California's Coastal Scrub

If you visit some parts of Marin County, California, you'll discover a unique habitat known as coastal scrub. A multitude of shrubs and low-growing plants grow there, including wax myrtle, monkey flowers, California sagebrush, California bay laurel, coyote bush, and native bunchgrasses. But you won't find many trees—just the occasional coast live oak or willow. All of those plants have adapted to the region's Mediterranean climate, where six months of wet cool weather are typically followed by six months of hot drought.

Many birds perch on and fly among the coastal scrub, including golden-crowned kinglets, white-crowned sparrows, golden-crowned sparrows, and Bewick's wrens. Rufous-crowned sparrows, vireos, kinglets, and wood warblers forage for insects in the green leaves of live oaks and wax myrtles. Bay checkerspot butterfly larvae feed on narrow-leaved plantain. Nearby streams are home to threatened coho salmon and steelhead, which support important fisheries. Rare northern spotted owls nest in nearby forests. In addition, many shorebirds move up local creeks when high tide covers their favored mud flats.

NEW ARRIVAL

In the 1850s, people began planting eucalyptus trees from Australia throughout coastal and central California. The trees grew extremely fast in the United States. They were deemed the perfect source of timber and fuel, replacing the redwood forests that had been clearcut.

Eucalyptus trees survive by sending long roots down and out through the soil. In the process, though, they can clog drains and damage streamsides. In addition, the trees blow over easily in the wind, bringing down more soil in the process. Most eucalyptus trees are filled with combustible resin and have long shredding bark. They produce great quantities of litter—fallen leaves, bark, and so forth—which in their native habitat was broken down by microbes and insects. To ensure that few other plants compete with them, eucalyptus trees also produce their own herbicide that kills many young plants beneath them.

Each winter, eucalyptus trees produce flowers that attract insects and, with them, insect-eating birds. But the flowers of the tree are filled with a sticky gum. In Australia, birds such as Australian honeyeaters and leaf gleaners have evolved long bills that enable them to reach into the flowers without getting the sticky gum all over their bills and faces.

Hawaiian Islands

If you've taken a close look at a world map, you know that the islands of Hawaii are isolated from the nearest mainland by huge distances—more than 2,500 miles. That's one of the main reasons for the tremendous number of species in Hawaii that are found there and nowhere else. Too far away to interbreed with populations on other continents, the species of Hawaii evolved over time in completely unique ways. One species of finch, possibly a Eurasian rosefinch, colonized the islands and eventually evolved into 54 separate species of Hawaiian honeycreepers!

Hawaii's birds did not evolve with any particular adaptation to predators because the islands had few. There were no snakes, no foxes, no raccoons, and no wild cats. There were only two birds of prey: the 'io (hawk) and pueo (owl). Many birds were flightless. Many birds, such as the nene goose, Hawaiian black-rumped petrels, and Newel's shearwaters, built their nests on the ground.

Hawaii's original list of native species included only two mammals: a bat and a seal. Reptiles, amphibians, insects, and other invertebrates abounded. In fact, the islands' tree snails are among the most prized native species.

NEW ARRIVAL

By the 1880s, the Hawaiian landscape had already changed considerably. Early Polynesian settlers—and later waves of Europeans—cut down native forests and introduced grazing animals and poultry. They also began cultivating sugar cane and other crops. But those crops were under attack by accidentally introduced Norway and black rats that had stowed away on ships. Because Hawaii had no predators, the rat populations threatened to grow out of control. So, settlers decided to introduce the small Indian mongoose, a weasel-like animal that is known to eat rats. The Indian mongoose is native from Iran, and traveled through India to Myanmar and the Malay Peninsula.

Small Indian Mongoose. Photo by Rick Taylor, 2/1/06. ©Borderland Tours.

Mongooses are small, slender animals with brown fur and a bushy tail. They breed two or three times a year, producing litters of three young. Females can begin breeding at the age of 10 weeks. Mongooses live in burrows and can adapt to a variety of settings. They feed on a wide variety of small vertebrates, including small mammals, snakes, iguanas, birds, eggs and young of larger vertebrates (for example, sea turtle eggs), large invertebrates, and on occasion, fruits and vegetables.

Florida Everglades

If you've spent any time in the Florida Everglades, you've seen an exceptionally rare and rich habitat. The Florida Everglades is North America's only flooded grassland, a "river of grass" that flows from the Kissimmee River south to the Florida Bay. Along the way, the water fills deep areas called sloughs, surrounds hardwood-covered islands called hammocks, and trickles past the roots of mangrove trees clinging to the shore.

