

LESSON FOUR

ENVIRONMENTAL STEWARDSHIP/BIOSECURITY

OBJECTIVES

Students will develop a biosecurity plan for an island.

BACKGROUND

TAKING RESPONSIBILITY: WHAT IS ENVIRONMENTAL STEWARDSHIP?

Many indigenous cultures practiced environmental stewardship by caring for the region in which they lived. They harvested food and resources sustainably to ensure the survival of healthy populations of the plants and animals that they depended on. By recognizing and respecting the importance of the natural environment and the relationships amongst species (food webs), they were able to live in balance with it, as a part of the diversity of their ecosystem.

Today, environmental stewardship means protecting the natural environment and using its resources in a sustainable way. It also means practicing conservation: taking actions to ensure that native plant and animal species, and the habitats that they require, continue to survive. Environmental stewardship happens at all levels, from the creation of parks and wildlife refuges by governments, to the actions of local people, including you. Being an environmental steward in your community can be as simple as recycling, picking up garbage in a local park or around lakes and streams, properly disposing of used fishing line and fishing nets, or conserving resources (e.g., electricity and water) so that your impact on the environment is smaller.

Another form of environmental stewardship is learning about the invasive species that are threatening the native ecosystems and wildlife found in your area, including how to identify them and how to prevent their spread. For example, invasive plants should be removed when they are found but be sure to put all pieces in the garbage, not in your yard waste or compost because some invasive plants can sprout from pieces as small as half an inch. Aquatic and marine invasive species are most often spread on boats and other equipment, such as boots,

waders, and fishing gear. Organizations working to prevent the spread of aquatic invasive species use campaigns such as www.dontmoveamussel.ca to teach the public to “clean, drain, and dry” their equipment every time they remove it from the water:

- CLEAN off all plants, animals, and sediment from your boat and related equipment (e.g., boots, waders, fishing gear).
- DRAIN (on dry land) any item that can hold water (e.g., buckets, wells, bilge, and ballast).
- DRY all items completely before launching the watercraft into another body of water.

Moving fish between lakes and streams must also be avoided; invasive northern pike (*Esox lucius*), which were illegally-introduced by the public into the waterways of south-central Alaska, are threatening local populations of salmon and trout. Pike are top-level predators in aquatic food chains and are highly piscivorous (fish eating). In lakes and rivers where pike are not native, trout, salmon, and other fish have not adapted defenses against the pike's predatory tactics and this invasive species is negatively impacting those populations.

PREVENTATIVE ACTIONS: BIOSECURITY

It is generally easier and less costly to prevent the introduction of an invasive species rather than attempt to remove a well-established plant or animal, although removal is possible and there have been over 1,300 whole-island invasive animal eradications completed worldwide with a success rate of 80%; more than half of these targeted rats. When there are physical barriers to colonization, as is the case with island ecosystems, preventative measures can be an effective way to keep an ecosystem free from invasive species.

In the context of invasive species, biosecurity refers to the implementation of actions to reduce the risk of invasive species introduction to a particular area (e.g., island) and how to respond to a confirmed invasive species incursion. A biosecurity plan provides the public and land managers with detailed guidelines and information that can be used to implement these actions and identifies pathways of invasion

with strategies for preventing or reducing the probability of new introductions/reinvasions.

Biosecurity is comprised of three primary components: prevention, detection, and response. These components must be implemented in concert and regularly monitored to ensure that vigilance is maintained in order to prevent, or rapidly respond, to an invasive species (re)invasion.

PREVENTION

Prevention measures include education, guidelines for visitors (e.g., checking for rats on boat before arriving at port), surveillance, and government policies and legislation. Rats are a common target of biosecurity measures on islands including the Aleutian Islands, Alaska because their introduction has significant effects on ground-nesting seabirds, as well as other native animal and plant species. Biosecurity plans are commonly implemented on islands to prevent the introduction or re-introduction of rats (if rats have been previously eradicated; see lesson 2).

