional metapopulation level, we examined a data set combined field notes and biological survey in western Riverside. For continental level, we used the national wide breeding bird survey data for the studies. The study will show a hierarchical pattern of spatial structure in different scales.

Levin, Simon A. Department of Ecology and Evolutionary Biology, Princeton University, Princeton, NJ, USA. T**op 10 list for landscape ecology.**
(Conveyed by J. Wu)

I. APPLIED CHALLENGES

1. Optimization of regional land- use patterns
   - Problems of reserve design in terrestrial and aquatic systems
   - Optimization under uncertainty
   - Accommodating mobile species across multiple scales
   - Scenario development
   - Resolving multiple uses
2. Valuation of ecosystem services
   - Utilitarian and other ethical perspectives
   - Bases for comparison among alternative choices
3. Integration of human and natural systems
   - Ecosystems and socioeconomic systems
   - Property rights and local control
4. Spread of invading species
   - Multiple modes of dispersal
   - Species interactions

II. CONCEPTUAL and METHODOLOGICAL ISSUES

1. Separating and integrating exogenous and endogenous influences
   - Pattern formation in heterogenous landscapes
   - Integrated modeling
2. Ecosystems and the biosphere as complex adaptive systems
   - Macroscopic patterns in relation to the level of selection
   - Ecological and evolutionary trends in resiliency
   - Determinants of levels of biodiversity
3. Interfaces between population biology and ecosystems science
   - Evolution and the constancy of element ratios
   - Evolution and the development of modularity
   - Evolution and consequences of dispersal and other traits
   - Stability of element cycles
   - Structure-functioning relationships—a functional taxonomy
   - Biodiversity and ecosystem functioning
   - Food webs and resiliency
4. Problems of scaling
   - From the individual to the aggregation
   - From the small-scale to the large-scale
   - From the species to the functional group
   - Renormalization methods
   - Dealing with multiple temporal scales and phase transitions
5. Dimensional reduction
   - Simplifying complex models
   - Lumping into functional groups
6. Terrestrial / marine comparisons
   - Role of mixing

Li, Bai-Lian. Department of Biology, University of New Mexico, Albuquerque, NM 87131, USA. **Spatiotemporal Complexity of Nonlinear Ecological Interactions.**

The exploration of complex spatiotemporal pattern formation mechanisms in a nonlinear complex system is increasingly becoming an important issue in natural, social, and technological sciences. The occurrence of multiple steady states and transitions from one to another after critical fluctuations, the phenomena of excitability, oscillations, waves and, in general, the emergence of macroscopic order from microscopic interactions in various nonlinear nonequilibrium systems in nature and society has required and stimulated many theoretical and, where possible, experimental studies. The classical approach to the solution of the problem of the origin of spatial structures was first developed by Turing (1952) and then elaborated by some followers. The results obtained in the course of these investigations indicate that the initially uniform distribution of reacting components can become unstable. As the instability develops further, a spatially nonuniform distribution of activators and inhibitors of the reaction occurs. The Turing pattern formation is based on the coupling of linear diffusivity of the activator is less than the diffusivity of the inhibitor. A major unsolved problem with the Turing approach is that the clear identification of activators and inhibitors which could be involved in the formation of patterns in chemical, biological or social systems is still missing and even seems hardly to be achieved. Nowadays, more realistic theoretical approaches are in progress. They are accounting for complex spatiotemporal dynamics of open spatially confined systems with the interaction between intrinsic dynamics and external forcing due to the impact of the system environment. This talk will introduce our recent work on this problem, especially on the processes underlying the dynamics of ecological interactions in spatially inhomogeneous aquatic systems to explain why the heterogeneity of the species spatial distribution can not always be reduced to the heterogeneity of the marine environment.

Li, Chao. Northern Forestry Centre, Canadian Forest Service, Edmonton, Alberta, Canada T6H 3S5. **Landscape Structure Based Simulation of Natural Fire Regimes.**

The idea of emulating natural fire regimes in harvest planning to achieve the goals of sustainable forest resource development and biodiversity maintenance has been widely discussed and accepted in central and western Canada. This idea was based on the belief that "Mother Nature knows the best". To implement this idea in practical forest resource management, managers need to know the natural fire size distributions and their spatial and temporal patterns, in order to decide the sizes of cutting patches over space and time. However, this information is not always available in most managed areas. The empirical methods of reconstructing natural fire regimes were well documented, but the associated resources demand often made them difficult or even impossible to be carried out. Therefore, the ecological modeling approach becomes an alternative for providing forest managers with such information. In this presentation, a methodology of reconstructing natural fire regimes based on current forest landscape structure shall be described. This methodology was based on the premise that a fire regime was the result of interactions among fire events, landscape structures, topography, weather, and fuels. A spatially explicit model for landscape dynamics (SEM-LAND) was developed for this purpose, and was validated in a study area in west-central Alberta. With the information of current landscape structure, a natural fire regime map can be generated from the application of this model.

Li,[1] Harbin and Jianguo Wu.[2] [1]USDA Forest Service Southern Research Station, Charleston, SC 29414, USA; [2]Landscape and Systems Ecology Lab, Arizona State University West, Phoenix, AZ 85069, USA. **Landscape Analysis with Pattern Indices: Problems and Solutions.**

Landscape ecology generated much excitement in the late 1980s and early 1990s. One reason was that it brought spatial analysis and modeling to the forefront of ecological research. However, high expectations for landscape analysis to improve our understanding and prediction of ecological processes have largely been unfulfilled. We argue that this lack of progress is due to three kinds of problems: conceptual problems with landscape analysis, inherent limitations of landscape indices, and improper use of these indices. For example, many landscape analyses treat quantitative description of spatial pattern as an end itself, and fail to take a step further to explore the relationship between pattern and process. Some landscape indices are highly sensitive to changing scales (grain and extent), while others are insensitive to certain important changes in spatial pattern. These ambiguities of indices hinder proper interpretation of results. In addition, landscape indices and map data are often used without justification of their ecological relevance, which may not only confound interpretation of results, but also lead to meaningless results. Thus, we must ask: Are landscape indices of any use and, if yes, how should they be used? In this study, we will explore the reasons for the lack of progress, discuss the underlying problems, and offer some solutions. It is most essential for landscape ecologists to go beyond the mere quantification of landscape pattern to examine how it may relate to ecological processes. We believe that it is time to do that—the unfulfilled promises need to be fulfilled.

Li,[1] Harbin, Zhengquan Wang,[2] and Carl C. Trettin.[1] [1]USDA Forest Service, Southern Research Station, Charleston, SC 29414, USA; [2]College of Forest Resources and Environment, Northeast Forestry University, Harbin, Heilongjiang 150040, P.R. China. **Scaling Up Carbon Estimates in Peat Soils: Sources and Consequences of Uncertainty.**

The growing concerns about global climate change have led to the international agreement of the Kyoto Protocol that calls for reduction of greenhouse gas emissions. However, the implementation of the Kyoto Protocol would require better estimates of carbon fluxes and pools at large scales. To get such estimates, one must scale up finer-scale information under great uncertainty because errors from many sources may propagate through the estimation processes. In this study, we examine and compare three methods to quantify uncertainty: the probability theory, the Taylor series approximation, and the Monte Carlo simulation. Errors propagate in the modeling process when the variances of the predictive variables get combined and when the output of one process (or operation) becomes the input of another. Using carbon estimates in peat soils of Finland as an example, we identify error sources, calculate the relative contribution of each source to the total uncertainty, and determine critical factors that are the most important sources of errors. For simple analysis of carbon storage in peat soils, the four error sources (bulk density, carbon content, peat depth, total area of a forest type) contribute equally to the uncertainty because of the simple model structure used. All three methods work well. For analysis of carbon fluxes, more processes (e.g., plant growth, soil and root respiration, OM decomposition) must be included. Model complexity and error sources increase. Only the Monte Carlo method handles this increased complexity. Uncertainties in both cases are high and must be reduced to arrive at useful estimates.

Lieberman, Arthur S. (Professor Emeritus of Physical Environmental Quality at Cornell University), Rehov Shimkin 21, Ahuza 34750, Haifa, Israel. **Top 10 list for landscape ecology. (Conveyed by J. Wu)**

1. It is imperative that the visibility of holistic landscape ecology be heightened at universities in the United States and Canada, through full-time semester courses, workshops, and problem-solving conferences. Emphasis on holistic thinking and research needs to be built into departments of urban and regional planning, landscape architecture, natural resources, and human ecology.

2. Training in holistic landscape ecology should be developed and conducted across North America in localities and regions for specialized audiences of decision makers, planners, and other professionals, as well as extension specialists and agents in land grant colleges in each of the states.

3. Long-term ecological research should increasingly include holistic landscape ecology focuses dealing with total human ecosystems.

4. Because the findings of holistic landscape ecology research are often too difficult for the public and officials to comprehend, they must be "distilled" into semi-popular language.

5. A bridging network of H.L.E. researchers, educators, practitioners and professional planners should be developed within the U.S. Section of IALE.

6. The U.S. section of IALE should have an annual session that deals with holistic landscape ecology. This should also be the case in conferences of "General Ecology" groups as well.

7. Holistic landscape ecology educators and practitioners need to produce a guide to pressing land and resource issues in the United States and Canada, and for international/regional/local goals for ecodiversity/open space and landscape protection, showing how H.L.E. can be put to work.

8. A brief, defining, and clearly understood publication on holistic landscape ecology should be prepared, to sharpen the understanding of focuses, content and achievements for a variety of North American audiences.

9. In response to print and electronic mass medias attention to urban sprawl and misguided land-use determinations, H.L.E. committed ecologists need to make the relevance of their science's perspectives known in these same media, for societal benefit in North America and internationally.

10. Holistic landscape ecology is noteworthy for its inclusion of the human societal dimension, which is too often excluded in other landscape ecology circles. Even in issues that seem to be strictly bio-ecological, human factors need to be in the picture. Today's realities dictate such an approach, as well as scientific rigor!

Lin,[1,2] Yu-Pin, Tung-po Teng,[2] and Chen-Fa Wu.[1] [1]Department of Landscape Architecture Chinese Culture University, Taipei, Taiwan 11114; [2]Department of Geography, Chinese Culture University, Taipei, Taiwan 11114. S**patial Continuity and Fragmentation Analysis of Vegetation Landscape at Lugiakan Conservation Area in Taiwan.**

The spatial patterns of vegetation may influence the ecological process and management in its environment, especially in conservation areas. Therefore, the systematic monitoring and spatial structural analysis of vegetation spatial variability are the most important issues for conservation management. This study conducted variography, indicator variography, Hausdorff-Besicovitch fractal dimension and geographic information system (GIS) to analyze the spatial continuity and fragmentation of the Normalized Different Vegetation Index (NDVI) of Lugiakan conservation area in 1994 summer in the Yangmingshan National Park in Taiwan. The results revealed that the NDVI spatial structure of Lugiakan area was a no nugget effect and geometric anisotropic exponential model with 780 m maximum range and 590 m minimum range. Moreover, the indicator variogram model of the 25th percentile NDVI was a 28.1% nugget effect and geometric anisotropic exponential model with 813 m maximum range and 1,016 m minimum range. The indicator variogram model of the 75th percentile NDVI was a 27.0% nugget effect and geometric anisotropic exponential model with 947.1 m maximum range and 1,227.3 m minimum range. Moreover, the highest Hausdorff-Besicovitch fractal dimensions of 25th and 75th NDVI were 1.901 and 1.851 in northeastern direction paralleled to topographical contour of this study area.

Lin,[1,3] Yu-Pin, Tsun-Kuo Chang,[2] Tung-po Teng,[3] and Chen-Fa Wu.[1]
[1]Department of Landscape Architecture, Chinese Culture University, Taipei, Taiwan 11114; [2]Graduate Institute of Agricultural Engineering, National Taiwan University, Taipei, Taiwan 10617; [3]Department of Geography, Chinese Culture University, Taipei, Taiwan, 11114. **A Study of Landscape Diversity and Soil Heavy Metal Pollution in an Agricultural Landscape.**

The soil of agricultural fields might be polluted by the wastewater, discharged into irrigation ditches, from human activities in Taiwan. This study used factor analysis and landscape diversity index of 55 16km^2 sampling sites in Changhua County in Taiwan to characterize the factor patterns among eight soil heavy metals (As, Cd, Cr, Cu, Hg, Ni, Pb and Zn), and to analyze the correlation between these factor patterns and landscape diversity to understand the characteristics soil heavy metals pollution and human activities. The results displayed that the agriculture-field was the matrix in this study area. Meanwhile, a four-factor model accounted for 92.03% of total variance in the measured soil heavy metal data of these 55 sampling sites. The first factor had high positive factor loading on Cd, Cr and Ni. The second factor had high positive factor loading on Cu, Pb and Zn. The third and forth factors had high positive loading on Hg and As, respectively. Moreover, only factor1 had significant relation with the landscape diversity index of these 55 sampling sites at the 0.05 level, according to the 2-tailed test. These results also implied that human activities dominated the local soil heavy metal pollution in this study area. Factors 3 and 4 had strongly no relation with landscape diversity. This might be due to that soil parent material mineralogy and may be a predominant factor in the total As content and Hg of soil. The results also displayed in geographic information system.

Lindemann, Jeremiah D. and William L. Baker. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. **GIS Analysis of Factors Influencing Blowdown in a Rocky Mountain Landscape.**

Large, infrequent disturbances create long-lasting physical and biological impacts influencing ecosystem processes. On October 25th, 1997, an unusual windstorm occurred northeast of Steamboat Springs, Colorado, in the Routt National Forest. Over 10,000 ha of forested land were affected by this storm in an area over 15 km by 45 km. A number of predictors have been studied in the past to determine what causes windthrow to occur where it does. These factors range from the natural physical setting, past disturbances, human-caused or influenced features to the variation in wind patterns that occurred during the blowdown. All these factors, and the patches of the blown-down forest were mapped into a GIS for analyzing the 1997 Routt National forest blowdown, using ArcView, Arc/Info and GRASS. Two methods were used to determine which predictors were most influential in this particular blowdown. First, Classification and Regression Trees (CART) were used with S-Plus to create a map predicting the blowdown pattern. Second, Logistic Regression was used to create a probability map of areas that were susceptible to the blowdown. These models show that the blowdown was primarily influenced by topographical factors, such as the Continental Divide, elevation and wind exposure, with less dependency on biological or land-use factors. The complexity of the topography led to a highly variable mosaic of disturbance patches. The results of this study help us understand how natural disturbances, such as windthrow, interact with, and shape the structure of the surrounding landscape.

Lioubimtseva, Elena. Department of Geography and Planning, Grand Valley State University, Allendale, MI 49401, USA. **Monitoring Changes in Arid Landscapes of Central Asia.**

Arid and semi-arid environments cover about 55% of the land in five republics of Central Asia. This vast desert region of about 3.5 million sq. km comprises the entire Turan Lowland and the Kazakh hills. There are several types of natural arid landscapes in this region, varying according to the mesoclimatic conditions, lithology of parent rocks and soil-vegetation relationships. As in many other arid regions of the world the influence of humans on the environment of Central Asia goes back a very long way. Except for the large oases alongside the major river valleys, where intensive irrigated agriculture was dominant for millennia, the most important human influences on the desert and semi-deserts biomes have been those connected with grazing. During the Soviet period, major efforts were focused on irrigation and monoculture development with extensive cotton plantations, especially in the southern desert biome, and cereal cultivation in the semi-desert. Analysis of temporal series of satellite data available since 1984 (NOAA–AVHRR and RESURS–MSU–SK imagery) and field research conducted in this region revealed dramatic transformation of landscape cover. Data interpretation resulted in the series of thematic maps including land-cover change, landscape systems and desertification. Several processes of human-induced landscape changes in this region comprise dramatic transformation of vegetation cover due to overgrazing and irrigation, salinization and petrification of soils, water and wind erosion as well as climatic changes caused the decrease of the Aral Sea level.

Lister,[1] Tonya, Rachel Riemann,[1] Mike Hoppus,[1] and Wayne Zipperer.[2] [1]USDA Forest Service, Northeastern Research Station, 11 Campus Boulevard, Suite 200, Newtown Square, PA 19073, USA; [2]USDA Forest Service, SUNY College of Environmental Science and Forestry, 5 Moon Library, Syracuse, NY 13210, USA.
Changes in Land-Use Patterns and Forest Fragmentation over 50 Years in the Baltimore Area and Their Effects on Forest Composition

The proximity of forestland to human development and land uses has increased rapidly in the Baltimore, Maryland area. Urban expansion and forest fragmentation reduce forest interior habitat, increase site disturbances, and often favor the invasion of exotic species. This study characterizes changes in land-use patterns over the past 50 years and sets the stage for determining how these changes affect forest composition and structure. Historic data from periodic forest surveys conducted by the USDA Forest Service's Forest Inventory and Analysis (FIA) unit were analyzed in Anne Arundel and Baltimore counties. Contextual information surrounding each inventory plot was compiled by photointerpreting and digitally mapping land uses within one kilometer of plot centers using aerial photos from 1949, 1963, 1979, 1988, and 1998. Patch metrics and forest fragmentation indicators were calculated, and their temporal dynamics analyzed. The relationship between changes in landscape pattern and forest characteristics on FIA plots also was examined where remeasurement occurred. Results indicate that forest fragmentation in this area is a stochastic process, with gains in forest being made where agricultural fields have reverted to forest, and losses occurring where urban sprawl has occurred. The analysis of species composition, and structure on FIA plots affected by urbanization indicates that changes have occurred through time, however no clear pattern has emerged. These findings are part of an ongoing study that will be expanded to include additional counties, as well as the incorporation of satellite data, where possible, in the fragmentation analysis.

Liu,[1] Jianguo, Marc Linderman,[1] Zhiyun Ouyang,[2] Li An,[1] Jian Yang,[3] and Hemin Zhang.[3] [1]Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan, USA; [2]Department of Systems Ecology, Chinese Academy of Sciences, Beijing, China; [3]China Center for Giant Panda Research and Conservation, Sichuan Province, China. **Panda Habitat Pattern and Process across Space and Time: Integrating Landscape Ecology with Human Demography, Behavior, and Socioeconomics at Multiple Scales.**

Global human population has exceeded six billion. It is now difficult to find a place on earth that is not directly or indirectly affected by human activities. Obvious examples are urban systems, which are human-dominated. A lesser known and most surprising phenomenon is that even in many protected areas, human population size is also increasing rapidly and human activities are becoming more extensive and intensive. Because protected areas, such as Wolong Nature Reserve in southwestern China, are the last hope and stronghold for biodiversity, it is urgently needed to evaluate the effectiveness of protected areas and to understand the mechanisms of human impacts. Established in 1975, Wolong Nature Reserve is a high-profile reserve for conserving the world-famous giant pandas. Taking a systems approach that integrates landscape ecology with human demography, behavior, and socioeconomics at multiple scales, we found that panda habitat across the landscape had been declining and fragmented at a higher rate, even after the reserve was established. These ironic results were due to the complex interactions among human population size, human population structure, the needs of local residents, social attitude and perception, and economic development.

Lookingbill, Todd, Kenneth Pierce, and Dean Urban. Nicholas School of the Environment, Duke University, Durham, NC 27708, USA. T**emperature in Montane Systems: Testing DEM–Derived Proxies with Field Data.**

Variability in temperature is a major determinant of vegetation pattern. Capturing fine-grain temperature variability at landscape scales cannot be accomplished easily using conventional sampling techniques. Yet, this is the scale at which ecosystems typically are managed. Various combinations of elevation, slope, and aspect often are used as proxies for temperature in montane ecosystems. We propose a low-cost and logistically feasible technique for collecting spatially explicit temperature data using a network of portable temperature micro-loggers. These data are used to generate simple equations for spatially extrapolating base station temperature measurements across complex terrain in the Sierra Nevadas and central Western Cascades. Results suggest that: 1) simple lapse rates do not adequately describe temperature in these ecosystems, and 2) temperature estimates would be improved significantly by using locally adapted lapse rates. DEM-derived proxies are compared in terms of their ability to describe temperature field data. The ability to estimate temperature variability across complex landscapes has important implications for ecological modeling, which frequently relies upon the simplifying assumptions associated with lapse rates in describing the environmental template.

Loucks, Orie L. Department of Zoology, Miami University, Oxford, OH 45056, USA. **Influencing the Social and Political Metabolism of Landscapes.**

This paper assumes we know about the natural processes of landscapes, including hydrologic interactions, carbon capture, secondary production, population and metapopulation dynamics, perturbation processes and ecological succession. Beyond that, we've learned much in recent years about human-generated processes that overlay natural landscapes, including land clearing, abandonment, fragmentation and recovery, conversion to commercial uses, reservoir development, irrigation, chemical enrichment of land and water, deposition of stressors, and introduction of exotic species. A further level of understanding is taking shape now. Here we need to consider how local to regional organizations, public and private, use policies or decision-making to influence the above processes. The result is a social and political integration of processes, a kind of metabolism, that is different for each landscape. Our economic and policy surveys on landscapes in the greater Columbus area of central Ohio have sought to estimate the willingness of people to pay for good stream water quality and biodiversity in the face of impending urban sprawl from Columbus into the Big Darby Creek watershed. We found the institutional influence is net-like, as well as hierarchical, capable of influencing pattern and process in both the natural and human-dominated system. Although essentially homeorhetic, however, the dynamics of this landscape system are capable of being redirected by human institutions. A second case study will illustrate why we believe financial institutions, such as the national capital markets, also can be enlisted to change human influence on the metabolism of landscapes.

Ludwig, John. CSIRO Sustainable Ecosystems, PMB 44, Winnellie, Darwin, Australia 0822. **Monitoring Landscape Health: A New Resource Retention Index Based on Remote Sensing.**

A healthy savanna landscape can be broadly defined as one that functions to 1) conserve resources by retaining water, soil and nutrients, 2) provide food and shelter (habitat) for fauna, and 3) meets the material, aesthetic and spiritual needs of people. How well landscapes specifically function to retain, not leak, vital resources such as water and nutrients can be indicated by the cover, number, size, shape and spatial pattern of vegetation patches. We have derived a landscape leakiness index for this resource retention function that is related to all these vegetation patch attributes, and that uses remotely sensed images. Using simulated landscape maps, and assuming that resources flow over these maps in a known direction, a directional leakiness index (DLI) was derived and tested for how well it logically related to patch cover, number and size, and to patch shape, arrangement and orientation (e.g., banded vegetation). Then, the utility of DLI was demonstrated by applying this index to Australian savanna landscapes that obviously differ in their patch attributes. Results for this leakiness index were also compared to those for the lacunarity index. Both DLI and Lacunarity logically positioned savanna landscapes along a function-dysfunction continuum, where dysfunctional landscapes are leaky (poorly retain resources). Using these landscape function indicators on remotely sensed images allows much broader landscapes to be monitored than is possible from ground-based methods.

Marshall, Treneice and Jiquan Chen. School of Forestry and Wood Products, Michigan Technological University, Houghton, MI 49931, USA.
Contribution of Wetland Ecotones on Vascular Plant Diversity within a Northern Hardwood Landscape.

Interior wetland ecotones exist as rare patch types in much of the Northern Wisconsin Landscape. The purpose of this project was to investigate the contribution of wetland ecotones to overall diversity in a northern hardwood landscape within the Chequamegon National Forest, WI. This study examines vascular plant diversity along a gradient from a wetland into a northern hardwood landscape. Data were collected along 90 120 m transects that were established from bog, small lake, and ephemeral stream edges (30 transects per wetland type). Plots were sampled for percent understory, overstory, moss, litter, and coarse woody debris cover in 1 x 1 m plots placed at 11 distances (0, 5, 10, 15, 20, 25, 30, 40, 60, 80, and 120 m) along each transect for a total of 990 plots. Lake transects exhibited high diversity between 0 and 5 m with the Shannon-Wiener Diversity Index (H') = 2.52. Diversity drastically drops beyond 5 m from the edge to H' = 1.72. For bog transects, diversity was low at the edge with H' = 1.11 but increased to H' = 1.94 at 5 m. For ephemeral streams, diversity remained high between 0 and 30 m with H' = 2.43, indicating that this feature has the greatest edge influence of the three ecotones examined in this study. Diversity drops to H' = 1.80 after 30 m. Small lakes and ephemeral increase diversity in northern hardwood landscapes while bogs show little effect.

