

# The Conservation The Behaviorist



Animal Behavior Society  Conservation Committee

The Conservation Behaviorist, an electronic news-update, informs ABS members about the Conservation Committee's activities, research trends in behavior and conservation, and relevant scientific news in conservation research where behavior plays an important role.  
[www.animalbehavior.org/Committees/Conservation](http://www.animalbehavior.org/Committees/Conservation)

Volume 6 - Number 1  
May 2008

## The ABS Conservation Committee

Created in 1997, the Conservation Committee aims to encourage ABS members to participate in research programs addressing the interface between animal behavior and conservation science. By identifying and evaluating the areas in which behavioral research has contributed to conservation, as well as the fields that need development, the Committee seeks to generate discussion and promote studies in behavior and conservation.

\* \* \* \* \*

## ABS Conservation Committee Members

**Colleen Cassady St. Clair, Chair**  
University of Alberta, Canada  
**Guillermo Paz-y-Miño C., Past Chair**  
University of Massachusetts Dartmouth  
**Daniel T. Blumstein**  
University of California Los Angeles  
**Richard Buchholz**  
University of Mississippi  
**John Eadie**  
University of California, Davis  
**Esteban Fernand**  
California State University, Long Beach  
**Elizabeth V. Lonsdorf**  
Lincoln Park Zoo  
**Debra M. Shier**  
Zoological Society of San Diego  
**Bruce A. Schulte**  
Georgia Southern University  
**Ronald R. Swaisgood**  
Zoological Society of San Diego  
**Ilonka von Lippke**  
University of California Los Angeles  
**Jessica Ward**  
University of Toronto  
**Mark L. Wildhaber**  
Columbia Environmental Research Center

## Interact with The Conservation Behaviorist

Send letters, announcements, comments and contributions to The Conservation Behaviorist [dshier@sandiegozoo.org](mailto:dshier@sandiegozoo.org)  
Deadlines for articles are the 15<sup>th</sup> of the month preceding the next news update. The next deadline is **October 15<sup>th</sup>**.  
Contributions submitted by members of the Animal Behavior Society and judged by the Conservation Committee to be appropriate will be published in The Conservation Behaviorist. The publication of such material does not imply ABS or Conservation Committee endorsement of the opinions expressed by contributors.

Editor **Guillermo Paz-y-Miño C.**  
Associate Editor **Debra M. Shier**

## Julie Jedlicka receives ABS Edward O. Wilson Conservation Award



**Project:** nesting success and foraging behavior of cavity-nesting birds in vineyard landscapes, page 11

## In this issue

The Conservation  
Behaviorist

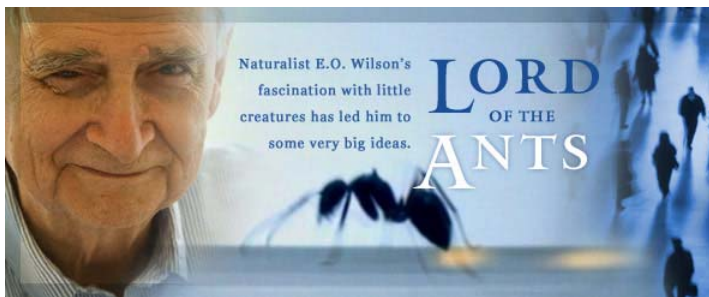


NOVA's *Lord of the Ants*, a conversation with E. O. Wilson, page 2

The E.O. Wilson Conservation Award 2009, page 6  
45<sup>th</sup> Annual Meeting of the Animal Behavior Society, page 6

**Feature Article:** *The spatial behaviors and habitat use of dugongs*, by James Sheppard, page 7

NOVA



NOVA has allowed The Conservation Behaviorist to reproduce this fascinating interview with professor Edward O. Wilson, **Lord of the Ants**.

For a complete story visit NOVA  
[www.pbs.org/wgbh/nova/eowilson/biophilia.html](http://www.pbs.org/wgbh/nova/eowilson/biophilia.html)

## A CONVERSATION WITH E. O. WILSON

In 1984, Edward Wilson published a slim volume called *Biophilia*. In it he proposed the eponymous term, which literally means "love of life," to label what he defined as humans' innate tendency to focus on living things, as opposed to the inanimate. While Wilson acknowledged that hard evidence for the proposition is not yet strong, the scientific study of biophilia being in its infancy, he stressed that "the biophilic tendency is nevertheless so clearly evinced in daily life and widely distributed as to deserve serious attention." He also hoped that an understanding and acceptance of our inherent love of nature, if it exists, might generate a new conservation ethic. On the eve of the book's 25th anniversary, NOVA's Peter Tyson spoke with the "father of biophilia" in his office at Harvard about where the concept stands today and what could happen—to both the natural and human worlds—if we fail to cultivate it.

### THE EVIDENCE SO FAR

**Q:** Is there a general consensus in the scientific community about whether biophilia exists? And if so, about whether it's innate, learned, or a combination of the two?

**Wilson:** Well, there is no doubt that I've ever seen that it exists. And there seems to be little doubt, at least I haven't seen a critique of it, that it has at least a partial genetic basis. It's too universal, and the cultural outcomes of it in different parts of the world are too convergent to simply call it an accident of culture. There's probably a complex of propensities that form convergent results in different cultures, but it also produces the ensemble of whatever these propensities are.

We have to distinguish, for example, between the apparently innate preference of habitat—an idea originally worked out by Gordon Orians at the University of Washington—and the deep love people have for their pets, which tends to be more a matter of human surrogates, particularly child surrogates. These are

very different impulses, but nonetheless they add up together to something very strong.

And in between, of course, is what can only be broadly called "the love of nature." I think that an attraction for natural environments is so basic that most people will understand it right away. The scientific evidence for the whole ensemble of pieces of it have been summarized in *The Biophilia Hypothesis*, which Steve Kellert and I edited. That's a little out of date; there's been a lot more since then. But it's a solid body of evidence in different disciplines.

**Q:** I found that book incredibly rich. You get all these essays from heavy thinkers, people who've really thought about it.