Preventative measures (biosecurity) that can help to reduce the likelihood of a rat incursion to a seabird island include:

- Signage such as posters and pamphlets that are made available at all points of entry to the island or archipelago to teach visitors about the value of protecting the island, the importance of biosecurity, and how to minimize accidental introduction of rats.
- Articles and ads in popular publications, including newspapers or magazines, can help to spread information about biosecurity projects to the public, including individuals that might otherwise not see signage.
- Face-to-face information exchange is a way of fully engaging the target audience (e.g., private boat owners, commercial fishing boat operators, tour operators) through conversations with biosecurity plan representatives.
- Snap traps and bait stations armed with rodenticide (poison) on boats and planes that travel to rat-free islands can be used to reduce the risk of a rat incursion. These can also be used in buildings and other structures.

- Visitor protocols instruct visitors on ways to ensure that they do not accidentally bring rats with them to a rat-free island.
- Policies and legislation such as the regulations adopted by the Alaska Board of Game, which require mariners to check boats and gear for rats and try to eradicate them if they are found, also help to avoid accidental introductions to seabird islands in Alaska. Violators face a year in jail and a US \$10,000 fine. Corporations could be fined up to US \$200,000. Alaska state wildlife regulations also prohibit the feeding of rats and other “deleterious exotic wildlife”; prohibit harboring rats on boats and within facilities such as harbors, ports, and airports; and permit rats to be eradicated with rodenticides (State of Alaska, 2007).

DETECTION

Detecting invasive species is an important part of any biosecurity plan and helps to ensure that the invasive species of interest (e.g., rats) do not arrive unnoticed and have the opportunity to become established. The arrival of a single or small number of individuals of an invasive species is called an incursion.

Both passive and active detection tools can be used to confirm the presence of an invasive species such as rats. Generally a combination of tools is most effective, especially for detecting an incursion of only a few individuals. Active detection methods include snap traps, bait stations (rodenticide (poison) bait inside a locking box that is designed to allow rats to enter while preventing children, livestock, pets and other animals from accessing the bait), and live traps. Passive detection tools include remotely operated cameras, detection dogs trained to sniff out rats, wax chew blocks filled with peanut butter (rats find them irresistible and will chew on them, leaving a telltale sign of rodent presence), and tracking tunnels (rats leave foot prints on an ink-smearing white card placed inside a small plastic tunnel as they walk through to get the peanut butter baits placed at each end).

RESPONSE

Capturing a single plant or animal is easier than eradicating an established population, so rapidly

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responding to a confirmed invasive species detection is critical to remove the invading individuals before they reproduce and become established. An island biosecurity plan will include a response plan that outlines specific techniques to quickly eradicate the invasive species. For example, if a rat is detected on a seabird island, the response plan will include details on how to deploy rodenticide (poison) baits, snap traps, and live traps to maximize the probability of quickly and effectively eradicating any rats that are present.

MATERIALS

- Internet
- Examples of Biosecurity Plans listed in resources

PROCEDURE

LAB 4.1 BIOSECURITY PLAN CASE STUDIES

Divide the class into groups and assign each group a biosecurity plan to review and present to the class.

LAB 4.2 DESIGN A BIOSECURITY PLAN

Based on the information presented, develop a biosecurity plan for an island community near you.

LAB 4.3 BIOSECURITY GAME

Create a habitat and try to protect it from an invasive species.

EXTEND AND EXPLORE

- Create your own biosecurity game.

RESOURCES

Galapagos Conservancy: Biosecurity
<http://www.galapagos.org/conservation/conservation/conservationchallenges/biosecurity/>

Coastal Conservation: Biosecurity Plan for Important Bird Areas of Haida Gwaii, British Columbia, Canada

<http://coastalconservancy.ca/projects/biosecurity-plan-for-important-bird-areas-of-haida-gwaii-british-columbia-canada/>

Pribilof Islands Sensitive Area Section

[https://dec.alaska.gov/spar/ppr/plans/scp_al/al_PribilofWildlifeGuidelines-Revision8\(July%202014\).pdf](https://dec.alaska.gov/spar/ppr/plans/scp_al/al_PribilofWildlifeGuidelines-Revision8(July%202014).pdf)

