WINGS

ESSAYS ON INVERTEBRATE CONSERVATION

THE XERCES SOCIETY SPRING 2009

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Introduction

Scott Hoffman Black

You'll notice that this issue of *Wings* is a departure of sorts. For nearly two decades, each issue of the magazine has had a theme—beetles, global warming, insects and the city, for instance—to which all of the articles related. We still intend to do themed issues, but over the past few years we have been approached by authors with great essay ideas that did not easily coalesce around a particular topic. The occasional themeless issue, such as this one, allows us to give these essays the light of day.

The first article delves into ephemeral water holes—water bodies that dry up, sometimes for lengthy periods. The author explores the strategies that invertebrates use to survive the dry times. Across the Atlantic, in Britain, we get a look at the Riverfly Partnership, an initiative to protect that nation's streams and rivers and the important insects that need them to survive. Survival is also the topic of an essay on deep-sea coral reefs and the amazing invertebrates that are adapted to life on the ocean floor. This issue is completed by a pair of articles that promote different ways to study butterflies—with a camera and with a net.

We hope that you will find each of these essays interesting and enjoyable.

The gray comma (*Polygonia progne*) is a skittish butterfly, likely to take flight as you approach. Capturing it in a photograph may test your stalking skills. Photograph by Bryan E. Reynolds.

The Memory of Water: Life in Ephemeral Water Holes

Craig Childs

I went looking for a water hole in the desert and when I got there it was dry. Walking in the stinging summer heat of southeast Utah for days, all of my needed belongings carried on my back through untrailed canyons and cliffs, I was counting on this water hole. It had always been full before, marked by the green tower of a single young cottonwood tree beneath a shading ledge eight hundred feet up a rock outcrop. It is a place where rain collects in a natural basin. When I found it empty, I stood still for a moment, astonished and afraid.

It is a hard and beautiful way to live, counting on ephemeral water holes like this. You have to be ready for long periods of waiting, traveling at night to preserve water in your body, sleeping in daytime shade. Then the rains come and you bathe in liquid prosperity, filling every bottle you have, drinking and drinking, even washing your face.

Instead of walking away from this dry hole dejected, I shrugged off my pack and dropped to my knees, my eyes sore and burned from the sun. I reached my hands in and began digging. Pawing into the sand I hoped for at least a taste of moisture, maybe a damp, wretched ball of clay I could pack into my cheek to keep me going to the next water.

There are holes I know of in other parts of the desert that are ridiculously rich with water. Some of these water holes, burrowed into the Navajo sandstone of the Utah-Arizona border, hold enough rainfall to fill a swimming pool. In the best years, these water holes are crowded with *Triops*, crustaceans one or two inches in length that look like tiny horseshoe crabs, rare water-dwellers deep in the desert. Whenever I see water filled with *Triops* performing energetic somersaults around each other, I am amazed that such creatures have found a niche in the desert.

Triops look ominous, with their shield-like carapaces and two poppy-seed eyes, a fleshy, pronged tail ringed like that of a rat, and wired sensory organs splayed off the front. They are among the oldest "living fossils" on earth, bodies completely unchanged for approximately four hundred million years. After predatory suction-feeding fish evolved about three hundred million years ago, the only *Triops* that remained were those not in the oceans. Congregating in loose aggregations of water holes, *Triops* survive by moving from one temporary water hole to the next, waiting out dry times in the form of eggs as parched as dust.

If there were any *Triops* in this dry Utah hole, they existed only in the form of anhydrobiotic cysts, the animal's waiting phase. Anhydrobiosis—life without water—is an adaptation common to many water-hole creatures. It is a form of existence in which all measurable life processes are shut down. Basically, these animals die but can, under the right circumstances, come back to life. Many invertebrates living in ephemeral water sources rely on anhydrobiotic stages to bridge the long, desiccating periods between rains. In their larval or egg form, they in essence become “seeds” that can withstand incredible pressures and doses of radiation that would quickly kill the adult phases. Unprotected cysts taken by space shuttle to outer space and exposed for prolonged periods to cosmic radiation were still able to come to life when added to water back on earth. Like pollen grains, the cysts of each species are uniquely shaped, with hooks or wings that grab onto passing animals or catch the wind in search of the next rain, the next water hole. They are models of physical endurance and patience.

At this empty water hole I was not in *my* waiting phase. I was very thirsty. I put my back into digging down through sand, spraying it out behind me until I reached a layer of putrid black clay that was slightly damp. At that layer I began digging outward, forming a basin. Black water beaded out of the clay. I quickly gathered flat pieces of sandstone and built up the edges of my basin, hold-

Tadpole shrimp (genus *Triops*) live only in temporary freshwater pools. They have an accelerated life cycle that allows them to develop from egg to adult in a matter of weeks. Photograph by Betty Nottle.

ing back the black clay. Clear water appeared through my sandstone cistern, slowly filling a cup in the bottom that I gathered in my palms and drank. It tasted good. After an hour, I had a couple of gallons of fresh water.

I once worked mapping water holes for the United States government along the border between Arizona and Mexico, a remote and desolate part of the Sonoran Desert. It is a region where you would expect no water at all, arid basins twenty miles wide broken by thorny, barren mountains. But there is water in the mountains, natural holes worn into bedrock collecting sporadic rainfall. In a good year I counted several thousands of gallons of water in the water holes of one of these ranges, and almost all of them were heavily populated with various crustaceans: tiny, bustling ostracods, clam shrimp in their own translucent shells, and fleets of fairy shrimp cruising the holes like sharks.

Even in the harshest of landscapes, water gathers into pools following rainstorms. Although they last only weeks or days, such pools often teem with life. Photograph taken at Vermillion Cliffs, Utah, by Zane Paxton.

As their name suggests, clam shrimp look like bivalve molluscs but are actually crustaceans. The female lays her eggs into a space beneath her shell; they are released when she molts. The eggs can survive up to seven years without water. Photograph by Betty Nottle.

Bees and dragonflies visited these water holes, slipping in and out while I took measurements. At times, when I rested in shade nearby, I heard bighorn sheep clattering down through loose rocks to the water, where they dipped their heads and drank. The water holes are strongholds of life.

What amazes me is the ability of invertebrates in these pools to determine how long water will last and to adjust their life cycles accordingly, each pool requiring distinct calibration. One observer visited an Arizona stock tank for the nineteen days that it held water after a heavy summer rain. Nearly twenty species of invertebrates and amphibians appeared during this time, and he took note of each. Predaceous beetles, *Eretes sticticus*, hatched by the thousands from eggs laid by adults that flew in from unknown water sources. Their development followed in perfect stride the slow vanishing of the pool. On the nineteenth day, at 10:30 in the morning, the pool came very near to drying. En masse, the beetles, which had only recently reached their adult phase, suddenly produced an intense, high-pitched buzzing sound. Then, as the researcher stood watching, the entire group of beetles lifted into flight at once. The swarm set off to the southwest, disappearing at the horizon. Within one hour the pond went dry.