Those varied habitats provide home to a wealth of creatures, many of them found nowhere else on Earth. The United States' only population of Florida panthers—numbering only about 60—ekes out a life by hiding in remote areas and feeding on deer, raccoons, and other animals. Flocks of wading birds rely on small fish and invertebrates for their food. Large fish prey on those smaller fish. Alligators cruise the waters in search of a meal of large fish, birds, or other easy prey. Large birds called snail kites fly overhead keeping an eye out for their one and only food: Florida apple snails.

All of those species have been hard hit by habitat loss in the Everglades, by drastic alterations to the natural flow by human communities, and by pollution. Panthers, wading birds, snail kites, and many other species are threatened or endangered. But new efforts are underway to restore some of the region's water flow, which could help the rare species bounce back and could lead to cleaner water resources for wildlife and people alike.

NEW ARRIVAL

In the mid-1990s, scientists were surprised to discover a strange creature inhabiting waterways in Georgia and Florida: the Asian swamp eel. Swamp eels grow to lengths of up to three feet, and they eat crayfish, shrimp, worms, frogs, tadpoles, and other fishes.

In their native region, swamp eels are commonly caught and sold for food, but in the United States, they have no known predators. They are native to Central and South America, Africa, and Australia, and extend from India to eastern Asia, including much of China.

Asian swamp eels have many adaptations to help them survive in the United States. They can live in everything from ponds to marshes to roadside ditches. They are highly secretive, with most of their activities occurring at night. Because they are air breathers, they can even survive on and travel across land to other bodies of water. The Asian swamp eel can survive weeks without food.

Asian swamp eels have been spotted within a mile of Everglades National Park.

page 2 Hawaiian Islands

Chicago Hardwood Forests

If you walk down the streets of Chicago's city neighborhoods, you'll be impressed by the number and size of large street trees. Among the most common trees are ash, cherry, elms, maples, elms, mulberry, oak, and plum.

You may not normally equate city trees with a forest, but that's what they form: an urban forest that makes cities cleaner, more attractive, and more wild. Chicago's urban forest is a rich habitat for wildlife, providing food and shelter for migrating and resident birds, squirrels, raccoons, opossums, and a host of insect species. The trees provide shade for residents and reduce cooling costs during the summer when they block sun from houses and businesses. They absorb pollutants from automobiles, making the air much healthier to breathe. In fact, scientists recently calculated that city trees in places such as Chicago play a major role in absorbing carbon dioxide that would otherwise reach the atmosphere and contribute to global warming (see source below).

Urban trees are so important to the city of Chicago that experts have estimated their value at about half a billion dollars. And that figure does not even include the hard-to-quantify benefits such as improved appearance, resident quality of life, and long-term climate improvement.

NEW ARRIVAL

In 1998, Chicago residents discovered unusual insects living on city trees: Asian longhorned beetles from China. Just two years before, Asian longhorned beetles had been found in two New York sites. Asian longhorned beetles are about 3/4 to 1 1/2 inches long. They feed on a variety of hardwood trees, especially ash, birches, buckeyes, elms, horsechestnuts, maples, poplars, sycamores, and willows.

Their life cycle begins when a female beetle chews her way through the bark of a host tree and deposits her eggs. Eleven days later, the larvae emerge from their eggs and begin to feed on the living tissue of the tree's xylem and phloem. These are the tree's pathways for carrying water from the tree roots up the tree and taking nutrients from the leafy canopy down, respectively. Once the pathways have been disrupted, the tree will no longer be able to circulate the water and nutrients it needs to survive. After reaching lengths of approximately two inches, the larvae enter the pupal stage. When the adults emerge from the pupa, they bore their way out of the trunk, leaving round exit holes that are just a bit larger than the diameter of a pencil.

Asian longhorned beetles live about one year and usually spread by natural means—flying about 400 yards or more in their beetle stage.

Nowak, D. J. "Atmospheric Carbon Dioxide Reduction by Chicago's Urban Forest." In E. G. McPherson, D. J. Nowak, and R. A. Rowntree, (eds.). *Chicago's Urban Forest Ecosystem: Results of the Chicago Urban Forest Climate Project. USDA Forest Service General Technical Report* NE-186. Radnor, PA: USDA, 1994, 83–94. cufr.ucdavis.edu/products/cufr_189_gtr186b.pdf.

Sagebrush Shrub Steppe

When early settlers traveled the intermountain west, they traveled through mile after mile of sagebrush habitat. More than 12 species of sagebrush grow from British Columbia to Baja California, reaching their greatest concentration in the Great Basin region of Nevada, western Utah, southern Oregon and Idaho, and a small part of eastern California. The hardy plant survives where many others can't by using its deep roots to tap into water and nutrients and by accomplishing photosynthesis even under very low levels of light.