Santa Cruz Island Restoration, California

<http://www.nps.gov/chis/learn/nature/restoring-santa-cruz-island.htm>

Santa Cruz Island Biosecurity Poster

http://www.esm.ucsb.edu/research/documents/santacruz_poster.pdf

Micronesia and Hawaii Biosecurity Plan (very large document)

http://www.navy.mil/submit/display.asp?story_id=86494

Palmyra Atoll Biosecurity Plan

<http://pubs.usgs.gov/of/2010/1097/pdf/of20101097.pdf>

Palmyra Atoll

<http://www.protectpalmyra.org/>

US Fish and Wildlife, Palmyra Atoll

http://www.fws.gov/refuge/palmyra_atoll/

California Trustee Councils, Seabird Colony Protection on Baja California Islands, Mexico: pp 24-36

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=8&ved=0ahUKewjOt6-1iK3LAhUC_mMKHaPiC_cQFgg-MAC&url=https%3A%2F%2Fwww.doi.gov%2Frestoration%2Flibrary%2Fupload%2FPostcards-from-the-Edge-International-Restoration-Projects-from-CA-Trustee-Councils.pdf&usq=AFQjCNFwMeKGaCN7qUCCXoL3NpiQG9k3A

Island Conservation Action in Northwest Mexico

https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=6&ved=0ahUKewiN39qW57zLAhVI7mMKHd12AMIQFghCMAU&url=http%3A%2F%2Fbio.research.ucsc.edu%2Fpeople%2Fcroll%2Fpdf%2FDonlan_2000.pdf&usq=AFQjCNEYCYkB4ohgiymQ3e-Q0n8xihFM7A&cad=rja

INSTRUCTIONS

Learn how a Biosecurity Plan helps address invasive species and how they address the specific needs of an ecosystem and community by researching three case studies.

- Divide the class into four or more groups and assign each group one of the case studies listed on the following pages. Use the Internet to research each island and its Biosecurity Plan.
- Have each group answer the following questions and present them to the class:
 1. Describe the characteristics of the landscape. What is unique about your system?
 2. Describe the native species.
 3. What are the identified threats from invasive species?
 4. What are the different ways an invasive species could be introduced?
 5. What is the main focus of the area's Biosecurity Plan?
 6. Who is involved?
 7. How successful has the Plan been to date?
 8. What are the ongoing risks to the area?
- After all groups have presented their findings, as a class discuss:
 1. Similarities in the Biosecurity Plans for each area.
 2. Differences in the Plans among areas?
 3. What are the keys to a successful Biosecurity Plan?

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LAB 4.1 BIOSECURITY PLAN CASE STUDIES

BIOSECURITY PLAN FOR IMPORTANT BIRD AREAS OF HAIDA GWAI, BRITISH COLUMBIA, CANADA

Haida Gwaii, British Columbia, Canada, is an isolated marine archipelago, renowned for its rugged coastline, temperate rainforest landscape, and distinct flora and fauna that have evolved during 14,000 years of isolation from the mainland. Approximately 1.5 million seabirds from 13 species nest on more than 200 offshore islands, islets, and rocks. Given the abundance of seabirds breeding on Haida Gwaii, Birdlife International has designated 19 locations as globally important bird areas (IBAs). The IBA program is a science-based initiative that monitors and conserves the world's most important places for birds and biodiversity.

Unfortunately, the accidental introduction of Norway and black rats to several Haida Gwaii islands has resulted in a drastic decline in nesting seabird populations. In response, Parks Canada Agency and partnership organizations such as Coastal Conservation have begun the process of eradicating rats from several islands within IBAs. Although rat eradication is a critical step in the process of seabird colony recovery and ecosystem restoration, the development of a detailed biosecurity plan that contains strategies to detect and prevent an incursion or (re)invasion is ultimately of greater importance to ensure long term protection of seabirds and island ecosystems.

A best management practices document for the biosecurity of important areas in Haida Gwaii was developed to provide guidelines for the creation of island-specific biosecurity plans that take into account the unique physical and environmental characteristics and the target invasive species for each island. The document includes prevention, detection, and response measures for rats, as well as invasive raccoons and deer, in order to prevent, or rapidly respond to, a (re)invasion. Of the three target invasive species, rat (re)invasions are considered a high priority and are the primary focus of the document given their significant negative impact on seabirds and ability to rapidly (re)colonize an island.