Mast,[1] Joy N. and Lawrence E. Stevens,[2] [1]Department of Geography and Public Planning, Northern Arizona University, Flagstaff, AZ 86011, USA; [2]Department of Biological Sciences, Northern Arizona University, Flagstaff, AZ 86011, USA. **Dendroecological Study of Black Cottonwood Dynamics along Regulated and Unregulated Rivers in British Columbia.**

Dendrochronological data can be modeled to develop a longer-term understanding of riparian tree responses over pre-impoundment and post-impoundment time. Flow regulation can strongly affect riparian tree growth and seedling establishment, as has been detected on the regulated Missouri, in the Grand Canyon, in southern Alberta, and in the Pacific Northwest. In this study, we used tree ring data to model black cottonwood (*Populus trichocarpa*) growth in relation to flow regimes on eight regulated and unregulated rivers in southern British Columbia. Black cottonwood cores were analyzed to determine both the magnitude and timing of tree growth responses to past flow regimes in both types of river systems. Overall, the trees sampled along the regulated rivers established as a cohort following a high flow event, with moderately fast growth and strong releases after subsequent high flow events. In contrast, the black cottonwoods along the unregulated rivers were slower growing, older, and more sensitive to suppression events. Such analysis enhances the understanding of the role of the timing and frequency of past flows and floods across a landscape, which are important determinants of riparian vegetation. Understanding patterns of change and the potential to alter future riparian tree growth requires a sound understanding of existing conditions and past growth patterns. Development of a descriptive model of tree growth under various flow regimes will provide managers with a means of evaluating the options for riparian management.

Mauz, Kathryn. Arid Lands Resource Sciences, Office of Arid Lands Studies, University of Arizona, Tucson, AZ 85719, USA. **Quantifying Land-Cover Change on the Catalina Piedmont, Tucson, Arizona, 1984–1998: Application of Remote Sensing and GIS Analysis Techniques.**

Rapidly expanding urban areas are ranked among the most serious threats to regional biodiversity in the Sonoran Desert. One of the several consequences cited of urbanization is habitat fragmentation—the reduction in size and segregation of areas of suitable habitat as a result of residential and other forms of development. Development in the Tucson, Arizona, urban area has for decades occurred along the floor of the Santa Cruz River valley, with well-known consequences for riparian habitats that once thrived there. More recently, residential and resort development has occurred on the bajadas and in the foothills of surrounding mountain ranges, representing encroachment into Arizona Upland as well as xeroriparian (dry wash) habitats unique to these physiographic settings. This study is an investigation of landscape fragmentation in the context of urban expansion through analysis of satellite remote sensing imagery of the northeast Tucson urban area. Analysis of landscape metrics for these images provides an indication of the effects of development on the size and distributions of upland habitat remnants between 1984 and 1998. These patterns are discussed in relation to county planning and zoning policies and to the urban ecological literature for the Tucson Basin.

McConnell, William J. Indiana University, Bloomington, IN 47405, USA.
Human-Environment Relations in Madagascar: The Importance of Spatial and Temporal Perspective.

Madagascar has attracted widespread attention as a global biodiversity hotspot and, despite recent challenges, international biodiversity conservation policy continues to adhere to the population pressure-on-resources thesis, which holds that rapid demographic growth has caused widespread environmental degradation. This paper examines the challenges to this thesis and evaluates its utility in explaining environmental change on the island. The paper examines the evolution of human settlement and forest cover in a region in the south-central highlands, and explores in detail one landscape—the Pays Zafimaniry—whose settlement in the past two centuries has been posited as an exemplar for the prior transformation of the rest of the highlands. The paper presents the results of a quantitative case study of population pressure and forest cover change in the region, considering these two variables at several spatial scales: the eastern rainforest, the Ambositra Region, and a portion of the Zafimaniry landscape. The case study sets out to explicate the scalar dynamics of land-use and land-cover change, specifically, to discover how and why the relationship between population and forest cover changes with the grain and extent of observation. The results of the case study and the historical narrative are analyzed with respect to the reliability of estimates of forest cover and population. The analysis identifies limitations and inconsistencies in our understanding of these phenomena and therefore in our ability to theorize the relationship between them.

McDonald,[1] Robert I., Robert K. Peet,[2] and Dean L. Urban.[3] [1]Nicholas School of the Environment, P.O. Box 90328, Duke University, Durham, NC 27708, USA; [2]Department of Biology, P.O. Box 3280, University of North Carolina, Chapel Hill, NC 27599, USA; [3]Nicholas School of the Environment, P.O. Box 90328, Duke University, Durham, NC 27708, USA. **Landscape Impacts on Oak Decline and Red Maple Increase.**

Throughout eastern deciduous forests, *Quercus* species are in decline, while more shade-tolerant species, especially *Acer rubrum*, are increasing in abundance. This study uses a unique time-series of data collected over 75 years in the Duke Forest (Durham, NC) to shed light on these trends. Results confirm that the transition from *Quercus* to *A. rubrum* dominance is occurring in the NC piedmont, with *Quercus* spp. declining in abundance over time on all mature hardwood sites studied. Early-successional stands dominated by *Pinus taeda* have shown a slight increase in *Quercus* spp. abundance, although *Quercus* spp.remain low in relative density. *Acer rubrum* has increased in abundance six-fold over the last 75 years, in both mature and early-successional stands. Spatial data from large stem maps confirms that *Quercus* spp. have elevated levels of mortality, primarily due to crowding with A. rubrum stems. An analysis of environmental characteristics that influence the rate of transition from *Quercus* to *A. rubrum* dominance shows that the transition rate is slowest on wet, clay-dominated soils. Factors increasing the transition rate include steep slopes, high solar radiation, and high levels of K in the soil. Interestingly, sites closer to urban developed lands have a faster transition rate as well, for unknown reasons. Overall, the rate at which the transition from *Quercus* to *A. rubrum* dominance is occurring is influenced by a complex set of local site and landscape characteristics, making prediction of the ultimate fate of these forests difficult.

McDonnell, Mark J. and Kirsten Parris. Australian Research Centre for Urban Ecology, Royal Botanic Gardens Melbourne, c/o Botany School, University of Melbourne, Victoria, 3010, Australia. **Creation of a Human Dominated Landscape (Melbourne) Has Increased the Breeding Range of Grey-Headed Flying Foxes (Pteropus poliocephalus) in Australia.**

Grey-headed flying-foxes occur along the Eastern seaboard of Australia from southern Queensland to Victoria. They often roost in large diurnal aggregations, known as camps, in tree canopies located close to a food source. Camps can contain thousands of individuals and can occur in rural, suburban and urban environments. Due to the fact they form large breeding colonies and their native habitat has been reduced by land clearing, there is some concern about their conservation status. Historically, there have been several camps located within the Brisbane and Sydney metropolitan areas, but the Melbourne camp at the Royal Botanic Gardens has only recently developed. Although there were sightings of summer migrants in and around Melbourne for decades, the first seasonal camp was established in 1981 which has now grown to a year-round camp of up to 8,000 individuals. Climatic data from the last 100+ years indicate that the temperature in Melbourne has been increasing, thus reducing the frequency and magnitude of frosts. The availability of food resources in the Melbourne area has also increased over the last 30 years with the planting and maturation of Queensland and New South Wales trees such as Corymbia maculata and Ficus macrophylla. This represents an unusual case where the development of a human dominated landscape (Melbourne) is providing new habitat for the future conservation of a potentially vulnerable species. The extension of the flying-fox breeding range is causing tensions with the human inhabitants of Melbourne. Issues such as tree and fruit damage, noise, smell and the recent discovery of the Australian Bat Lyssavirus (ABL) and Hendra virus in the population have been identified as causes of concern.

McGarigal,[1] Kevin, William Romme,[2] Edward Roworth,[1] and Michele Crist.[1] [1]Department of Natural Resources Conservation, University of Massachusetts, Amherst, MA 01003, USA; [2]Biology Department, Fort Lewis College, Durango, CO 81301, USA. **Rocky Mountain Landscape Simulator (RMLANDS): Characterizing the Expected Range of Variation in Landscape Structure and Fsunction.**

Characterizing the expected range of variation (ERV) in landscape structure and function is a requirement of landscape planning in some federal land management agencies. A quantitative framework for characterizing ERV is especially useful for evaluating alternative land management scenarios. Spatially explicit computer models that simulate disturbance and successional processes and their affects on landscape patterns provide a means to establish this framework. We developed the Rocky Mountain Landscape Simulator (RMLANDS), a spatially-explicit, raster-based, stochastic simulation model of disturbance and succession processes for application in Rocky Mountain landscapes. The model is a visual C++ program that interfaces with ArcInfo and ArcView GIS software. It requires several input grids derived from the Integrated Resources Inventory (IRI) database used by the US Forest Service. Fire and various forms of logging disturbances are modeled as stochastic, multi-step, multi-scale processes that interplay with a stochastic, multiple pathway succession model at a 10-year time step. We applied this model to an area in the south-central highlands section of the southern Rocky Mountains province. To establish the ERV for current climatic conditions, we simulated several different fire regimes and quantified the range of variation in several landscape metrics computed using the program FRAGSTATS. The results illustrate the dynamic nature of landscape structure and highlight in the effect of spatial extent on measured dynamics. They also demonstrate the relative sensitivity of measured dynamics to variations in fire size and frequency. More importantly, the quantified ERV provides a framework for evaluating alternative land management scenarios involving anthropogenic disturbances.

McGarigal, Kevin, Scott Jackson, Brad Compton, Kasey Rolih, Ede Ene, Kirstin Seleen, and Curt Griffin. Department of Natural Resources Conservation, University of Massachusetts, Amherst, MA 01003, USA.
Biodiversity Assessment: A Coarse-Filtered Landscape Ecological Approach.

Given increasing threats of development in remaining natural areas, habitat protection is becoming increasingly important for the conservation of biodiversity. Yet, it is often difficult to identify the habitats and habitat patches in greatest need of protection, or those that will provide the greatest ecological value for the cost of protection. In response, we have developed a method for quantitatively evaluating biodiversity using a coarse-filter, natural community-based approach and applied this method in a western Massachusetts watershed. Our approach involves applying one or more biodiversity filters to each point and patch in the landscape. Our landscape is a map of predicted natural communities modeled from satellite imagery and terrain data. Each filter acts as a lens that allows you to see different aspects of the underlying natural community map, and consists of a model that applies community-specific criteria to the content, context, spatia character, or condition of a point or patch in the landscape to arrive at an index of biodiversity value. Each filter takes input parameters that are supplied separately for each community, and returns a value ranging from 0 (low biodiversity value) to 1 (high value). Typically, several filters are applied to the landscape and then integrated in a weighted linear combination. Weights are supplied by the user to reflect the relative importance of each filter for each community. This process results in a final biodiversity value for each point in the landscape. Our coarse filter is a first step in the process of targeting land for conservation.

McIntyre,[1] Nancy and Mark Hostetler.[2] [1]Department of Biological Sciences, Texas Tech University, Box 43131, Lubbock, TX 79409-3131, USA; [2]Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, FL 32611-0430, USA. **Effects of Urban Land Use on Pollinator Communities in a Desert Metropolis.**

We compared the richness and abundance of bee (Hymenoptera: Apoidea) communities in two seasons (September 1998 and April 1999) among four types of urban land use in the Phoenix, Arizona, USA, metropolitan area (xeriscaped residential yards, mesiscaped residential yards, urban desert-remnant parks, and desert parks at the interface between the metropolitan area and the outlying desert matrix). Richness and abundance of bees were generally lower in residential areas than in desert areas, with desert areas on the fringe of the metro area possessing the highest diversity of all sites. Residential yards that utilized xeric landscaping had a more diverse bee community (with proportionally more rare species) than did mesic (turf grass) yards, particularly in late summer. Although bee community structure was apparently unaffected by the number of local habitat features (native and exotic trees, shrubs, cacti, and herbaceous plants in addition to human-built structures), the types of habitat features do appear to influence the number and types of bees present in an area. These results suggest that urban development can be designed to promote the conservation of pollinator bees. Specifically, preservation of desert and greater use of xeric landscaping rather than mesiscaping may help preserve this ecologically and economically vital group of organisms.

McKenzie, Donald, Amy E. Hessl, Susan Prichard, and David L. Peterson. Cascadia Field Station, P.O. Box 352100, University of Washington, Seattle, WA 98195, USA. L**inking Multi-Scale Empirical Approaches to Process-Based Models of Fire and Succession.**

Spatially explicit models that are applied at broad scales require large amounts of empirical data as inputs, but existing data are rarely adequate for process-based modeling of fire and succession at these scales. Varying resolution, extent, and spatial pattern often limit the ability to aggregate raw data effectively. Empirical-statistical and semi-qualitative approaches can produce data layers or time series that capture the spatial and temporal variation in parameters essential for landscape fire succession models. We present five examples: three that demonstrate the creation of spatial data layers through empirical modeling, and two that demonstrate spatio-temporal layers. 1) A continental-scale qualitative model of vegetation transitions in response to altered fire regimes produces data layers that are keyed to modeling fire effects. 2) A regional-scale statistical model produces a spatial coverage of fire return intervals. 3) A sub-regional statistical model links vegetation to climate and implicitly incorporates fire when carefully validated at fine scales by a process-based fire succession model. 4) Landscape-scale models of fire-climate interactions over time refine spatial coverages of fire regimes and provide inputs for stochastic elements of fire succession models. 5) A sub-watershed-scale (1–3 ha) reconstruction of Holocene fire frequency using charcoal, linked to climate and macrofossils, provides a template for long-term simulations of fire and succession.

McPherson, A. Michelle and Philip D. Taylor. ACWERN, Department of Biology, Acadia University, Wolfville, Nova Scotia, Canada B0P 1X0. **Effects of Landscape Change and Forest Regeneration on Peatland Dragonflies (Odonata) in Western Newfoundland.**

Movements and distributions of many organisms are changed when landscapes are altered by human use. The boreal ecosystem near the Main River, Newfoundland has been extensively logged; we question how this activity has affected populations of dragonflies inhabiting peatlands in this naturally heterogeneous area. In particular, we are interested in 1) whether spatial structure of populations is altered and 2) whether these changes are caused by finer-scale characteristics of bogs or 3) changes in landscape connectivity. To determine how species abundance relates to the type of habitat in which bogs are imbedded and how this changes as forest regenerates, we sampled bogs in 7 different contexts. Exuviae (shed exoskeletons) of 11 odonate species were collected at water pools in bogs surrounded by: mature forest, scrub, and clear-cuts from 1991-1998. The structure of pools—water depth, pH, bank slope, bottom type, and emergent, submergent, and surrounding vegetation—was also measured. We are using this information to model the effects of landscape change on species abundance and distribution at pool, bog and landscape scales.

Meegan,[1] Rebecca P., David S. Maehr,[1] and Thomas S. Hoctor.[2] [1]Department of Forestry, University of Kentucky, Lexington, KY 40546-0073, USA; [2]Department of Landscape Architecture, University of Florida, Gainesville, FL 32611-5704, USA. **Recovering the Florida Panther through Regional Conservation Planning.**

Southwest Florida is experiencing rapid human population growth and infrastructure development that may limit dispersal and population growth of the Florida panther (*Puma concolor coryi*). The southwest Florida landscape is a patchwork of agricultural, urban, and natural areas that includes some of the largest tracts of conservation lands in the eastern United States, but they appear to be disconnected from other conservation lands to the north. The bulk of public lands are in extreme southern Florida; the northern portions of occupied panther range are dominated by private lands. Panther habitat on private land can be of high quality but is usually patchy. These features not only limit the ability of panthers to inhabit remaining forests, but the associated fragmentation reduces the ability of individual panthers to disperse away from the source population. We used two decades of radio telemetry data and ArcView GIS to develop a regional blueprint for landscape restoration that enhances panther dispersal, facilitates population colonization to the north, and that can serve as a tool for future land-use decisions in the region. GIS tools were used to relate telemetry data to landscape features and to identify strategic linkages vital to continued dispersal and occupation of panthers in southwest Florida. Our future land-use map incorporates proposed development permit data and their potential to impede normal demographics of this endangered subspecies. This analysis suggest that landscape-scale, panther conservation opportunities are still possible in the increasingly denatured region.

Mehaffey, Megan H., Maliha S. Nash, Tim G. Wade, and Curt M. Edmonds. U.S. Environmental Protection Agency, Las Vegas, NV 89119, USA. **New York City Water Supply: A 25 Year Landscape Analysis of the Catskill/Delaware Watersheds.**

A number of water bodies located within the New York City water supply system are impaired by nutrients, pathogens and sediment. The objective of this study was to investigate long term landscape and water quality trends using multiple snap shots in time spanning two decades (1975–1998). Biweekly water quality, rainfall and discharge data from 1987–1998 was used to examine temporal and discharge relations at six locations within the watershed. Stepwise multiple regression analyses (n=32) were used to determine the contribution of the landscape metrics to surface water total nitrogen, total phosphorous, and fecal coliform. Percentages of agriculture and urban development were the dominant landscape variables over the years and explained 25–65% of the variability in water quality measurements. Barren, agriculture on steep slopes and agriculture on erodible soils were also contributed significantly to water but explaining only a small portion (4–8%) of the overall variability. During the past two decades the release of agricultural fields from farming has returned a small percentage of land (2%) to secondary growth forest. Most of the change in landscape took place from 1985 to 1998 and corresponds to decreases in nitrogen (0.039 to 0.009 mg/L/month) and phosphorous (0.053 to 2.81 mu g/L/month). With over half of the remaining agriculture located within 240 meters of streams, efforts to further decrease pollution would have the greatest impact by directing best management practices and land acquisition within these riparian zones. Notice: The U.S. Environmental Protection Agency (EPA), through its Office of Research and Development (ORD), funded this research and approved this abstract as a basis for an oral presentation. The actual presentation has not been peer reviewed by EPA.

Meretsky,[1] Vicky, Tom Evans,[2] Eduardo Brondizio,[3] Cynthia Croissant,[2] and Dawn Parker.[4] [1]School of Public and Environmental Affairs, Indiana University, Bloomington, IN 47405, USA; [2]Department of Geography, Indiana University, Bloomington, IN 47405, USA; [3]Department of Anthropology, Indiana University, Bloomington, IN 47405, USA; [4]Center for the Study of Institutions, Population and Environmental Change, Indiana University, Bloomington, IN 47405, USA.
Characterizing Landscape Composition and Pattern: Cross-Site Comparison of Social and Biophysical Factors.

Substantial research has been conducted addressing global environmental change and regional-scale monitoring through land-cover-change analysis. To date, however, little research has dealt with linking social and institutional drivers to landscape-change outcomes across different social or physical landscapes. It is useful to understand the role of anthropogenic forces at individual sites, but we must be able to compare these forces among sites to make well-informed management and policy decisions. Land-cover change modeling is a powerful tool to help researchers understand relationships between human processes and land-cover change. Agent-based modeling is one approach whereby agents of land-cover change are modeled as individuals and, critically, interactions between those agents are incorporated. In this presentation, we outline a methodology to calibrate and validate agent-based models of landscape change. We propose a conceptual framework of landscape characterization to address the need for cross-site and cross-time comparison, and the interactive relationships between social, institutional, and biophysical factors. We use this framework to compare a once deforested and now reforesting Midwestern landscape and a landscape in the Brazilian Amazon that is currently being deforested. Issues addressed in this cross-site analysis include (i) comparison of landcover classifications from different ecosystems, (ii) linking social factors to landscape outcomes under different land-use systems and (iii) comparison of landscapes at different stages of settlement / development. Our analytic techniques involve describing the spatial patterns of landscapes and relating these to anthropogenic drivers of landscape change. In particular, we examine the fragmentation and connectivity of landscapes in the context of various systems of agricultural production and institutional factors affecting landscape change.

Metzger, Jean Paul. Department of Ecology, University of Sao Paulo, Rua do Matao 321, trv. 14, 05508-900, Sao Paulo, Brazil. **Effects of Deforestation Pattern and Private Nature Reserves on the Forest Conservation in Agricultural Areas of the Brazilian Amazon.**

Deforestation rate in the Brazilian Amazon has been increasing in recent years. According to the deforestation pattern, the spatial distribution of the forest remnants can considerably change, affecting differently the capacity of the landscape to conserve native species. In the present work, we simulated the effects of fallow period (long and short), deforestation pattern (EDGE, HALF-EDGE, RANDOM, ROW) and private nature reserves extent (80, 50 and 20%) on forest conservation using simple land-use and land-cover sequences. Simulations were run for settlement projects that produce a fish-bone pattern of occupation and where slash-and-burn agriculture is predominantly used. Because conservation can not be considered without economic development, we also simulated the influence of different land-use patterns on the potential forest regeneration. Results showed that the best scenario for forest conservation is the maintenance of 80% of the lot as private reserve and the grouping of the reserves from different farmers at the end of the lot, using EDGE or HALF-EDGE deforestation pattern. In this scenario, long lots will allow the formation of wide forest corridors. ROW and RANDOM patterns will create more contacts among the landscape units, so facilitating the seed fluxes and the regeneration process. Considering both forest conservation and agricultural productivity, HALF-EDGE pattern of deforestation (land use) in a lot of 2,000m by 500m, with LR of 50% seems to be the best compromise. To guarantee the private forest preservation and assemblage, these forests should be pre-established when settlements are planned and grouped at the end of the lots.

Miriti, Maria. Department of Ecology and Evolution SUNY at Stony Brook
Stony Brook NY 11794, USA. **What can distort the identification of landscape spatial pattern?**

Our ability to recognize ecological phenomena such as size structure of populations or resource competition is coupled to our ability to recognize patterns or the area a particular phenomenon encompasses. Phenomena incorporate processes that are both intrinsic and extrinsic to organisms. Intrinsic processes include aspects of population dynamics; extrinsic processes include the distribution of necessary resources. The interaction of these processes leads to recognizable units. Technological advances have improved researchers' capacity to measure phenomena that occur at very small and very large observational scales creating opportunities for collaboration among researchers from such previously independent fields as geology, cartography and ecology, each with its own distinct terminology. In particular, ecological studies that have traditionally focussed on pairwise interactions among individuals within a restricted area can now encompass interactions over large spatial areas. Several issues emerge from increased collaboration and increased choice of level of observation, among them two stand out. Care should be taken to distinguish the spatial extent of a phenomenon versus the spatial extent of observation, especially since the two are not independent and the level of inference will be constrained by the interaction among the two. Second, as the interests of distinct fields continues to merge, the need for conformity of terminology becomes increasingly important. Attention to these points will improve our ability to measure and characterize ecological phenomena at large spatial scales.

Mladenoff, David J. Department of Forest Ecology and Management,
University of Wisconsin, Madison, WI 54706, USA. **Challenges for Landscape Ecology.**

I will review major issues identified in the past and assess their current status, particularly in the context of how landscape ecology has developed historically from its roots. I will try to examine if the conceptual and applied issues have changed in emphases in the past decade or so, and why. Finally, I will look at current and future challenges in the application of the science.

Mohamed, AbuBakr AbdelAziz. Crop, Soil, and Water Sciences Division, International Rice Research Institute, P.O. Box 3127, MCPO1271 Makati City, Philippines. **Modeling Spatial Heterogeneity for Planning Land Use in Rainfed Environment.**

Current methodologies for incorporating spatial heterogeneity in land-use planning are based on the concept of land unit (LU). The LU is defined as a relatively homogenous area of land demarcated on a map and possessing specified land characteristics and/or qualities. These land characteristics and qualities are described only in biophysical terms. Purely socio-economic characteristics are not included in the concept. A feature common across rainfed production environments is the high micro spatial heterogeneity. The sources of this heterogeneity are the significant differences over space in biophysical and socio-economic conditions. Obviously, this creates the difficulty of using the land unit as a unit for land-use modeling in spatially heterogeneous rainfed environments. In this paper a methodology for modeling spatial heterogeneity in land-use planning is developed and operationalised. The paper comprises four sections. Section one gives a description of the problem. Section two lays the main conceptual foundation. A methodology is developed and outlined in section three. Operationalisation of the methodology for the case of Ubon Ratchathani District in North East Thailand is carried out and described in section four. Finally, strengths and limitations of the methodology are discussed in section five.

Mouat,[1] David, Carl Steinitz,[2] Robert Anderson,[3] Hector Arias,[4] Scott Bassett,[2] Mary Cablk,[1] Michael Flaxman,[2] Tomas Goode,[5] Robert Lozar,[6] Thomas Mattock, III,[5] Winifred Rose,[6] Richard Peiser,[2] and Allan Shearer.[2] [1]Desert Research Institute, Reno, NV 89512, USA; [2]Department of Landscape Architecture, Harvard University, Cambridge, MA 02138, USA; [3]Environmental Division, U.S. Army Training and Doctrine Command, Fort Monroe, VA 23651, USA; [4]Gabinete de Estudios Ambientales, A.C., Hermosillo, Sonora, Mexico; [5]Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721; [6]U.S. Army Construction Engineering Research Laboratory, Champaign, IL 61862, USA.
Alternative Futures of the Upper San Pedro River Watershed, Arizona and Sonora: Politics of Landscape Change.