Where sagebrush grows strong, it's something like a community center, providing food, shelter, and even dance space to residents who need it. A total of about 100 bird species, 70 mammals, and 23 amphibians and reptiles depend on sagebrush to some degree, but some are extremely dependent. Pronghorn, for example, rely on sagebrush for about 90 percent of the food they eat. Sage grouse, sage sparrow, sagebrush lizard, and sagebrush vole rely on eating sagebrush and the grasses that grow around it. Sage sparrows and Brewer's sparrows build their nests in sagebrush. Mule deer hide their fawns in the brush. Sage grouse also find shelter from wind, snow, and sun in sagebrush areas. What's more, the spare ground around sagebrush bushes provides the perfect spot for male sage grouses to perform their annual mating dances.

The value of sagebrush extends beyond the species that rely directly on it. Predator species, such as raptors, are drawn to the diversity of small mammals and birds that inhabit sagebrush areas. Where it grows, sagebrush also plays an important ecological function by stabilizing soils and preventing erosion.

Sagebrush in Wyoming, photo by Bureau of Land Management Wyoming

NEW ARRIVAL

Cheatgrass, also known as Downy Brome, is native to the Mediterranean region and was introduced in the United States. in packing materials and, perhaps, as a seed contaminant, in the 1800s. This plant is hardy and grows rapidly, particularly on land that has been disturbed by cattle grazing, farming, or other uses.

The plant is unpalatable and may injure livestock because it forms sharp-edged seed clusters. Cheatgrass also is highly flammable. This plant now affects more than 100 million acres in the United States.

Sources:
Lipske, Michael. "America's Forgotten Ecosystem." *National Wildlife*, (October/November 2000).
Cox, George W. *Alien Species in North America and Hawaii: Impacts on Natural Ecosystems*. Washington, DC: Island Press, 1999.

Atlantic Coastal Estuaries

Up and down the Atlantic Coast, oysters, clams, crabs, and mussels thrive in rich marine habitats called estuaries. Estuaries form where rivers empty out into saltwater bays, creating a mixture of freshwater and saltwater. You will often find them surrounding coastal salt marshes. Wherever they occur, estuaries support a tremendous diversity of marine life—including a lot of popular seafood.

Rich in nutrients and sheltered from big waves, estuaries provide the perfect conditions for many aquatic species to begin their lives. The juvenile Atlantic stingray, summer flounder, bluefish, white perch, striped bass, and other coastal fish spend part of their lives feeding and reproducing in estuary waters. Blue crabs carry out their entire life cycle in and near estuary waters. Scallops, softshell clams, and oysters breed and feed in the brackish waters. Those species, in turn, provide food for many shorebirds including American oystercatchers, gulls, terns, herons, and more.

The Chesapeake Bay, located between Maryland, Virginia, and Delaware, is the largest estuary in the United States. The Chesapeake Bay is one of many Atlantic Coastal estuaries that supplies us with seafood. In fact, more than 60 percent of the edible seafood in the United States comes from coastal estuaries.

NEW ARRIVAL

Scientists estimate that the first European green crabs arrived on the Atlantic Coast more than 150 years ago. Those crabs, originally from Europe, probably arrived in the ballast water of ships. Ships take on ballast water in port after emptying cargo. The water helps the ships stay stable for their next journey. Unfortunately, that ballast water is full of aquatic species from the original port. When the ships discharge the ballast water in their next port, the species are discharged, too.

Young green crabs do best in coastal ponds, lagoons, and bays. They are voracious eaters, consuming mussels, clams, snails, other crabs, barnacles, aquatic worms, and green algae. They can't easily crush a hard clam shell, but they can dig out soft clams from the clams' burrows that are six inches deep. Under the right conditions, female green crabs can spawn up to 185,000 eggs at a time.

Understanding Invaders Worksheet

1. Describe the original ecosystem (before the arrival of the new species).

2. Using the information provided, draw a diagram showing the web of relationships in the original ecosystem (for example, predator/prey relations, ways animals depend on plant habitat, ways people depend on wild species, etc.)

3. Are there any plants or animals in the original ecosystem that seem particularly important? Explain.

4. What is the nonnative species described on your handout.

5. Where did it come from, and how did it get to the ecosystem?

6. Make some predictions about how this new species might affect the ecosystem. What changes might occur? What benefits might come of those changes? What problems? Be sure to provide a justification for your ideas.

Useful Websites on Invasive Species

California Academy of Sciences
www.calacademy.org/science_now/—The California Academy of Sciences' website has a Science Now section that presents a changing display of current issues and research being done in California.