This kind of ability to perceive subtle environmental signals of impending change is common among dwellers of ephemeral water sources. Phenotypic plasticity allows organisms to alter their body shape in step with changes in the surrounding environment. Toads, fairy

The end can be abrupt for inhabitants of temporary pools. Dead clam shrimp litter this dry water hole, but their eggs remain as cysts, lying dormant until the next wet period. Photograph by Betty Nottle.

shrimp, and beetles will shrink and stretch their growth rates in precise cadence with the pool's life span. Development rates in water holes depend not on the original size of the pool but on the rate at which it dries. Thus, small pools do not necessarily produce small organisms. Rather, pools that dry quickly produce small organisms because the animals must develop rapidly, resulting in dwarfed adults. It is not the actual volume of water that matters, but how fast the volume is decreasing.

No one yet knows how this rate is perceived. After numerous studies, mostly involving mosquitoes, researchers have been left guessing, suggesting that the organisms distinguish the changing amount of time or effort necessary to move from the top of a pool to the bottom, or that they gain cues from increased crowding. It could be that the mosquitoes discern a changing volume of air in their tracheal systems during their descent to the bottom of the pool. Whatever it is, these organisms appear to know exactly how long their habitat will last. In the case of *Eretes sticticus*, it was down to the hour.

My own adjustments are simple calculations, trekking across the desert feeling the dwindling weight of water on my back, scanning the horizon for a likely canyon, wash, or plain of sandstone where rainwater might collect. After building my cistern, I filled all the bottles I had and hitched my pack onto my shoulders. I moved back into the open desert, a blistering landscape of red stone and blue sky. That night I set a camp and was awakened by a searing crash of thunder and the smell of rain. An unexpected thunderstorm barged in. Rain pummeled me. I had no sleeping bag, no tent, only a wool serape pulled over me. The ground was still hot from the day, and the pounding rain was welcome. My serape quickly soaked through to my skin and I lay in a bath of wind and rain.

Thunderstorms are fickle. They will drop a quarter of the year's precipitation, maybe two inches, in one canyon and leave neighboring canyons absolutely dry. With such localized, sporadic rainfall, some water holes go empty for years at a time. Yet when the rains come and the holes fill, life quickly springs from (or into) the water. The predaceous, aquatic backswimmer *Notonecta* flies from hole to hole. To find the next water hole, it seeks polarized ultraviolet light reflected from smooth bodies of water, the same method used by water striders and dragonflies. Ultraviolet sensors are located in the lower portion of its compound eyes. *Notonecta* flies with its body tilted fifteen degrees to the horizon, placing these UV sensors at a level that will be struck by polarized light off a flat surface at an optimum angle, initiating a dive-and-plunge response. Once, sitting in the desert with a cup of water in my hand, I was bombarded by backswimmers. Five of them made a bull's-eye into the cup. Its mouth just four inches across, it contained the only water to be found in the area.

With all this rain around me on this night, the desert exploded into streams and small flash floods. Even after the thunderstorm departed, dragging its pulses of lightning elsewhere, I lay on wet sandstone listening for hours to burbling, grumbling water that finally dwindled into drips that sounded like chimes on the rock. In the morning I walked back to the water hole I had found dry the day before. This time it was filled to the top with a hundred gallons of red floodwater. I knelt at the edge, cupped my hands, and drank. It was not a wise thing to do, but the water seemed like such a blessing that I could not help myself. Within a minute my stomach cramped into a knot. I doubled over and waited for the pain to pass, knowing it would not linger. I had done this many times before, perhaps a foolish act. It's just hard for me not to drink fresh floodwater when it comes, and feel the zing of life inside of me. The water hole had been waiting, its floor packed with cysts silently prepared for any touch of moisture. When the water came, life erupted and I could feel it in my stomach, the sharp taste of the desert being born again.

Craig Childs has published more than a dozen critically acclaimed books on nature, science, and adventure, including The Secret Knowledge of Water. *He is a commentator for National Public Radio's* Morning Edition, *and his work has appeared in* The New York Times, *the* Los Angeles Times, Men's Journal, Outside, *and* Orion. *He lives off the grid with his wife and two sons at the foot of Colorado's West Elk Mountains. More can be found at his web site, www.houseofrain.com.*

Capturing Butterflies Photographically

Bryan E. Reynolds

Close-up photography of butterflies can be one of the most challenging and physically demanding types of photography, but also one of the most rewarding . On any given day you might be hauling heavy camera gear through swamps and thickets, up rocky cliffs, or across deserts. You might be dodging rattlesnakes, wasps, mosquitoes, or ticks. You can expect sunburn, scraped elbows, and sweat dripping into your eyes. But the reward is sweet indeed when all that trouble yields a great shot.

If you're serious about taking photographs of butterflies (or, for that matter, any small object; the techniques I'll discuss work with other insects, spiders, lichen, reptiles, and amphibians), you need to know what gear to use and how to use it. You should also understand where to find butterflies, their behaviors, and how to stalk them once you find them.

The best camera to use in your hunt is a single-lens reflex (SLR) with a medium telephoto lens, either fixed focal length or zoom. Whether you opt for film or digital is a personal choice. Most people now use digital, but a few still prefer film. The techniques I describe here work for either.

Modern mid-priced SLR cameras provide impressive functions for the money, such as auto-focusing, auto-exposure, and optional flash units. In addition, all of the top camera companies have a myriad of lenses that can be used on their SLR bodies. The best choice is any lens with a focal length between 80 mm and 200 mm. In this general focal range you will find a few that are special macro lenses. Nikon, for example, offers a 105 mm and a 200 mm macro lens (it calls them "micro" lenses) that focus to life size, meaning that the image on the negative or slide is the same size as the subject.

If you already own a macro lens such as these, great, you're ready to go. If you don't, I wouldn't go right out and buy one. Most photographers probably already own a suitable telephoto zoom lens (such as an 80–200 mm or 70–300 mm) to which an inexpensive diopter can be added. A diopter is a small, easy-to-carry, high-quality, multi-element lens that when screwed onto the front of your prime lens provides instant close-focusing ability. This zoom-and-diopter combination works really well for photographing butterflies and offers great versatility; after you finish shooting that mountain, just screw on a diopter, and you're ready for close-ups. Besides convenience, you also don't have to refocus as you zoom in and out with this combo.

Lenses ranging from 80 mm to 200 mm focal lengths provide two benefits over the shorter 50 mm to 60 mm lenses. First is background control. The shorter lenses have such a wide field of view that distracting elements, such as beer cans or your feet, sometimes accidentally end up in the photograph. A longer lens narrows down what the camera sees and helps prevent this from happening. The second, and probably more important consideration, is working distance, the distance between the butterfly and the front of your lens. A 50 mm lens has a working distance of less than one foot to get a frame-filling shot of a butterfly. A 200 mm lens will achieve the same image size at four times the distance. At this greater working distance you won't be as intrusive to the subject's natural behavior. Stick with a longer lens and decrease your frustration.