On Haida Gwaii, the most common pathway for rat (re)introductions to IBA islands is by

transport aboard ocean-going vessels, including commercial and private boats or barges, specifically, vessels that anchor within a rat's swimming range to IBA islands (less than 800 m based on New Zealand studies). There is an ongoing risk of new rat introductions to IBA islands given that major Haida Gwaii port towns have healthy rat populations and some vessels from their respective harbors make regular trips to, or near IBA islands. Vessels originating from ports outside of Haida Gwaii (North America and abroad) pose an equally significant risk if the ship and/or barge anchors near an IBA island, or if a shipwreck occurs on or near the island.

LOCAL ACTION: INVASIVE SPECIES PREVENTION ON THE PRIBILOF ISLANDS, ALASKA, USA

Located approximately 200 miles north of Unalaska in the Bering Sea, the Pribilof Islands are home to large populations of breeding seabirds, including the red-legged kittiwake (*Rissa brevirostris*), which is endemic to the Bering Sea region, with 80% of the world's population nesting on St. George Island. The islands are also home to unique non-bird species such as the Pribilof Island shrew (*Sorex pribilofensis*), another endemic species found only on St. Paul Island. St. Paul and St. George islands are currently rat-free, but the presence of commercial ship harbors puts both islands at high risk for accidental rat invasions (Commercial ships may have rats on board that could come onshore while the ship is anchored in port). The local economy of the islands centers primarily on seafood processing and the associated shipping traffic is a risk factor for rat invasion. If rats became established they would severely impact populations of seabirds and shrews, and could also potentially pass diseases to marine mammals such as seals. In response to this threat a rodent invasion prevention program was initiated in 1993, and the city governments of St. Paul and St. George both passed regulations on rodent prevention, including barring infested ships from entering the harbor and requiring onshore processors to implement rat prevention programs. The U.S. Fish and Wildlife Service has also committed to retaining a rat-free status for the Pribilofs

through prevention techniques and community education.

Biosecurity measures on the Pribilofs include many of the prevention, detection, and response strategies. Additionally, community members have taken steps to reduce places for rats to hide and nest around the harbor and buildings and improve garbage control (reduced food sources for rats). The risk of rat incursions due to a shipwreck is also a concern; more than eight vessel groundings have occurred on the Pribilofs since 1987. In partnership with the communities of St. Paul and St. George, the Alaska Marine National Wildlife Reserve (AMNWR) developed a shipwreck response plan to combat the potential invasion of rats from shipwrecks. The strategy involves coordinating with the US Coast Guard to prevent potentially infested ships from running aground on or near seabird islands that are vulnerable to rat invasion, as well as defensive measures in the event that a shipwreck does occur.

BIOSECURITY ON THE GALAPAGOS ISLANDS, ECUADOR

The Galapagos Islands are an archipelago of 19 islands and scores of islets and rocks, situated over 23,000 square miles of ocean, approximately 600 miles west of the mainland of Ecuador in South America. This region has been described as one of the most unique, diverse, and scientifically important places on earth. Approximately 97% of the total emerged (above water) land surface was designated a national park in 1959 and the islands are surrounded by the Galapagos Marine Reserve, which was created in 1986. The human population of the Galapagos is approximately 30,000 and is restricted to only 4 islands, the remaining 3% of the land mass. Approximately 170,000 tourists visit the islands each year, increasing the risk of invasive species introductions.

Since the discovery of Galapagos in 1535, humans have introduced many species to the islands, both intentionally (e.g., goats, pigs, cats, and ornamental and food plants) and accidentally (e.g., rodents, insects, plants). “Invasive species pose the greatest threat to nature in the Galapagos” (Directorate of the Galapagos

National Park, 2012), leading authorities to institute biosecurity measures in an attempt to protect the islands from further introductions.

The Galapagos biosecurity program includes three key components: an inspection and quarantine program; control and eradication of invasive species—both new arrivals and established species; and outreach work to create community awareness, support, and participation. All boats and airplanes arriving on the islands are inspected for foreign food and animals, and divers inspect boat hulls to check for invasive marine species. Vessels failing to pass these inspections are required to leave the Galapagos Marine Reserve.

Community involvement is essential to the prevention and control of invasions and an awareness campaign has also been implemented to help connect the local people and management organizations such as the Directorate of the Galapagos National Park. Local teachers are trained to teach their students about invasive species, and many school children participate in invasive species projects, such as invertebrate monitoring.