**Wilson:** That's very true. In fact, there are specialists in aspects of this. For example, those who study the biology and the psychology of phobias quickly arrive at the flip side of biophilia. But I always wanted biophobias to be part of biophilia, because the evidence is that the response to predators and to poisonous snakes (which spreads out to snakes generally) generate so much of our culture: our symbolism, the traits we give gods, the symbols of power, the symbols of fear, and so on. They are so pervasive that we need to include biophobia under the broad umbrella of biophilia, as part of the ensemble that I mentioned.

**Q:** Since *The Biophilia Hypothesis* came out in 1993, have there been any genetic discoveries that support the notion of biophilia?

**Wilson:** I haven't tried to keep up with it beyond that meeting [held in August 1992 at the Woods Hole Oceanographic Institution to discuss biophilia and out of which the book came]. But with work by investigators like Arne Öhman [a psychologist at the Karolinska Institute in Sweden who has worked on phobias] and others, they'd already gone into such detail about development and the probable hereditary basis and so on, that the evidence is very strong that way.

Eventually, I think we will know a lot more, including where the genes are located and which fear receptors are activated. I'm pretty sure the fear response will be found to be particularly sensitive to certain inputs, and that will include both pleasurable, emotional feedback and the excitement of fear.

## "It's becoming part of the culture to think rationally about saving the natural world."

**Q:** Do you think, as Gary Paul Nabhan and Sara St. Antoine write in *The Biophilia Hypothesis*, that the genes for biophilia, if they exist, now have fewer environmental triggers to stimulate their full expression among contemporary cultures than they used to?

**Wilson:** That's an interesting question. As I pointed out in the chapter on the serpent in *Biophilia*, the vast majority of people don't ever see a snake in nature. And they're sure not being hunted

by cave lions and oversized crocodiles, although they were universally through most of the history of the species. So that part of it is far less true. Also far less true is the chance to unfold more completely a sense of belonging to a habitat, particularly savanna, although that continues to resonate in our making choices for habitation, having city parks, and the like.

So I think that [a sense of biophilia still] resonates strongly, yet probably they are right, it doesn't develop as fully as it did in our ancestors 10,000 or even 5,000 years ago.

## AN OPTIMISTIC VIEW

**Q:** With the world's population exploding, is it still possible for most people to nurture a sense of biophilia? Or is it likely to be just crushed underfoot, particularly among poor people? In the rich countries we have the luxury to think about these things, but what about the peasant farmer in the Amazon who's just trying to feed his family?

**Wilson:** That is the dilemma of the 21st century—the juggernaut of development, which is extremely hard to stop. The destruction of tropical forests is a good focal point too. (And tropical grassland. Since the 1970s, 80 percent of the tropical grasslands have been destroyed and developed. That's one [ecosystem] we don't think about very much, but tropical grasslands are extremely rich. We don't know how much biodiversity and local ecosystems have gone from that [loss] alone.)

But considering tropical forests, in some parts of the world slash-and-burn [agriculture] has been a key force of destruction. That's particularly true of Africa; that combined with bushmeat hunting is devastating parts of Africa.

We don't need to clear the 4 to 6 percent of the Earth's surface remaining in tropical rain forests, with most of the animal and plant species living there. We don't need to clear that. Any of it. There are ways of taking what's been cleared and devastated, other habitats like saline, you know, with low biodiversity and dry land. The Sahel, the spreading dry country south of the Sahara, begs for the development of dry-land agriculture. Once that gets introduced, even poor people would be better off.

As you can see, I'm a pessimist. No, I'm not a pessimist. [laughs] I'm an optimist.

**Q:** You are an optimist. But how do you keep optimistic in the face of this juggernaut, as you termed it? And, as you asked in *Biophilia*, do we humans love the Earth enough to save it?

**Wilson:** I doubt that most people with short-term thinking love the natural world enough to save it. But more and more are beginning to get a different perspective, particularly in industrialized countries. It's becoming part of the culture to think rationally about saving the natural world. Both because it's the right thing to do—and notice the quick spread of this attitude through the evangelical community—but we will save the natural world in order to save ourselves. I think the right way of looking at it, and the reason I'm an optimist, is that we still have a lot of elasticity, a lot of wiggle room. The kinds of elasticity and wiggle room that would allow us to save virtually

all of the natural environments in the world while dramatically improving ourselves with the land and with the technology yet undeveloped.

Look at this country. This is what I consider real patriotism. Look at the United States of America and say we are at risk from various major movements worldwide of losing our edge, of losing our leadership. We don't need to. We have the greatest scientific minds and capacities in the world. We have experience, and the kind of capitalist system to build technologies swiftly. We can, if we want, lead the world in two areas right away.

One is alternative energy, if we have the will to do it. We can produce the technology that others would beg, borrow, or steal to get. We're in better shape to do it. And we have some elasticity even within our country, so that we're not going to suffer anywhere while we do this changeover.

## "Soccer moms are the enemy of natural history and the full development of a child."

The other reason I'm optimistic is what we've been talking about, particularly with reference to the living world. We need a whole new agriculture and silvaculture, the growing of forest, which will take land that has been pretty well ruined as far as natural environments are concerned, and land that's growing dry due to climate change, and develop the crops that can grow in those spreading habitats. The world is going to have to go to dry-land agriculture.

If we can get the crops developed, and find the way—it'll take subsidies at first, you know, prime the pump—to introduce and spread these crops or at least strains of them, replacing the great traditional ones like wheat and potatoes and millet even, we can greatly increase the productivity of [already cleared] lands. I think that's the way we should be thinking, and we should be optimistic about that.

**Q:** That's refreshing to hear. Getting back to biophilia for a moment...

**Wilson:** You got me on a soapbox.

**Q:** No, it's all tied in.

**Wilson:** I'm happy to tell you, it's getting to be a crowded soapbox. Did you know that Tom Friedman of *The New York Times* is coming out with a new book this summer? I really like the sound of what he has in mind. He talks like this, but he also is gathering a lot of information to tie together, in something that will appeal to a broad audience, of how we're in an exponential growth phase of so many things: the depletion of resources, the cost of fossil fuels, population, and so on.