Another piece of equipment recommended by many books is a tripod. A tripod will add stability and reduce camera shake. However, given that you'll be chasing active subjects, hand-holding is the way to go. This will provide better mobility and considerably lighten your load in the field.

Now that you have your basic gear you should read—or re-read—your manual and get to know your camera. It is really important that you are familiar with the basics, such as where the dials are and what they do, and how to change lenses and film (or memory cards) before you go into the field. A fumbled adjustment or use of the wrong camera setting can be the difference between an acceptable photograph and a great one.

Proper exposure is the first consideration. Most cameras provide four options: auto exposure, manual exposure, shutter priority, or aperture priority. Auto exposure is effectively a point-and-shoot option; the camera sets both shutter speed and aperture. Manual exposure allows you to choose both shutter speed and aperture settings. In between are the two semi-automatic options of

The northern pearly eye (*Enodia anthedon*) likes deep woods. Using total flash was the only way to capture this image. Photograph by Bryan E. Reynolds.

A thumbnail-sized Sheridan's hairstreak (*Callophrys sheridanii*) perched in typical North Dakota badlands habitat. To get close, the photographer had to drop to his belly and then, to obtain sharp focus, made sure to keep the wings parallel. Photograph by Bryan E. Reynolds.

shutter priority or aperture priority, in which you chose either shutter speed or aperture and the camera automatically sets the other. I would recommend you opt for aperture priority. By setting the aperture, or f-stop, you control the depth of field, i.e., how much of the photograph is in sharp focus. An f-stop between f8 and f16 will give your subject just the right amount of sharpness while keeping the background out of focus. However, you have to be careful in low-light situations or if the subject is moving fast or blowing around in the wind. In these situations, flash will have to be used or you could end up with blurry photographs.

The action-stopping capability of flash will freeze any movement of the subject or compensate for low-light situations. Current cameras come with through the lens (TTL) technology, or point-and-shoot flash. The camera will measure the light bouncing off the subject and the flash will extinguish itself when the proper amount of light has hit the film (or, in digital bodies, the sensor). Some cameras come with a flash unit built in. Others require that a flash be purchased separately. They both work the same, but for ease of use in the field, the built-in flash is handier and is one less item to carry around or get lost. Just turn on the flash unit and fire away.

Using flash in this manner is very easy. Basically, you point and shoot. However, total flash can sometimes create unnatural-looking black backgrounds. This happens when the subject is totally exposed by the flash but the flash unit is not powerful enough to light the background, something that frequently happens with butterflies up on tall flowers. One way to help with this is to change the shutter speed. The flash sync-speed (the default shutter speed when using flash) of most modern SLR cameras is 1/200 or 1/250 of a second. Slowing this down to around 1/60 of a second will allow some of the ambient light to come in to provide some illumination of the background. To do this you have to change your camera setting to manual instead of aperture priority. When using this technique on bright sunny days, you have to be careful that you don't get dual images of the butterfly, one from your flash and one from the natural light at the same time, a problem known as ghosting. It's always best to test your system before trying it in the field.

To test your system, take photographs with and without flash and compare them. Which ones do you like best and why? If you have butterflies in your yard, practice with them before you try the techniques farther out in the field. Play with the f-stop and shutter speed on the same subject to see how the photograph changes. Take notes on what you try and don't be afraid to experiment. Once you've practiced at home, you're finally ready to venture forth.

Finding butterflies is usually easy. The hard part is getting close enough to them to get good photographs. Butterflies are typically easier to approach when they're preoccupied with activities such as mating or feeding. Butterflies nectaring on flowers almost always stay still—and they make a pleasing image. Some, however, prefer foods other than nectar. A pile of mammal scat will draw many butterflies. Other species will slurp drunkenly on fermenting apples or tree sap and several like to gather around puddles after a rain to take in minerals, in which circumstances they can often be easier to approach.

Once you find a butterfly, stalk up on it slowly. I routinely crawl on my belly to get close. If the wings are closed, photograph from the side, or photograph from above if the wings are open. By doing this, more of the butterfly will be in focus because the focal plane will

A cloudless sulphur (*Phoebis sennae*) nectaring on a cardinal flower. A moderate f-stop (around f8) rendered both the butterfly and the flower sharp, making them pop out against the background. Photograph by Bryan E. Reynolds.

be parallel to the wings. Preset your magnification and focus, then slowly move back and forth to get the butterfly crisply in your viewfinder. Expect the butterfly to flush, possibly several times, before you even get a shot off. Don't give up; stick with that same individual. I've found that, after a few attempts, a butterfly gets used to my presence and allows a closer approach.

Butterfly photography is not a gentle activity. A good day in the field will involve several hours of bending, stooping, squatting, crawling, getting up and down, holding your breath—and a little cursing. It can also be hard on your knees and elbows; I sometimes wear knee and elbow pads. But, stick with it. The more you're out chasing, the better you'll get to know the behaviors and habits of the butterflies in your area, and the better your photographs will become. Using a handheld rig with a zoom–diopter setup or short telephoto lens, TTL flash, and a lot of patience, will provide you with many hours of fun and great pictures of butterflies.

Bryan Reynolds is a professional nature and wildlife photographer. His work has appeared in several publications from the National Geographic Society, as well as such magazines as Outdoor Photographer, Nature Photographer, Photo Techniques, Highlights for Children, *and* Discover. *Check out his web site at www.bryanreynoldsphoto.com.*

Butterflies can make for striking images, but they can be elusive. Stalking and photographing them is easier when they are preoccupied by feeding or mating. Butterflies drinking at a puddle, photographed in Guyana by Piotr Naskrecki.

The Beauty of Butterfly Nets

Robert Michael Pyle

It is in many ways apt that this piece should be penned on a Friday the thirteenth, the day between Charles Darwin's two hundredth birthday and St. Valentine's Day. The thirteenth, because an unlucky day to me is one when I don't get outdoors in direct contact with nature. Valentine's, because this essay is really a love letter to one of my favorite tools and field companions. And Darwin Day, on account of the simple and certain fact that our all-time greatest naturalist might have merely toiled in quiet obscurity as a country vicar, had it not been for his butterfly net.

When Darwin cut theology classes at Cambridge, he did so to collect beetles and chase swallowtails at Wicken Fen. That's what led him astray, ultimately to his voyage on the *Beagle*, to the Galapagos, and to his residence at Down House where *On the Origin of Species* was written. Things are not too different in our time: E. O. Wilson didn't need a net to study ants, but he made clear in his memoir, *Naturalist*, that his carefree days afield with his insect net were the hours that made him who he is. The godfather of the Karner blue butterfly (*Lycaeides melissa samuelis*) and a great literary recorder of the "individuating detail," Vladimir Nabokov, put it this way: "The ordinary stroller might feel on sauntering out a twinge of pleasure . . . but the cold of the metal netstick in my right hand magnifies the pleasure to almost intolerable bliss."