In addition to these biosecurity actions, the Directorate of the Galapagos National Park, the Charles Darwin Foundation, and organizations such as Island Conservation are working together to eradicate invasive species that are already established on the islands. For example, in 2006, Project Isabella was completed, with the successful eradication of feral goats and donkeys from northern Isabela Island; goats, donkeys, and pigs from Santiago Island, and goats from Pinta Island. Additional successes include the eradication of black rats from Pinzon Island, fire ants— little fire ant (*Wasmannia auropunctata*), the tropical fire ant (*Solenopsis geminata*), the Singapore ant (*Monomorim destructor*), and the big-headed ant (*Pheidole megacephala*)—from Marchena Island, rock pigeons (*Columba livia*) from Galapagos Island, feral cats from Baltra Island, and one species of blackberry from much of Santa Cruz Island.

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LAB 4.1 BIOSECURITY PLAN CASE STUDIES

BIOSECURITY ON SANTA CRUZ ISLAND, CALIFORNIA

The Channel Islands National Park off the southern coast of California is comprised of five islands. At over 96 miles, Santa Cruz Island is the largest of California's offshore islands. The National Park Service owns and manages 24% of the park, while The Nature Conservancy owns and manages the remaining 76%. Both organizations work closely together to maintain the biodiversity and biosecurity of the island.

Santa Cruz Island is home to 60 species and subspecies endemic to the Channel Islands. Only four native species of mammals reside on all of the Channel Islands: island fox (*Urocyon littoralis*), island deer mouse (*Peromyscus maniculatus*), harvest mouse (*Reithrodontomys megalotis*), and spotted skunk (*Spilogale gracilis amphiala*). The island fox and island deer mouse have evolved into separate subspecies on each island. Four lizards (*Xantusia riversiana*, *Sceloporus occidentalis becki*, *Elgaria m. multicarinata*, *Uta Stansburinia*) one salamander (*Batrachoseps pacificus*), one frog (*Pseudacris H. Hypochondriaca*), and two non-venomous snakes (*Pituophis catenifer pumilis*, *Coluber constrictor mormon*) are also found on the islands. Santa Cruz Island is home to eleven species of bats including a colony of Townsend's big-eared bats (*Corynorhinus townsendii*). Four species of pinnipeds breed on the Channels Islands: northern elephant seals (*Mirounga angustirostris*), California sea lions (*Zalophus californianus*), harbor seals (*Phoca vitulina*), and northern fur seals (*Callorhinus ursinus*).

Over 300,000 people per year visit the island by private passenger ferries. Private vessels and aircraft are allowed to visit the island through a permitting process.

Today, biosecurity on Santa Cruz island is focused on three species and a group of diseases identified to pose the greatest risk to island biodiversity: rats (*Rattus* spp.), Cape ivy (*Delairea odorata*), New Zealand mudsnail (*Potomopyrgus antiposarum*), and canine-vectoring diseases.

Working together, the National Park Service and The Nature Conservancy have identified potential activities that pose the highest risk

for introduction of these nonnative species and developed protocols for prevention and detection.

Education and outreach is a crucial component of Santa Cruz Island's biosecurity. Boaters are educated on preventing rats from swimming to shore from vessels and visitors are provided information on the restrictions of companion animals. Signage reminds visitors of the importance of keeping the islands free of invasive species.

In addition to the biosecurity plan, the National Park Service and The Nature Conservancy have been working on eradication current invasive species. Non-native feral pigs (*Sus scrofa*) and non-native fennel (*Foeniculum vulgare*, invasive weed) were identified as two of the most destructive invasive species. Pig rooting caused massive damage to native vegetation and archeological sites while piglets provided year-round prey for golden eagles allowing the birds to establish resident populations on Santa Cruz Island. The native fox also fell prey to the golden eagles causing the fox population to decline dramatically.

In 2005 the National Park Service began a pig eradication program which was completed in 2007.

BIOSECURITY ON THE CORONADO ISLANDS, MEXICO

The Coronado Islands (Islas Coronado or Islas Coronados) are a group of four islands (North Coronado, Pilón de Azúcar, Central Coronado, and South Coronado) eight miles off the northwest coast of the Baja, Mexico.

During the 1920's the islands were home to a casino and a lucrative trade in illegal alcohol during prohibition. Currently, South Coronado Island is home to two lighthouses staffed by the Mexican Coast Guard.