This investigation explores how urban growth and landscape change in the Upper San Pedro River Watershed (from its headwaters near Cananea, Sonora, to Redington, Arizona) might influence the hydrology and biodiversity of the area over the next 20 years. The assessment considers the Sonora and Arizona portions of the watershed as a single area; it investigates the widest range of policy issues which have been raised by stakeholders; and it adds spatial and temporal dimensions to anticipated changes and their impacts. The purpose of the investigation is to provide information to the many stakeholders and jurisdictions of the region regarding issues, strategic planning choices, and their possible consequences related to the built and natural environment. We have modeled and designed three groups of scenarios projected to the year 2020. These include one which considers interpretations of the region's existing planning documents and land-use practices, one which investigates lower than forecast population growth and tightly controlled development zones, and one which anticipates greater than forecast population growth and low density development across the region. Each of these is expanded by variations that alter key policy positions. Evaluations of the scenarios reveal the impact which each of the scenarios and the scenario variants are likely to have on water, especially ground water, and consequently the ability of the San Pedro River to maintain its flow as well as on species habitats both within the riparian zone and elsewhere. These evaluations provide guidance for the region's stakeholders to better determine how they wish their future to be.

Mueller, Felix and Ernst-Walter Reiche. Ecology Center, University of Kiel, Schauenburgerstrasse 112, D 24118 Kiel, Germany. **Ecological Gradients as Hierarchical Indicators of Ecosystem and Landscape Integrity.**

The paper will give a report on a landscape oriented analysis of different Northern German ecosystems (forest and arable land) and watersheds which was carried out to analyze the interactions of spatial patterns and ecological processes on different scales. Soil analyses, modelling approaches and community ecological methods to characterize ecological heterogeneity have been combined as parts of a long-term ecosystem research project to investigate the role of scale in heterogeneous landscapes. The results of the presented study lead to the understanding of ecosystems and landscapes as systems of interacting ecological gradients which are assigned to a hierarchy of structural scales. They are specifically interrelated with different ecological processes and also the consequences of human landuse can be distinguished to corresponding scales. The resulting significance of gradient hierarchies will be used to apply the principles of ecosystem thermodynamics, self-organization and emergence. Finally an outlook will be given to potential pathways for applying the derived theory in environmental management.

Müller, Felix. Ecology Center, University of Kiel, Schauenburgerstrasse 112, D 24118 Kiel, Germany. **Ecosystem Synergetics: Applying Systems Theoretical Concepts to Ecosystem and Landscape Development.**

In this paper the general contributions of different ecosystem theories for the understanding of ecosystem and landscape development are discussed. The fundamental principles of network theory, information theory, thermodynamics, and synergetics are focussed in a set of integrating hypotheses to describe the general tendencies in ecosystem and landscape development. One central concept which arises from a combination of the various theories is based on the comprehension of gradients as holistic linkages between structural and functional views of ecosystems. The dynamics of these gradients are coupled with the thermodynamically based theory of ecological orientors which describe the "complexification" phase of ecosystem successions. The orientor principles will be illustrated by empirical and model based case studies to characterize and to compare different ecological systems.

Nagendra, Harini, Jane Southworth, and Catherine M. Tucker. Center for Study of Institutions, Population, and Environmental Change, Indiana University, Bloomington, IN 47408, USA. **Using Landscape Metrics to Interpret Trajectories of Land-Cover Change: A case study in Western Honduras.**

Understanding the relationship between human behavior and forest change poses a major challenge for environmental research. This study addresses the issues of trajectories of land-cover change and their relationship to the social and biophysical characteristics of the landscape. The study area is located within a mountainous region of pine oak forest in Western Honduras. Remote sensing imagery of three time points (1987, 1991, and 1996) were used to create single date classifications. In addition, a number of change grids were created for forest and non-forest classes between the different time periods. Metrics of land-cover change were used to infer patterns of land-use change. For instance, areas of reforestation were significantly larger when compared to areas of deforestation, across all dates. In addition, land-cover trajectories were related to accessibility characteristics of the landscape, including distance to roads, elevation and slope. In the study landscape, patch size was a good indicator of economic activity: with small patches representing subsistence agriculture, and large patches relating to logging. Spatially, the small patches of swidden agriculture were found close to roads, at lower elevations and on more gradual slopes between 1987 and 1991. However, since 1991, coffee production has started to spread throughout the community and this resulted in clearings of forest on steep slopes and higher elevations. Results highlight the importance of landscape metrics in monitoring multi-date land-cover change as compared to single date analyses.

Nassauer, Joan Iverson and Robert C Corry.* School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI 48109-1115, USA.
A GIS-Based Spatial Model of Cultural Landscape Preferences for Altrenative Agricultural Landscape Scenarios.

To model cultural preference for alternative landscapes, we developed a method that uses empirical surveys to derive landcover-specific preference values. Investigators using surveys to measure cultural landscape preferences depict landscapes in a mode that closely approximates the perspective from which people are likely to see the landscape in ordinary experience: on the ground or in a low-level aerial perspective view. These landscape images are the experimental stimuli for which respondents rate their preferences. Results reflect respondents, preferences for whole landscape views ˆ not particular landcovers or maps of landcover combinations. At the same time, to include cultural preference in an integrated assessment of multiple landscape variables across a large area, investigators want to display preference values as spatial landscape characteristics (i.e., in a GIS). Determining spatial characteristics from empirical responses to landscape images typically has required investigators to make dramatic inferences from the survey data or to rely solely on expert-based systems of aesthetic valuation to link attributes to GIS landcover data. The method we have developed directly employs empirical data from preference surveys to ascribe an objective preference value to each GIS landcover class in the context of a specific alternative agricultural landscape scenario. The method allows the relative overall cultural preference for each alternative scenario to be objectively described and compared, and it allows preferences to be combined with other landscape ecological variables in an integrated assessment across a larger landscape. We will demonstrate the method as we applied it to compare alternative scenarios for two Iowa watersheds.

Naveh, Zev. Technion, Israel Institute of Technology, Haifa, Israel. **Naveh's Top 10 List for Landscape Ecology in the Twenty-First Century.**

My first topic is the suggestion to deal further with the topics presented in this session by using the IALE bulletin internet website as a forum for further dialogue and enhancing better interaction between landscape ecologists all over the world. In my opinion, these topics cannot be formulated in isolation from the severe global ecological crisis. They should be therefore problem-solving oriented and present a clear vision of the practical goal(s) that landscape ecology has to achieve. These have to take into consideration that at the present transition stage towards the global information age, human society has reached a crucial turning point in its relation to nature. It is confronted with the choice between further sustainable evolution of organic life on earth or its further degradation and extinction. In these topics I will make a strong point that if landscape ecology wishes to play a meaningful role in this choice, it has to become a transdisciplinary, future-oriented and mission driven science. For this purpose it has to broaden its conceptual and methodological basis and shift its main focus to the prevention of further landscape degradation, and to the safeguarding, restoring and creating of sustainable, healthy, productive and attractive multifunctional landscapes for the emerging information society. These topics will indicate how to implement these transdisciplinary challenges in landscape ecological education, research, and action.

Ng, Evelyn. Department of Geography and Recreation, University of Wyoming, Laramie, WY 82071, USA. **Environmental Policies for Solar Energy Use in a Closed Micro-Business System.**

This study examines the feasibility of using solar energy in small, environment-dependent business systems and recommends government policies to promote the usage of alternative energy. The study is meant to be applicable to businesses such as ranches or small nature-based resorts that are willing to be environmentally friendly and reduce their overall operating costs. The study focuses on the energy needs of such operations and an assessment of their option to utilize solar energy technology. The viability of this option is measured by evaluating environmental factors, capacity of technology and qualification for government incentives. Three Wyoming guest ranches are used as case studies to compare the practicability of harnessing solar energy for different sized operations. The ranches were selected based on their number of guests, varying from small to large. An analysis of energy use based on diurnal and seasonal demands and need location reveals that solar energy is a viable option for small businesses. Federal and local government policies concerning solar energy usage are investigated, particularly those pertaining to small businesses. Their applicability to the case studies is examined and recommendations for solar energy use in a closed micro-business system presented.

Nicholson,[1] Matthew and Thomas Mather.[2] [1]Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, IL 62901, USA; [2]Center for Vector-Borne Disease, University of Rhode Island, Kingston, RI 02881, USA. **Spatial and Temporal Trends in Deer Tick Abundance: Implications for Human Lyme Disease Risk.**

Lyme disease is a tick-transmitted borreliosis of humans and domestic animals emerging as a significant threat to public health in north temperate regions of the world. The disease is caused by infection with the spirochete Borrelia burgdorferi and is transmitted by the bite of ticks in the genus Ixodes. Clearly, disease vector-host-pathogen interactions exist at multiple scales, both temporally and spatially, however, few researchers have addressed the scale of disease risk. We have been investigating the spatial and temporal aspects of human Lyme disease risk for 7 years in an endemic area, Rhode Island, USA. Although suitable habitats are available across the state clear spatial trends exist in disease risk and tick abundance. Indeed, tick populations are highly spatially autocorrelated with hyper-abundant tick populations and areas where ticks are absent from suitable habitats occurring within 60 km. In addition, a two-year cycle appears to exist in both tick abundance and Lyme disease prevalence. We report on those landscape features that affect tick distribution and abundance. Further, we examine environmental factors that could be used as predictors of human Lyme disease risk.

Nielsen, Clayton K. and Alan Woolf. Cooperative Wildlife Research Laboratory and Department of Zoology, Southern Illinois University at Carbondale, Mailcode 6504, Carbondale, IL 62901, USA. **Considering Landscape Physiognomy in Studies of Habitat Use-Availability**.

Analyses of habitat use-availability are central to landscape-scale ecological studies of many wildlife species. Choice of appropriate variables to represent landscape structure is an important consideration for use-availability analyses. Landscape structure is comprised of two primary elements: composition (i.e., proportion of each cover type, regardless of placement) and physiognomy (i.e., shapes and arrangements of cover-type patches). However, few researchers have incorporated physiognomic variables in studies of habitat use-availability. We quantified compositional and physiognomic habitat variables within four categories of fixed kernel use-area (home ranges and core areas of M and F, respectively) for 52 adult bobcats (Lynx rufus) in southern Illinois. We tested for differences in habitat use among these four use-area categories to illustrate the importance of physiognomic variables in studies of habitat use-availability. Five of 69 habitat variables differed among categories of use-area ($P < 0.0295$); of these, four were physiognomic variables. We also tested whether habitat variables predicted size of bobcat use-areas. Habitat components predicted size ($P < 0.0001$) of all use-area categories. Four to eight variables were significant per analysis; of these, four to six were physiognomic variables. Further, habitat accounted for 88–97% of the variance in use-area size. We contend that ignoring the physiognomic component in studies of habitat use may lead to inappropriate landscape management recommendations. In conclusion, knowledge of the influence of habitat physiognomy and composition on home range and core area size may be useful to biologists to predict the influence of landscape management activities on wildlife.

Noorizan, Mohamed. Department of Landscape Architecture, Faculty of Design and Architecture, Universiti Putra Malaysia, 43400 UPM, Serdang, Selangor, Malaysia. **The Revitalisation of Malaysian Urban Landscapes.**

As we are all aware, human influences on landscapes are numerous and subject to various levels of activities. The rapid growth and development of towns and cities in Malaysia have posed a significant influence and increase in the landscape heterogeneity and organisation of the urban areas. As the country progresses towards a developed nation, a more promising approach is being undertaken and planned in order to ensure a balance between natural and built environment, while at the same time developing a harmonious relationship between man and nature. This paper inrends to present some aspects of the development focussing on the strategies, approaches and management of the urban landscapes in gearing towards a sustainable future.

Nugranad[1] Jarunee, Peter August,[2] Daniel Civco,[3] Y. Q. Wang.[2] [1]Remote Sensing Division, National Research Council of Thailand, 196 Paholyothin Road, Chatuchak, Bangkok 10900, Thailand; [2]Department of Natural Resources Science, University of Rhode Island, Kingston, RI 02881, USA; [3]Department of Natural Resources Management and Engineering, University of Connecticut, Storrs, CT 06269, USA. **Biophysical and Socio-Economic Correlates of Land Cover in the Mae Taeng Watershed of Northern Thailand.**

Environmental factors and socio-economic driving forces contribute to the complexity and patterns of land cover. The objective of this study is to understand the biophysical, social, and economic forces that affect land use and land cover in the Mae Taeng watershed in northern Thailand. We used 1997 Landsat Thematic Mapper imagery to assess land cover. Historical aerial photography and 1:50,000-scale land-use maps were used as reference data. The overall classification accuracy was 96% with a Khat value of 0.95. Census statistics from the Thai government provided social and economic characteristics of region. We obtained landform and infrastructure information from regional maps. Villages were the spatial unit of analysis for this study and we had biophysical data for 147 villages and socioeconomic data for 51 villages. These data were integrated with a Geographic Information System (GIS) and used to develop a predictive model of land cover based on biophysical, social, and economic characteristics of the region. Models created from the biophysical or socio-economic variables explained 70–90% of the variation in land-cover composition of villages. Developed lands occurred near rivers in low, flat regions and had a population of older, more educated individuals. Agricultural land occurred near rivers in low slope regions. Forests occurred at high elevation on steep slopes away from rivers.

Obbink, Marion (M.H.) and Jan (J.G.P.W.) Clevers. Centre for Geo-Information, Wageningen University and Research, Wageningen, The Netherlands. **Aggregate Sets: A New Hierarchical Approach to Link Change Processes and Complex Spatial Patterns.**

In the last two decades, tropical rainforests have been modified most profoundly by humans. Monitoring the rapid decline of rainforests is of utmost importance. Traditionally, remote sensing image-processing techniques are focused on land-cover classifications *per-pixel*. However, to facilitate policy decisions and support planning and development strategies, information is needed on change processes. Human-induced change processes occur on higher spatial aggregation levels and are visual on high-resolution remote sensing imagery as land-cover mosaics at *supra-pixel level*. The land-cover mosaics; are complex spatial patterns characterized as non-nested aggregated heterogeneous objects with fuzzy spatial extents. A promising approach to observe and model these kinds of spatial objects is aggregate sets. Aggregate sets are hierarchical linked spatial n x n pixel blocks or windows at supra-pixel level. It is a true multi-scale approach. Aggregate sets stratify systematically remote sensing imagery into observable or measurable units. For each spatial object in particular, an aggregate set is defined. A set consists of at least three elements: the focal, upper and lower aggregate. The selection of the elements is semantically driven. Each aggregate is described by its pattern primitives. This multi-dimensionality can be regarded as a fuzzy partition of the aggregate universe. The combination of multi-scale and multi-dimensionality is a new alternative concept to model complex heterogeneous objects with fuzzy spatial extents. Described hierarchical approach is currently tested using optical and radar satellite data for a study site in Indonesia (Kalimantan).

Ohmann,[1] Janet L. and Matthew J. Gregory.[2] [1]USDA Forest Service, Pacific Northwest Research Station, Corvallis, OR 97330, USA; [2]Department of Forest Science, Oregon State University, Corvallis, OR 97330, USA.
Alternative Approaches for Scaling Up fine-Resolution, Mapped Vegetation Data for Regional Analysis.

Landscape ecologists now have tools that allow them to predictively map forest vegetation across large regions at very fine spatial resolution, and with a high degree of floristic and physiognomic detail. However, this overload of information must be aggregated and summarized before it is interpretable and useful for regional analysis. We examined alternative approaches for rescaling mapped vegetation for three million hectares in the coastal province of Oregon, USA. The map was produced with the Gradient Nearest Neighbor method for predictive vegetation mapping. It had a spatial resolution of 25 m and each pixel was attributed with a list of tree species, sizes, and densities present. We compared three rescaling methods, each at four spatial resolutions (0.06 ha, 1 ha, 4 ha, and 8 ha): resampling the mapped independent variables to a coarser resolution prior to spatial prediction; resampling the predicted vegetation to a coarser resolution; and aggregating pixels in the mapped predictions to larger, irregularly shaped patches using a rule set based on a vegetation similarity matrix. We compared the rescaling methods and resolutions for how well they maintained relative proportions of vegetation conditions within the regional landscape, and for their effect on metrics of landscape pattern. We also evaluated effects on prediction accuracy at the local scale using an independent dataset of field plots. None of the rescaling methods was superior for all of the evaluation criteria. Choice of an appropriate approach will depend on study objectives and costs.

O'Neill, Robert V. Oak Ridge, TN 37830, USA. **Top 4 issues in landscape ecology. (Conveyed by J. Wu)**

1. Land-cover dynamics are driven by economics. Landscape ecology needs to incorporate the insights of economic geography, which studies how economic activity is distributed in space, and resource economics, which determines how land will be used.

2. Metapopulation Theory. Landscape ecology needs to increasingly emphasize modeling of aquatic and terrestrial organisms operating on a landscape fragmented and structured by economics. Insights should be incorporated from metapopulation theory, population genetics and cellular automaton to be able to translate changes in the landcover to impacts on populations.

3. Nonlinear Dynamics. Ecological systems are adapted to the spatial distribution of habitats, resources, and disturbance regimes that they have experienced over their evolutionary history. Currently, human society is driving ecological systems outside their evolutionary envelope and the assumption that the ecological systems will remain stable is unjustified. Landscape ecology needs to develop a theory of metastable, nonlinear systems distributed in space.

4. Monitoring. Approaches to instability on large scales may be most detectable at the landscape scale = increases in spatial variability.

Paranjape, Anagha. School of Planning and Landscape Architecture, Arizona State University, Tempe, AZ 85287, USA. **Adaptation of Visual Resource Management (VRM) Systems for the Visual Quality Assessment of Urban-Natural Landscapes.**

Over the course of the twentieth century, the trend towards urbanization has multiplied all over the world. Natural landscapes are being compromised with little or no concern towards preserving their natural quality. In the past three decades, research has empirically shown that the visual quality of the natural landscape is a very valuable resource. Efforts have been pioneered to assess and mitigate the visual quality of natural landscapes in face of growth and development. The negative externalities imposed by urbanization activities have compelled all federal agencies to assess and mitigate visual impacts on federal lands. The Forest Service and the Bureau of Land Management (BLM) have developed a framework of guidelines for assessing the visual quality of landscapes, enabling effective visual impact mitigation. The Visual Resource Management (VRM) Systems are now employed by these federal agencies to manage visual quality on federal lands. At the same time, research has extended to the visual quality analysis of the complex urban environment. Urban imageability and likability concepts have been put forth to better understand the human preference for landscape visual quality in the urban landscapes. Through this thesis research, a broad outline or a framework is presented to assess the visual quality of urban-natural landscapes. An attempt is made to tie together the two theories, namely the VRM systems and the urban likability, to develop a methodology for visual quality and impact assessment. This work seeks to extend the VRM systems into the visual quality analysis of landscapes within an urban setting.

Paul,[1] John F., Randy L. Comeleo,[2] Jane Copeland.[3] [1]U.S. Environmental Protection Agency, Narragansett, RI 02882, USA; [2]OAO Corporation, Corvallis, OR 97333 USA; [3]OAO Corporation, Narragansett, RI 02882, USA. **Landscape Structure and Estuarine Condition in the Mid-Atlantic Region of the United States: I. Developing Quantitative Relationships.**

In a previously published study, quantitative relationships were developed between landscape metrics and sediment contamination for 25 small estuarine systems within Chesapeake Bay. Nonparametric statistical analysis (rank transformation) was used to develop an empirical relationship between sediment contamination and developed land (positive), herbaceous land (negative), and point source loading (positive). These analyses have been extended to include 75 small estuarine systems across the mid-Atlantic and southern New England region of the U.S. for which USEPA Environmental Monitoring and Assessment (EMAP) data were available. Because of the dramatic differences in characteristics and dynamics of the estuaries across the region, adjustment for differing hydrology, sediment characteristics, and sediment origins were included in the analysis. Multiple linear regression with stepwise selection was used to develop statistical models for sediment metals, organics, and total PAHs with three functional forms (linear, rank, and exponential). The landscape metrics most strongly related with sediment metals levels were the percent area of non-forested wetlands (negative contribution), and percent area of urban land and effluent volume (positive correlations). The metric most strongly related with sediment organics was percent area of urban land, while with total PAHs the metrics were percent area of urban land and percent area of nonforested wetlands. The models included silt-clay content or total organic carbon of sediments and categorization by sediment origin or estuarine hydrology, suggesting the importance of sediment characteristics and hydrology in mitigating the influence of the landscape metrics on sediment contamination levels. The results suggest the possibility of developing predictive models of estuarine sediment contamination for various distributions of land cover and point source discharges

Pennington, Deana D. Department of Geosciences, Oregon State University, Corvallis, OR 97331, USA. **Spatiotemporal Analysis of Landscape Structure, Function, and Change in the Western Cascades of Oregon.**

The purpose of this study was to compare the effects of naturally and anthropogenically disturbed forests in the Western Cascades of Oregon on selected biotic, hydrologic, and nutrient processes. Objectives were to: 1) develop methods for creating representative landscapes, 2) quantify landscape structure and function, and 3) compare the effects of natural and human landscape patterns on specific elements of biodiversity, evapotranspiration, stream flow, and carbon processes. Wildfire landscapes were simulated using the LADS model and parameters from dendrochronological studies. Archival research on spatial patterns and rates of early harvest disturbance were integrated with TM imagery to create historical harvest landscapes. Results from smaller scale harvest modeling were used to create hypothetical future landscapes. Vegetation structure was characterized in terms of the types and amounts of vegetation present through distributed, stratified, and spatially explicit metrics. Vegetation was placed in the context of ridges, streams, and hillslope components and broad scale environmental trends to delineate critical landscape features. Expected results include a decrease in the heterogeneity of vegetation structure. Connectivity between habitats via riparian corridors may be marginal, mitigated by landscape context. Evapotranspiration is expected to vary significantly in low elevation lands, where the conversion to predominantly young conifer plantations should result in much higher rates. At high elevations, variability of peak and low flows is expected to be influenced by increased connectivity between open patches and stream networks. Carbon cycling is increased in harvested landscapes, with interesting resultant fuel connectivity.

Peters, D. P. C. Jornada Experimental Range, Las Cruces, NM 88003, USA. **Landscape-Scale Consequences of Small-Scale Disturbances at a Grassland-Shrubland Ecotone.**

The objective of this study was to evaluate the role of small-scale disturbances within different patch types to landscape-scale patterns in species composition and dominance at a shortgrass steppe- Chihuahuan desert ecotone. Species removals were conducted at the Sevilleta LTER in central New Mexico within five different patch types where communities are dominated or codominated by one of two perennial grasses (blue grama, black grama) and one shrub (creosotebush). Within each patch type, all plants of the dominant species were removed from 5 3m x 4m plots starting in 1995; five control plots were also located within each patch type. Cover and density by species have been estimated annually. Similarity indices were used to compare patch-scale patterns in species composition with the landscape mosaic. Annuals dominated all removal plots one year after removals were initiated. Subsequent recovery patterns depended upon the dominant species removed. Blue grama removal resulted in establishment and growth of perennial grasses whereas removal of black grama promoted recovery by perennial forbs. Removal of creosotebush in mixed communities with black grama resulted in recovery by perennial forbs, grasses, and shrubs whereas removal of this species in shrub-dominated communities resulted in little change in the vegetation. These results indicate that mortality of dominant species by small-scale disturbances has dramatic effects on vegetation patterns that may alter the landscape mosaic at this arid-semiarid ecotone.

Pickett, S.T.A. Institute of Ecosystem Studies, Millbrook, NY 12545. **The Landscape Paradigm in Ecology: Heterogeneity, Hierarchy, and Humans.**

Using disparate examples of research projects that I have been involved in highlights key aspects of a framework for landscape ecology. The attempt to extract the similarities from these examples shows the ubiquity of heterogeneity, exposes some of its functional features, and helps to show the role of humans in creating and responding to heterogeneous urban and wild systems. A framework that can accommodate such a wide variety of studies recognizes 1) the kinds, frequency, and configuration of elements of heterogeneity, 2) that heterogeneity is nested and scalable, 3) that determining the nature and control of flux is key to understanding heterogeneity, and 4) that a human ecosystem model can accommodate the range of individual and institutional processes in understanding ecosystems. Such a framework may serve landscape ecology well, and help inform other disciplines about the important insights of landscape ecology.