Some readers perhaps find it odd to read an encomium to the classic collecting implement in a journal devoted to insect conservation. But this is no contradiction, as was recognized in the earliest days of the Xerces Society, when its collecting policy was carefully crafted. When collecting presents an actual conservation risk with overzealous pursuit of rare or highly restricted species, we of course oppose it. But this is an uncommon event. For the most part, aerial insect populations in particular are reproductively adept, elusive, and highly resistant to overcollecting. Besides, as anyone who has actually tried to catch butterflies knows, a human being wielding a net is one of the most inefficient predators you could design. On the other hand, in order to conserve something, you have to know exactly where it occurs. The great contribution of the net-wielders is in building and updating the database of invertebrate distribution. This is why, as counterintuitive as it may seem to some, butterfly nets have been among our most important instruments for insect conservation.

But that is just one reason we should appreciate these simple and centuries-old implements. True, our field guides, state butterfly atlases, and rare-species surveys have commonly depended upon specimens in hand. More and more these days these functions are being conducted with binoculars and digital cameras instead, and that's all to the good when it serves the purpose just as well. But it doesn't always.

Pinned specimens contribute to scientific knowledge about butterfly diversity and distribution. They are also useful for education; this box, which includes both rare and common species, is used to train land managers to identify butterflies. Photograph by Jim Haeger.

The fact is, many butterflies—especially certain blues, skippers, and rare varieties only subtly differentiated from more-common types—require close examination for positive identification. For these it doesn't help to have an approximate ID; positive recognition is essential.

For example, during my recently completed Butterfly Big Year, I was looking (among other things) at the responses of ranges to changing climate, and I certainly saw some dramatic examples. But, at one spot in arid north Texas, I thought I had found a species abundant more than a hundred miles north of any previous records. Surrounded by my field guides, I still couldn't determine the species for sure from my notes, or from photographs. Even the national authority on the group had to dissect a specimen to be certain which of two species it represented—and in the end, he was able to determine that it was the one that belonged there after all.

So the reliability of occurrence data is essential—and often it is still the net that sifts good data from bad. Nets are seldom weapons of mass destruction and need not even be lethal. I do a great deal of my field survey and teaching with harmless catch-and-release. I find that people make a deeper connection when they can examine a creature up close, from every angle, and then carefully release it to a flower, or a child's nose. This practice, employing net, tweezers, and a light and practiced touch, gives a far more satisfactory encounter for a group than a fleeting glimpse from yards away.

And that brings us to my favorite reason for loving butterfly nets: they are the cheapest, simplest, and most effective environmental education tools ever invented. Give a child a pair of binoculars or a camera, and he will be occupied for a moment or two, before setting it aside. But give her a net, and watch her go! Besides, the argument that all interaction with butterflies should be conducted solely through optics is an elitist one; most kids can't afford close-focusing binoculars or a good camera, but they can often pull together twelve or fourteen bucks for a basic net from BioQuip—or make one themselves, as my friends and I always did. To this day I chiefly use a net fashioned from a Colorado cottonwood branch—an artifact from my youth—that I named Marsha. I made Marsha almost forty years ago, and she has had a hard life (described in detail in *Walking the High Ridge: Life as Field Trip*). Yet she is still with me, a beloved friend who has helped me introduce butterflies to thousands of children and their parents.

Kids love nets because chasing insects is *fun*. It also brings the chaser face-to-face with exciting, novel, always-surprising *life*. Talk to any number of biologists, doctors, wildlife managers, and other life-science professionals, and the preponderance of them will tell you that catching bugs was a vital early stimulus for their engagement with nature. And consider the current crisis of children's disconnection from the living world, articulated in Richard Louv's book *Last Child in the Woods: Saving Our Children from Nature Deficit Disorder.* Most kids used to wander freely and catch fireflies in a jar—or crawdads, or polliwogs—and, through those encounters, learned to connect with the land on which we all depend. These days, their attachment to electronica almost from birth, combined with parents' fears for their child's safety and the loss of accessible habitats close to home, means that this fundamental experience of roaming freely is increasingly rare. Where will our future conservationists

Butterfly nets offer children an intimate connection to butterflies that cannot be replicated by viewing from afar. Photograph by Idie Ulsh.

and biologists come from, when kids no longer chase grasshoppers in real life? Well, there is no more effective defense against nature deficit disorder than the butterfly net! That's why the Lepidopterists' Society has initiated the Outernet Project, to get free nets into the hands of curious kids, and to get them outdoors with knowledgeable mentors.

Now, some people oppose the use of nets outright. With the exciting rise of butterfly watching and photography in the outdoor-recreation repertoire, an either/or mentality has too often crept into people's attitudes. Since my *Watching Washington Butterflies* (1974) and *Handbook for Butterfly Watchers* (1984) were among the first books to push these activities, I accept some responsibility for this trend. However, I have always promoted watching and photography *alongside*—not *instead of*—responsible netting. I continue to preach mutual tolerance in this regard and an ecumenical approach among watchers and catchers, as parallel parts of the community of butterfly lovers.

For my own part, I have carried both my binoculars and my netstick (when appropriate) for several decades, and I feel naked without either one. They can be wonderfully complementary means for exploring the living world. During the Butterfly Big Year, I used Marsha a great deal—as net, yes, but also as companion, and walking staff. But I also employed Akito, a beautifully engineered, extendible and collapsible Japanese net, given me by a fine lepidopterist of the same name; a basic BioQuip wooden-handled net, easy to jump out of the car with; and a little foldable job known as Mini-Marsha that fits into a pocket for times when I need both hands. I used them all—or none. When investigating endangered species, such as the Uncompahgre fritillary above thirteen thousand feet in Colorado's San Juan Mountains with Xerces director Scott Black; in parks and preserves, where nets were not welcome; or when in company with watchers uncomfortable with nets, I relied solely on my binoculars. The point is, all of our appliances for apprehending nature, taken together, are like a good tool box: more than the sum of their parts. When a butterfly in the bush just won't do, a net in the hand, deftly and gently wielded, may be just the right tool for the job.

Watching and photographing butterflies as a recreational pastime now draws increasing numbers of enthusiasts. But to me, doing away with butterfly nets, as some advocates of butterfly watching would like to do, would be a mistake. Many butterfly watchers, like most biologists, began with a butterfly net, and learned much of what they know on the end of it. Many will go on to enjoy butterflies through ground glass instead of gossamer mesh; more power to them. My wish for all children is that they may know the delight of a sunny day afield in company with the bright wings of summer. If that should involve a net, more power to them, too.

Robert Michael Pyle, the founder of the Xerces Society, made his first butterfly net fifty years ago. Portraits of the several nets employed during his 2008 Butterfly Big Year, including, of course, Marsha, may be viewed on the Butterfly-A-Thon blog at www.xerces.org. Bob is the author of fifteen books, among them The Butterflies of Cascadia *and* Sky Time in Gray's River.