These are small and rocky islands, home to ten species of reptiles, California sea lions, elephant seals, and harbor seals, as well as several species of sea bird. The islands are also home to the largest known colony of the Xantus's Murrelet also known as Guadalupe Murrelet (*Synthliboramphus hypoleucus*) which is listed as

Endangered on the IUCN Red List of Threatened Species. The islands are generally not inhabited, but there is a small Mexican Coast Guard station and a small lighthouse on the largest of the four islands. The islands are regularly visited by tourist cruises from San Diego, pleasure boaters, Mexican commercial fishermen looking for abalone and sea urchins, and sport fishing charters looking for yellowtail. The Island at one point had rabbits, mice, and most damaging feral cats as introduced species. The cats had devastated the Xantus's Murrelet. Through a joint effort between the US Fish and Wildlife and the Mexican Government these introduced species have been removed.

Biosecurity actions involve boater education, habitat restoration, disturbance reduction, and monitoring. A bi-national partnership between Audubon, Conservacion de Islas, Friends of the Mexican Fund for the Conservation of Nature, and The Cornell Lab of Ornithology provides the structure and support needed for ongoing biosecurity.

BIOSECURITY ON PALMYRA ATOLL, HAWAII

Palmyra Atoll consists of many islets, most not exceeding 2 meters in height, 1,600 km southwest of Hawaii. The atoll was privately owned from 1911 until 2000 when The Nature Conservancy purchased emergent lands. From 1940-45 the U. S. Military used the island. During this time the island and lagoons were modified dramatically. The military installed an airstrip, housing, hospital, bunkers, and pillboxes that were all abandoned or destroyed at the end of World War II. In 2001 it was established as a National Wildlife Refuge. Palmyra Atoll is one of the few atolls without a long settlement history or fishing history.

Invasive species on the islets are black rat (*R. rattus*) and coconut palm (*Cocos nucifera*). A native species of coral, corallimorph (*Rhodactis howsei*), is also considered to be invasive due to the fact that it takes advantage of human-altered habitat and out competes other native species.

Native species being affected by black rats and coconut palms are *Pisonia grandis* a forest

member of the Bougainvillea family and the Red-footed Booby (*Sula sula*).

In 2010 the U. S. Geological Survey prepared a Palmyra Atoll biosecurity plan for The Nature Conservancy.

Potential pathways of introduction were identified as clothing, shoes, marine vessels, aircraft, and food.

Prevention techniques involve freezing clothing for 48 hours before arriving and before travelling between islets and quarantining vessels, aircraft, food, and freight.

Early detection is key to preventing a species from becoming established. Detection methods include collecting baseline data on native and non-native species and monitoring populations. High-risk sites of introduction are areas with regular human activities.

Eradication has already been attempted on Palmyra Atoll. From 2011-2012 the U.S. Fish and Wildlife Service and The Nature Conservancy made a second and successful attempt to eradicate the population of rats introduced during World War II.

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LAB 4.1 BIOSECURITY PLAN C.S. - TEACHER KEY

Case Study #1: Haida Gwaii

1. Describe the characteristics of the landscape. What is unique about your system?
 - Archipelago, rugged coastline, temperate rainforest
2. Describe the native species.
 - Distinct plants and animals, 1.5 million nesting seabirds, 13 different species of seabirds
3. What are the identified threats from invasive species?
 - Biggest threat is accidental introduction of Norway and Black rats that has led to a decline in nesting seabird populations. Eradication of rats is underway.
4. What is the main focus of the area's Biosecurity Plan?
 - Unique plans for each island. Prevention, detection, and response for rats, raccoons, and deer. Main focus is rats.
5. Who is involved?
 - Birdlife International, Canada Parks department, partner organizations, and community.
6. How successful has the Plan been to date?
 - Plan is new.
7. What are the ongoing risks to the area?
 - Boat traffic is the biggest threat since boats can carry rats from ports with healthy rat populations to islands with no rats.