Invasive Species Specialist Group
www.issg.org—This website lists the top 100 invasive species around the world and provides a global invasive species database.

The Nature Conservancy
tncweeds.ucdavis.edu/products/gallery/regionlist.html—This website provides information on The Nature Conservancy's Global Invasive Species Initiative. It includes resources designed to help conservationists deal with invasive species.

Union of Concerned Scientists
www.ucsusa.org/invasive_species/—The Union of Concerned Scientists' website provides information on invasive species, on what individuals can do to help prevent species invasions, and on links for additional information about invasive species.

U.S. Bureau of Land Management
www.blm.gov/education/LearningLandscapes/explorers/lifetime/invasive.html—This website hosted by the U.S. Bureau of Land Management provides useful links for information about invasive species, as well as state and field office resources.

USDA Forest Service
www.fs.fed.us—This website is the home page for the Forest Service. It includes information on regional offices, as well as information and links on invasive species.

USDA National Agricultural Library
www.invasivespeciesinfo.gov—This website provides information about invasive species and serves as a reference gateway to information, programs, organizations, and services about invasive species. It includes information about the effects of invasive species and the federal government's response, as well as select species profiles.

World Wildlife Fund
www.worldwildlife.org—This website is for the World Wildlife Fund. Use the search button to find information on specific invasive species and articles on invasives.

Nonnative Controversy: Swan Song

Almost everyone agrees that mute swans are majestic, beautiful birds. What they don't agree on is whether mute swans belong on New England lakes. Mute swans were introduced to this country from Europe in the 1800s. Since then, they've spread throughout the mid-Atlantic and New England region. Now biologists say that the invasive birds are damaging to wetlands. They say the swans force out native water birds, making it impossible for the native birds to nest and reproduce.

In Vermont, **wildlife managers** concerned about the effects of mute swans recently began shooting and killing mute swans on their lakes after other control methods didn't work. **Local residents** were furious, especially because the shootings were unannounced, and because they happened right in front of the residents.

What to Do

The main characters in your scenario are shown in bold type. Use them and any others characters you come up with to act out a situation depicting the conflict over mute swans on Vermont's lakes.

Sources

Allin, Charles C. "Mute Swan (Cygnus olor) impact on submerged aquatic vegetation and macroinvertebrates in a Rhode Island coastal pond." Northeastern Naturalist. 2003. www.dem.ri.gov/programs/bnatres/ fishwild/pdf/muteswan.pdf (accessed December 26, 2006).

Atlantic Flyway Council. "Atlantic Flyway Mute Swan Management Plan, 2003–2013." July 2003. www.dnr.state.md.us/wildlife/afc-muteplan.html (accessed December 26, 2006).

Olsen, Stephen and Eleanor Ely. "Rhode Island's Swans: Beauties or Beasts?" Sea Grant, Rhode Island: 1988. www.seagrant.gso.uri.edu/factsheets/ri_swans.html (accessed December 26, 2006).

Nonnative Controversy: Marina Mussels

When divers explored a marina off the Australian town of Darwin, they saw something they knew didn't belong: tiny mussels related to the zebra mussel that have clogged up North America's Great Lakes. Hundreds of millions of those mussels were clinging to piers and boat hulls and lines where there had been none just six months earlier. The divers, who were part of an inspection team from a scientific agency, identified the mussels as coming from Central America. They believed the mussels had arrived on the hull of a yacht. Within a week, **government officials** took drastic action. First, they refused to let any boats in the area leave port, despite the objections of **boat owners**. Then they poisoned the waters of the marina with chlorine and copper. The poison killed all the mussels, but it also killed everything else that lived in the marina. Now, though, the native species are coming back and the Central American mussels haven't returned. But was it worth the $1.5 million price? What happens if the mussels show up again? And is it ecologically acceptable to poison natural areas and to kill off so much life? These issues have yet to be resolved.

What to Do

The main characters in your scenario are shown in bold type. Use them and any other characters you come up with to portray some of the conflicts and complexities involved in getting the Central American mussels out of the Darwin marina.

Sources

CSIRO's Centre for Research on Introduced Marine Pests. "The Facts: Black-Striped Mussel." Australia's Commonwealth Scientific and Research Organization: 2004. www.marine.csiro.au/LeafletsFolder/blstriped.html (accessed December 26, 2006).