All these things are intertwined, and so we have to learn how to look at them as one combined, nonlinear process that's just about going to bear us away unless we handle them now as a whole. I think more and more people are thinking like that. They're deciding that yes, we've really got to face it. And if we do it, there's going to be light at the end of that tunnel. We'll be so much better off.



**Q: We'll survive.**

**Wilson:** *We'll do more than survive. I think we're going to do very well.*

**DANGERS OF DISSOCIATION**

**Q:** What could happen to people, to society, if, despite your optimism, we continue to distance ourselves from nature and let our biophilia atrophy?

**Wilson:** *I don't know. There's now a lot of concern, even consternation, among not just naturalists and poets and outdoors professionals but spreading through I think a better part of the educated public, that we've cut ourselves off from something vital to full human psychological and emotional development. I think that the author of *Last Child in the Woods*, Richard Louv, hit on something, because it became such a popular theme to talk about that book [which posits that children today suffer from what Louv calls "nature-deficit disorder"] that people woke up and said, "Yeah, something's wrong."*

*Just last week I was at the first Aspen Environment Forum in Colorado, and I gave a keynote. I made a remark there: "Soccer moms are the enemy of natural history and the full development of a child." That got applause. [laughs] And many responded afterward agreeing with me. Someone said, "We just over-program kids. We're so desperate to move them in a certain direction that we're leaving out a very important part of childhood." There's a strong feeling that that's the case, that there's something about a child's experience—many of them had it, others have just heard about it—that should be looked at.*

*I believe that probably a good focus point is biophilia. What is it that we want to cultivate? The dire comparison I make is between children brought up in a totally humanized, artifactual environment, urban or suburban, and cattle brought up in a feedlot. When you see cattle in a feedlot, they seem perfectly content, but they're not cattle. It's an exaggeration, of course, to compare those with children, but somehow children can be perfectly happy with computer screens and games and movies where they get to see not only African wildlife but, lo and behold, dinosaurs. But they're just not fully developing their psychic energy and their propensities to develop and seek on their own.*

**Q:** Could this result in more than stunted psychic development? Could it actually threaten our survival if, because of it, we continue our rampant destruction of nature?

**Wilson:** *It's too hard to call. What does it mean when you say a child or a person hasn't fully developed? Suburban environment, watching football, moving up the ladder at the local corporation, sex, children—all that is pretty satisfying. But what does it mean to have a world that just comes down to that? It's hard to say. All I know is that not developing in that direction, having enough people not having a sense of place associated with nature, is very dangerous to the environment. At Aspen, each person was allowed three minutes to state one big idea. I gave mine in my keynote. It concerns [what I call] the first rule of climate management. The first rule is that if you save the living environment—save the species and ecosystems that are our*

*cradle and where we developed and on which we've depended for literally millions of years—then automatically you'll save the physical environment. Because you can't save the living environment, of course, without being very careful about the physical environment.*

**"I'd be willing to place a bet that among people who get out into the outdoors early and really love it, there are fewer depressed people."**

*But if you save only the physical environment, such as doing what it takes to slow down climate change, get a sustainable source of fresh water, develop alternative fuels, reduce pollution, all the things that people think correctly are of central importance in management of the planet—if that's all you go for, then you will lose them both, the physical and living environments.*

*Because the living environment is what really sustains us. The living environment creates the soil, creates most of the atmosphere. It's not just something "out there." The biosphere is a membrane, a very thin membrane of living organism. We were born in it, and it presents exactly the right conditions for our lives, including—the whole point of our conversation—psychological and spiritual [benefits].*

**Q:** To what degree do you think that emotional problems that many people today, particularly in cities, suffer from, like depression and anxiety, might be due to a lack of contact with nature?

**Wilson:** *I think it may have a lot to do with it. Psychologists and psychiatrists themselves seem in agreement on the benefits of what's called "the wilderness experience." To be able to [give this to] young people who may have gotten themselves all tangled up with their concerns about ego and peer relationships and their future and are falling into that frame of mind and becoming very depressed because they have such a narrow conception of the world. The wilderness experience is being able to get into a world that's just filled with life, that's fascinating to watch in every aspect, and that does not depend on you. It tells them that there's so much more to the world.*

*I've never seen a test made of it, but I'd be willing to place a bet that among full-blown outdoorsmen, the birders and the fishermen, people who get out into the outdoors early and really love it, I bet there are fewer depressed people. That's an interesting proposition to check out.*

**BENEFITS OF BIOPHILIA**

**Q:** I bet you're right. I go out into nature all I can.

**Wilson:** *There are so many things to do. And you know as well as I that it's not just going into a natural environment and saying, "Aah, the air is great, and I love the scenery." Serious naturalists, serious outdoorsmen have goals. They want to see how many birds they can spot. They want to see if they can catch a sight. They're*

willing to go up, shall we say, the Choctawhatchee River in order to get a glimpse of a swallow-tailed kite. If they're fishermen, they want to fish a certain river to see if they can bring up a large specimen of a certain kind of fish. This is what they live for.

**Q:** Yes, and they likely identify a lot more closely with those animals and with nature in general than city dwellers. Lately I've been looking at things even as small as ants, your specialty, and thinking, *As much evolution went into those creatures as into me.* And I've been reading about "immortal genes" that reveal how intimately we're tied to all other creatures on this planet. Why is it so hard for us humans to accept that we are cousin to all other living things?

**Wilson:** Because we're tribal. It's always been a great survival value for people to believe they belong to a superior tribe. That's just in human relationships. Spirit, patriotism, courage under fire, all these things have been generated almost certainly by group competition, tribe against tribe—an idea, incidentally, first spelled out in some detail by Darwin in *Descent of Man*. This is where intelligence and courage and altruism and high-quality people come from, he said—the exigencies of tribal conflict. And the tribes that win have what we call the "nobler" qualities in them.