Case Study #2: Pribilof Islands

1. Describe the characteristics of the landscape. What is unique about your system?
 - Two remote islands in the Bering Sea home to both native seabird populations and non-seabird species.
2. Describe the native species.
 - Large populations of breeding seabirds including the red-legged kittiwake which is endemic to the Bering Sea. Also home to a unique native species: the Pribilof Island shrew.
3. What are the identified threats from invasive species?
 - Rats are the primary threat. Rats could negatively impact seabird populations and also pass diseases to marine mammal populations that haul out on the islands.
4. What is the main focus of the area's Biosecurity Plan?
 - There is a large amount of commercial boat traffic which poses a constant threat of rat invasion. The Plan includes laws for vessels, education, and prevention programs for visitors and community members, partnerships to deal with shipwrecks, and community programs to reduce cover opportunities for rats and control garbage.
5. Who is involved?
 - City governments, U.S. Fish and Wildlife, U.S. Coast Guard, communities
6. How successful has the Plan been to date?
 - The plan was initiated in 1993 and the islands remain rat free.
7. What are the ongoing risks to the area?
 - Boat traffic is the largest ongoing risk. It is necessary for commerce so it is not possible to eliminate the threat.

Case Study #3: Galapagos Islands

1. Describe the characteristics of the landscape. What is unique about your system?
 - Archipelago of 19 islands. One of the most unique and diverse places on the planet. 97% is designated as a national park.
2. Describe the native species.
 - Many species are unique to the Galapagos, for example: reptiles such as the Giant tortoise and lava lizard, birds such as the Galapagos penguin and waved albatross, and mammals such as the Galapagos sea lions.
3. What are the identified threats from invasive species?
 - Many invasive species have been introduced since humans discovered the islands in the 1500s. These include goats, pigs, cats, rodents, insects, and plants.
4. What is the main focus of the area's Biosecurity Plan?
 - There are a number of plans in place. The current Plan focuses on protection from further introduction of invasive species. There are also plans taking place focused on the eradication of established invasive species.
5. Who is involved?
 - Directorate of Galapagos National Park, Charles Darwin Foundation, Island Conservation, community, school teachers, and students.
6. How successful has the Plan been to date?
 - Eradication has been successful on various islands for: rats, several ant species, goats, donkeys, pigs, cats, rock pigeons, and blackberry. The community and others actively participate to implement programs.
7. What are the ongoing risks to the area?
 - Tourists, boat, and airplane traffic.

Case Study #4: Santa Cruz Island, California

1. Describe the characteristics of the landscape. What is unique about the ecosystem?
 - Rugged coastal island
2. Describe the native species.
 - 60 endemic species
3. What are the identified threats from invasive species?
 - Rats, dogs, plants
4. What is the main focus of the area's Biosecurity Plan?
 - Educating tourists and informing boaters.
5. Who is involved?
 - National Park Service, The Nature Conservancy
6. How successful has the plan been to date?
 - Plan is new.
7. What are the ongoing risks to the area?
 - Boat traffic and tourists.

Case Study #5: Coronado Islands, Mexico

1. Describe the characteristics of the landscape. What is unique about the ecosystem?
 - Four islands of the coast of Baja Mexico. Formerly occupied by a casino and illegal alcohol traders.
2. Describe the native species.

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LAB 4.1 BIOSECURITY PLAN C.S. - TEACHER KEY

- Seabirds: Ashy Storm-Petrel (*Oceanodroma homocroa*), Black Storm-Petrel (*Oceanodroma melania*), Brown Pelican (*Pelecanus occidentalis*), Brandts Cormorant (*Phalacrocorax pencillatus*), Double-crested Cormorant (*Phalacrocorax auritus*), Western Gull (*Larus occidentalis*), Xantus murrelet (*Synthliboramphus hypoleucus*)
 - Extirpated Seabirds: Leach's Stormpetrel (*Oceanodroma leucorhoa*) Cassin's Auklet (*Ptychoramphus aleuticus*), Xantus' Murrelets (*Synthliboramphus hypoleucus*), and Black Storm Petrels (*O. melania*)
 - Coronado rattlesnake (*Crotalus oreganus caliginis*)
 - Los Coronados Song Sparrow (*Melospiza melodia coronatorum*), Los Coronados House Finch (*Carpodacus mexicanus clementis*)
 - Los Coronados whiptail lizard (*Cnemidophorus tigris vividus*), Los Coronados alligator lizard (*Elgaria multicarinata nana*)
 - Los Coronados white-footed mouse (*Peromyscus maniculatus assimilis*)
3. What are the identified threats from invasive species?
 - Rats and formerly feral cats are eating seabirds.
 4. What is the main focus of the area's Biosecurity Plan?
 - Educating boaters and tourists.
 5. Who is involved?
 - Audubon, Conservacion de Islas, Friends of the Mexican Fund for the Conservation of Nature, and The Cornell Lab of Ornithology
 6. How successful has the Plan been to date?
 - Successful
 7. What are the ongoing risks to the area?
 - Boaters, tourists