Pierce, Kenneth B., Todd Lookingbill, and Dean Urban. Nicholas School of the Environment, Duke University, Durham, NC 27708, USA. **An Assessment of Proximate Climate Variables and Their Relative Impact of Vegetation Patterns in Montane Systems.**

Landscape analyses of vegetation patterns often rely on slope, aspect and elevation as determinants of local climate. Although there are obvious relations to these factors at large scales, at smaller scales the correlations are often less strong. This may in part be due to the fact that multiple sites with identical elevation, slope and aspect may occupy many different topographic positions. We took the position in the landscape matrix into account by using a GIS and a digital elevation model to assess the annual potential solar radiation (PSR) at a site using solar/land surface geometry and local topographic shading. We also used a temperature model based on HOBO data loggers to calculate a measure of growing degree days at our field sites in the Sierra Nevada and the Western Cascades. We then compared vegetation patterns to several indices derived from local topographic field measurements, our PSR landscape index, estimated growing degree days and a similar measure of mid-afternoon solar exposure using the ARC/INFO function Hillshade. Results suggest a more explicit representation of the landscape context of a site is important in assessing vegetation responses to local environment.

Pijanowski, Bryan C. College of Natural Science, Michigan State University, East Lansing, MI 48824, USA. **Can a Neural-Network–Based Land-Use Change Model Generalize across Space and Time? An Application of the Land Transformation Model for the Twin Cities and Detroit Metropolitan Areas.**

I parameterized the GIS and neural net-based Land Transformation Model for the Detroit (DMA) and Twin Cities Metropolitan Areas (TCMA) using historical land-use data derived from aerial photography. I built several neural net models and attempted to test whether these models were transferable across the two metropolitan regions and whether a regional model provided as good a fit as a locally parameterized model. The overall accuracy of the model to predict urban transitions was 37% and 33% for the TCMA and DMA, respectively. An "internal" versus "external" learning exercise resulted in models that appeared to be fairly transferable in one case (DMA applied to TCMA) and not well transferable in the other case (TCMA applied to DMA). A "local" versus "regional" exercise produced results suggesting that learning from larger scale spatial patterns does not reduce the affect of the model to predict smaller, local trends. I discuss the implications of these two learning exercises and suggest ways in which the models could be improved. Overall accuracy of the presented models is judged against previous LTM applications in Michigan's Grand Traverse Bay Watershed and Kuala Lumpur, Malaysia.

Pinto,[1] M. A., K. Baum,[1] W. Rubink,[2] S. Johnston,[1] R. N. Coulson.[1] [1]Knowledge Engineering Laboratory, Department of Entomology, Texas A&M University, College Station, TX, USA; [2]USDA/ARS, Weslaco, TX, USA. **Spatial and Temporal Patterns of Mitochondrial DNA in Feral Honey Bees: Impact of Africanization.**

There are two controversial views about the genetic nature of the Africanized honeybee in the Americas. One view reports that Africanized honeybees have spread by maternal migration of African swarms and the population has retained an African genetic integrity. The other one states that the population of Africanized honeybees consists of African/European hybrids. In the present study the genetic interaction between Africanized and European honeybees is investigated. From 1990 to 2000, honeybee workers have been collected from feral colonies on the Welder Wildlife Refuge (San Patricio County, Texas), covering a pre- and post-Africanization period. Two hundred and eighty two colonies, representing swarms and spatially referenced tree cavities, were analyzed for mitochondrial DNA. The temporal and spatial mitotypes distribution is shown. Also, the level of Africanization is compared with the number of active and inactive cavities each year, and this information related to the arrival of the Varroa mite.

Poiani,[1] Karen, Kent Gilges,[2] Ayn Shlisky,[1] and Jeff Hardesty.[3] [1]The Nature Conservancy, Department of Natural Resources, Cornell University, Ithaca, NY 14853, USA; [2]The Forest Bank, Center for Compatible Economic Development, The Nature Conservancy, Rochester, NY 14604, USA; [3]The Nature Conservancy, Department of Botany, University of Florida, Gainesville, FL 32611, USA. **Compatible Forest Management, Conservation, and Landscape Ecology: A Forest Management Network.**

"Compatible" forest management is quickly becoming a critical strategy at many high-priority conservation areas. For example, The Nature Conservancy now has a large number of priority landscapes focused on the outright conservation of forest ecosystems. In addition, there will be a large number of conservation areas where the surrounding forest is critical to the conservation of embedded species and ecosystems such as wetlands, rivers, and streams. Forest management must be compatible with and advance conservation goals and should be carried out within an adaptive management framework. To achieve these goals, The Nature Conservancy has organized a network of on-the-ground practitioners to develop and test an adaptive management framework for compatible forestry and conservation. The objective of the forest management network is to make significant and tangible progress toward implementing compatible forest management strategies at 3 high-priority "focal" landscapes, while leveraging critical learning and best practices to 15–25 "participating" landscapes. The adaptive management framework and network includes four parts: (1) articulating the scientific basis for forest health and integrity, (2) determining a landscape-level vision of success with desired future conditions and strategies for achieving those conditions, (3) developing stand-level management objectives and protocol for achieving those objectives, and (4) outlining a long-term monitoring plan that assesses both management activities and forest health.

Powell,[1] Scott L., Andrew J. Hansen,[1] and Rick L. Lawrence.[2] [1]Ecology Department, Montana State University, Bozeman, MT 59717, USA; [2]Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, MT 59717, USA. **Monitoring Forest Response to Past and Future Global Change in the Greater Yellowstone Ecosystem.**

Climate and land-use change in the Greater Yellowstone Ecosystem are associated with dynamic changes in vegetation patterns. Our study aims to quantify the hypothesized expansion of conifer forest cover and the associated decline of key hardwood cover types using a 25 year time series of Landsat TM imagery. Land-cover classification will be performed using Classification and Regression Tree analysis (CART), the benefit of which enables incorporation of useful ancillary and spectral data into a rule-based model. Our vegetation classification scheme will enable analyses of several trajectories of conifer forest change by detailing both percent composition and seral stage. Locations of rapid change within the Greater Yellowstone Ecosystem will be identified for future monitoring of global change. Consequences of hypothesized changes in vegetation types will be assessed in several manners. Firstly, changes in carbon storage over time will be quantified and secondly, the implications of vegetative changes on biodiversity will be analyzed.

Pringle, Catherine, Elizabeth Anderson, Effie Greathouse, and James March. Institute of Ecology, University of Georgia, Athens, GA 30606, USA. **How Do Different Spatial Patterns of Disturbance along Stream Networks Affect Ecosystem Function?**

A major challenge is to understand how the location and extent of human disturbance, within a drainage basin, interact with stream network configuration to affect ecosystem processes. Cumulative hydrological modifications (dams, water withdrawals, etc.), along drainage networks are increasingly affecting the biological integrity of the greater landscape, to the extent that even protected areas (e.g., parks) are threatened. *Given the magnitude and extent of hydrological modifications, can we develop some predictive capability regarding how different spatial patterns or configurations of hydrological alterations within a stream network affect ecosystem function?* Two case studies illustrate how development of this predictive capability would allow us to make more environmentally sound decisions regarding the placement of future dams, water diversions, and other hydrological modifications within drainage networks. A case study from Puerto Rico shows how the location of dams and water withdrawals along island streams can affect the longitudinal distribution of fishes and shrimps (by blocking migration and/or causing direct mortality), with cascading ecosystem-wide effects. Our studies of migratory shrimps indicate that there is a positive exponential relationship between total stream length (above a given location within a stream network) and the magnitude of migration of larval shrimps, indicating that managers might consider establishing water intakes on low-order, low altitude streams to avoid massive larval shrimp mortality which often occurs at water intakes. A second case study examines recent hydropower development on Costa Rica's Atlantic Slope which has resulted in stream de-watering and isolation of stream headwaters. Studies are currently underway to examine cumulative impacts of established hydropower projects within the drainage network.

Qi, Ye. Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94720-3310, USA. **Estimating Species Richness by Family: Does Scale Matter?**

We derived an equation for the relationship between species and family numbers of plants within a region, based on species-area and family-area relationships. Using an analytical procedure, we showed that the size of census plot does not affect the species-family relationship. The equation of the species-family relationship was used to explain the similarity in the species-family relationships obtained statistically for samples of Neo-tropical forests and of Southern Africa woody plants, with striking contrast in their size of sampling grids. The equation is also used to explain the difference between these two regions and the State of California. The derived species-family relationship serves as a basis for an effective approach in mapping the geographical distribution of plant species diversity based family numbers. The latter tends to be estimated much more easily and accurately.

Redman[1], C. L. and N.B. Grimm.[2] [1]Center for Environmental Studies and [2]Department of Biology, Arizona State University, Tempe, AZ 85287, USA.
Pattern and process in the human-dominated landscape of central Arizona

The Central Arizona-Phoenix Long-Term Ecological Research (CAP LTER) project is a multifaceted study aimed at answering the question, "How does the pattern of development of the city alter ecological conditions of the city and its surrounding environment, and vice versa?" Central to answering this question is understanding how land-use change is driven by societal decisions, how these decisions alter ecological pattern and process, and how changes in ecological conditions further influence human decision-making. Of the 24 sites funded under the nationwide LTER program, Phoenix and Baltimore are the only 2 established specifically to study urban ecosystems. The rationale for the study of human-dominated systems is three-pronged. First, humans dominate Earth's ecosystems; therefore, humans must be integrated into models for a complete understanding of ecological systems. Second, development of these more realistic models for ecological systems will lead to greater success in finding solutions to environmental problems. Third, although the study of ecological phenomena in urban environments is not a new area of science, the concept of city as ecosystem is relatively new for the field of ecology. Studying cities as ecosystems within new paradigms of ecosystem science will both raise the collective consciousness of ecologists about urban ecosystems and contribute to the further development of concepts that apply to all ecosystems. We will present background information on the central Arizona-Phoenix landscape, results from the first three years of CAP LTER research, and a conceptual basis for integration of social and ecological systems.

Reed, Catherine C. Entomology Department, University of Minnesota, St. Paul, MN 55108, USA. **Native Bee Species Persistence and Recolonization on Midwestern Prairie Fragments.**

A three-year field study of insects on flowers in eight Minnesota prairies showed a high diversity of bee species persisting on prairie remnants, and recolonizing prairie reconstructions, even where plant populations were small. Both remnants and reconstructions usually display high plant species richness and a long blooming season, so that both generalist and specialist bee species are able to survive. Bees are well adapted to foraging for scattered resources. Prairie and most other habitats are patchy at the scale of bee foraging distances. The prairie on small and large scales has been continually disturbed by fire, and most prairie animals are able to disperse rapidly into areas where vegetation is regrowing following fire, so the ability of bees to recolonize new areas is not surprising. However, the major differences in bee species composition among nearby sites suggests that there is some randomness in location of and establishment on prairie sites by bees. The distance bees can fly to colonize new sites remains unknown. Despite the apparent high mobility of bees, many studies of prairie plant demography indicate that lack of pollinator visits is reducing seed production by plants, especially in small fragmented populations. Reduced pollinator visitation to plants in small populations relative to nearby large populations may be based in bee patch choice on the scale of daily foraging bouts. We do not know whether bees are unable to find isolated small clusters, unwilling to return to them, and the distance they will fly from nest to foraging site remains unknown also.

Restrepo, Carla, Bruce T. Milne,* D. Bader, W. Pockman, and A. Kerkhoff. Department of Biology, University of New Mexico, Albuquerque, NM 871131, USA. **Variation in Vegetation Growth Rates: Implications for the Evolution of Semi-Arid Landscapes.**

Landscapes exhibit remarkable statistical patterns best characterized by power-laws. These patterns are thought to result from the interaction between geomorphic processes acting over long periods of time and ecosystem processes acting over short periods of time. Whereas geomorphic processes contribute to the production and mobilization of sediment, ecosystem processes contribute to their immobilization by increasing the shear forces acting on the terrain. The shear forces contributed by the vegetation, however, are likely to change depending on rates of vegetation growth which are largely controlled by inputs of energy, water, and nutrients. In this paper we develop a model where implicit feedbacks between ecosystem and geomorphic processes drive the evolution of landscapes. We specifically ask how variation in vegetation growth rates, such as those resulting from changes in land use, may move landscapes away from a steady state characterized by power-laws. We focus on semi-arid ecosystems where sheet and gully erosion are the dominant processes transforming landscapes.

Richey, David J. Department of Landscape Architecture, University of Oregon, Eugene, OR 97403-5247, USA. **Design and Prioritized Implementation of Woody Riparian Buffers for Increasing Effective Shade in Agricultural Landscapes of the Willamette River Valley, Oregon.**

Elevated water temperature is one of the most prevalent problems affecting water-quality limited streams in the Willamette Valley, Oregon. This condition affects water quality for aquatic habitats, including negative effects on threatened and endangered fish species. Woody riparian buffers are noted for their use in combating a number of water quality issues including water temperature, and are being implemented, primarily in forested landscapes, through legislation and management plans for public lands. Agricultural landscapes in the Willamette Valley have recently been targeted for implementation of riparian buffers, primarily in response to salmon recovery concerns. Modeling effects of riparian vegetation on stream temperature has been used in several projects to show the benefits of riparian buffers in reducing stream heating through their high correlation to lower stream temperatures. Using a hierarchical targeting methodology, I first prioritize watersheds, and subsequently sites within selected watersheds, for installation of woody riparian buffers for stream shading using effective shade as a surrogate measure for reduced stream temperature. Geographic prioritization for implementation of woody riparian buffers within a watershed is determined using physiographic and economic criteria under scenarios representing key elements of prevalent conservation strategies. Comparisons of the definition of a site, its shading value, its economic value, and its contribution to overall stream thermal condition illustrate the return on investment for incremental stream buffering. Geographic configuration and estimated cost-to-benefit ratios of different valuation assumptions are compared and evaluated with regard to informing the design of riparian conservation buffer strategies.

Riitters,[1] Kurt, Jim Wickham,[2] Bob O'Neill,[3] and Bruce Jones.[4] [1]US Forest Service, Research Triangle Park, NC 27709, USA; [2]U.S. EPA, Research Triangle Park, NC 27709, USA; [3]Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN 37830, USA; [4]U.S. EPA, Las Vegas, NV, 89173, USA. **Modeling the Risk of Forest Fragmentation in the Mid-Atlantic Region.**

The risk that a landscape will experience forest fragmentation is modeled as a function of sensitivity, vulnerability, and future stress for landscapes in the mid-Atlantic region. In a model appropriate for regional and national risk assessment, sensitivity is estimated from the current spatial arrangement of forests within a landscape, vulnerability depends on land ownership, and estimates of stress come from regional land-use change scenarios. Risk is highest where forests are arranged in linear patterns (sensitivity) on private lands (vulnerability) near expanding urban areas (stress). The model is used to rank landscapes in the region in terms of relative risk of forest fragmentation under different stress scenarios. The differences in estimated risk can be used to identify those landscapes that could serve as targets for restoration or preventative actions, and landscapes that are at or near critical thresholds of forest pattern.

Rollins, Matthew and Robert Keane. Fire Sciences Laboratory, Rocky Mountain Research Station, United States Forest Service, Missoula, MT 59807, USA. **Remote Sensing and Gradient Modeling for Ecosystem Management.**

Spatial information on ecosystem patterns and processes are becoming increasingly valuable as more and broader landscapes are managed with an ecosystem perspective and as new technologies make the compilation and analysis of large spatial databases more efficient. Successful, scientifically based ecosystem management depends on spatially explicit evaluation of how ecosystem processes work together to determine landscape patterns. We present the Landscape Ecosystem Inventory System (LEIS), a prototype mapping system that integrates extensive ecological sampling and remote sensing with both empirical and mechanistic cartographic modeling to create a variety of maps useful for ecosystem management. The primary objective of LEIS is to provide cost-effective, standardized methods for rapidly generating spatial inventories of ecosystem characteristics at landscape scales. A landscape scale, gradient stratified field campaign provided a database including over 120 measured variables measured from 950 plots within broad study areas on the Nez Perce and Kootenai National Forests in Idaho and Montana. These measured variables were used as input to a suite of spatially explicit weather, fire, and ecosystem process models to simulate 80 additional variables for weather, fire, and ecophysiological processes. Using these data within a GIS including digital orthophoto quadrangles and Landsat ETM+ imagery we mapped old growth forest, basal area, and potential western larch (*Larix occidentalis*) habitat in each study area. These mapping efforts serve as examples of the utility of LEIS for forest management planning with an ecosystem perspective.

Rubino, Matt J., Terri J. King, and George R. Hess. Forestry Department, North Carolina State University, Raleigh, NC 27695-8002, USA. **A Focal Species Approach to Wildlife Planning.**

The Triangle region of North Carolina is undergoing rapid development and major shifts in land use that will alter our wildlife communities in undesirable ways. We are developing a wildlife conservation plan for the Triangle with the long-term goal of creating a regional network of habitat suitable for a broad range of wildlife. We haven chosen to apply a focal species approach that utilizes a suite of species whose needs collectively represent landscape characteristics that encompass the needs of many other species. Through a Delphi Survey method, eight species were selected as our focal group to represent the compositional and spatial requirements needed to identify habitat in the study area. So far, we have developed habitat models for two focal species, the Barred owl and the Ovenbird. The Barred owl is being used to select functional habitat within bottomland forests, and the Ovenbird to select habitat within upland forests. Habitat requirements for each species were derived from the literature and expert opinion and matched with available geographic information systems data. We used the Arc/Info and ArcView geographic information systems to analyze raster data at a spatial resolution of 30 meters. Data layers included hydrography, soils, roads, the National Wetland Inventory, and a base land-cover dataset derived from the Mult-resolution Landcover Characterization (MRLC). Using these data, we have produced maps that show potential habitat of varying degrees of quality for the Ovenbird and Barred owl. In the long-term, we will develop similar maps for all of the focal species and combine them to create a regional habitat network.

Sanchez-Azofeifa,[1] G. Arturo, Gretchen Daily,[2] and Paul Ehrlich.[3] [1]Earth and Atmospheric Sciences Department, University of Alberta, Edmonton, Alberta, Canada T6G 2E3; [2]Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA 94305-5020, USA; [3]Center for Conservation Biology, Department of Biological Sciences, Stanford University, Stanford, CA 94305-5020, USA. **Isolation of National Parks in the Tropics.**

Tropical deforestation and habitat fragmentation are important forces driving environmental deterioration and biodiversity losses in tropical environments. Efforts to control the spread and impacts of these forces are often promoted by the implementation of national parks and biological reserves. These policies contribute to having two main land-use/cover change (LUCC) gradients in the landscape: one in which conservation policies are effective and another in which we have uncontrolled deforestation and habitat fragmentation which -in fact- contributes to the isolation of the former. In this paper, we present results from a nationwide landscape fragmentation study conducted in Costa Rica, Central America. Costa Rica has been selected not only because 25% of its territory is under conservation initiatives, but also because the country holds approximately 4 to 5% of all tropical biodiversity worldwide. In this paper, we present the first estimates ever of habitat fragmentation, deforestation rates and secondary growth inside of Costa Rica's National Parks and Biological reserves. In addition, we provide the results of a comprehensive analysis of the level and impact of habitat fragmentation of each of the twelve ecological life zones presented in the country. We also evaluate the use of non-traditional landscape fragmentation measures to quantify the level of connection between all national parks and biological reserves. We concluded that national parks in Costa Rica are currently stable in terms of the LUCC dynamics, but that current deforestation and habitat fragmentation processes outside of these conservation areas are contributing to their isolation in the Central American landscape.

Schade, John D., Stuart G. Fisher, Julia C. Henry, and Jill, R. Welter.
Department of Biology, Arizona State University, Tempe, AZ 85287, USA.
Hydrologic and Nutrient Exchange between Stream and Riparian Zone in an Arid-Land Watershed.

Our objectives were to determine the hydrologic linkage between surface stream and riparian zone, and the role of riparian vegetation in retention of stream-water nitrogen at multiple spatial scales in Sycamore Creek, a Sonoran Desert stream. At the reach scale (~1 km), several studies have shown that the dominant flowpath of water is from stream to riparian zone. These studies also show the riparian zone to be a strong sink for stream water nitrogen. Mass balance calculations suggest most nitrogen retention is due to denitrification, with a smaller contribution by plant uptake. Stable isotope experiments suggest that most nitrogen is removed at a narrow interface between stream and riparian zone. At a smaller scale (1–10 m), patches of gravel bar colonized by a riparian shrub within a single reach showed similar patterns, with colonized patches acting as nitrogen sinks and most nitrogen retention occurring over a small spatial scale (~10 cm) at the interface between colonized and uncolonized gravel bar locations. These smaller scale riparian patches allowed us to more rigorously determine the mechanism for nitrogen retention. Results of experimental manipulations showed that the presence of the plant stimulated microbial process rates leading to loss of nitrogen via denitrification. These results show a strong hydrologic connection between surface stream and riparian zone. They also suggest that a strong interaction between plants and microbes is responsible for the effectiveness of the riparian zone as a sink for nitrogen at multiple spatial scales.

Schoennagel,[1] Tania, Monica G. Turner,[2] and William H. Romme.[3] [1]Depts.of Botany and Zoology, University of Wisconsin, Madison, WI, USA; [2]Dept. of Zoology, University of Wisconsin, Madison, WI, USA; [3]Dept. of Biology, Fort Lewis College, Durango, CO, USA. **Spatial and Temporal Influences of Fire Regimes on Initial Pathways of Succession Across the Yellowstone Landscape.**

Climate change is expected to alter disturbances regimes such as fire, resulting in significant changes in vegetation patterns and carbon sequestration across forested landscapes. The objective of this research is to test for and predict shifts in initial successional pathways in response to a range of different intervals between stand replacing fires across the subalpine plateaus of Yellowstone National Park. Previous work has considered the effects of fire severity, fire size and level of serotiny in explaining initial pathways of postfire succession across the Yellowstone landscape. The effects of the third component of the disturbance regime, fire interval, remains largely unexplored, and is a fundamental link in predicting effects of climate change across the landscape. Plant community composition was sampled during summer 2000 in 50 stands exhibiting a range of intervals between stand replacing fires (12 yrs–395 yrs). Our results highlight significant interactions between fire interval, fire size and percent serotiny in predicting initial postfire succession. For example, we detect threshold responses in lodgepole pine densities to different fire intervals in areas where the percentage of serotinous individuals is high. These results suggest that the landscape mosaic of stand structure produced by fire regimes in Yellowstone National Park is contingent on variation in both the spatial and temporal patterns of fire.

Schooley,[1] Robert L. and John A. Wiens.[1,2] [1]Department of Biology, Colorado State University, Fort Collins, CO 80523, USA; [2]National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101, USA.
Predicting the Distribution and Abundance of a Habitat Specialist: Grain Size and Spatial Effects.

How do animal-habitat relationships change with spatial scale? Do such relationships depend on whether one attempts to predict the presence and absence or the abundance of a species? What influence might spatial autocorrelation of variables have on predictive habitat models? We have addressed these sorts of questions by focusing on a specialist that has easily defined suitable habitat. Our system includes cactus bugs (*Chelinidea vittiger*) that are closely tied to their host plant, Opuntia cactus. We counted bugs and measured cactus within contiguous quadrats along a 700 m transect using a fine sampling grain (0.5 m^2). We modeled the spatial structure of the cactus cover with autocorrelation analyses. We then developed predictive regression models (non-spatial and spatial) for occupancy and abundance of bugs using a range of grain sizes. The correlogram indicated that cactus cover was positively correlated up to 60 m, negatively correlated from ca. 280–320 m, and not autocorrelated at other scales. Our ability to predict the response of cactus bugs to this habitat patchiness depended on the grain size of our sampling. A grain size that was too small may have created noise from sampling at a scale smaller than the habitat patches recognized by the cactus bugs. Grain size also can affect the relative predictability of an occupancy model versus an abundance model; there may be interplay between the question asked and the grain of observation.