That's an interesting area of theory I'm working in right now. I don't want to go into it, but it's a very hot issue, exactly where altruism and what we call "noble" qualities of humans come from. But it appears to me that much of it occurs from tribal identification and the belief that your tribe is above other tribes. And I think that part of our contempt for the life that supports us is an extension of such tribalism. [pause] How can you love an ant?! [laughs]

**Q:** How can you love an ant? [laughs too]

**Wilson:** Well, actually you can. Not love it, but... A couple of years ago I attended a local conference of damselfly specialists and enthusiasts. I thought maybe there'd be five or six coming, people here or there who just happened to like damselflies. My god, there were 30 or 40 of them! And when they all came together, it was the same thing. They all knew the damselflies. One of them from upstate New York had just produced a beautiful guidebook. They gave talks. They told war stories about finding a new bog in Connecticut, you know, which had five species, including two that were endangered. The hunt for *Williamsonia*, which is a near-extinct one, and how a team was able to locate it in three more ponds on the Cape.

This may be laughable to a person you picked off the street. But these people are talking about animals that are 300 million years old and all that time have been vital parts of the environment. And they're beautiful—most of them are iridescent blue or green. I'll tell you, for me it beats the hell out of NASCAR! [laughs]

**Q:** And if you asked them if they love their damselflies, I bet they'd say yes.

**Wilson:** Yes, they would. But they'd want to qualify it, of course. They would say it's a beautiful subject, it's a beautiful world, and it's wonderful to know about something in such detail that when you go out [into the field and find them] it's meaningful.

When I step off a plane anywhere, for example, I'm already looking around, because I know the ants that are supposed to be there. There may be 100 species, but I know them, or many of them, and where they might be found, and so on. It's a familiar world for me, which speaks of the sense of place and a sense of belonging.

## "Nature doesn't belong to anybody. And it's not forbidden to touch it. It's his. *His!*"

Even when the plane is landing and I'm at the window, I start scouring the suburbs. I'm looking at where the housing developments are, where the kids are—you know, like myself when I was 10, 12, 14—and I'm spotting the woodlots that are left and the woods or seemingly natural environments along streams. I'm plotting in my mind—you know, just dreaming—how long it would take to walk or ride a bike from that suburb I see over to that forest. And I'm thinking, I hope the kids there have discovered it. [laughs] I hope they're finding out how to walk it from one end to another and that they're finding tiger salamanders and spotting red-eyed vireos.

**Q:** Native Americans traditionally had that kind of intimacy with the landscape and its wildlife. What would an Indian hunter of a century or two ago think of what we're doing today, of many people's wanton disregard for the natural world?

**Wilson:** They never tire of telling us, do they? [laughs] At the opening event in Aspen last week were two Ute Indians, a gentleman and his wife. They had to be very well-educated people, but they put on their traditional dress of the Ute. And he gave us a very fine talk about the Ute tribe, the culture, and so on, which has held on pretty well in the Colorado mountains. And that was the theme: the radical difference in culture, and how we might very well appropriate more of their way of looking at the Earth and not go too far with our way of looking at the Earth.

## AT PEACE WITH THE WORLD

**Q:** I just got a copy of a new book called *Biophilic Design*, for which you wrote a chapter. So-called biophilic architecture really seems to be taking off.

**Wilson:** A lot of architects are saying this is the next big thing. Maybe we've had enough around the world of Le Corbusier and buildings and monuments to ourselves. You know, gigantic phalli, huge arches, forbidding terraces and walkways as in our City Hall, neo-Soviet buildings. [laughs] These are things in which we're celebrating our strength, our power, our conquest of the world, right? How great we are! But maybe what we really need down deep is to get closer to where we came from. That doesn't mean we become more primitive, but we just feel better about it.

I recently visited an office building in North Carolina. It was by a professional and very successful architect, and it was [designed biophilically]. He had selected a little knoll. He had to cut some trees, but he left the rest on this little knoll overlooking a stream. And you sit there with a glassed-in wall endlessly looking out, while chipmunks and warblers and so on are all over the place and the stream is flowing by. And you're at peace. I am. [laughs]

**Q:** I hear you. I have an 11-year-old son who is autistic. He can't go to a mall or fair because they're too overwhelming. Instead I take him out into nature, and he adores it. He calms right down, because there's no competition and there's this natural love for nature, I suppose.

**Wilson:** I'm pleased to hear that. The thing about nature is it's so rich, and yet it's not owned by other people. I mean, your son sees the remarkable spectacle of a frog springing out and splashing in the water, and a water snake coursing along, and an odd flower growing up—all that doesn't belong to anybody. It's not claimed by somebody over there. And it's not forbidden to touch it. It's his. His! ■

© NOVA [www.pbs.org/wgbh/nova/eowilson/biophilia.html](http://www.pbs.org/wgbh/nova/eowilson/biophilia.html)

## 45<sup>th</sup> Annual Meeting Animal Behavior Society 16-20 August, 2008 Snowbird, Utah, USA



**Keynote speaker:** John Mitani, University of Michigan, *The behavior of wild chimpanzees.*

**Distinguished Animal Behaviorist address:** Jerram Brown, Emeritus of SUNY Albany, *Studies on Behavior and Ecology of the Mexican Jay, 1969-2004.*

**Fellows lecture:** Mary Jane West-Eberhard, Smithsonian Tropical Research Institute, *Alternative developmental pathways and why*

## The E. O. Wilson Conservation Award 2009

The Edward O. Wilson ABS Student Research Grant for Conservation seeks to encourage graduate students of animal behavior to participate in meaningful conservation-related research. The award is part of the **ABS Student Research Grant Program** and it supports a **proposal** considered meritorious for its science and conservation component.

E. O. Wilson, professor at Harvard University, who in 2002 received the ABS Distinguished Animal Behaviorist Award, is one of the world's most eminent scientists and pioneers in biodiversity conservation.

For additional information on this award visit [www.animalbehavior.org/ABSGrants](http://www.animalbehavior.org/ABSGrants) or contact the **Conservation Committee** [cstclair@ualberta.ca](mailto:cstclair@ualberta.ca)

*they are so important in behavior and evolution.*

**Fellows lecture:** R. Haven Wiley, University of North Carolina Chapel Hill, *A Signal-Detection Equilibrium in the Evolution of Communication.*

**Symposium:** *Pathways to Novelty and Diversity: The Causes and Consequences of Polyphenism.* Organizers: David W. Pfennig, University of North Carolina, Chapel Hill, Armin Moczek, Indiana University.