Riverfly Partnership: Protecting Britain's Rivers

Vicky Kindemba

In picturing a British river, many people will imagine the languid flow of a lowland stream beneath drooping trees, the surface broken only by the circular ripples left by trout rising to feed. Within the watery depths and hovering around the river banks, there are insects that underpin the health of rivers; these are the "riverflies," a collective of insect groups including mayflies, stoneflies, and caddisflies. The immature stages of riverflies can commonly be seen darting among water plants; and the larvae of one group, caddisflies, carry elegantly crafted cases over the stony riverbed. The adults of all of the groups swarm at the river surface and flit between bank-side plants.

Healthy rivers are alive with riverflies. They are an essential component of freshwater ecosystems, forming an important link in aquatic food chains by feeding on algae and being eaten by predatory fish such as trout and salmon. An abundance of riverflies and other invertebrates is central to the sustainability of rivers in terms of both habitat quality and species diversity.

Mayflies, stoneflies, and caddisflies all live in water when immature and on land as adults. Because of this change between life stages, they require appropriate vegetation—both in the stream channel and along the riverbank—for shelter throughout their lives.

In a country as small and as densely populated as Britain, there are many threats to riverfly populations. Straightening and widening river channels causes the loss of important bank-side

The term "riverfly" refers to members of three orders of insects. One of these is Trichoptera, the caddisflies. Because they are cannot tolerate pollution, they can be used as indicators of stream health. Yellow spotted sedge (*Philopotamus montanus*), photographed by Stuart Crofts.

and shallow in-stream habitat. Draining and in-filling ponds removes habitat for some specialized species. Soil erosion from farmland smothers stony riverbeds, prevents plant growth, and clogs the gills of riverfly larvae. Farmland also sheds nutrients, which boosts growth of aquatic vegetation to excessive levels, and insecticides wash from both farms and industrial sites during heavy rain. The impact of insecticides can be catastrophic. Just a teaspoon full of cypermethrin-based pesticide can devastate populations of riverflies and other aquatic invertebrates along more than six miles (ten kilometers) of a river. In addition, disused mines contribute damaging acidic runoff. Many of these impacts are compounded by diversion or removal of water: reduced

Britain's rivers and streams are home to a diverse community of insects. Because they live in the water as larvae and in the air as adults, riverflies need bank-side vegetation as well as clean conditions in the stream channel itself. Photograph by John Bridges.

river flows result in less habitat for riverflies, and less water means pollutants become more concentrated. Away from the water's edge, light pollution is a growing issue for adult caddisflies, as artificial light can lure them away from the water and cause them to become disoriented.

Careful management of waterways and bank-side vegetation is critical to maintaining riverfly populations. A buffer strip of vegetation can be a good way to filter water running off adjacent land to reduce nutrients, sediments, and other pollutants from entering the river. Excessive cutting of bank-side and in-stream vegetation can be detrimental, but the clogging of watercourses with plant life is also a problem. A moderate amount of bank-side grazing creates a mixed vegetation sward, which is ideal habitat for many species, but too much can cause bank erosion and stream siltation. A careful balance is needed to achieve natural river systems with a variety of vegetation, clean rocky beds, and open water.

The problems facing riverflies were noticed decades ago by scientists, anglers, and others closely associated with Britain's rivers. In the mid-1970s, the first recording program was established to survey for caddisflies; a similar program was started for mayflies in 2000. During the 1980s, monitoring of riverflies was pioneered and training workshops for anglers first presented. The workshops became increasingly popular through the 1990s. The positive results of these activities were witnessed in 1999, when monitoring by a local anglers' group highlighted serious pollution incidents on the River Wey. In 2001, Britain's Environment Agency

Another order of riverflies is Plecoptera, the stoneflies. *Nemoura cinerea*, photographed by John Bridges.

published a landmark report documenting the dramatic decline of riverflies in chalk streams, which had been noted by anglers.

The culmination of all of this activity was the creation in 2004 of the United Kingdom Riverfly Partnership. Today the Riverfly Partnership brings together anglers, conservationists, entomologists and other scientists, watercourse managers, and government agencies to work together to increase expertise in and understanding of British riverfly populations and to promote conservation efforts. Semi-annual meetings bring together the partner organizations to develop workshops, conferences, and outreach materials, and to address research, fundraising, and policy issues.

The third order of riverflies is Ephemeroptera, the mayflies. Mayflies have fleeting lives as adults, as little as thirty minutes for some species. *Leptophlebia*, photographed by John Bridges.

Funds for the partnership support the monitoring workshops as well as conservation programs. Funding is also used to support workshop trainers and staff of partner organizations who are working on Partnership tasks.

The importance of anglers as watchdogs of rivers and lakes was demonstrated by the protection of the River Wey, and anglers are becoming increasingly proactive in the monitoring and management of their rivers. A significant part of the work of the Riverfly Partnership is the Angling Monitoring Initiative. This initiative uses a simple technique that enables angling groups to monitor the biological quality of their rivers by recording riverfly larvae on a monthly basis. Riverflies were used due to their general intolerance to pollution and need for good water quality, a sensitivity that has caused them to be called "the canaries of our river systems." To support anglers, the Partnership organizes training courses and provides expert guidance. Angling groups throughout Britain are now monitoring the health of their river catchments and collecting long-term data on their rivers, which are fed back to government agencies. This regular monitoring helps to identify any changes in water quality and alerts government agencies to problems, allowing pollution incidents to be dealt with rapidly and effectively by these agencies. Monitoring by angling groups has already led to successful prosecution of river polluters.

The Riverfly Partnership is also involved in the conservation of rare and threatened riverfly species. Eight riverfly species have been designated as conservation priorities by the British government, including the iron blue mayfly (*Nigrobaetis niger*), which has declined significantly, and a caddisfly, the small grey sedge (*Glossosoma intermedium*), which recent surveys found in only two streams. The Partnership's Species and Habitat Group has secured funding for a project that will raise awareness, carry out research, and implement conservation projects for the eight priority species. Over the next three years, the Species and Habitat Group will conduct surveys to establish priority species' distribution and abundance, and increase understanding and monitoring through the publication of resources and keys. Monitoring of the focal species will be expanded. Conservation guidelines for each species will be produced and distributed to land managers and anglers to promote habitat management and creation, such as the excavation of ponds to benefit the window winged sedge caddisfly (*Hagenella clathrata*). Captive breeding programs will be developed for species with restored river habitat within their historic range.

By engaging a diversity of organizations and interest groups, the Partnership is taking strides to ensure that rivers and streams maintain their importance, both visually and ecologically, in Britain's countryside. Rivers, streams, and ponds are, quite literally, downstream of everything else and are impacted by what happens on the surrounding land. Fortunately for Britain's rivers, the Riverfly Partnership is promoting greater awareness, understanding, and conservation of three keystone groups of insects—mayflies, stoneflies, and caddisflies.