Schulte, Lisa A. and David M. Mladenoff. Department of Forest Ecology and Management, University of Wisconsin, Madison, WI 53706, USA. **Effect of Scale on the Study of Pattern and Process in a Historical Landscape.**

Questions of pattern, process, and scale are fundamentally intertwined and are integral to the study of ecology. Whereas most studies exploring these questions are based on either theoretical landscapes or real landscapes dominated by human land use, we focus our studies on a historical landscape largely dominated by natural processes. Our goal is to better understand the natural constraints and feedbacks that maintained compositional and structural patterning on a historical, forested landscape. We study northern Wisconsin's forests prior to European settlement using the U.S. General Land Office's original Public Land Survey records (1832–1866), Geographic Information Systems, and cluster analysis. Because choice of scale influences the study of pattern, we analyze the landscape at five different spatial resolutions (2.6–94.1 km2) and compare landscape composition, configuration, and complexity across these scales. Thresholds in these metric calculations are linked with changes in the importance of ecological drivers and processes. For example, the dominance of trees from the genus *Pinus* within the northwestern Wisconsin Pine Barrens may be driven by soil characteristics; however, finer-scale patterns in species composition and tree density relate to fire regime. Knowledge gained here not only advances our understanding of historical ecosystem processes and the scales at which they may operate, but can also lend insight into ecological changes resulting from intensive human land use. Our results provide guidance for managing current and future landscapes if maintenance of ecosystem integrity and resilience over broad spatial scales is an objective.

Seagle, Steven W., Brian R. Sturtevant, Robert A. Chastain, and Philip A. Townsend. Appalachian Laboratory, University of Maryland Center for Environmental Science, Frostburg, MD 21532, USA. **Spatial Variation of Forest-Floor Litter Invertebrates in Topographically Diverse Landscapes.**

Forest-floor invertebrate communities are classically viewed as donor-controlled assemblages dependent on detrital input from forest vegetation. However, the quantity and quality of detrital input is controlled by forest tree species composition, topographic position, and potentially regional physiographic effects. Forest litter invertebrates were sampled within the wetter Appalachian Plateau province and drier Ridge-and-Valley province of Western Maryland. Within each province, study sites were stratified between drier and wetter topographic positions. Forest composition, forest physical/vertical structure, long-term forest productivity, detritus production (leaf fall), and detrital C and N were also characterized for these sites. These variables are used to predict the abundance of invertebrate detritivores and spatial variation in invertebrate community structure. These relationships are examined to assess the potential for landscape/topographic position to exert "top-down" control on feedbacks between community structure and site productivity.

Shapiro, Tamara,[1] Emily W.B. Russell,[2] and Jean Marie Hartman.[3] [1]Department of Landscape Architecture, Rutgers University, New Brunswick, NJ 08901, USA; [2]Department of Geologic Sciences, Rutgers University, Newark, NJ 07102, USA; and [3]Department of Landscape Architecture, Rutgers University, New Brunswick, NJ 08901, USA. **Forces of Environmental Change in the Hackensack Meadowlands: A Historic Analysis.**

The Hackensack Meadowlands Development Commission manages a 32 square-mile urban wetland area, located five miles west of Manhattan in one of the busiest and most intensely developed transportation and industrial corridors on the continent. Since pre-colonial settlement, this landscape has changed dramatically from a freshwater cedar swamp to a brackish tidal marsh dominated by Phragmites australis. Large-scale land-use patterns have been the most obvious agents of systemic change. For example, farmers have cleared and drained areas for agricultural use; transportation infrastructures and landfills have impounded and contaminated hydrologic systems. This project chronicles land-use history of the Meadowlands, focusing on five periods: European settlement (mid-eighteenth century); road and railroad building (mid-nineteenth century); post-industrial (early twentieth century); initial legislative action (late 1960s); and current conditions. Through analysis and mapping of historic development and vegetation data from land deeds, maps, and other archival sources, we analyze relationships between land-use and ecological change. Our findings challenge commonly held assumptions regarding causes of vegetal change. For example, the widespread invasion of Phragmites australis is generally attributed to the building of the Oradell Dam in the 1920s. However, we found that Phragmites was well established in the area by 1890. Also, current research may underestimate the role of external forces, such as sea level rise and fire, as factors in the change from a freshwater to a brackish ecosystem. Our findings should direct future planning, restoration, and design projects within this urban wetland system and provide a model for similar systems elsewhere.

Silbernagel,[1] Janet and T. F. H. Allen.[2] [1]Department of Landscape Architecture, University of Wisconsin, Madison, WI 53706, USA; [2]Department of Botany, University of Wisconsin, Madison, WI 53706, USA. **Negotiating the Cultural Landscape as a Bumblebee: Complex Foraging Behavior and Levels of Organization.**

We are interested in how native pollinators, namely bumblebees, move about a cultural landscape while foraging. More specifically, how does the heterogeneity of floral resource patches influence foraging paths? In our first test of this process we compared paired natural heath bogs and cultivated cranberry bogs in Northern Wisconsin. However, like any ecological process, there are multiple scales of foraging, with different activities operating at different scales. Moreover, some scales of foraging behavior are not coincident with human levels of observation or typical scales of cultural landscape form. For example, there is a wealth of controlled, experimental research on bumblebee foraging at the flower or flower cluster scale. But there has been little work that assesses spatially explicit foraging between plants or patches. On the other hand, there have been broader scale studies to address habitat preferences and foraging distance across fields and landscapes, but the results are inconclusive and provide little understanding of the flight sequence between habitats. In other words, beyond the small patch / plot scale, the world of bumblebee travel is nearly invisible to us. And it is at these scales that cultural processes most significantly alter landscape structure. This paper presents the issue of native pollinator landscape relationships where levels of observation and management inadequately match those of the process under study. We propose an approach that borrows from complex systems theory to model spatial processes for scales with little empirical data, based on current knowledge from scales above and below that in question.

Skabelund, Lee R. Department of Landscape Architecture, Virginia Polytechnic Institute and State University, Blacksburg, Virginia 24061, USA.
Grounding Community Planning/Design with an Understanding of Site and Landscape Ecology: Learning from the Brown Farm Park Master Planning Process—Blacksburg, Virginia.

The importance of initiating planning/design with a sufficient understanding of a site and its larger landscape connections–including the interactions among pattern, process, scale, and hierarchy–cannot be underestimated. Failure to understand and reveal site and landscape structure, function and dynamics to participants in citizen-driven planning processes leads to less effective, inefficient and often contentious master planning. This presentation critiques the development of the Brown Farm Park Master Plan in Blacksburg, Virginia, focusing on what we learn from mistakes made during the process–and from the coordinated, grassroots efforts to correct planning missteps. Purchased by the town in fall 1998, Brown Farm became a center of community attention when the master planning process was initiated in 1999. As a result of recent changes in its use and management, this human-dominated farm has been profoundly altered by natural forces, now providing cover, food and nesting habitats for over 160 species of birds, and for many mammals, amphibians, reptiles, butterflies and insects. It is posited that earlier analysis and community dialogue about site/landscape ecology would have narrowed the range of recreation facilities considered appropriate for Brown Farm Park, encouraging park planners/designers and community members to look beyond this ecologically important site for more intensive park facilities and recreation programs. Grounding community land planning and design with an understanding of site and landscape ecology is more likely to occur where ecologists, biologists and environmental planners/designers become actively involved in local planning efforts early in the process.

Skinner,[1] Carl N. and Scott L. Stephens.[2] [1]U.S. Forest Service, Pacific Southwest Research Station, 2400 Washington Ave., Redding, CA 96001, USA; [2]College of Natural Resources, Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA, USA.
Changes in Fire Regimes in Mixed Conifer Forests of the Sierra San Pedro Martir, Baja California, Mexico.

The conifer forests of the Sierra San Pedro Martir (SSPM) of northern Baja California, Mexico are unusual among forests of western North American because they have not been harvested and have not been influenced by systematic fire suppression. The species found there are common in forests of California. Some have suggested these forests may serve as reference conditions for forests of the Sierra Nevada. We are conducting a dendrochronology based fire history for two 1 km^2 areas within the SSPM. Our data from these sites suggest that several fire regime parameters changed around 1800 AD. Fires became less frequent after 1800. For fires that scarred at least three trees in each sample area, the pre-1800 median fire return intervals were 9 and 8.5 (ranges 4–21 and 4–27) while post-1800 were 18 and 17 (ranges 7–43 and 5–43) respectively. Several factors may have contributed to this apparent change in the fire regime. The San Pedro Martir mission was established in 1794 bringing a) the introduction of cattle grazing to the adjacent mountains and b) diseases that contributed to decline in native populations. Additionally, climate variation as evidenced in a synchronous decline of fire scars from ~1780 to ~1840 throughout the American Southwest and northwestern Mexico may have been a factor.

Smith,[1] Elizabeth R., R.V. O'Neill,[2] K. Bruce Jones,[3] James D. Wickham,[1] and Kurt H. Riitters.[4] [1]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Research Triangle Park, NC 27711, USA; [2]Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN 37830 USA; [3]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Las Vegas, NV 89119, USA; [4]USDA Forest Service, Forest Health Monitoring Program, Research Triangle Park, NC 27709, USA. **A Strategy for Assessing Current and Future Regional Vulnerabilities.**

Improving environmental decision making requires an assessment of relative risk posed by multiple stressors, now and into the future. Landscape sciences provide an opportunity to put regional-scale problems into perspective, and allow trade-offs to be compared through future scenario analysis. EPA's Regional Vulnerability Assessment (ReVA) Program is a new research initiative designed to develop and demonstrate an approach for assessing current and future environmental vulnerabilities and applying this information at the regional- to local-scales. This is being down through a combination of landscape-based exposure/effects models, regional-scale stressor- and resource-distribution models, new integrative techniques, and incorporation of socio-economics to develop plausible future scenarios and to communicate results in terms of potential changes in quality of life. ReVA's pilot study is being done in the mid-Atlantic region as a part of the Mid-Atlantic Integrated Assessment (MAIA). The first assessment, vulnerability of forests and streams, will be completed in FY 2002.

Smith,[1] Eric L. and Drew McMahan.[2] [1]Forest Health Technology Enterprise Team, USDA Forest Service, Fort Collins, CO 80526, USA; [2]Intecs International, Fort Collins, CO 80526, USA. **An Integrated System to Model and Display Bark Beetle and Management Impacts on a Forest Landscape.**

Forest disturbance processes interact with the landscape, affecting, and being affected by, landscape conditions. Management of forests for timber has left a legacy of forest growth models. The USDA Forest Service's Forest Vegetation Simulator (FVS) is available for most forest types in the USA, and is widely used by government and private firms. Important parts of FVS are stand scale insect and disease impact models. The Westwide Pine Beetle Model (WWPB) is the first landscape scale disturbance model for the FVS system. Pine bark beetles are major disturbance agents in the western USA, periodically killing large groups of trees over extensive areas. The WWPB is a process-based model incorporating within stand beetle population dynamics and tree mortality functions. Between stand beetle dispersion is done in a spatially explicit landscape of individual stands. FVS provides stand growth projections and forest management options, so alternative management and beetle outbreak scenarios can be modeled over long time periods. Inputs and outputs interface with Forest Service GIS and tabular databases, and outputs can be displayed as somewhat realistic images with visualization software. We have applied the model to a landscape on the edge of Colorado intensively developed Vail Valley, where thinning have been proposed as a forest protection measure. Use of visualization tools to display forest conditions over time and space, as affected by beetle outbreaks and management alternatives, is an essential tool for communicating the results of this model where scenic conditions are so highly valued.

Smith,[1] Jonathan, James D. Wickham,[1] Douglas Norton,[2] Tim G. Wade,[3] and K. Bruce Jones.[3] [1]U.S. Environmental Protection Agency, Landscape Characterization Branch (MD-56), Research Triangle Park, NC 27711, USA; [2]U.S. Environmental Protection Agency, Office of Water, 1200 Pennsylvania Ave. NW, Washington DC, 20460, USA; [3]U.S. Environmental Protection Agency, Landscape Ecology Branch, P.O. Box 93478, Las Vegas, NV 89193, USA. **Utilization of Landscape Indicators to Model Water Quality.**

Many water-bodies within the United States are contaminated by non-point source (NPS) pollution, which is defined as those materials posing a threat to water quality arising from a number of individual sources and diffused through hydrologic processes. One such NPS pollutant is fecal coliform, which is derived from animal wastes, including humans, and is most often associalted with urban and agricultural areas. It is postulated that by using landscape indicators, those water-bodies that may be at risk of fecal coliform contamination may be identified. This study utilizeed landscape indicators derived from the Multi-Resolution Land Characterization (MRLC) project to analyze fecal coliform contamination in South Carolina. Also utilized were fourteen digit hydrologin unit code watersheds of the state, a digital elevation model and water test point data stating whether the fecal coliform levels exceeded those set in accordance with section 303(d) of the Clean Water Act. Proportions of the various land covers were identified within the individual watersheds and then analyzed using logistic regression. The results reveal that watersheds with large proportions of urban land cover and agriculture on steep slopes had a very high probability of being impaired. This information will aid managers make knowledgeable decisions on assigning conservation resources and assessing future impacts of land-cover changes.

Snep, Robbert. Department of Landscape Ecology, Alterra, Green World Research, 6700 AA Wageningen, The Netherlands. **Modelling and Planning Nature and Biodiversity in Cities: The (Urban) Landscape Ecological Approach.**

In the Netherlands, there is a growing awareness of the importance of nature in cities. Study of nature in urban areas is one of the strategic research projects of Alterra. The question is how population networks of urban species can function in a sustainable way. To answer this question three aspects have to be taken into consideration. First question is how population networks of urban species function in a sustainable way. The Rotterdam Institute for Urban Nature (bSR) has been collecting data from the Port of Rotterdam on the occurence of various plants and animal species. At the same time Alterra has established a spatial expertsystem (LARCH-urban). This model calculates the spatial configuration and the viability of local and meta-populations of urban species. Results of both research programs have been matched. The model has further been developed, which lead to better conclusions on the viability of populations in the port of Rotterdam. Second question is how the ongoing process of urban development can be steered in such a way, that ecological conditions are optimized. A planning strategy has been developed, the so-called 'strategy of the two networks'. This strategy leads to a planning based on flows of water and traffic. Goals are to establish clean urban water systems and urban areas without the noise of traffic; these are the spatial basis for continuous networks of green and water areas, with (among others) high value for urban nature and recreation. Third question is how urban nature can get the active support from local people. Urban ecologists tend to think in terms of functional biodiversity. However for a successful implementation more attention has to be paid for other aspects of the multipurpose use of urban nature, as for example recreative and sport interaction. Also the visible quality of urban nature, as experienced by architects and urban planners, is very important. The challenge is how to combine all these different aims in urban nature with a high rate of biodiversity. The question how to develop sustainable populations of urban species turns out to be a delta research. This means that alpha (sociological and psychological), beta (ecological) and gamma (planning) researchers have to cooperate in this research program.

Song, B.,[1] P. Zollner,[2] D. J. Mladenoff,[1] Eric Gustafson,[2] H. S. He,[3] and V. C. Radeloff.[1] [1]Department of Forest Ecology and Management, University of Wisconsin, Madison, WI 53706, USA. [2]North Central Research Station, 5985 Highway K, Rhinelander, WI, USA. [3]School of Natural Resources, University of Missouri, Columbia, MO, USA. **3-D Visualization of Management Alternatives on the Chequamegon National Forest.**

3-D visualization provides a better understanding of the ecological consequences of changes resulting from land and resource management. It helps managers in planning for the many demands on public lands as well as researchers in understanding how complex landscapes respond to different management scenarios. Using GIS ArcView, World Construction Set, and LANDIS with Harvest Module, we assessed forest landscape patterns under different management alternatives in the Chequamegon National Forest. This work can be useful to managers, researchers, and the public in alternative land and resource management planning designs.

Spirn, Anne W. School of Architecture and Planning, MIT, Cambridge, MA 02139, USA. **Watersheds, History, Landscape Planning and Community Development: Reflections on Fifteen Years of the West Philadelphia Landscape Project.**

This paper describes the West Philadelphia Landscape Project as a laboratory for developing and testing theories of urban landscape change, planning, and management since 1987. It relates how processes of development, settlement, migration and disinvestment have interacted with natural processes such as water flow to produce landscapes of poverty. It summarizes discoveries (such as the high correlation in many inner-city neighborhoods between vacant land and buried floodplains) and projects (such as the transformation of low-lying vacant land into a landscape amenity and stormwater detention facility, thereby rebuilding a neighborhood, reducing combined sewer overflows, and improving regional water quality). The paper summarizes the results of this research-in-action, sets that work within the context of broader issues in urban and environmental policy, and reflects on lessons for the theory and practice of landscape ecology and landscape planning and management.

Springborn,[1] Elizabeth G. and David S. Maehr.[2] [1]Departments of Animal Science and Forestry, University of Kentucky, Lexington, KY 40503, USA; [2]Department of Forestry, University of Kentucky, Lexington, KY 40503, USA. **Conduits, Filters, and Barriers to Elk Movement in a Heterogeneous Landscape in Eastern Kentucky.**

To evaluate the restoration of a native species such as elk, which were extirpated from Kentucky by 1850, it is important to understand the colonization patterns of translocated individuals. The object of this study is to identify landscape features that influence the dispersion and home range establishment of reintroduced elk (*Cervus elaphus*) in eastern Kentucky. GPS radio collars were fitted on 22 elk during 1998, 1999, and 2000 to study elk movement from four release sites. Locations were obtained every three to six hours for up to 13 months per elk. A total of 250–2500 locations were obtained for each animal. This variation was caused by an equipment failure rate of over 50%. Topography, hydrology, land use, urban areas, mining sites, and highway land-cover data were examined in ArcView GIS relative to elk movement data. To date, most elk (87–90%) appear to remain within 20 km of the release site, whereas others (<5%) have moved >150 km from it. Landscape features such as rugged topography, rivers, and highways do not present barriers to the movement of individuals that chose to leave the release site, but may influence colonization patterns. Elk prefer to follow topographic contours rather than moving perpendicular to ridgelines and valleys. As such, ridgelines may act as conduits to elk movements and may help managers predict the direction and extent of colonization.

Stein, D. L. Department of Physics, University of Arizona, Tucson, AZ 85721, USA. **Spin Glasses, Disorder, and Complexity.**

Our deep physical and mathematical understanding of ordered systems in the solid and liquid state—for example, crystals, ferromagnets, superconductors, liquid crystals, and many others—has been of fundamental scientific and technological importance throughout the second half of this century. However, there exist many systems, both familiar and unfamiliar in everyday use, in which randomness or disorder plays a key role, and in which our mathematical and physical understanding remains comparatively primitive. One familiar example is ordinary window glass, where the atoms or molecules are "stuck" in random locations (as opposed to a regular crystalline array as would be found, for example, in ice). Spin glasses are disordered magnetic systems that are thought to be prototypes for this kind of macroscopic "frozen-in" disorder, and they may be more amenable to mathematical analysis than other materials in this class. Nevertheless, little fundamental progress has been made even here. In this talk I will introduce some basic features of spin glass experiment and theory, and discuss why some the methods and concepts developed to understand spin glasses may have wider applicability in the field of complexity.

Steinitz,[1] Carl, David Mouat,[2] Robert Anderson,[3] Hector Arias,[4] Scott Bassett,[1] Mary Cablk,[2] Micahel Flaxman,[1] Tomas Goode,[5] Robert Lozar,[6] Thomas Maddock, III,[5] Winifred Rose,[6] Richard Peiser,[1] and Allan Shearer[1]. [1]Department of Landscape Architecture, Harvard University, Cambridge, MA 02138, USA; [2]Desert Research Institute, Reno, NV 89512, USA; [3]Environmental Division, U.S. Army Training and Doctrine Command, Fort Monroe, VA 23651, USA; [4]Gabinete de Estudios Ambientales, A.C., Hermosillo, Mexico; [5]Department of Hydrology and Water Resources, University of Arizona, Tucson, AZ 85721, USA; [6]U.S. Army Construction and Engineering Research Laboratory, P.O. Box 9005, Champaign, IL 61826, USA. **Alternative Futures of the Upper San Pedro River Watershed, Arizona and Sonora: A Modeling Approach.**

This investigation explores how urban growth and change in the Upper San Pedro River Watershed (from the headwaters near Cananea, Sonora, to Redington, Arizona) might influence the hydrology and biodiversity of the area over the next 20 years. A suite of process models is used to describe how the current landscape works, and to assess the potential impact of each of a set of alternative futures and their variations relative to conditions in 2000. A development model evaluates the attractiveness of the available land for different types of development (e.g., commercial, suburban, etc.). It then simulates the urbanization of the region under different scenarios for change. A hydrologic model evaluates change in terms of head configuration, loss of groundwater storage, stream capture volume, and flows in the San Pedro River. A vegetation model responds to changes in the hydrologic regime combined with changes in fire and grazing management practice. The resultant predicted new vegetation patterns form the basis for regional biodiversity assessment. A visual model assesses potential impact on the region's landscape in terms of scenic preferences. We developed several alternative futures, which encompassed a reasonable range of possibilities. These scenarios were based on three groups of issues: development, water use, and land management. The modeling environment within which the scenarios were developed was also used in the evaluation process. The scenarios were evaluated against water availability, developemnt, land management, and biodiversity. These evaluations provide guidance for the region's stakeholders to better determine how they wish their future to be.

Stralberg, Diana, Nadav Nur, and Hildie Spautz. Point Reyes Bird Observatory, 4990 Shoreline Highway, Stinson Beach, CA 94970, USA.
Landscape-Level Influences on Breeding Songbirds in San Francisco Bay Tidal Marshes.

Tidal marsh, formerly the dominant habitat type in the San Francisco Bay Estuary, has been reduced to less than 15% of its original extent as a result of human activities. Consequently, marsh-dependent songbirds, including three endemic subspecies of Song Sparrow (*Melospiza melodia*) and the Salt Marsh Yellowthroat (*Geothlypis trichas sinuosa*), have experienced a severe loss of habitat, and have been restricted in many areas to isolated marsh fragments with increasing amounts of urban upland edge. Previous analyses have demonstrated significant relationships between the abundance of these two species and various habitat features, including vegetation composition and degree of marsh channelization. This study seeks to improve our understanding of songbird habitat requirements by examining the additional and interactive influences of landscape-level features, including marsh area and isolation, marsh-upland edge configuration and landscape matrix composition. Using point count survey data collected at 51 individual marshes throughout the San Francisco Bay Estuary, we fit a series of nested regression models to determine the additional contribution of landscape features on Song Sparrow abundance and Yellowthroat presence/absence at each marsh, above and beyond the variation explained by within-marsh variation in habitat features. Spatial autocorrelation in abundance was examined and explicitly incorporated into the models when necessary. Results from these models will help inform the calculation of new population estimates for each of the subspecies, as well as planning and prioritizing restoration efforts throughout the Bay ecosystem.

Sturtevant, Brian R., Steven W. Seagle, and Philip Townsend. Appalachian Laboratory, University of Maryland Center for Environmental Science, 301 Braddock Road, Frostburg, MD 21532, USA. **Comparing Terrain-Based Models of Forest Productivity in Western Maryland: Extending to Regional Scales.**

Digital elevation data are useful in predicting both potential vegetation and site quality within mountainous forest systems and at the landscape scale. However, predictions at regional scales become problematic as large-scale discontinuities in geology and climate are encountered. We present a comparison of terrain-based forest productivity models derived from field plot data from two physiographic provinces (Ridge and Valley and Appalachian Plateau) of western Maryland. These two provinces differ both in terms of climate (e.g., growing season, precipitation) and bedrock geology. Results indicate that the productivity of sites within the drier climate of the Ridge and Valley is sensitive to terrain indicators related to hydrology and solar exposure. Productivity of sites within the Appalachian Plateau appears less sensitive to topography in general, and may be more related to factors associated with soil depth. Regional precipitation models that account for elevation effects may help to combine the two different forest productivity models. This comparison represents the first step in providing a broad-scale, fine resolution model of forest productivity useful at regional scales.