## Feature Article

## The spatial behaviors and habitat use of dugongs

Most species forage in spatially complex environments with patchy resource distributions that are often heterogeneous across a hierarchy of scales. Hence, studies of animal-environment interactions frequently use a spatial approach. Statistical analysis of spatial structure can reveal non-random patterns of habitat use, population dynamics, predation and resource selection; particularly in patchy environments. Spatial statistical techniques are also powerful management tools for identifying the scales at which to concentrate conservation efforts that are biologically meaningful to the target species. Here, I report on a recent study of the spatial behavior and habitat use of dugongs in Queensland, Australia, using spatial analytical techniques, with a view to enhancing the ecological basis for dugong conservation management.

By James Sheppard\*

Spatial analysis in ecology can be broadly defined as the quantitative analysis of spatially explicit data [1-3]. Modeling techniques can be applied to the analysis of spatial data in ecology to infer the existence of underlying processes, such as movements or responses to environmental heterogeneity, and spatially explicit individual-based models are used to analyze fine-scale animal movement behaviors and habitat use [4, 5]. Analysis of the relationship between individual animals and their environment at small scales may enable extrapolation to broader scales and to population levels [4]. Advances in spatial theory and modeling have coincided with advances in analytical power, including software for statistical techniques and geographic information systems (GIS). Nonetheless, problems with spatial analyses still exist. For example, habitat investigations tend to examine large spatial scales rather than local spatial scales, particularly for vertebrates. Accordingly, the relationship between animals and their environment at the individual level is still poorly understood [6]. I examined the movement patterns of individual wild dugongs across the domains of spatial scale that the animals used their habitat.

**The unique niche of the dugong:** The dugong is the only herbivorous mammal that is strictly marine, and the only surviving representative of a highly specialized group of marine mammals (family Dugongidae; order Sirenia). The only other modern dugongid, Steller's sea cow, was exterminated by sealers within 27 years of its discovery in 1741. The other extant Family in the order Sirenia is the Trichechidae (manatees) [7]. The dugong is a large hindgut fermenter that grazes predominantly on seagrass. Adults are usually between

2 and 3 meters long and are long-lived (approximately 70 years) with low reproductive potential, high adult survivorship, long generation time and a high female investment in each offspring [8, 9].



*Dugong secured in a floatation device that is tied alongside the catch vessel to enable the animal's breathing to be unimpeded (J. Sheppard © photo).*

**Dugong conservation management issues:** The dugong's range extends through the coastal and island waters of over 40 tropical and sub-tropical countries in the Indo-West Pacific. Only relict populations of dugongs now exist in most of its range. Australian waters contain the world's largest dugong population and are recognized as the dugong's stronghold. Throughout their ranges all sirenians, including dugongs, are vulnerable to threatening anthropogenic processes which include direct exploitation, habitat destruction or modification, pollution, mortality or injury from boats and interactions with fisheries [10]. Consequently, all extant members of the Order Sirenia are now listed in The World Conservation Union Red Data Book of Threatened Species as 'Vulnerable to Extinction'.

**Dugong spatial behaviors & habitat use – what we know:** Dugongs require warm seas, as evidenced by their tropical and subtropical distribution. Within this range they favor protected shallow bays, mangrove channels, and the lee of large inshore islands where the extensive seagrass meadows which comprise their food resource occur [11, 12]. Nonetheless, dugongs also utilize deeper offshore habitats and have been known to cross deep (3 – 4 kilometers) oceanic stretches of water [13]. Relatively little is known about the seasonal movements, including possible migrations of dugongs. Most observations have been localized to the vicinity of seagrass beds [14-16]. Dugong movement is constrained by tidal periodicity and amplitude and by the climate because they require warm waters and depths of 1 meter or more [17, 18].

**Dugong spatial behaviors & habitat use – what we need to know:** Dugongs are large primary consumers of seagrass communities, and thereby shape the diversity, structure, and dynamics of these extensive ecosystems. However, despite 40 years of research the influence of seagrass food quality on dugong grazing patterns and nutritional ecology is poorly understood. Because dugongs are seagrass specialists, understanding the interaction between dugongs and their food

supply is crucial to their conservation because any degradative impacts on the seagrass meadows that dugongs depend on for food will have direct negative impacts on dugong populations. Information on the foraging behaviors of wild dugongs is limited because research is constrained by prohibitive technological, logistic and economic challenges. Dugongs are relatively inaccessible in the wild and difficult to observe directly. Habitat selection by dugongs is beginning to receive greater attention by managers and ecologists, but a model capable of predicting habitat choices by dugongs based on the attributes of those habitats is lacking. Information is needed on dugong spatial patterns, including movement behaviors and habitat use, across domains of scale and a summary of dugong movement behaviors and habitat use across scales is needed to address dugong spatial patterns within a cohesive management strategy.

**Research aims and hypotheses:** My primary aims were to investigate the factors driving the large and fine-scale spatial behavior of dugongs and to identify and describe their feeding preferences, resource use and potential foraging strategies at multiple scales. I aimed to determine whether dugongs select seagrass on the basis of its nutrient content and whether the distribution of quality seagrass food resources is the main driver of dugong spatial patterns. My general hypotheses were as follows: (1) Dugongs forage like terrestrial mammalian grazers in that they prefer habitats where their intake of energy and/or nutrients (i.e. foraging efficiency) is greatest; (2) patterns of dugong movements and habitat use across spatial scales are intimately linked to the availability and distribution of quality (high nutrient concentrations, low fiber) seagrass forage.

**Dugong telemetry and spatial analysis:** My project capitalized on recent technology incorporating accurate GPS technology into tracking equipment to monitor the habitat use of wild dugongs in sub-tropical and tropical waters of Australia at very high resolution (< 10 meters). Advances in GIS and spatial modeling enabled me to analyze habitat selection of the satellite-tracked dugongs in a spatially explicit manner. I used hierarchical scales of spatial analyses to assess the relative importance of different seagrass meadows and parts of meadows to dugongs at scales that are suitable for informing policy on the management of human activities.