Zebra mussels

Nonnative Controversy: Discord Over Cordgrass

The Willapa Bay region of Washington state is one of the most productive coastal areas in the world. Oyster, clam, and salmon fisheries are a huge part of the economy. Thousands of birds come here to feed and nest. Unfortunately, the health of this region is threatened by several invasive species, including *Spartina*, or cordgrass. *Spartina* was brought to the region in the 1800s as packing material for eastern oysters, which were introduced to revive the oyster industry after native oysters were harvested to near extinction. Unfortunately, the *Spartina* has grown out of control in its new home, reducing the habitat for native crabs, snails, salmon, shorebirds, and other organisms.

Not surprisingly, people are working hard to get rid of *Spartina* to protect the ecosystem and the economy. They've tried mowing and hand-plucking the cordgrass, and some people are advocating that a *Spartina*-eating insect be introduced to the area. But so far the most cost-efficient control method seems to be an herbicide that, when dumped into the water, kills off much of the grass. Many people involved in the **oyster industry** favor this control method. But others do not.

Members of the **Shoalwater Bay Indian Tribe**, which has a reservation on the edge of the bay, have complained. They don't think it makes sense to put a poison in the water, because it can be absorbed by other living things in the bay. They're especially concerned because members of their tribe have been having serious health problems. In one recent period, for example, 18 of 27 pregnancies ended in miscarriage. Because they think those health problems may be tied to the use of chemical herbicides, the Shoalwater Bay Indians and other concerned individuals think that people should investigate new ways of controlling *Spartina*. The Indians point out that some **industries** mow and hand-cut the *Spartina* and make it into paper and other products. This method wouldn't get rid of the grass as cheaply or quickly as herbicides, but it might be much better for people and the ecosystem over the long run.

What to Do

The main characters in your scenario are shown in bold type. Use them and any other characters you come up with to portray the conflict over controlling *Spartina* grass in Willapa Bay.

Sources

Murphy, Kyle C., Randall R. Taylor, and Chad H. Phillips. "Spartina Eradication." Washington State Department of Agriculture (WSDA): 2007. agr.wa.gov/PlantsInsects/Weeds/Spartina/default.htm (accessed December 26, 2006).

Murphy, Kyle, Brad White, and John Lundberg. "Historical Reduction of Spartina Grass Occurs in Willapa Bay." WSDA: 2005. agr.wa.gov/News/2005/05-27.htm (accessed December 26, 2006).

Riggs, Sharon. "The Cordgrass Is Not Always Greener on the Other Side." Environmental Protection Agency: 1999. http://www.epa.gov/owow/estuaries/coastlines/99oct.pdf (accessed December 26, 2006).

Spartina

How to Prevent Invasive Species

Here are some ways to help stop the introduction and spread of harmful invasive species in your community:

Gardening
- Avoid growing plants known to be invasive.
- Be cautious when buying plants from nurseries or seeds from other regions of the country.
- Avoid using seed mixtures, especially ones labeled "wildflowers."
- Landscape with plants native to your area.
- Never dispose of unwanted plants or garden clippings in a nearby park, local body of water, or natural area.

Boating and Fishing
- Never transport water, animals, or plants from one body of water to another.
- Do not release live fish, including bait, into a new body of water.
- Remove all aquatic plants and animals from hulls, propellers, intakes, trailers, and gear before leaving a launch area.
- Wash all fishing tackle, downriggers, and lines to prevent spreading small, larval forms of aquatic invaders.

Pets
- Buy any legal, nonnative pets only from reputable dealers.
- Don't release any pets or aquarium fish into a native habitat or natural body of water.
- Purchase certified weed free hay for horses.

Traveling
- Never carry fruit, seeds, live plants, soil, or animals into or out of the country.
- Within the country, don't transport items such as hay, wood, soil, sod, or gravel from one part to another.
- Wash your boots and tires to remove soil and weed seeds before you hike in a new area.
- Abide by local and international quarantines to prevent the spread of serious pests, weeds, and diseases.

Take Action!
- Tell others about the harm that invasive species can cause.
- If local nurseries sell invasive plants or seeds, let them know your concerns.
- Volunteer to help remove invasive plants from your local park or nature reserve.
- Learn to recognize common invaders and to keep an eye out for signs of new ones. Check trees, gardens, vacant lots, roadsides, yards, agricultural areas, wetlands, ponds, and lakes.
- If you think you have found a new infestation, contact your county agricultural agent or state Department of Natural Resources. Early detection is crucial to stopping an invasive from becoming permanently established!

Student Page

Content Questions

1. What is a nonnative species?

2. What is an invasive species?

3. How have people and their activities caused nonnative species to spread to new environments?

4. What are some of the different ways that invasive species affect our environment?

5. What are scientists doing to control invasive species?

6. What things can individuals do to limit the spread of invasive species?

7. How does the problem of invasive species compare to with environmental problems?