Sun-Kee Hong,[1] In-Ju Song,[2] Eun-Kyong Lee,[1] Do-Won Lee,[3] and Ji-Hae Shin.[2]
[1]Environmental Planning Institute, Seoul National University, Seoul 151-742, Korea; [2]Seoul Development Institute, Seoul 100-250, Korea; [3]Graduate School of Environmental Studies, Seoul National University, Seoul 151-742, Korea. **Changes in Landscape Pattern and Their Effects on Ecosystem Functions in the Seoul Area: Guidelines for Urban Landscape Conservation and Ecological**

Landscape change has been largely influenced by human activities. Developed urban areas may often serve as an important source habitat for populations of introduced plant species. In recent years, this situation has become one of environmental problems in urban landscape management for controlling these introduced plants and conserving the native vegetation. This research is focused on landscape changes and their effect on ecosystem functions in the Seoul area. Spatio-temporal variations in the structure of forest patches in the urban landscape were quantified from 1983 to 1999. Thirty-two landscape indices were calculated using FRAGSTATS and four of them were selected by pearson's correlation analysis and factor analysis. In order to know the distribution pattern of two representative naturalized plants (*Robinia pseudoacacia* and *Eupatorium rugosum*) in the developed area of Seoul, Kangdong-Gu, one of administrative areas was selected for this study. The results showed that forest patches became smaller and more irregular in shape and that the diversity of patch types and the variation in forest patch size both increased. The analysis also suggested that the two species often occurred in the same habitat and were often found in forest edges disturbed by human activities. Their distribution patterns were related to landscape indices (patch size and shape) in the forest edge. Based on these findings, we propose guidelines for the urban landscape conservation and ecological planning in Seoul.

Sutton, Richard K. Agronomy and Horticulture, University of Nebraska–Lincoln, Lincoln, NE 68583-0724, USA. **Effects of Grain, Extent, and Scale in a Hierarchical Test on Mystery, Legibility, and Preference in Rural Landscapes.**

Spatial constructs are important for the study and management of land and biological resources, including aesthetics. Kaplan and Kaplan,s description of mystery and legibility implies spatial influence on landscape scene preference. In this study, concepts of grain and extent, were used as hierarchial descriptors of scale and tested for effects on mystery, legibility, and preference. Grain was conceptualized as the dominant space enclosing viewers as they imagined themselves in a photo of a landscape scene. Extent was conceptualized as the number of boundaries beyond that dominant boundary. Three by three factorial treatments of grain and extent were shown in scenes of a rural watershed. From a pool of 66 scenes, three from each of nine scale classes were randomly shown to and rated for preference by 22 groups of students and rural residents (n=382). ANOVA tests showed legibility ratings significantly increased with enlarging extent and decreased with enlarging grain. Mystery ratings significantly increased with decrease in grain. Significant grain*extent interaction effects appeared for legibility, mystery and preference ratings. Some results appear to fit Appleton,s aesthetic concepts of prospect and refuge. Large scale and high legibility interacted to create an increased preference rating. This situation was labeled a "prospect" effect. Landscape scenes smaller in scale and rated high for mystery were rated higher for preference than those rated low for mystery. This situation was labeled a "refuge" effect. A significant mystery legibility scale interaction effect for preference ratings, revealed scale has a significant impact on the preference ratings of low legibility-low mystery scenes.

Swaffield, Simon R. Environmental Management and Design Division, Lincoln University, Canterbury, New Zealand. S**ociety, Culture and Landscape Ecology: Connections and Tensions.**

There is growing awareness of the need to better integrate landscape ecology with an understanding of culture and society (Nassauer 1997). To realise these connections it will be essential to develop a shared language and understanding. Just as social scientists are not typically well versed in landscape ecology, neither are landscape ecologists commonly aware of key concepts and assumptions in the social sciences. Nor are these different ways of thinking necessarily compatible with each other in all respects. In this presentation, the epistemological and methodological underpinnings of landscape ecology will be contrasted and compared with several major schools of social science. Areas of compatibility and tension are highlighted, and contrasts between North American and European approaches to landscape ecology noted, insofar as they relate to society and culture. The discussion will be illustrated by reference to a typical urban issue: the rehabilitation and revegetation of urban wetlands and waterways. The review reveals that there are significant challenges in achieving conceptual integration between landscape ecology and the social sciences at a theoretical level. Instead, it is argued that the most fruitful avenue for integration will be through the intermediary activities of design and planning (Lineham and Gross 1998, Wiens and Moss 1999). In essence, this constitutes a case study approach. Cumulative knowledge development across case studies will depend upon the identification of robust metaphors of nature-and-culture, within which more discipline specific concepts and theories can be nested. Nassauer's concept of "cues for care" (1995) provides one such metaphor, with the potential to draw together several realms of knowledge in a practical setting. The paper concludes by identifying from recent work a range of potential integrating metaphors for urban landscape ecology.

Swanson,[1] Frederick J., Sherri L. Johnson,[2] Kai U. Snyder,[3] and Steven A. Acker.[4]
[1]USDA Forest Service, Forestry Sciences Lab, Corvallis, OR 97331, USA; [2]Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331, USA; [3]E&S Environmental, 2162 NW Fillmore Ave, Corvallis, OR 97330, USA; [4]National Park Service, 909 First Ave, Seattle, WA 98104, USA. **Disturbance of Aquatic and Riparian Systems in a Mountain River Network.**

Patterns of disturbance in aquatic and riparian systems in mountain landscapes can be strongly influenced by the structure of stream networks. Network structure determines, in part, the distribution of geomorphic processes and their effectiveness as disturbance agents within stream systems. A 50-year record of debris flows in a Cascade Mountain landscape reveals a concentration of events in a limited set of the first- through third-order channels and a shifting mosaic of linear disturbance patches within the stream and riparian network across that part of the landscape. Channel segments not subjected to recent debris flows may serve as refuges in debris-flow producing floods, and sources of organisms to recolonize severely disturbed patches. Study of a major flood in 1996 on fourth- and fifth-order channels suggests that the widespread, 30-year-old, riparian alder stands experienced highest severity disturbance (removal) where floated wood was moving in a congested manner. These batches of wood were commonly delivered to the larger channel by debris flows from tributaries. Uncongested wood movement (floating individual pieces) tended to topple trees without removing them. Analysis of stem-map data from before and after the flood in a wide valley floor area with extensive alder stands shows a fine-grained pattern of disturbance patches of toppled and removed stems. These patterns reflect changes in channel position, impacts of floated wood, and other processes influenced by channel position. Aquatic habitat was altered directly by channel change and bed turnover, as well as indirectly by alteration of the riparian zone and its influences on the aquatic system. These observations form a basis for defining both deterministic and more stochastic properties of the disturbance regime over this mountain stream network.

Tang, Jianwu, Ming Xu, and Ye Qi. Department of Environmental Science, Policy, and Management, University of California, 135 Giannini Hall Berkeley, CA 94720-3312, USA. **The Impact of Forest Thinning on Soil Respiration.**

Soil respiration is controlled by soil temperature, soil moisture, fine root biomass, microbial biomass, and soil physical and chemical properties. The thinning of forests will change soil temperature and moisture and thus change the soil CO_2 efflux. Using an LI-6400 Soil CO_2 Flux System we measured soil surface CO_2 efflux in an 8-year-old ponderosa pine plantation, 58% of which is covered by trees, in the Sierra Nevada Mountains in California from June 1998 to April 2000 before a pre-commercial thinning, and from April to November 2000 after the thinning. We established two 20 m by 20 m sampling plots and measured soil CO_2 efflux and soil temperatures (10 and 20 cm in depth) and moisture on a 3 by 3 matrix of sampling points in each plot. We found although soil temperature and moisture explain most of the temporal variations in soil CO_2 efflux, they explain only a little part of the spatial variation of soil CO_2 efflux. A thinning intensity of 60% of the trees significantly changed the microclimate in the forest, but the soil CO_2 efflux does not vary significantly before and after the thinning.

Tanizaki, K. F. and R. P. F. Pedrosa. Ecology Sector/DBAV/ Universidade do Estado do Rio de Janeiro, São Francisco Xavier, 524/PHLC sala220, Maracanã, Rio de Janeiro; Brazil. **Establishing Priorities for Conservation and Management in the Atlantic Coastal Forests: Case Study of Rio de Janeiro State, Brazil.**

Forests are associated with many services which human being are dependent upon, such as wood, non timber products, watershed protection and carbon stock. The objective of this study was the development of a set of analyses to evaluate forest distribution and landscape dynamics, selecting priority areas for forest resources management and conservation using the State of Rio de Janeiro as a study case of the Atlantic Coastal Forest, one of the most endangered forests of the world. For this, some guidelines were established to survey biophysical aspects related with forest distribution using political boundaries - once they are responsible for land-use monitoring and forest management policies. This study was conducted in three steps: The first to obtain an environmental and historical panorama of the Atlantic Coastal Forest and the main characteristics of the land-use processes. A second step focused the actual forest distribution and dynamics, including the shape of fragments, topography, climate, socio-economy, occurrence of fires and their consequences to vegetation and carbon stock measurement in forest. The last step focused on carbon stocks for the entire state and estimated the uncertainties involved with the measurements. Results show a concentration of forest remnants in municipalities around the main mountains chains with 36 of the 91 municipalities accounting for 90% of the forests. Carbon stocks in the vegetation were estimated to be approximately 150 Mg/ha and 75 Mg/ha in forests abandoned for 70 and 40 years respectively. The actual carbon stocks in forest are approximately 0.11Gg with a uncertainty of 30%.

Tankersley Jr.,[1] Roger D., Kenneth H. Orvis,[2] and Elizabeth R. Smith.[3]
[1]Tennessee Valley Authority, Norris, TN 37828, USA; [2]Department of Geography, University of Tennessee, Knoxville, TN 37996, USA; [3]U.S. EPA Office of Research and Development, Research Triangle Park, NC 27711, USA. **The Geography of Migration: A Landscape View of Stopover Habitats and Pathways in the Eastern United States.**

This project examines Neotropical migratory birds in the eastern United States, using habitat and movement models to highlight areas where stopover habitat is essential. Within a GIS, we are developing indicators of stopover habitat (natural landcover, forest fragmentation, road density, percent agriculture, etc.), based on field data collected during spring migration, 1999. These indicators highlight the landscape- and local-scale factors that determine habitat suitability. Mapping those factors across the eastern U.S., we can create a habitat surface used to model corridors of movement across the region. These habitat patterns illuminate teleconnections across the landscape, highlighting both the flyways that migrating birds follow, and the habitat locations they choose for stopovers. Connectivity is key: quality habitats must be located appropriately along the overland migration route. A random distribution of habitats will not insure the continued success of migratory species in our region, and there are likely key areas that must remain to insure successful migration. As we develop models of habitat use and migration pathways, we can also examine how future changes in the environment may affect existing stopover hotspots. Integrating with other research in ReVA, we will examine how future scenarios affect existing migratory habitats. For example, new development may bisect a forested river corridor used by migrants. At certain locations, this type of disturbance may have a significant impact on the migrant bird population. Only through a landscape view can we identify environmental factors key to successful migration, and understand how future changes may alter the migration landscape.

Theobald, David M. Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO 80523, USA; and The Nature Conservancy's Smith Fellowship Program. **Quantitative Measures of the Urban-Rural Gradient.**

An important challenge of landscape ecology is to integrate socio-economic and ecological data in a quantitative fashion in an effort to better understand human-dominated ecosystems. However, progress in such integration is impeded by a lack of standard definitions and a lack of an operational gradient. For example, although "urban" is defined by the US Census Bureau as a population density of 1,000 per square mile or more, suburban, exurban, and rural are defined simply as "not urban". However, these terms are commonly used in social and ecological research, though only infrequently are they defined quantitatively. This handicaps not only attempts to integrate socio-economic and ecological data, but it obviates comparative analyses of research conducted in different locations and times. There are a number of conceptual frameworks to draw from, such as Forman and Godron's urban-suburban-cultivated-managed-natural, McIntyre and Hobbs' relictual-fragmented-variegated-intact, and McDonnell and Pickett's urban-rural transect. In this paper I describe a number of quantitative attributes of human-dominated ecosystems, such as population density, housing density, land-use type, and road density, to operationalize the urban-rural gradient.

Thompson, Craig M. and Kevin McGarigal. Department of Natural Resource Conservation, University of Massachusetts, Amherst, MA 01003-4210, USA. Effects of Scale on Bald Eagle (Haliaeetus leucocephalus) Habitat Selection along the Lower Hudson River.

Recent advances in landscape ecology have highlighted the need for a better understanding of the impact of spatial scales on species' habitat selection. By understanding how species habitat requirements change over spatial scales and how scale influences spatial analyses, we can develop a more organism-centered view of an environment. We investigated breeding bald eagle selection of well-documented habitat requirements over a range of scales by systematically varying both the grain and extent of the landscape. Four bald eagle pairs were intensively monitored during the 1999 and 2000 breeding season. Habitat features measured included access to foraging areas, nest / perch tree availability, and freedom from disturbance. The landscape grain, defined as the minimum mapping unit, was systematically varied by aggregating coverage grid cells. At each grain, selection was measured using a chi-squared goodness-of-fit test. Landscape extent, the area encompassed by a study, was varied by systematically increasing a window of analysis around used habitat. Discriminant analysis of landscape metrics was used to quantify selection between used and random locations at each extent. We believe that such a hierarchical approach can better define the effects of scale on both species habitat selection and the variation within resource selection, and could be useful in improving wildlife management techniques.

Tinker,[1] Daniel B., William H. Romme,[2] and Don G. Despain.[3] [1]Department of Geosciences and Natural Resources Management, Western Carolina University, Cullowhee, NC 28723, USA; [2]Biology Department, Fort Lewis College, Durango, CO 81301, USA; [3]USGS, Department of Biology, Montana State University, Bozeman, MT 59717, USA. **Historic Range of Variability in Landscape Structure in Subalpine Forests of the**

A measure of the historic range of variability (HRV) in landscape structure is essential for evaluating current landscape patterns of Rocky Mountain coniferous forests subjected to intensive timber harvest. We used a GIS and FRAGSTATS to calculate four key landscape metrics on two ~130,000-ha landscapes in the Greater Yellowstone Area: 1) Yellowstone National Park (YNP), which has been shaped by natural fires; and 2) the adjacent Targhee National Forest (TNF), which has undergone intensive clearcutting for 30 years. Landscape metrics were calculated at 20-yr intervals for YNP for the period from 1705–1995, and were used to evaluate the relative effects of small vs. large fire events on landscape structure. They were then compared to similar metrics for pre- and post-harvest landscapes of the TNF. Total number of patches was higher after the large 1988 fires, and mean patch size was reduced by almost half. The amount of unburned forest was less following the 1988 fires (63% vs. 72–90%), yet the number of unburned patches increased nearly tenfold (230 vs. 41). Total core area per patch also decreased after 1988. Only edge density was similar to earlier landscapes. Timber harvesting in the TNF produced a threefold increase in number of patches (1,481 vs. 437), and mean patch size decreased by ~70%. None of the post-harvest TNF landscape metrics fell within the HRV in YNP, even though pre-harvest TNF landscape metrics were all within, or nearly within, the HRV for YNP. Understanding the consequences of changes in landscape structure is important for population, community, ecosystem, and landscape function.

Tjallingii, Sybrand P. Alterra, Green World Research, P.O. Box 476700 AA Wageningen, The Netherlands. **Carrying Structures of the Urban Landscape.**

In the "old world" cities needed to adapt to their landscape.. More recently, urban form and function seem to have almost lost contact with the local landscape. In this paper I argue there is a need to pick up the "old thread" and develop a new ecological approach to urban development in general: an ecological conditions strategy in urban planning and design. Following the 'design with nature' tradition, I will elaborate new practical answers to planning issues of the network society and network urbanization. A case study of the region around Schiphol Airport near Amsterdam, The Netherlands, will demonstrate the approach which aims to create supporting conditions for human health and safety, for the identity of urban places and for sustainable urban development, including basic environmental conditions for wildlife. The strategy of the two networks is central to this approach. Carrying both land use and flow management, the two spatial networks of traffic and water may act as a starting point in a planning process that may frame further decision making about new urban developments as well as for the restructuring of old urban districts.

Tluk V. Toschanowitz,[1] Katharina, Timothy J. Roper,[2] Karin Frank.[3] [1]Institute of Environmental Systems Research, University of Osnabrueck, D-49076 Osnabrueck, Germany; [2]School of Biological Sciences, University of Sussex, Brighton BN1 9QG, Great Britain; [3]Department of Ecological Modelling, UFZ-Centre for Environmental Research Leipzig-Halle, D-04318 Leipzig, Germany. **Assessing the Effect of Traffic on Different Hierarchical Levels of Population Ecology: Lessons from an Individual-Based**

In human-dominated areas, traffic represents one of the most important driving forces for population decline. Therefore, developing strategies for reducing the negative effect of traffic is an important contribution to harmonizing human beings and nature. We present an individual-based, spatially explicit simulation model that allows the effect of traffic (road network, traffic flow) on different hierarchical levels of population ecology (from individual mortality to population viability) to be assessed, the role of the species' ecology (esp. spacing behavior) to be analyzed and rather general conclusions for landscape evaluation as well as traffic planning and management to be drawn. To demonstrate the potential of this approach, the model is applied to a population of the Eurasian badger (*Meles meles*) in Great Britain. Moreover, the results of the simulation model will be compared with the results produced by a simple landscape index for "Traffic Mortality". This index summarizes certain characteristics of both the spatial structure of the road network and the traffic flow as well as the species' ecology. We will demonstrate to what extent the simple index allows the results of the model at least qualitatively to be correctly predicted so that it can be used as a tool for decision-support. Finally, some general conclusions are drawn concerning a model-based deduction of indices which allow both landscape structures and disturbance regimes to be assessed "through the eyes" of a certain species.

Tole, L. Center for Development Studies, University of Glasgow, Glasgow, U.K. **Habitat Loss and Anthropogenic Disturbance in Jamaica's Hellshire Hills Region.**

This paper provides empirical assessments of the magnitude of human pressures on species habitat in Jamaica's Hellshire Hills region. Remotely sensed satellite data are used to derive estimates of the rate of forest conversion—the study's spatial indicator of habit loss—both within and outside the region. Moreover, a regression analysis of island-wide deforestation estimates and key socio-economic driving forces for 51 administrative districts that adjusts for location within and immediately outside the Hellshire Hills region suggests that immiserating pressures on species habitat, particularly outside the region, are greater in these areas than anywhere else on the island. Simulations of species loss and edge-induced disturbances to species habitat at the region's margin also suggest that the potential impacts of forest conversion in the region may be substantial and extend well beyond its boundaries. Together, the study's findings raise important questions about the capacity of the region—which has been accorded protected status within the newly established Portland Bight Protected Area—to provide for the long-term preservation and viability of the region's species. It is concluded that while quantitative estimates and biogeographical simulations can provide a general sense of the anthropogenic threats the region faces, appropriate reserve design and species protection will require the collection of detailed empirical data on species diversity, habitat requirements and spatial distribution. Before this information is collected, however, priorities for biodiversity conservation must be set and their trade-offs assessed within the overall context of a rural development plan for the region's desperately poor population.

Townsend, Philip A., Robert A. Chastain, Brian R. Sturtevant, and Steven W. Seagle. Appalachian Laboratory, University of Maryland Center for Environmental Science, 301 Braddock Road, Frostburg, MD 21532, USA.
Characterization of Forest Vertical Structure for Landscape Studies.

The vertical structure of forests influences many components of forest ecosystems ranging from arthropod production to avian biodiversity to understory/regeneration dynamics. As such, forest vertical structure may be an important indicator of ecosystem functioning and health. Typically, studies of forest structure tend to be conducted at an intensive scale due to the detail of measurements that are required to generate a three-dimensional representation of the forest. Studies conducted at progressively broader scales must use increasingly generalized models of the forest canopy. However, with recent advances in remote sensing technologies and landscape-scale spatial modeling, there is now a need to develop improved approaches to characterize the spatial and vertical variability of forest canopy structure across landscapes. Here we outline a method to generate detailed measures of forest vertical structure appropriate for landscape-scale studies. First, we describe our field and measurement methodologies. Next, we outline the computational approaches needed to calculate the geometric properties of forests. Then we introduce a method to integrate multiple measurements of canopies (and different layers of canopies) into a smaller, more manageable number of interpretable values. Finally, we demonstrate the applicability of our method to remote sensing studies, as well as studies of forest interior birds, invertebrates, and understory dynamics.

Tran,[1] Liem T., C. Gregory Knight,[1,2] Robert V. O'Neill,[3] Elizabeth R. Smith,[4] Kurt H. Riitters,[5] and James Wickham.[4] [1]Center for Integrated Regional Assessment, the Pennsylvania State University, University Park, PA 16802, USA; [2]Department of Geography, Pennsylvania State University, University Park, PA 16802, USA; [3]Oak Ridge National Laboratory, Environmental Sciences Division, Oak Ridge, TN 37830, USA; [4]U.S. Environmental Protection Agency, National Exposure Research Laboratory, Research Triangle Park, NC 27711, USA; [5]U.S. Department of Agriculture, Forest Service, Forest Health Monitoring Program, Research Triangle Park, NC 27711, USA. **Fuzzy Decision Analysis for Integrated Environmental Vulnerability Assessment of the Mid-Atlantic Region.**

A fuzzy decision analysis method for integrating ecological indicators is developed. This is a combination of a fuzzy ranking method and the Analytic Hierarchy Process (AHP). The method is capable ranking ecosystems in terms of environmental conditions and suggesting cumulative impacts across a large region. Using data on land-cover, population, roads, streams, air pollution, and topography of the Mid-Atlantic region, we are able to point out areas which are in relatively poor condition and/or vulnerable to future deterioration. The method offers an easy and comprehensive way to combine the strengths of fuzzy set theory and the AHP for ecological assessment. Furthermore, the suggested method can serve as a building block for the evaluation of environmental policies.

Tueller,[1] Paul T., Michael Limb,[2] and Jianguo Wu.[3] [1]Department of Environmental and Resource Sciences, University of Nevada Reno, Reno, NV 89512, USA; [2]Bureau of Land Management, Klamath Falls, OR 97603, USA; [3]Landscape and Systems Ecology Lab, Arizona State University West, Phoenix, AZ 85069, USA. **Landscape Pattern and Ecosystem Attributes on a Western Nevada Rangeland Ecosystem.**

Range management has two basic components: 1) protection and enhancement of the soil/vegetation complex, and 2) maintaining or improving the output of consumable range products. Preexisting rangeland data can be applied to range management questions using landscape ecology techniques along with remote sensing/GIS. Vegetation of the eastern Carson Valley, Nevada was mapped using image processing techniques to decorrelate and classify bands 4, 3, and 1 of two Landsat Thematic Mapper satellite images from 1984 and 1996. The maximum likelihood supervised classification algorithm with the addition of United States Geological Survey Digital Elevation Models resulted in 64% overall map accuracy. Landscape structure metrics were calculated using FRAGSTATS. Above ground biomass and plant canopy cover data were collected by analyzing NRCS soil surveys and ground survey data, respectively. Relationships between vegetation type, landscape structure metrics, and ecosystem attributes were detected using correspondence analysis. A relationship was found between plant cover variables and shape index, core area and core area index. A plot of factor 1 vs. factor 2 together represented 98. 4% of the variation within the data set. Changes in vegetation from 1984 to 1996 were described using GIS techniques. Changes in landscape structure metrics were quantified by applying a multivector subsampling technique to the 1984 and 1996 vegetation maps. Results varied from quadrant to quadrant. In the northeast quadrant the only substantial change was in average patch fractal dimension, in the northwest a slight decrease in mean patch size suggested an increase in uniformity from 1984 to 1996, in the southeast and southwest quadrants we found increase in mean patch size

Turner, Monica G. Department of Zoology, University of Wisconsin, Madison, WI 53706, USA. **Five Key research directions in landscape ecology. (Conveyed by J. Wu)**

Spatial heterogeneity and ecosystem processes. Landscape ecology has made tremendous progress in quantifying spatial patterns and how they change, and in understanding the consequences of landscape patterns, especially habitat fragmentation, for populations. However, our understanding of ecosystem processes in the landscape-how rates vary over space and at different spatial scales, and what controls this variation-is in its infancy). Process-based studies are costly and often require sophisticated laboratory equipment and methods, and it may be quite difficult to collect an adequate number of samples (across both space and time). However, this is an important challenge to landscape and ecosystem ecologists, and the integration of these two areas of ecology should be a high priority.

Thresholds, nonlinearities, and rules for scaling. Critical thresholds in landscape pattern provide an example of a nonlinearity with important implications for understanding the relationship between pattern and process. Identifying and understanding the nonlinearities associated with changes in spatial and temporal scale provide exciting opportunities for research and very practical applied challenges. The effects of scale are now well recognized, but the need for improved quantitative understanding remains critical. Ecologists still struggle with identifying the "right" scale(s) for studying and understanding particular patterns and processes, and extrapolating the knowledge gained at one scale to other scales. The "rules of thumb" that have been suggested for scaling need to be tested more widely, and the qualitative differences associated with changes in spatial pattern (e.g., critical thresholds) need to be considered in actual landscapes. Nonlinear dynamics and scaling are likely to continue to motivate a considerable volume of basic and applied research in landscape ecology.