I investigated the mechanisms that produce the large-scale distribution and movement patterns of dugongs by reanalyzing the results of historical aerial surveys and satellite tracking conducted by earlier researchers in combination with new data from my GPS telemetry of dugongs. I identified the role of physical environmental characteristics in determining the activity patterns and fine-scale space-use of dugongs tracked in coastal and deepwater seagrass habitats that were physiographically dissimilar. I categorized dugong seagrass habitats as inshore/intertidal or offshore/subtidal depending on their distance to the shore and the water depth: Inshore/intertidal habitats had a shallow component that was exposed at low-tide. Offshore/subtidal habitats were at least 5 kilometers from the nearest mainland and were at least 3 meters deep at mean low water spring tide.

I confirmed a seagrass meadow as important dugong habitat on the basis of the tracking data. I then used marine videography, Near-infrared Spectroscopy (NIRS) and GIS to survey, analyze and map seagrass species composition,

nutrient profile and patch structure of the meadow. I modeled resource selection within the habitat by comparing the dugongs' use of space with the distribution of their seagrass food resources within an area defined using the combined space-use of the tracked animals. I analyzed the association of dugongs with seagrass quantity (biomass) and quality (nutrients) within time/tide combinations to examine the influences of tidal periodicity and the diel cycle on resource selection. I used resource utilization functions [19] to relate a probabilistic measure of each individual dugong's space-use in each time/tide combination (dependent variable) to the spatial landscapes of the resource variables (independent variables).

**Capturing and tagging wild dugongs:** The value of research activities that capture, tag and remotely track wild dugongs to improve population conservation efforts must be weighed against the stress caused to individual animals and the risk of injury or death. Sirenians are protected by legislation in most countries and research on dugongs must follow stringent guidelines to avoid legal transgressions [10]. I captured dugongs using the 'rodeo' method, which has been used to successfully tag more than 70 animals without incident. Only animals  $\geq 2$  meters long without an attendant calf were captured. To facilitate the ease of capture and GPS tag deployment each dugong was carefully herded into shallow water using a catch boat and corralled into the intertidal zone. A field assistant then jumped from the prow of the boat onto the tail of the surfacing dugong, after it had taken a breath, which effectively prevented any further movement. Once the dugong was captured, a flotation device was placed under it and tied off against the side of the catch boat to act as a cradle to ensure the animal could always surface for air without escaping. Assistants were stationed across the length of the secured dugong to provide support, monitor the animal's wellbeing and keep it steady while the satellite tag was attached. The total time taken to capture, tag and release a dugong was typically only 10 - 12 minutes. When operating in deep (> 2 meters) and/or turbid water we used a spotter plane to locate dugongs.



*Two jumpers capturing a wild dugong in shallow intertidal waters (J. Sheppard © photo).*

**Large-scale movements between seagrass habitats:** Tracked dugongs were followed for periods ranging from 15 to 551 days and exhibited a large range of individualistic movement behaviors; 26 individuals were relatively sedentary (moving < 15 kilometers) while 44 made large-scale movements (> 15 kilometers) of up to 560 kilometers from their capture sites and



often bypassed known dugong habitats [20]. Male and female animals, including cows with calves, undertook large-scale movements. At least some of these movements were return movements to the capture location, suggesting that such movements were ranging rather than dispersal movements. Large-scale movements included macro-scale regional movements ( $> 100$  kilometers) and meso-scale inter-patch local movements ( $15 \leq 100$  kilometers) and were qualitatively different from tidally-driven micro-scale commuting movements between and within seagrass beds ( $< 15$  kilometers). Large-scale movements were rapid, apparently directed and coastal; the tracked dugongs rarely venturing more than 20 kilometers off the coast. My analysis of dive profiles suggests that dugongs make repeated deep dives while traveling (presumably tracking the sea floor) rather than remaining at the surface.



*Dugong secured alongside a capture boat with the GPS-tag floating at the top of the picture (J. Sheppard © photo).*

Dugongs have poor thermoregulatory capacity [21]. Some of the animals that I studied in the high latitude limits of the dugongs' range on the Australian east coast in winter apparently undertook long distance movements in response to low water temperatures, similar to the seasonal movements of Florida manatees [20]. Dugongs seem to respond to a water temperature threshold of  $17 - 18^{\circ}\text{C}$ , below which they undertake meso-scale thermoregulatory movements to warm-water offshore habitats. My tracking data suggest that dugongs maintain a spatial memory of specific habitat hotspots—patches of quality seagrass food resources, which they visit periodically. Dugongs may use these visits to monitor the quantity and quality of food resources, balancing the net rate of energy/nutrient gain from the current patch with the potential energetic costs and benefits of moving to another meadow.

Social cues may also be driving these behaviors. For example, male dugongs may be following estrous females. Intraspecific social dominance hierarchies and competitive exclusion may preclude subordinate animals from occupying certain seagrass habitats. Another plausible explanation for dugongs bypassing seemingly high-quality habitat and for the individual variability in the range of areas used by different individuals is that movements are learned behaviors, reflecting the individual's experience as a dependent calf.



*Field assistant securing a captured dugong with a GPS-tag attached to its tail (J. Sheppard © photo).*

**Small-scale movements within seagrass habitats:** The small-scale spatial behaviors of the dugongs I tracked were modified by the physical variables specific to their habitats, especially within inshore/intertidal areas where the effects of the tide were strongest [22]. Dugongs were active throughout the diel cycle, and animals within inshore/intertidal habitats made use of deep-water refuges and moved closer to the shore at night than the day. Onshore movement towards the coast at high tide allowed dugongs to make use of shallow intertidal seagrass beds. Dugongs were closer to shore in the afternoons and evenings than in the mornings, which may be related to the avoidance of predators (sharks) and/or vessels. Physical environment variables had little or no effect on the spatial patterns of dugongs tracked in deep-water offshore habitats.