Vicky Kindemba is the freshwater officer at Buglife—The Invertebrate Conservation Trust, Britain's leading invertebrate conservation organization. She chairs the Riverfly Partnership's Species and Habitat Group. Craig Macadam of the Mayfly Recording Scheme and Bridget Peacock, director of the Riverfly Partnership, contributed to this article. To learn more about the Partnership visit www.riverflies.org, and for information about the conservation of riverflies visit the web site of Buglife at www.buglife.org.uk.

The cinnamon sedge caddisfly (*Limnephilus lunatus*) is widespread across Europe. In Britain, the adults may be seen anytime between May and September, often resting on waterside vegetation. Photograph by John Bridges.

The Importance of Deep-Sea Coral Communities

Brian Tissot

I remember my first dive clearly, gradually sinking to the bottom in three hundred feet (ninety meters) of water. As the bottom approached, the water cleared and in the dim light I could make out white objects covering the seafloor. Suddenly, we landed and the submersible's pilot turned on the outside lights. Wow! We were surrounded by corals, sponges, and feather duster worms, carpeting the rolling landscape as far as the eye could see.

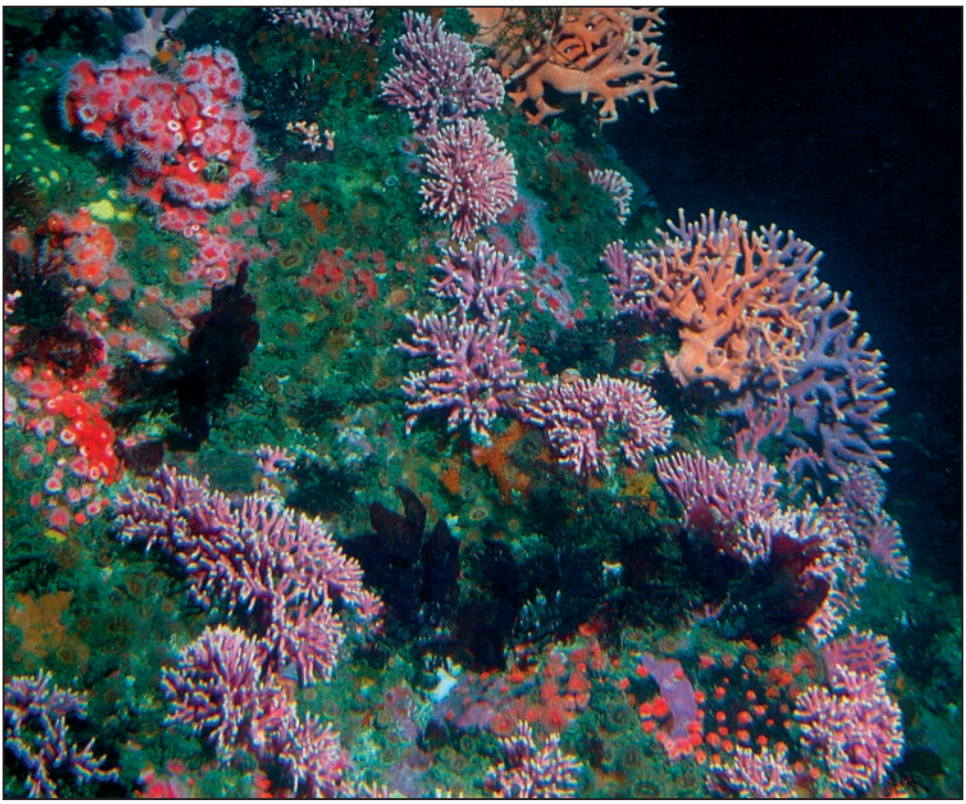
This first encounter with deep-sea corals was on Heceta Bank, forty miles (sixty-five kilometers) off the Oregon coast, hardly a place that fits the classic image of a reef basking in sunlight under clear tropical waters. Corals, though, are world-wide in distribution and are quite common in both shallow and deep oceans as well as warm and cold seas. Unlike corals in shallow tropical waters, cold-water deep-sea corals and their associated communities are relatively unexplored. In the last few decades, however, we have begun to learn a great deal about these fascinating communities, their unique role in sustaining healthy fisheries, and the serious threats they face from human impacts.

Corals are classified in the phylum Cnidaria (from the Greek word *knide*, or "stinging nettle"). We currently know of dozens of species in several taxonomic groups, including stony corals, black corals, gold corals, hydrocorals, and gorgonian corals. Like their tropical counterparts, deep-sea corals comprise solitary or colonial anemone-like polyps supported by external calcareous skeletons. Individual polyps harvest plankton and other nutrients from seawater using stinging cells. Because they feed on food-laden ocean currents, they are often found in habitats that exhibit very specific combinations of substrate, ocean currents, sedimentation rate, temperature, and salinity.

Although corals are animals, they are often mistaken for plants due to their sessile habit and bushy or tree-like shapes. Large aggregations of corals may resemble small forests or thickets. Some coral colonies may exceed fifteen feet (five meters) in height and form extensive deep-water "coral gardens." These are often associated with large numbers of fish and other marine life, as evidenced by the schools of small juvenile rockfish—a commercially important species that uses these areas for nursery habitat—that I saw among the corals and sponges on Heceta Bank.

Deep-sea corals inhabit the deeper continental shelves, slopes, canyons, and seamounts of the ocean at depths anywhere from one hundred sixty feet (fifty meters) to ten thousand feet (more than three thousand meters). For this vast area of the ocean, our knowledge is extremely limited. Although recent advances in seafloor mapping and submersible technology have permitted scientists to begin to locate and map the distribution and abundance of deep-sea corals, research efforts in deep-water environments are extremely costly and logistically difficult, so individual research missions typically cover small sites. Still, we have learned that deep-sea corals are both ecologically important and vulnerable to a wide variety of threats from human activities, and as such are in dire need of coordinated conservation efforts around the globe.

Of course, one major reason why deep-sea corals are so important is the ability of some species to build reefs, features which may include other invertebrates such as sponges, feather dusters (crinoids), basket stars (brittle stars), and anemones. Taken together, these "structure-forming" invertebrates may serve as important habitat for a wide variety of marine life, especially fishes. In addition to shelter, these structures may improve feeding habits and provide critical breeding grounds and nursery areas for vulnerable young fish. In Alaska, a study by Bob Stone of the National Oceanic and Atmospheric Administration (NOAA) has shown that 85 percent of commercially important fishes and crabs were observed in association with corals and other structure-forming in-



Deep-sea corals may form reefs that are both impressive and diverse. These reefs, in turn, provide habitat to many other species and are important for productive fisheries. Hydrocorals and strawberry anemones, photographed by Victoria O'Connell.

vertebrates. In the Atlantic waters off the coast of the southeastern United States, coral structures have trapped sediments that, together with the skeletal material of dead corals, have formed reefs eighty feet (twenty-five meters) high at depths of twelve hundred feet (three hundred and sixty-five meters) below the surface. A study by John Reed of the Harbor Branch Oceanographic Institute found these reefs to be occupied by seventy species of fish and more than three hundred species of invertebrates.