Causes and consequences of land-use change. Increases in the extent and intensity of human land uses are primary drivers of landscape change worldwide. Land-use patterns and changes are spatial phenomena, and landscape ecologists have an opportunity to contribute toward understanding and predicting these patterns and their ecological consequences. This area should receive increasing attention from landscape ecologists. In addition, greater emphasis is needed on understanding "land-use legacies", i.e., the types, extents, and durations of persistent effects of prior land use on ecological patterns and processes.

Sampling. Landscape ecology is certainly not constrained to address questions over large areas, but one must recognize that many landscape ecological studies do so. The problems inherent in sampling across large regions in a way that permits inference of the effects of spatial heterogeneity remain challenging. We need to develop improved ways of sampling over large areas, using appropriate (and possibly new) statistical methods for data analysis, and using creative combinations of the assortment of available methods, including field sampling, experimentation, remote sensing, and modeling.

Relating landscape metrics to ecological processes. The development of landscape pattern analysis has been rapid, but there are major areas in which further understanding is sorely needed. Most importantly, the empirical relationships between landscape patterns and ecological processes of interest must be better documented and the underlying mechanisms understood. The relative sensitivity of different metrics to detecting changes in the landscape is not known; i.e., how much does the landscape need to change before a metric can detect the change? Progress in these areas will help ecologists determine what is worth measuring and why, and when a change in a metric is significant both statistically and ecologically. It remains a critical research task to determine what constitutes a "significant" change, both statistically and ecologically, in spatial metrics, and to relate such changes to ecologically relevant responses. Many applications of landscape ecology depend heavily on such understanding.

Turner,[1] S. J. and A.R. Johnson.[2] [1]The Department of Biological Sciences, St. Cloud State University, St. Cloud, MN 56301 USA; [2]The Department of Environmental Toxicology, Clemson University, 509 Westinghouse Road, Pendleton, SC 29670, USA. **Fragmented Native Populations in Agricultural Landscapes: The Case of an Orchid and Its Pollinators.**

Fragmentation of orchid habitat and declines in pollinator populations may be linked synergistically in agricultural landscapes. Small size orchid populations and their relative isolation negatively affect species persistence and in addition agricultural chemicals in the environment can reduce pollinator abundances and thereby decrease reproduction among the remaining plants. Fewer pollinators searching for fewer orchids. Even in clonal species these circumstances can lead to extinction through compounding Allee effects. We have developed a preliminary meta population model to explore the possible consequences of different size and shape habitat fragmentations linked with the number and distance of travel for pollinators. Our model is based on the ecology of *Platanthera psycodes*, a terrestrial orchid which is pollinated by species of butterflies and diurnal hawkmoths. The model generally represents many other species of *Platanthera* that exist in fragmented populations and have specialized pollinator relationships. This study investigates the potential for habitat fragmentation and chemical contaminants to disrupt plant-pollinator mutualisms. This presentation is an early portion of a field and modeling study that investigates the sustainability of interacting populations of native plants and their pollinators in ecosystems within a landscape mosaic of different land uses.

Tyler,[1] Marnie W., Don McKenzie,[1] and David L. Peterson.[2] [1]College of Forest Resources, University of Washington, Seattle, WA 98195, USA; [2]USGS Forest and Rangeland Ecosystem Science Center, Cascadia Field Station, University of Washington. **Effects of Human Land Use on Landscape Structure on the Western Olympic Peninsula, Washington, U.S.A.**

The Pacific Northwest and Washington's Olympic Peninsula (OP) in particular have received a great deal of attention regarding loss and fragmentation of some of the largest tracts of old-growth forests in the United States. Human activities, including timber harvest, urban development, and agricultural conversion have dramatically changed landscape structure on the OP over the last 40 years. Timber harvest has been the single most significant agent of change. This study evaluates current landscape structure on the western OP and projects conditions 200 years into the future. We examine the current spatial distribution and associated diversity of forest herbaceous species diversity of forests in four age categories: regeneration (0–20 years), young (21–80), mature (81–200) and late seral (>200 years). We then project future spatial patterns of these age categories and quantify landscape structure under three land-use scenarios: 1) zero timber harvest on public lands, 2) continued implementation of the 1994 Northwest Forest Plan, and 3) resumption of harvest levels that occurred on the OP during the 1970s and 1980s. The structures of these future landscapes are compared with respect to patch diversity, edge, evenness, and other landscape metrics. Future landscapes will be interpreted in terms of herbaceous species diversity and relative abundance of four forest bird species

Urban, Dean L. Nicholas School of the Environment, Duke University, Durham, NC 27708, USA. **Extending Community Ecological Analyses to Landscape Scales.**

Community ecologists have at their disposal a powerful arsenal of analytic methods including ordination, classification (clustering), and regression. In particular, the triad of nonmetric multidimensional scaling, hierarchical clustering, and Mantel tests are appealing because they proceed from the same dissimilarity matrices and hence are computationally complementary. But extending these methods to landscapes can be confounded by the logistics of sampling with fine grain over large spatial extent. As a result, correlative models based on sparse data from heterogeneous landscapes may be overfitted and misleading. I present a multi-phased approach in which correlative models are iteratively built and then attacked at their uncertainties, by locating new field sampling locations to generate the data needed to resolve these uncertainties. This approach involves a combination of the triad of methods (above) in conjunction with regression trees that map model uncertainties into geographic space using a GIS. I illustrate the approach using data on forest pattern in the southern Sierra Nevada.

Vanucchi-Hartung, Jamie. Department of Landscape Architecture, Cornell University, Ithaca, NY 14850, USA. **Landscapes, Process and Time: Past and Future in the Present.**

Site complexities are too often oversimplified by reductionist methods of site analysis typically employed by landscape architects. Analysis by reduction yields a false sense of understanding, leading to site interventions that fail to produce meaning true to place and process. It is my contention that our typical methods of analysis focus heavily on current site conditions while neglecting two essential site events: process and time. Any site is a product of a series of particular past events where site conditions and process interacted to inform and transform the other. In the present there is also the sense of becoming—patterns and process give cues to the future. I propose a method of site comprehension where process and time are emphasized and revealed in site patterns. The proposed method is applied to a site in the Catskill Mountains of New York, where a "natural" site condition is in reality the product of extensive modification by the actions of humans. Human and non-human events exist as landscape ghosts, no longer present while their influences persist. Processes of varying temporal and spatial scales overlap and interweave to produce patterns of complexity. In this complexity the essence of a site reveals itself as a mysterious and wonderful mosaic of the past, present and future.

Wagner, Helene H.,[1] Jonathan M. Bossenbroek,[1] Michelle M. Hawks,[1] Beatrice Van Horne,[1] and John A. Wiens.[2] [1]Department of Biology, Colorado State University, Fort Collins, CO 80523, USA; [2]National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101, USA. **Spatial Covariance in Plant Communities: An Integration of Variogram Modeling, Multi-Scale Ordination and the Testing for Assembly Rules.**

Spatial structure in plant communities occurs in the forms of (1) species-specific aggregation patterns (auto-correlation), (2) distance-dependent interaction between species (cross-correlations), and (3) the spatial structure of environmental conditions (trend). Different methods deal with these different components of spatial variation: geostatistical analysis reveals autocorrelation in a spatial sample; ordination techniques describe multi-species response to environmental factors; and the variance of quadrat species richness has been used as an indicator for interspecific interactions in the search for community assembly rules. Based on the mathematical properties of presence-absence data we show how variogram modeling, multi-scale ordination and the testing of interspecific associations can be integrated by using the same set of distance-dependent variance-covariance matrices. We thus provide a framework for partitioning spatial covariance and for factoring out specific components of spatial covariance. Furthermore, this mathematical approach greatly increases the interpretability of variograms of plant communities, extends multi-scale ordination to non-systematic spatial samples, and provides a spatial extension and an empirical null-model for the variance test of species richness.

Wainger, Lisa A. and Dennis M. King. University of Maryland, Center for Environmental Science, CBL, Solomons, MD 20688, USA. **Linking Environmental Indicators to Socio-Economic Indicators to Communicate Trade-Offs.**

We are designing a system where regional environmental resources are viewed as an asset portfolio to be managed for risk. Our analysis examines the trade-offs between land conversion and the maintenance of ecosystem services necessary to meet environmental and economic goals. By examining the services that are of particular importance to the economy or character of a region, we emphasize issues central to maintaining essential or preferred services of communities. Using a landscape-based approach, we link changes in environmental resources with their consequences in terms of changes in or risks to valued ecosystem services. We use two main approaches: 1) Develop a suite of spatial risk indicators that will show where projected changes in environmental resources are likely to produce costs or hardships due to dominant economic activities or other socio-economic conditions; 2) Employ regional economic models to evaluate the economic effects of investments in (e.g., preservation or restoration) and use of ecological resources under projected land-use change. Our approach will consider variables reflecting quality of life, resource pressure and the levels of risk management by governments. Quality of life will be reflected in indicators of access to resources and of projected changes in household spending to accommodate resource change (e.g., increased costs of water filtration, commuting times). Resource pressure indicators will aim to gauge the efficiency of resource use. Risk management indicators will evaluate management activities that act to minimize disruption of ecosystem services (e.g., greenway preservation incentives).

Waser, Nickolas M. Department of Biology, University of California, Riverside CA 92521, USA. I**solation and Low Density: Two Effects of Fragmentation on Plant Populations, and Their Implications for Pollination by Animals.**

Natural or anthropogenic fragmentation of habitats is expected to increase the isolation of plant populations from each other, reduce population sizes, and decrease local population densities. Separately or in concert these changes in population attributes may influence plant reproduction through changes in the quantity or quality of pollination services. Experiments with herbaceous montane plants suggest that bumblebee and hummingbird pollinators will fly relatively long distances among population isolates, effectively connecting them as a metapopulation in terms of pollen dispersal. However, overall pollination success is reduced in isolates, and might have been reduced even further if other flowers acceptable to these generalist pollinators had been abundant in intervening landscape elements. Additional experiments suggest that the rate of pollinator visitation to flowers sometimes declines as population density is reduced, and seed production sometimes declines as well, but these results are not universal and vary with pollinator species and ecological context. To reach predictive generalizations about fragmentation and pollination success, it will be most profitable to begin with a solid focus on pollinator foraging behavior and how this is adapted for a complex mosaic of landscape elements and of diverse flowers distributed within elements.

Washington-Allen,[1,2] Robert A., Neil E. West,[1] R. Douglas Ramsey,[3] and Carolyn T. Hunsaker.[4] [1]Department of Rangeland Resources, Utah State University, Logan, UT 84322, USA; [2]Environmental Sciences Division, Oak Ridge National Laboratory, MS 6407, Oak Ridge, TN 37831, USA; [3]Remote Sensing/GIS Laboratory and Department of Geography and Earth Resources, Utah State University, Logan, UT 84322, USA; [4]USDA Forest Service, Pacific Southwest Research Laboratory, Fresno, CA 93710, USA. **A Dynamical Systems Perspective on Being Dried, Eaten, and Burned: What Is a Semi-Arid Landscape To Do?**

A 27-year retrospective study (1972 to 1998) was conducted for determining the ecological integrity of a sagebrush steppe landscape using multi-temporal Landsat satellite imagery. Landscape integrity was measured using ecological indicators of change in vegetation response, landscape pattern and composition, and soil erosion. Objectives of the study were 1) to characterize the historical trajectory of the ecological indicators and 2) postdict their response in relation to grazing, fire, and climate change. The research hypotheses were that land degradation is indicated by a declining vegetation index trend, increased landscape fragmentation, encroachment by shrubland, phase transitions from depositional to erosional states, and abrupt changes at thresholds characterized by coincident high grazing and drought conditions. Dynamical systems analysis was used to characterize the historical response of indicators. Linear regression, curve-fitting, timeseries analyses, and catastrophe theory were used to relate indicator response to constraints. We found that 1) sagebrush steppe was an unstable limit cycle that was linearly constrained by climate and non-linearly by herbivory; 2) in the early 1970s woody encroachment initially increased but then stabilized after 1973; 3) grassland cover was slightly decreasing in riparian areas, 4) the landscape was fragmenting, but a trajectory of connectivity was evident in the late 1990s; 5) the soil erosion trend was stable for SSI suggesting no soil loss in the 27-year period; and 6) low vegetation response was coincident with high stocking rates and drought, but recovery was affected as a function of El Niño events and changes in grazing-management.

Weber, Whitney L., John L. Roseberry, and Alan Woolf. Cooperative Wildlife Research Laboratory, Southern Illinois University, Carbondale, IL 62901, USA. **Contribution of the Conservation Reserve Program to General Landscape Structure in Illinois.**

The Conservation Reserve Program (CRP) has been converting environmentally sensitive acreage from agricultural production to semi-permanent vegetative cover since 1986. Agriculture comprises > 80% of overall land use in Illinois and CRP could have a profound impact on both landscape composition and structure. We recorded geographical locations and associated attribute data for all CRP fields within 11 selected counties in west-central and southern Illinois. Locations of CRP fields recorded on 1:12,000 scale black and white aerial photographs were used to create digitized land-cover images on county maps in ArcView (Environmental Systems Research Institute (ESRI), Redlands, CA USA). Landscape metrics were quantified using the spatial analysis program FRAGSTATS. CRP land tended to be situated in heterogeneous landscapes characterized by small patches, greater edge density and diversity, and consequently greater fragmentation. Proportion of grassland and woodland habitats increased as cropland was removed from production. In addition, enrollment in CRP generally resulted in larger patch size and decreased edge and patch density. These results suggest CRP has the potential to increase habitat for species requiring larger core areas of grassland and woodland, but may be detrimental to edge dependent species.

Weller, Donald E., Thomas E. Jordan, and David L. Correll. Smithsonian Environmental Research Center, Edgewater, MD 21037, USA. **Effects of Riparian Buffer Configuration on Nutrient Inputs to Streams.**

Nutrient losses from the land impact aquatic ecosystem processes, particularly where human activities elevate land discharges. Riparian buffers can moderate such impacts by intercepting nutrients lost from uphill ecosystems. The spatial distribution of riparian buffer and its nutrient retention function interact to control on the linkage of terrestrial and aquatic systems through nutrient transfers. We have studied the effects of riparian buffers on nutrient discharges with several methods applied at different spatial scales. Sampling nutrient concentrations along transects through riparian forests has shown strong filtering effects, and riparian forests can retain 90% or more of the sediment, nitrogen, or phosphorus transported in surface or groundwater. Analysis of mathematical models documents how the pattern of buffer distribution interacts with buffer function to yield overall landscape discharge. Where the buffering function in consistently effective, variation in buffer width and the frequency of gaps in the buffer are critically important to nutrient discharge. Model analysis also categorizes and quantifies errors in understanding or predicting nutrient discharge that arise from not correctly accounting for the presence and function of riparian buffers. Some field studies demonstrate that riparian buffers are ineffective filters when bypassed by deep groundwater flow or concentrated surface flow. These complexities, along with inadequacies in stream and land-cover maps, confound efforts to relate the presence and configuration of riparian buffers to stream water chemistry at watershed and regional scales.

Welter, Jill R., Stuart G. Fisher, Julia C. Henry, and John D. Schade. Department of Biology, Arizona State University, Tempe, AZ 85287, USA. **Nutrient Transport and Processing in the Uplands and Intermittent Drainage Network: Linking Terrestrial and Aquatic Ecosy**stems.

In the Sycamore Creek watershed in Arizona, only 10% of annual atmospheric nitrogen inputs to the watershed are exported in streamflow. In this nitrogen-limited system, where is the missing nitrogen and which components of the landscape are responsible for its retention? We investigated the role of the terrestrial uplands, which are variable in topography and vegetative cover, as well as the network of intermittent rills and channels that hydrologically link the terrestrial landscape with perennial streams during storms. Storm size and intensity are extremely variable in the Southwestern U.S. and therefore, characteristics of individual storms may influence where and by what mechanism nutrient retention occurs. Results show that small storms (<0.5 cm) wet the desert uplands and generated some overland flow, but did not hydrologically connect the terrestrial landscape with the intermittent stream network. Soil nitrogen storage varied with topography, with highest storage occurring within vegetated patches, and sites with low relief. As storm size increased, the extent of surface flow in the channel network increased. Only the largest storms generated flow in high order channels and during the 2000 monsoon season, only one storm (2.9 cm) resulted in flooding in Sycamore Creek, the largest channel in the catchment. Results suggest that storms interact with the landscape, wetting and "activating" different parts of the landscape in relation to storm size and intensity. During most of the year retention of atmospheric nitrogen is confined to the terrestrial landscape, while only large storms result in transport of nitrogen to the aquatic components of the watershed.

Wickham,[1] J., E. Smith,[1] R. O'Neill,[2] T.Wade,[1] K. Riitters,[3] K. Jones.[4] [1]National Exposure Research Laboratory, EPA, RTP, NC 27711, USA; [2]Oak Ridge National Laboratory, Oak Ridge, TN 37830, USA; [3]Forest Health Monitoring Unit, Forest Service, RTP, NC 27709, USA. [4]**National Exposure Research Laboratory, EPA, Las Vegas, NV 89119, USA.** **Propagating Nutrient Export Risk Across Watersheds.**

The disciplines of landscape ecology and ecological risk assessment emerged at about the same time. A focus of landscape ecology is the movement of biota, water, and energy across the horizontal (x,y)plane. Ecological risk assessment focuses on methodologies for predicting the likelihood of an event (e.g., local extinction). The two disciplines can be linked by moving risk in the x,y plane. We present a model of nutrient export risk that is based on relationships between nutrient export and land cover that are well documented in the literature. We then accumulate the risk in downstream watersheds based on in-stream nutrient decay relationships developed for modeling the processes denitrification and sedimentation. Initial results suggest that nutrient export risk accumulates quickly in downstream watersheds, and reducing that risk is best optimized by afforestation of downstream not upstream watersheds.

Wiens, John A. National Center for Ecological Analysis and Synthesis, University of California Santa Barbara, Santa Barbara, CA 93101 and Department of Biology, Colorado State University, Fort Collins, CO 80523, USA. **Looking Ahead by Looking Back: What Are the Central Issues of Landscape Ecology?**

It isn't clear whether the number of central issues in a discipline increases or diminishes as the discipline grows and matures. One might think that some issues would be resolved, but as we accumulate new knowledge or develop new theories, new issues may emerge. From time to time over the past two decades, prominent landscape ecologists have identified what they considered to be the primary issues. I'll draw on this historical perspective to develop a set of current issues that demand our attention. The degree of concordance between this list and those presented previously may be an indication of whether we're making real progress, or simply restating or refining the same old issues with new technologies and terminologies.

Wiens,[1] John A., Helene H. Wagner,[2] Michelle M. Hawks,[2] Jonathan M. Bossenbroek,[2] and Beatrice Van Horne.[2] [1]National Center for Ecological Analysis and Synthesis, Santa Barbara, CA 93101, USA; [2]Department of Biology, Colorado State University, Fort Collins, CO 80523, USA. **Changes in the Structure of Grassland-Dominated Landscapes along a Precipitation and Productivity Gradient in the Central plains.**

Cross-site comparisons are often used to understand how ecological patterns and processes vary with environmental conditions. Sites are often contrasted in terms of differences in the mean values of environmental factors, assuming that their spatial structure remains constant. We examined changes in the nature and the scale of landscape patterns along a transect from the Shortgrass Steppe LTER in eastern Colorado to the tallgrass prairie at the Konza Prairie LTER in eastern Kansas. For each grassland in a random sample of grasslands along this transect, we performed moving window analysis of 30-m resolution spectral bands (Landsat 7). Multi-scale ordination revealed that both the relative importance of PCA factors and the scale of their pattern of variation changed systematically along the transect. We conclude that cross-site comparisons should consider not only changes in the mean of environmental factors, but also their spatial structure.

Wilkerson, Cynthia R. Department of Wildlife Ecology and Conservation, University of Florida, Gainesville, Fl 32611, USA. **Isolated Temporary Wetlands as Prey Refugia for Anuran Communities.**

Classic island biogeography theory predicts that presence of near, connected patches in close spatial proximity are best for maintaining viable metapopulations. However, in some systems with spatially and temporally asynchronous dynamics in herbivore-plant and predator-prey relationships, isolated patches may play a key role in persistence of species assemblages at the landscape scale. This research investigates the importance of isolated, temporal wetlands of north-central Florida for viable anuran communities. My hypothesis is that isolated temporary wetlands function for these species as refugia from predation by aquatic insects. The field experimental design consists of eight mesocosms arrays. Each array includes three mesocosms at 10m, 100m, and 500m distances from a natural source pond. Response variables are identity and timing and species of adult and larval aquatic insects that are potential predators of anuran larvae. Preliminary results indicate that a longer predator-free period exists in more isolated mesocosms. Field results will be combined with anuran and aquatic insect natural history data to develop a spatial model that will relate relative wetland isolation to anuran productivity. This project is an attempt to incorporate predator-prey relationships into a spatial analysis of community-level habitat dynamics.

Willems, Geert P.A., Wim G. M. van der Knaap, and Catharinus F. Jaarsma.*
Department of Environmental Sciences, Land-use Planning Group,
Wageningen University, Generaal Foulkesweg 13, 6703 BJ Wageningen, The
Netherlands. **Planning within Heterogeneous Landscapes: Confronting the Patterns of Movement and Processes in Time and Space of Man and Animal.**

Landscapes are being used more intensively than ever before. This is especially true for those landscapes around cities. The result is the need for a proper and adequate planning of the rural-urban interactions that occur within such intensively used areas. In this paper we will focus on planning measures, based on both patterns of movement and underlying processes of time and space from the perspective of both fauna and recreationists. The rural surroundings of a city often provide a suitable setting for many different outdoor recreational activities. However many animals, in search of their daily food and a resting-place, use these same rural surroundings. Both movement patterns of man and animal can cross paths with each other. The results are often disturbances that can negatively affect the animal. With the geographical time-space analysis (Hägerstrand- approach) one can visualize time-space behavior of people. This human-based approach has already been applied for various subsets of people, like recreationists. Here we have extended the approach to movement patterns in time and space of animals. Next, confronting both patterns of man and animal, we will focus on the conflict-situations that occur either in time, in space or both. Based on the results, any related constraints become apparent and can be addressed by specific planning of mitigating measures. This procedure can be repeated for different scales (in time and space), landuses and species. Both GIS and 3D presentations herewith provide useful tools to customize and further develop this approach. Examples will be used to illustrate several aspects of this approach.

Wilmer, Henry. The Wilderness Society, Center for Landscape Analysis, 1424
4th Ave. Suite 816, Seattle, WA 98101, USA. **Effects of Fire and Logging on Landscape Structure in the Greater Yellowstone Ecosystem.**

Ecologists have recognized disturbance as an important driver of spatial patterns in a landscape and the composition of its species. Wildfire in particular has received special attention as a recurrent, ubiquitous disturbance that has greatly influenced the structure of Rocky Mountain forest ecosystems. However, in recent decades, staggered-setting clearcut logging has altered the spatial and temporal characteristics of historic landscape patterns driven by fire. Increasingly, landscape ecologists are using patterns of natural disturbance as a guide for ecosystem management. My study area in the Greater Yellowstone Ecosystem (GYE) contained patterns of intensive logging in the Targhee National Forest (TNF) directly adjacent to patterns resulting from wildfire in 1988 in Yellowstone National Park (YNP). To compare these disturbance types, I tested hypotheses at two scales. At the landscape scale, spatial patterns of clearcuts and wildfires were subsampled at various extents and quantified using landscape metrics. A finer-scaled field study focused on post-disturbance biological legacy within stands. Results indicate that clearcutting fragmented forests more than wildfire. Furthermore, multi-scaled frequency distributions of 9 landscape metrics revealed thresholds in scaling effects for each disturbance type. The field study demonstrated that clearcutting is a more severe disturbance type than wildfire. These differences between clearcutting and wildfire at both the landscape and stand scales have important ecological consequences for the natural fire regime. Spatially explicit fire simulations indicated that clearcutting disrupts the natural disturbance regime. Recognizing this important consequence, timber harvest strategies can be developed that better mimic natural landscape patterns and sustain levels of biodiversity.