The space-use of the tracked dugongs was consistently centered over seagrass patches with high nitrogen concentrations, except during the day at low tides when their space-use was centered over high seagrass biomass. Dugong association with seagrass high in starch was positive during both day and night high tides when dugongs could access intertidal areas where the seagrass biomass was generally low and where seagrass starch levels were elevated [23]. I cautiously infer that this behavior was indicative of: (1) a time-minimizing strategy at low-tide, i.e. minimizing foraging time by feeding in areas of high biomass, and; (2) an energy-maximizing strategy at high-tide, i.e. maximizing energy intake by foraging for sparse foods high in starch content. Patterns of dugong association with specific seagrass species were less definite.

**Research synthesis and management outcomes:** On the basis of my research findings I posit that dugong habitat selection and resource use on the east coast of Australia occur hierarchically, across (at least) three different domains of scale: (1) at a regional-scale ( $> 10\,000\text{ km}^2$ ) dugongs select habitat at the level

of individual bays; (2) at a landscape-scale ( $< 10\,000\text{ km}^2$ ), dugongs select seagrass pastures within bays along the coast comprised of nutritious plant species; (3) at a local-scale ( $< 10\text{ km}^2$ ) within seagrass pastures that are within bays along the coast, dugongs select seagrass patches on the basis of their nutrient concentrations. I recommend that the appropriate scales at which to manage dugong populations and their seagrass habitats are coordinated within and across the hierarchical scales of habitat use indicated by my analysis.



**'Quality' dugong habitat on the east coast of Australia, looking back at the shore from the intertidal zone boundary at low tide. The seagrass meadow is comprised of high starch, high nitrogen, and low fiber species but is unavailable to foraging dugongs twice daily due to tidal periodicity (J. Sheppard © photo).**

My finding that dugongs frequently undertake large-scale moves has implications for management at a range of scales, and strengthens the aerial survey and genetic evidence for management and monitoring at ecological scales that cross jurisdictions. The capacity of large-scale monitoring programs to detect trends in dugong numbers at scales of even thousands of  $\text{km}^2$  is confounded by the dugongs' tendency to undertake large-scale moves. With movement between bays a common occurrence, estimates of population size and trends can only be meaningfully made at regional scales. The tendency for dugongs to track the bottom on large-scale movements may increase their vulnerability to incidental capture in bottom set gill nets. In addition, if dugongs transfer their spatial knowledge of the location of quality food resource patches to their offspring, then local depletions will lead to loss of this knowledge. Areas of high quality seagrass may thus become unknown to dugongs. In the absence of grazing pressure such areas may become less valuable as dugong habitat if the early seral stage species of seagrass preferred by dugongs convert to more fibrous species.

My research suggests that dugongs actively select seagrass habitats dominated by plant species that have high starch and nitrogen content. Bays containing these quality food resources comprise an interlinked network of core habitats between which dugongs frequently move. Accordingly, bays along the coast with seagrass meadows dominated by nutritious seagrass species should be afforded a high level of protection as potential quality dugong habitat. Bays with extensive intertidal meadows should also receive enhanced protection, even if the seagrass biomass is low because these meadows

may have elevated starch content. Even though they have low seagrass biomass, warm water thermoregulatory habitats play an important role in maintaining dugong populations and should be included in dugong habitat protection strategies.

In August 2006 the Great Sandy Marine Park was officially legislated by the Queensland Government. The new marine park includes Habitat Protection Zones for the dugong seagrass habitats that were identified by this study. Three important seagrass habitats have also been designated as Go-Slow Zones. Boaters traversing Go-Slow Zones must remain in a non-planing mode and not operate a vessel '... in a way or at a speed that could reasonably be expected to result in the striking of a dugong' [24, 25]. Thus, this study provides an example of how the analysis of the spatial behaviors and habitat use of a threatened species can provide valuable tools for conservation management ■

\*James Sheppard is a postdoctoral fellow at CRES, Zoological Society of San Diego.