Back in 1988 when we took that first dive to Heceta Bank, the principal creatures of interest for the research cruise were fishes, with deep-sea coral communities as just a piece of seafloor "habitat." Those of us with an interest in the corals almost had to be stowaways in the submersible. Fourteen years later, in 2002, I returned to the Bank for a new series of dives. However, this time the corals and other invertebrates were on an equal footing with fishes—recognition that damage to deep-sea coral communities was a key element in recent failures of the Northwest groundfish fishery. Our team's research focus was now on how fish and benthic invertebrates live together and how these deep-sea coral communities form essential fish habitat, the holy grail of recent conservation efforts.

The last six years have seen a growing scientific and political interest in deep-sea coral communities stemming both from our increased understanding of the importance of these ecosystems as habitat for fishes, and from their high vulnerability to human impacts. Many deep-sea corals—particularly gorgonians, black corals, and sea pens—are slow-growing and long-lived. Gorgonians in Alaska may be one or two centuries old by the time they reach six feet (two meters) in height; a colony of gold coral in the Bahamas was estimated to be eighteen hundred years old! These ancient features are especially vulnerable to mobile fishing gear: bottom trawls that target bottom-dwelling fish drag nets on the seafloor and can break, smash, and otherwise damage deep-sea corals and other marine life. These coral communities can take many years to recover, and coral damage can significantly affect organisms in surrounding ecosystems, particularly fishes that depend on corals for essential habitat for shelter, feeding, and reproduction.

Research documenting the impacts of different fishing methods on seafloor habitats has found corals to be particularly vulnerable. For example, Mark Hixon of Oregon State University and I recently conducted a study off the Oregon coast that showed that fishing using bottom trawls reduced the abundance of sea pens by 99 percent and decreased the overall abundance of benthic invertebrates by 55 percent. Other studies from around the world have yielded similar results, and many nations have taken steps to provide protection for habitats where deep-sea corals occur.

In the last few years conservation of deep-sea corals has also been emerging as a high-priority policy issue in North America. In 2005, the Bottom Trawl and Deep-Sea Coral Habitat Act was introduced into the United States Congress. This would have temporarily banned the use of mobile bottom-tending fishing gear in unstudied areas until research determined whether deep-sea coral ecosystems are present, and would

Gorgonian soft corals offer shelter to rockfish. When damaged by fishing trawls, they may take a century to grow back. Photograph courtesy of Ed Bowlby, NOAA.

have permanently banned the use of mobile fishing gear in Coral Habitat Conservation Zones where deep-sea coral ecosystems are known to exist. Although this act did not pass, the next year Congress did provide protection for deep-sea coral habitats by amending the reauthorized Magnuson-Stevens Fishery Conservation and Management Act.

Also in 2005, NOAA Fisheries closed nearly four hundred thousand square miles (a million square kilometers) of the North Pacific Ocean surrounding the Aleutian Islands of Alaska to destructive commercial fishing. These areas included spectacular deep-sea coral and sponge gardens. Similarly, in 2006, NOAA Fisheries approved a plan to establish and protect more than 130,000 square miles (337,000 square kilometers) of marine waters off the West Coast of North America as essential fish habitat for commercially valuable bottom fish. Within much of this area the plan prohibited fishing methods—such as bottom trawling—that can cause long-term damage to the ocean floor. During this same period both the North Pacific and Pacific Fishery Management Councils proposed and adopted fishery management plans that provide protection for deep-sea coral habitats.

In the two decades since my first dive, ocean management has clearly improved, but we are still just beginning to understand and protect these valuable deep-sea habitats. Currently there is insufficient protection—and it is not keeping pace with the rapidly expanding exploitation of marine resources. In the past decade, fishing trawlers operating in the open seas in international waters have had devastating effects on deep-sea coral habitats. Protecting these areas, to be successful, requires both increased awareness and international cooperation. Thus, in addition to more research on deep-sea corals, which will no doubt reveal some surprises, we need to spread the word about these fantastic organisms and their critical importance to sustaining healthy fisheries and maintaining the oceans' productivity.

Brian Tissot is a professor in the School of Earth and Environmental Science at Washington State University in Vancouver, Washington. A marine ecologist, he specializes in studies of marine invertebrates, especially on issues that occur at the interface between biology, fishery management, and policy. He also studies the effects of the live aquarium trade on coral reefs in Hawaii and the restoration of endangered black abalone in California.

Deep reefs form a physical structure on which many other species can live, often with one species finding refuge in or on another. Feather stars on a vase sponge, photographed by Rick Starr.

XERCES NEWS

Research on and Advocacy for Rare and At-Risk Invertebrates

With funding from the U. S. Forest Service and the Bureau of Land Management, Xerces Society staff members are engaged in assessments of forty-nine species of rare Pacific Northwest invertebrates. These animals include dragonflies, stoneflies, butterflies, caddisflies, snails, and the Oregon giant earthworm (the largest earthworm in North America, reported to have lily-scented spit). We are working to understand habitat requirements and mapping the distribution of these species so that land-management agencies and the Xerces Society can better understand—and thus protect—these vulnerable creatures.

This summer, Xerces staff will survey for the Siuslaw hairy-necked tiger beetle (*Cicindela hirticollis siuslawensis*) in the sand dunes of the Oregon coast. This tiger beetle once ranged along the Pacific coast from southern Washington state to northern California, but may now be relegated to only a few locations in Oregon. Surveys will allow us to fully understand the extent of decline that this species has experienced, and help us to prioritize conservation efforts.

Each year the Joan Mosenthal DeWind Award, administered by the Xerces Society, provides funding for research into Lepidoptera conservation. Two individuals were awarded grants for this year. Erica Henry of Washington State University at Vancouver is investigating ways to manage habitat for highly imperiled populations of the mardon skipper (*Polites mardon mardon*) in Washington's Puget Trough. Zach Gompert of the University of Wyoming will examine how a bacterial infection (*Wolbachia*) affects the Karner blue butterfly (*Lycaeides melissa samuelis*), an endangered species found in the upper Midwest and Northeast. This infection may negatively impact the demographics of Karner blue populations.

We continue to advocate for such species as the Salt Creek tiger beetle (*Cicindela nevadica lincolniana*). The U. S. Fish and Wildlife Service recently announced the reopening of the comment period on a proposal to designate critical habitat for the tiger beetle under the Endangered Species Act. The USFWS is proposing to add 138 acres of critical habitat resulting in a total area of just 1,933 acres.

Three years ago, a multi-agency team of scientists concluded that more than thirty-six thousand acres of critical habitat were needed for the recovery of the Salt Creek tiger beetle. At the prompting of the USFWS, this team revised their recommendation to fifteen thousand acres, but expressed that this was the minimum amount needed for the species to recover. Scientists involved in the conservation of this tiger beetle believe that the present proposal of less than two thousand acres will be inadequate for the protection or recovery of this species. The Xerces Society is working with these scientists to ensure that the USFWS provides meaningful protection for the Salt Creek tiger beetle.