Wimberly, Michael C. and Janet L. Ohmann. USDA Forest Service Pacific Northwest Research Station, Corvallis, OR 97331, USA. **Spatial Patterns of Forest Landscape Change in the Oregon Coast Range between 1936 and 1996.**

Forest landscapes in the Douglas-fir region of western North America have changed considerably since the early twentieth century. Fires and timber harvesting have reduced the amount of old growth in the landscape, leading to concern for the survival of native species associated with late-successional habitats. Quantitative assessments of these landscape transformations are needed to measure the amount of change, and to elucidate the processes that drive landscape dynamics. Our study examined changes in the proportion of forest seral stages in the Oregon Coast Range between 1936 and 1996. A map of forest composition and structure in 1996 was derived from Landsat TM imagery and environmental GIS data using the Gradient Nearest-Neighbor (GNN) technique. The 1996 map was reclassified and rescaled to match forest types mapped in a 1936 survey of forest vegetation in western Oregon and Washington. Changes in the relative proportion of major forest types were summarized for the entire Coast Range (30,900 km2), and for 13 subbasins (1600-3600 km2). The overall trend was a decrease in percent cover of large conifer forest types (47%-12%), and a corresponding increase in early-successional and small conifer forest types (51%-86%). Subbasins dominated by private lands had the greatest decreases in large conifer forest types, whereas subbasins dominated by federal and state lands exhibited smaller declines (R2>=0.54). Results support our working hypothesis of a widespread decrease in late-successional forests over the past 60 years, and suggest that land ownership is a strong predictor of the regional pattern of forest landscape change.

With,[1] Kimberly A. and Anthony W. King.[2] [1]Division of Biology, Kansas State University, Manhattan, KS 66506, USA; [2]Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA. **The Effect of Landscape Structure on Critical Biodiversity.**

Critical biodiversity is the level of species richness at which communities are most susceptible to perturbation, where even a small perturbation may trigger mass extinction. Beyond this threshold, species spontaneously form ordered communities with well-defined spatial structure and mass extinctions no longer occur. Do communities naturally evolve to the critical biodiversity point? We adopted a complex systems approach to explore how landscape pattern affected the critical biodiversity threshold (Sc) and the ability of communities to self-organize in heterogeneous random and fractal landscapes. Fractal landscapes with high spatial contagion (H = 0.5, 1.0) were characterized by an early explosion of diversity, which quickly collapsed but produced sufficient novelty in species types that community organization occurred more rapidly and predictably than in random landscapes. For example, communities that evolved in random and clumped fractal (H = 1.0) landscapes had nearly the same average richness (random S = 22.0, fractal S = 20.5; n = 15 landscapes each), but the range of variation among evolutionary trajectories was 3x greater in random landscapes (random CV = 66%, fractal CV = 21%). Critical biodiversity increased in landscapes with high spatial contagion (random Sc = 15; clumped fractal Sc = 20) and there was a striking tendency for communities on clumped fractal landscapes to evolve to the critical biodiversity threshold. Spatial structure is not a prerequisite for the emergence of community structure, but organized communities are inevitable in highly structured landscapes. Order begets order and this order reduces the susceptibility of communities to local perturbation and the likelihood of mass extinction.

Wolf, Joy J. Department of Geography, University of Wisconsin–Parkside, Kenosha, WI 53141, USA. **Effects of Prescribed Burning as a Control for Exotic Invasion in Rocky Mountain National Park Grasslands.**

Natural disturbance regimes are key elements of vegetation patterns and dynamics, and maintain heterogeneity in natural plant communities. Exotic invasion, often fostered by disturbance created by humans and altered natural disturbance regimes, has led to a change in resource availability and species composition in many grassland communities. In Rocky Mountain National Park, montane grasslands invaded by *Melilotus officinalis* and *M. alba* invasion had less native, grass and perennial species, more exotic, forb and annual species and less available nitrogen, net mineralization and soil moisture compared to non-invaded grasslands. In order to test the restoration of species composition and nitrogen availability in invaded grasslands and control *Melilotus* invasion, I employed a prescribed burn experiment. I burned field plots in invaded and control patches. Fire eliminated *Melilotus* species throughout the season, increased the number of native, grass and perennial species in invaded patches, facilitated the germination of new species, and temporarily increased available nitrogen. This experiment assessed the competitiveness of native species on *Melilotus* species and the role of disturbance regimes in exotic invasion. The application demonstrated that *Melilotus* species' ability to invade grasslands may be influenced by fire as a natural disturbance.

Woodward, Joan and Kyle Brown. Department of Landscape Architecture, California State Polytechnic University, Pomona, CA 91768, USA. **Patterns of Perseverance: Thirty Years of Ecological Planning in Los Angeles.**

Cal Poly Pomona's Graduate Program in Landscape Architecture has produced over 100 client-funded plans that propose improvements to ecological function in highly stressed urban or urban fringe areas, with over fifty projects located within the Los Angeles region alone. Plans typically address watershed management issues, such as habitat connection and restoration, park and recreation system creation or rehabilitation, and regeneration of resources, such as water treatment and harvesting. This paper examines three points relative to this accomplishment. First, it considers the cumulative effects from this body of planning and evaluates whether or not their shared goals and common ethic have produced plans that effect measurable attributes, ie. landscape connectivity. Second, whereas landscape ecological principles are most useful in analyzing issues and proposing alternatives at coarser scales, planning in the public realm requires a finer scale approach for effective implementation; this favors landscape planning based on a "cumulative" approach guided by common principles derived from a comprehensive, regional approach. Third, universities, as important service-oriented institutions within the community can significantly effect change within a region; departments should be encouraged to examine net results from student and faculty projects to understand, coordinate, and demonstrate their beneficial and persistent influence.

Wu, Jianguo. Department of Life Sciences, Arizona State University West, Phoenix, AZ 85069, USA. **Effects of Changing Grain Size and Extent in Landscape Characterization and Pattern Analysis: Generalities and Idiosyncrasies.**

Spatial heterogeneity is ubiquitous in all landscapes and often exhibits scale multiplicity and dependence. The relationship between pattern and scale is a central issue in ecology. In particular, understanding the dynamics of spatial heterogeneity and its ecological consequences is a major goal of landscape ecology. In this paper, we ask the following questions: How is spatial pattern related to the scale of analysis (grain and extent) in different landscapes? Are there general scaling rules for the spatial pattern of landscapes? Our results show that landscape metrics respond to changing grain size rather differently, and these changes are reflective of the modifiable areal unit problem (MAUP) as well as multiple-scale structures in landscape pattern. The direction of analysis also may have significant effects on the result of pattern analysis as the extent is changed. Some aspects of landscape pattern exhibit consistent, predictable patterns over a wide range of grain size or extent, suggesting general scaling functions, whereas others have nonlinear, apparently unpredictable response curves. We also discuss the implications of these results for landscape analysis and present recommendations for the proper use of pattern indices.

Wu, Jianguo. Department of Life Sciences, Arizona State University West, Phoenix, AZ 85069, USA. **Top 10 List for Landscape Ecology in the Twenty-First Century: Introduction.**

In the past 20 years we have evidenced a rapid and exciting development of landscape ecology in theory and practice worldwide. As a new century begins to unfold, it is appropriate and timely to reflect the major achievements that have been made so far and identify the most important issues and challenges that lie ahead. Therefore, at the special session, "Top 10 List for Landscape Ecology in the 21st Century", a group of leading landscape ecologists are invited to present their top 10 lists in landscape ecology in the 21st century. Hopefully, these lists together are indicative of the most important questions, challenges, and directions in theory and practice of landscape ecology. In addition to 10 presentations, several other ecologists worldwide will contribute to this special session by submitting their top 10 lists by mail. I will summarize all the mail-in contributions in the introduction to the session.

Wu, Wanli. School of Natural Resource Sciences, University of Nebraska-Lincoln, Lincoln, NE 68583, USA. **Scales and Processes of Flow Regime, Hydrologic Connectivity, and Riverine Landscape Patterns on Braided River Floodplains.**

Floodplains of braided rivers contain dynamic interactive pathways and heterogeneous landscape patterns. Natural hydraulic regimes such like flood pulses create diverse riverine aquatic and riparian habitats and sustain hydrologic connectivity among braided channels, backwaters, riverine wetlands and wet meadows across the broad floodplains. In highly regulated river systems, declined hydrologic fluctuation by dams and irrigation diversions, bank stabilization, and lowland cultivation reduces degree of hydrologic connectivity and interactions between the river flow and the riverine habitats. Understanding riverine landscape patterns associated with hydrologic processes is essential for conservation of river ecosystem. Hydrologic connectivity among riverine habitat patches, as a key control factor for ecological processes and landscape patterns, has hierarchical characteristic and distinguished temporal changes. The spatial-temporal dynamics of the hydrologic connectivity is natural driving force of biodiversity on the braided river floodplains. Thus, strategy of biodiversity conservation in braided river system should be shifted from focusing restoration efforts on protecting individual species to sustain or create capable and efficient hydrological connectivity, so that the river itself may structures its braided flow system and maintains hydrologic and ecologic interactions among the riverine landscape components. To facilitate analysis of hydrologic features of riverine landscape in response to river discharges, I developed a series of spatial explicit models, coupled with hydrologic statistical models at different spatial scales. A case study of the Middle Platte River in Nebraska demonstrates how human regulating instream flow as disturbance may affect the relationships of the pattern-process of the riverine landscape on the braided floodplain.

Wu,[1] X. Ben and Daniel Z. Sui.[2] [1]Department of Rangeland Ecology and Management, Texas A&M University, College Station, TX 77843, USA; [2]Department of Geography, Texas A&M University, College Station, TX 77843, USA. **Exploring Urban Residential Segregation Using a Lacunarity-Based Measure.**

It has been recognized that urban residential segregation is a scale-dependent phenomenon, and yet all existing structural or spatial indices measure only certain dimensions of segregation at one single-scale. Inspired by new metrics developed by landscape ecologists to measure landscape heterogeneity, this paper explores the feasibility of a multi-scale, lacunarity-based segregation measure. We also developed a straightforward GIS-based procedure to calculate this measure. Our initial simulation results show that lacunarity is an effective measure that can capture multiple dimensions of segregation patterns at multiple scales. We tested our method using the census tract level data for the city of Houston between 1980 and 1990. Our preliminary results show a significant decline of segregation by both race and class in Houston during the 1980s, but segregation by race is far more important in magnitude across scales than segregation by class. Our case study in Houston calls for a revision of the Wilson hypothesis.

Wunneburger,[1] D. F., R. N. Coulson,[2] S. T. O'Keefe,[2] and S. B. Vinson.[2]
[1]GeoInformatics Studio, College of Architecture, Texas A&M University, College Station, TX 77843, USA; [2]Knowledge Engineering Laboratory, Department of Entomology, Texas A&M University, College Station, TX 77843, USA. **Hazard and Risk Rating Post Oak Savanna Landscapes for the Red Imported Fire Ant.**

In this study we investigated the spatial and temporal distribution and abundance of the red imported fire ant (RIFA), *Solenopsis invicta*, in a representative post oak savanna landscape. Fire ant mounds, occurring within the different patches that form the landscape mosaic, were used to characterize populations. The basic types of terrestrial patches include variations of woodlands, agricultural fields, and grasslands. The relative suitability for of each patch type for the RIFA was defined. These data were used to develop both hazard and risk maps. The hazard maps illustrate which landscape elements are most suitable for the ant and the risk maps identify temporal variation in suitability.

Xu, Ming, Qinghua Guo and Ye Qi. Department of Environmental Science, Policy and Management, University of California, Berkeley, CA 94720, USA.
Detecting Spatial Patterns in a Young Ponderosa Pine Plantation Using 0.5 m Resolution Digital Imagery.

The spatial pattern of canopies in a forest ecosystem is critical to ecosystem functions because the overstory canopy controls the redistribution of solar energy to other ecosystem components. The spatial pattern of major underground ecological processes has been rarely studied due to the difficulties of the direct measurement of underground processes. Using a 0.5m resolution digital imagery and geostatistic analysis we find that the range value of the semivariogram from the digital imagery is the average canopy size and the periodicity of the semivariogram is the summation of the average canopy size and average gap size in a nine-year old ponderosa pine plantation in the Sierra Nevada Mountains, California. We also find that the underground ecological processes, such as soil respiration and temperature, present the same spatial patterns as the aboveground canopies. The semivariograms of soil respiration and temperature demonstrate the same range and periodicity as those from the digital imagery. Our results suggest that it may be possible to examine the spatial patterns of underground ecological processes through remote sensing.

Yamashita, Sampei. Department of Civil Engineering, Kyushu Sangyo University, Fukuoka, Japan. **Attractiveness of a Wooded River Landscape and Changes in Its Colors in the Daytime.**

The woods and trees along a river play an important role in mitigating flood damage, restoring and purifying river water, and providing water birds and aquatic animals with food and habitats. In addition to these objective qualities, trees have the subjective, aesthetic quality of enhancing the attractiveness of a river landscape by casting their shadow across the water. This study takes landscape colors into consideration and evaluates the attractiveness of a wooded river landscape in a rural area of Japan by using the method of paired comparisons. Photographs of the landscape are taken and colors of its major elements are measured from different viewpoints at different times. After the most preferred viewpoint is determined, the relationship between preferred landscape images and apparent colors of the landscape elements is examined. Preference of a landscape image is primarily affected by the value and chroma of the landscape elements relatively close to the viewpoint—woods, its shadow on the water, and its reflection in the water. The value and chroma of both relatively distant mountains and the reflection of the sky on the water are also relevant to the preference of the image. The results can give us information about how to design and preserve valuable woods along rivers.

Yemshanov, Dennis and Ajith H. Perera. Ontario Forest Research Institute, 1235 Queen St. E., Sault Ste. Marie, Ontario, Canada P6A 2E5. **Modelling Boreal Forest Landcover Dynamics After Fire Disturbance: A Markovian Approach.**

We describe a large-scale spatially explicit simulation model of postfire landcover changes in North American boreal biome. This model is a time-dependent Markov chain with discrete states of succession corresponding to dominant tree species in forest canopy. The period of species persistence in canopy and their extinction rates constitute temporal variables used in the model parameterization. Probabilities of forest cover transition are stratified spatially by geoclimate, moisture and edaphic gradients and are organized in a decision-tree. The model is spatially explicit, using GIS data layers of forest cover composition, time since last forest cover transition, time since last catastrophic fire, geoclimate, soil moisture regime and soil nutrient status. The model output constitutes GIS layers of time since last fire disturbance, transition age, forest cover composition, and canopy age for every 10-year time step of simulation at 1 ha resolution. As a case study, we simulated post-fire forest cover transitions in a 3.7 million ha region in northern boreal Ontario, Canada. The results showed that the dependency of transition processes on site conditions (moisture and geoclimate) is higher than on time since last forest cover transition or fire disturbance. Also, we estimated the trend of post-fire change of forest cover over 200 years: a decline of pioneer forest cover types and their replacement by late-successional tree species exceeded 10 times the average replacement rate of forest cover in the study region.

Yokohari, Makoto, Takashi Watanabe, and Takashi Hirohara. University of Tsukuba, Tsukuba, Ibaraki, 305-8573, Japan. **Restoring Ecological Relationships between Urban and Rural Landscapes: A New Ecological Planning Concept for Asian Mega-Cities.**

The explosive post-war growth of Asian mega-cities has resulted in serious environmental problems including air and water pollution and insufficient urban infrastructure. The rapid growth has also produced a disordered mixture of urban and rural landscapes at the fringe of these mega-cities. Western urban planning concepts including greenbelts and zoning have been ineffective in managing urban growth. Through historical spatial analysis, a distinct "micro-juxtaposition" pattern of urban and rural landscapes was identified. This pattern informed a planning concept for landscape ecological-based urban planning for these mega-cities. In the concept, the ecological functions of farmland and woodland, including water retention capability, micro-climate control and the conservation of visual quality of the area, are regarded as the key functions for the restoration of contemporary urban landscapes. Case studies of this ecological planning concept are made to the urban fringe areas of Tokyo, Japan. The concept is proposed as a model for 21st century urban planning for Asian meg-cities.

Zebisch,[1] Marc, Hartmut Kenneweg,[1] Valentina Krysanova,[2] and Frank Wechsung.[2] [1]Institute for Landscape Development, Technical University Berlin, Germany; [2]Potsdam Institute for Climate Impact Research, Germany.
Landscape Responses to External Driving Forces in Brandenburg, Germany.

Global change, reflected in a modified EU agrarian policy, may influence the future land-use pattern across Europe. Three districts in the state of Brandenburg (East Germany) were selected to investigate the impact of land-use changes on landscape quality represented by biodiversity and landscape aesthetics. Initially two sets of future land-use pattern were created: the first one realized a pattern according to predicted trends in agriculture and forestry, which were obtained by agro-economical simulations. The second set contained conversion patterns along these trend in a range from zero to hundred percent. The pattern generation was performed by rule-based decision approaches as well as by statistical classification methods. The resulting sets of land-use patterns were evaluated in respect of the landscape qualities biodiversity and landscape aesthetics. It was assumed, that both landscape qualities are related to internal as well as to spatial attributes of the patches and of the patch composition. While internal attributes were assessed by rule-based systems, spatial attributes were investigated using landscape metrics, calculated with FRAGSTATS and other spatial evaluation methods. The sum of single indices was merged to a set of attributes related to biodiversity and landscape aesthetics. Finally the sensitivity of landscape qualities towards land-use change was summarized in partial response function towards land-use change. This supplements the statements about the impact of the predicted changes according to the agro-economic scenarios.

Zhang, Huayong. Center of Eco-Environmental Sciences and Institute of Botany, Chinese Academy of Sciences, Beijing, P. R. China. **Vegetation Pattern and Climatic Conditions: A Statistical Thermodynamics**

The relationship between vegetation pattern and environmental factors has long been a central issue in ecology, and is particularly important to the study of structure and functioning of landscapes. Early seminal works in the formation and distribution of plant communities by ecologists, notably Frederic E. Clements, Henry A. Gleason, John Curtis, and several European geobotanists, laid an extremely important empirical foundation necessary for understanding the relationship between vegetation and climate. However, to a large extent it was Robert H. Whittaker's gradient-based approach and community-ecosystem integrative framework that most effectively synthesized diverse views, leading to a general and comprehensive theory of large-scale vegetation pattern which has influenced the thinking of generations of ecologists worldwide after him. However, this general theory is basically an empirical and inductive one that was gradually formed by accumulating and distilling numerous factual studies. In recent decades, with considerable success attempts have been made to identify environmental factors and mechanisms that are responsible for vegetation formation and distribution. Yet, a general deductive theory that can quantitatively predict large-scale vegetation pattern is still lacking. If the goals of science are understanding and prediction, developing such theories has to be satisfactory and rewarding. In this paper, we develop such a theory based on statistical thermodynamics and ecological principles. Based on the general understanding that evapotranspiration is closely correlated to vegetation pattern over large spatial scales, we assume that the amount of entropy "pumped" into the environment by a landscape through evapotranspiration approximates the total loss of entropy of the landscape system. According to the Boltzmann equation, we have derived a statistical thermodynamic model to describe the formation and distribution of vegetation pattern at regional or global scales. The index, 1/w, which is a function of the area of the ecological system and the efficiency of exporting entropy from the ecological system by evapotranspiration, can be used to indicate the degree of "order" in the vegetation pattern. By analyzing the mathematical properties and ecological meanings of this statistical thermodynamic model, some interesting general properties of vegetation patterns become apparent. The model predicts that for a landscape to maintain a persistent vegetation pattern, it must be larger than a minimum area which can be estimated using the model. The model also predicts how climatic conditions (temperature and moisture) determine the complexity and degree of order of landscape pattern. For a given landscape, the model can be used to predict how its vegetation pattern, as a system property, when climatic conditions change. Our model can serve as a uniform theoretical framework that describes the order and complexity in large-scale ecological patterns and the critical conditions of phase transitions in the formation and evolution of these patterns. To test this validity of the model, we have generated a map of world biome types in relation to mean annual temperature and mean annual precipitation, and compared it with the empirical global biome map by R. H. Whittaker (1975). The model predicted map agreed with the empirical map remarkably well at the global scale.

Zhang, Jiahua and Hiroshi Kanzawa. Atmospheric Environment Division, National Institute for Environmental Studies, Tsukuba, Japan. **Landscape Dynamics in Typical Ecological Regions of China Based on Remote Sensing and GI**S.

In the last two decades, China has experienced rapid development in its economy. At present, it is clear that China is confronting the seriousness of the resource and environmental problems caused by human activities and the change of natural conditions. Therefore, it is important for China to pay more attention to the study of land-use/cover change, and landscape environmental patterns. Based on the multi-temporal Landsat data, national resources survey data, and, integrated with GIS technology, the landscape dynamics of Chinese typical ecological regions have been studied. To the landscape change of the seacoast and cultivated land in Yellow River Mouth area, the results of the investigation shows that the length of the coastline was extended in last 17 years; the rate of increase was 0.73 km yr^{-1}, while the rate of deposit was 2.1 km yr^{-1}. The city's land increased by 6.5 km^2 yr^{-1} by means of cultivating the barren land. To the desertification landscape dynamic of Horqin Sandy Land, the result indicated that the desertification area was increased from 60.02% of the total land area in 1970s to 64.82% in 1980s, and then decreased to 54.90% in early 1990s. To recent landscape change of the North Tibet lakes, the investigation presented that the trend of the water area of the Namu Lake change was decreasing nearly tens years, the rate of the decreasing wa! s 2.14 km^2 yr-1. Finally, the cause of landscape dynamic affected by human activities and climatic change also discussed.

Zheng, Daolan and Stephen D. Prince. Department of Geography, University of Maryland, College Park, MD 20742, USA. **Grid Net Primary Production Estimates in Finland and Sweden at 1-km and 0.5 Degree Cell Sizes.**

We produced maps of the total litterfall production, annual mean stem increment and net primary production (NPP) at 1-km and 0.5° cell resolutions for forestlands in Finland and Sweden. Our methodology links forest inventory data with remotely sensed plant biomass through allometric relations and statistical models. Gridded NPP estimates provide a visual representation of spatial patterns for different components of forest productivity for resource-management decision makers and as databases for tuning and validating vegetation and ecosystem models at large scales. We estimated annual mean stem increment from the total plant biomass resulted from AVHRR data (1990-93) and forest inventory data in Finland and Sweden. Total litterfall was estimated as a function of elevation and latitude. Leaf litterfall was estimated from the total litterfall based on forest types. Finally, we calculated total NPP using commonly accepted relationships between belowground and aboveground NPP. Our results show forest productivity decreased from southwest to northeast and increased from high elevations to low lands in the study area in general. At 1-km cell size, Mean value of the aboveground NPP was 407 g/m^2/yr with a standard deviation (SD) of 99 g/m^2/yr. The mean value of the total NPP was 561g/m^2/yr with a SD of 130 g/m^2/yr. As expected, ranges of extreme values and SD were reduced while the mean values of the estimated NPP stayed almost constant as 1-km estimates were aggregated to 0.5° cells.

Zollner,[1] Patrick A., Eric J. Gustafson,[1] S. He Hong,[2] and David J. Mladenoff.[3] [1]USDA Forest Service, North Central Research Station, Rhinelander, WI 54501, USA; [2]University of Missouri, Department of Forestry, Columbia, MO 65211, USA; [3]University of Wisconsin Madison, Department of Forest Ecology and Management, Madison, WI 53706, USA. **Modeling the Influence of Dynamic Zoning on Forest Composition in the Northern Lake States.**

The simulation model HARVEST has demonstrated that a dynamic zoning management strategy can increase timber production and reduce forest fragmentation by clustering timber harvest activity in space and time. However, HARVEST does not track the identity of individual tree species, making the effect of these temporally rotating timber production zones on patterns of forest succession unclear. We used LANDIS (a forest disturbance and succession simulation model) to investigate the influence of dynamic zoning scenarios on the composition and spatial arrangement of tree species. We designed LANDIS harvest regimes to mimic the silvicultral practices on the Great Divide Ranger District of the Chequamegon/Nicolet National Forest in Northern Wisconsin. However, we varied the spatial and temporal arrangement of these prescriptions according to different dynamic zoning scenarios. These variations included; comparing timber production zones based on the existing management a!rea map to alternative timber production zones that were more contiguous, changing the size of the timber production zones, and changing the length of the period between harvests within a timber production zone. All simulations were run for 100 years with the same background level of natural disturbance from forest fires and windthrows. Scenarios with more intense dynamic activity (e.g. fewer timber production zones that were larger but where harvests occurred for longer periods) produced more forest interior, but a higher proportion of early successional tree species on the ranger district. Our results demonstrate LANDIS's capability to examine the influence of dynamic zoning scenarios on multiple characteristics that are important to forest management.

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