## References

1. Legendre P, Fortin MJ. Spatial pattern and ecological analysis. *Vegetatio*. 1989;80:107-38.
2. Liebholt AM, Gurevitch J. Integrating the statistical analysis of spatial data in ecology. *Ecography*. 2002;25:553-7.
3. Perry JN, Liebholt AM, Rosenberg MS, Dungan J, Miriti M, Jakomulski A, et al. Illustrations and guidelines for selecting statistical methods for quantifying spatial pattern in ecological data. *Ecography*. 2002;25:578-600.
4. Wiens JA. Spatial scaling in ecology. *Functional ecology*. 1989;3:385-97.
5. Morales JM, Fortin D, Frair JL, Merrill EH. Adaptive models for large herbivore movements in heterogeneous landscapes. *Landscape Ecology*. 2005;20:301-16.
6. Nilsen EB, Linnell JDC, Andersen R. Individual access to preferred habitat affects fitness components in female roe deer *Capreolus capreolus*. *Journal of Animal Ecology*. 2004;73:44-50.
7. Domning DP. Evolution of the Sirenia and Desmostylia. In: Mazin J-M, de Buffrenil V, editors. *Secondary Adaptation of Tetrapods to Life in Water*. Germany: Verlag; 2001. p. 151-67.
8. Marsh H, Heinsohn GE, Marsh L. Breeding cycle, life history and population dynamics of the dugong *Dugong dugon* (Sirenia: Dugongidae). *Australian Journal of Zoology*. 1984;32(6):767-802.
9. Kwan D. Towards a sustainable indigenous fishery for dugongs in Torres Strait: A contribution of empirical data and process [PhD thesis]. Townsville: James Cook University; 2002.
10. Marsh H, Penrose H, Eros C, Hugues J. Dugong: status report and action plans for countries and territories. Townsville; 2002.
11. Heinsohn GE, Wake J, Marsh H, Spain AV. The dugong (*Dugong dugon* (Müller)) in the seagrass system. *Aquaculture*. 1977;12(1977):235-48.
12. Lanyon J. The nutritional ecology of the dugong (*Dugong dugon*) in tropical north Queensland [PhD Thesis]. Victoria, Australia: Monash University; 1991.
13. Hobbs JPA, Frisch AJ, Hender J, Gilligan J. Long-distance oceanic movement of a solitary dugong (*Dugong dugon*) to the Cocos (Keeling) Islands. *Aquatic Mammals*. 2007;33(2):175-8.
14. Marsh H, Rathbun GB. Development and application of conventional and satellite radio-tracking techniques for studying dugong movements and habitat usage. *Australian Wildlife Research*. 1990;17:83-100.
15. de Jongh HH, Langeveld P, van der Wal M. Movement and home ranges of dugongs around the Lease Islands, East Indonesia. *Mar Ecol*. 1998;19(3):179-93.
16. Hodgson AJ, Marsh H. Response of dugongs to boat traffic: The risk of disturbance and displacement. *Journal of Experimental Marine Biology and Ecology*. 2007;340(1):50-61.
17. Preen AR. Interactions between dugongs and seagrasses in a subtropical environment [PhD Thesis]. Townsville: James Cook University; 1992.
18. Marsh H, Prince RIT, Saalfeld WK, Shepherd R. The distribution and abundance of the dugong in Shark Bay, Western Australia. *Wildl Res*. 1994;21(2):149-61.
19. Millsaugh JJ, Nielson RM, McDonald L, Marzluff JM, Gitzen RA, Rittenhouse CD, et al. Analysis of resource selection using utilization distributions. *Journal of Wildlife Management*. 2006;70:384-94.
20. Sheppard JK, Preen AR, Marsh H, Lawler IR, Whiting SD, Jones RE. Movement heterogeneity of dugongs, *Dugong dugon* (Müller) over large spatial scales. *Journal of Experimental Marine Biology and Ecology*. 2006;334:64-83.
21. Gales NJ, McCauley RD, Lanyon J, Holley DK. Changes in abundance of dugongs in Shark Bay, Ningaloo and Exmouth Gulf, Western Australia: evidence for large-scale migration. *Wildl Res*. 2004;31:283-90.
22. Sheppard JK, Jones RE, Marsh H, Lawler IR. Effects of tidal and diel cycles on dugong habitat use. *Journal of Wildlife Management*. In press.
23. Sheppard JK, Marsh H, Lawler IR. Seagrass as pasture for seacows: Landscape-level dugong habitat evaluation. *Estuarine Coastal and Shelf Science*. 2007;71:117-32.
24. EPA. Marine Parks (Great Sandy) Zoning Plan 2006. State of Queensland: Queensland Environmental Protection Agency; 2006.
25. Maitland RN, Lawler IR, Sheppard JK. Assessing the risk of boat strike on dugongs (*Dugong dugon*) at Burrum Heads, Queensland, Australia. *Pacific Conservation Biology*. 2007;12(4):321-7.



## E. O. Wilson Conservation Award

This year's E. O. Wilson Conservation Award went to **Julie Jedlicka**, a PhD candidate at the Environmental Studies program, University of California Santa Cruz. Her research will investigate the nesting success and foraging behavior of cavity-nesting birds in vineyard landscapes. Understanding how bird species use vineyard and riparian microhabitats may inform conservation efforts and help preserve avian wildlife. According to Jedlicka, the American Bird Conservancy includes California (CA) oak savannahs on their list of top 20 most threatened bird habitats in the United States. As oaks are deforested, many cavity-nesting songbirds are lost to an agricultural landscape increasingly composed of vineyards and as a result their populations are declining. During the past decade, some winegrape growers in Sonoma and Mendocino Counties have placed songbird nestboxes in their vineyards to help conserve native bird species. "There is no information available quantifying how cavity-nesting bird species use CA vineyard landscapes. It is unknown whether vineyard landscapes provide the food resources necessary to sustain reproductive populations of cavity-nesting birds. Detailed information on avian behavior is needed before one may evaluate nestbox programs as suitable for conservation," says Jedlicka.

The Conservation Behaviorist spoke with **Julie Jedlicka** about the E. O. Wilson Conservation Award; here is what she said:

### What was your immediate reaction to receiving the E. O. Wilson award?

*I was both excited and grateful. The good news came in the middle of my field season, and boosted my motivation for waking up at 4AM to study avian behavior. I especially appreciated reading the positive feedback from the reviewers. Generally I believe graduate students strongly value receiving written responses to our applications, so thank you to all those who take the time to write reviews of graduate work.*

### What do you think about the award? Will it encourage students to present more proposals with conservation content?

*I think the award is pressing for behavioral ecologists in today's world. Extinction rates are alarmingly high and I believe there are many exciting mergers that can take place between the fields of conservation biology and animal behavior. The fact that this award exists influenced me to include a conservation context in my proposal, and imagine other students were influenced similarly. I would expect more graduate research will be*

*presented that highlights animal behavior in an applied, conservation context.*

### Why do you work in the interface of animal behavior-conservation biology?

*Because I find it challenging and rewarding; I am motivated by the many positive changes scientists are promoting, and I want to be part of the scientific movement that encourages conservation, especially on non-traditional landscapes such as agricultural land. I also see my work pulling from other disciplines such as agroecology, ornithology and entomology. I am a PhD candidate in an*



*interdisciplinary department (Environmental Studies at UCSC) and find it increasingly hard to delineate certain disciplines from one another, such as animal behavior and conservation biology. I guess I am most interested in combining knowledge and techniques to produce research that is meaningful and unique.*

*Jedlicka checking bird nestboxes at field site (L. Barrow © photo).*

### How did you become interested in the foraging behavior and nesting success of cavity-nesting songbirds in vineyard landscapes?

*As a masters student in Ecology and Evolutionary Biology at University of Michigan I studied the foraging behavior of the Rufous-capped Warbler in shaded coffee agroecosystems with surprisingly high avian species diversity. This coffee farm, Finca Irlanda, is certified as bird-friendly, a label created by the Smithsonian Migratory Bird Center. As a result of my affiliation with this project and its proponents, I decided for my doctoral research I would investigate the potential for bird-friendly agriculture in the United States. After moving to California, I learned about the grassroots activism of some winegrape growers to conserve native cavity-nesting birds in vineyard landscapes. And from there my research continues to grow.*

### How do you see yourself in the future? Academic work? Conservation-oriented work?

*Both; I am inspired to continue conducting applicable, conservation-minded research in an academic setting. I think academia creates opportunities for conservation-oriented and animal behavior research programs ■*