Protecting Endangered Yellow-Faced Bees in Hawai'i

A number of yellow-faced bees (*Hylaeus* species) endemic to the Hawaiian Islands are threatened with extinction. Yellow-faced bees are important pollinators of native Hawaiian plants (many of which are also endangered). The decline of these pollinators could lead to the loss of native plants; conversely, their protection could aid the recovery of some endangered plants.

In order to gain protection for these yellow-faced bees and the habitats upon which they depend, in March 2009 the Xerces Society petitioned the U. S. Fish and Wildlife Service to protect seven of the most at-risk species under the Endangered Species Act. The petitioned species include: *H. anthracinus*, *H. longiceps*, *H. assimulans*, *H. facilis*, *H. hilaris*, *H. kuakea*, and *H. mana*.

In the late 1800s and early 1900s, the biologist R. C. L. Perkins called yellow-faced bees "almost the most ubiquitous of any Hawaiian insects." By surveying many of Perkins' original collecting locations, biologist Karl Magnacca has demonstrated that most Hawaiian yellow-faced bee species are in decline, many of them are extremely rare, and several are possibly extinct.

Yellow-faced bees can be found in a variety of habitats on the Hawaiian Islands, including coasts, dry forests and shrublands, mesic and wet forests, and subalpine shrublands. All Hawaiian yellow-faced bees strongly depend on an intact community of native plants and are mostly absent from habitats dominated by non-native plant species. The bees require habitat with a diversity of plants that flower throughout the year so that a consistent source of pollen and nectar is available. They also need an abundance of nest sites, in the ground for some species and in hollow-stemmed plants for others.

The yellow-faced bees are threatened by development (particularly in coastal areas), fire, feral ungulates such as pigs, invasive ants, and the loss of native vegetation to invasive plant species. Remnant populations of many species of Hawaiian yellow-faced bees are small and isolated, and thus especially vulnerable to habitat loss, predation, stochastic events, and other changes. Conservation of these important pollinators will require active management of natural areas where populations are known to exist.

Xerces Lobbies for Pollinator Funding in the U. S. Farm Bill

The Xerces Society recently worked with Senator Barbara Boxer (D-CA) to draft a letter requesting that the Agriculture Appropriations Subcommittee allocate $20 million for pollinator research. If allocated, this money will increase the resilience and security of U. S. farming systems by supporting vital research into Colony Collapse Disorder in managed honey bees, and into how native bees can be used to diversify the range of species employed for pollinating crops. The 2008 Farm Bill authorized $100 million over five years to further our scientific understanding of agricultural pollinators, but the funds must be appropriated by Congress each year.

Managed and native pollinators

play a key role in providing more than $18 billion—and perhaps as much as $27 billion—per year in agricultural products in the United States. Yet, total spending on pollinators at the Department of Agriculture accounts for merely a hundredth of 1 percent of the agency's budget. Without native bees and honey bees, our current yields of alfalfa, almonds, apples, cherries, cranberries, blueberries, kiwis, strawberries, melons, squash, peppers, peaches, pears, plums, carrots, onions, and other crops would not be possible.

The Xerces Society reached out to thousands of people asking them to contact their Senators and urge them to support this effort. With their help, Senator Boxer's letter requesting funding for pollinator research funding was signed by Daniel Akaka (D-HI), Max Baucus (D-MT), Sherrod Brown (D-OH), Maria Cantwell (D-WA), Kent Conrad (D-ND), Mike Crapo (R-ID), Russell Feingold (D-WI), Dianne Feinstein (D-CA), Kristen Gillibrand (D-NY), Orrin Hatch (R-WY), Tim Johnson (D-SD), Patrick Leahy (D-VT), Robert Menendez (D-NJ), Jack Reed (D-RI), James Risch (R-ID), Bernie Sanders (I-VT), Charles Schumer (D-NY), Debbie Stabenow (D-MI), and Ron Wyden (D-OR).

Staff Changes at the Xerces Society

When you call our Portland, Oregon, office you may hear a new voice on the other end of the line. Suzanne Granahan has joined the Xerces Society as our new membership and administrative associate. She will be providing membership services and office management support. Sean Tenney, who served in the position for the past year and a half, has left Xerces so that he can travel through Mexico and Central America. We wish Sean the best, and welcome Suzanne.

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For information about membership and our conservation programs for native pollinators, endangered species, and aquatic invertebrates, contact us:

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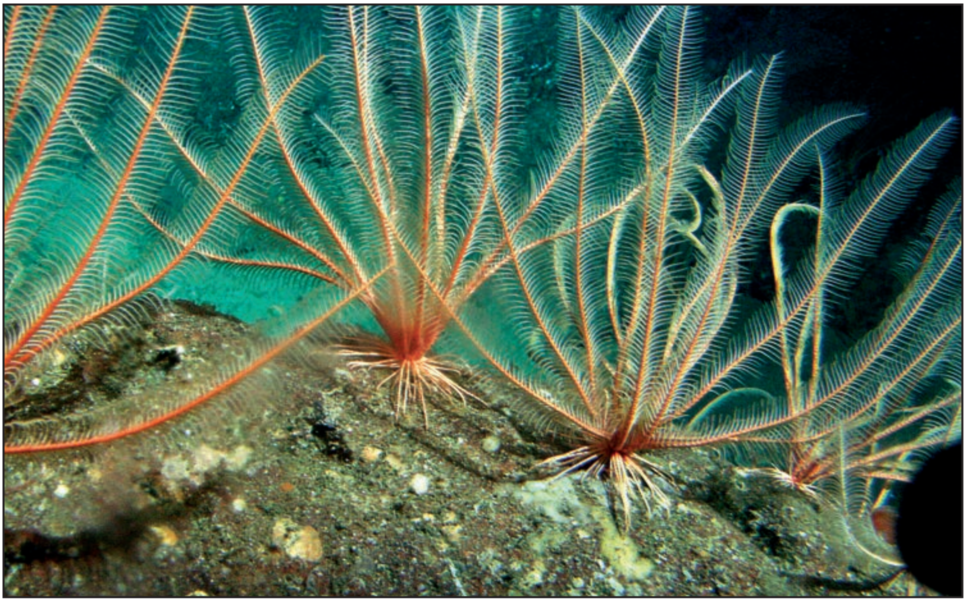

Although having the appearance of plants, these feather stars are actually invertebrates, and are closely related to sea stars and urchins. They hold their arms out to catch the rain of detritus that descends from the ocean's surface. Photograph by Michael Carver, Cordell Bank National Marine Sanctuary.

Our cover photograph shows a water strider (genus *Gerris*)—called a pond skater in Britain—on the surface of a pond. Hairs on the insect's feet prevent it from sinking. The mirrorlike reflection on the water makes it obvious how the meniscus flexes under the strider's feet as it moves. Photograph by David Chauvin.