Case Study #6: Palmyra Atoll, Hawaii

1. Describe the characteristics of the landscape. What is unique about the ecosystem??
 - Flat atoll, consists of several islets
2. Describe the native species.
 - Coconut crab (*Birgus latro*)
 - Seabirds: Red-footed Booby (*Sula sula*), Brown booby (*Sula leucogaster*), Masked Booby (*Sula dactylatra*), Sooty Tern (*Onychoprion fuscata*), Black Noddy (*Anous minutus*), Brown Noddy (*Anous stolidus*) and Great Frigatebird (*Fregata minor*)
 - Migratory birds: Pacific Golden Plovers (*Pluvialis fulva*), the Bristle-thighed Curlew (*Numenius tahitiensis*), Ruddy Turnstones (*Arenaria interpres*), and Wandering Tattlers (*Heteroscelus incanus*)
 - *Pisonia grandis*
3. What are the identified threats from invasive species?
 - Boaters, researchers
4. What is the main focus of the area's Biosecurity Plan?
 - Preventing introduction of invasives from boats, food, and airplanes.
5. Who is involved?
 - The Nature Conservancy, U. S. Fish and Wildlife Service
6. How successful has the Plan been to date?
 - Successful
7. What are the ongoing risks to the area?
 - Boats, airplanes, researchers

Comparisons

1. Similarities in the Biosecurity Plans
 - Government, community, and special interest groups are all involved.
 - Plans have three main components: prevention, detection, response.
 - All areas are islands and boat traffic is a constant threat.
2. Differences in the Plans among areas?
 - Plans are unique to the landscape and native species involved.
 - Plans may have slightly different focuses such as keeping invasive species out or dealing with further incursions.
3. What are the keys to a successful Biosecurity Plan?
 - Community involvement is imperative.
 - Diligence in monitoring and enforcing the rules to prevent/control incursions.

LESSON FOUR**LAB 4.2 DESIGN A BIOSECURITY PLAN****INSTRUCTIONS**

Design a biosecurity plan for your island or an island near you. Illustrate how you would prevent rats or another invasive species from entering the island. Make sure to include a map of the protected area and potential points of entry.

Include all areas of potential introduction.

Areas of introduction:

- Harbor
 - ◆ Cargo/shipping containers
 - ◆ Luggage
 - ◆ Dock lines
 - ◆ Fishing gear
- Airport
 - ◆ Cargo
 - ◆ Luggage
- Shipwreck off shore
 - ◆ Floating debris
 - ◆ Swimming
- Grocery Store
 - ◆ Food containers

Describe methods of detection and prevention.

How would the community be involved?

DISCUSSION

How successful was your biosecurity plan?

What would you do differently next time?

Was it hard to develop a good plan without infringing on people's rights to privacy?

- Did you search luggage or backpacks?
- Were you able to interview people entering the area to find out if they were carrying invasive species?
- What was the most time consuming part of the project?
- What was the hardest?

Student Name: _____ Date: _____

Island Name: _____

Invasive species	Protected species
Global Conservation Status	
Pathways of Entry	
Prevention Methods	
Detection Methods	
Community Involvement	

LESSON FOUR**LAB 4.3 BIOSECURITY GAME****MATERIALS**

- Lab 4.2 Biosecurity Plan
- School/classroom to represent an island
- 50 images or objects representing the rats (invasive species)
- 120 images or objects representing seabirds, chicks, and eggs (protected species)
- 20-30 images of traps or methods of detecting and catching rats

SET-UP**RAT TEAM**

Assign 1/3 of the class or members of the school/community to act as rats. Distribute the rat images provided (or create your own). It is the job of the Rat Team to enter the bio-secure area and find the protected species habitat. Students may hide the rats in a back pack or bag to get it in the building but once in the building the invasive species must be out in the open. If you are specifically asked by the Biosecurity Team if you are harboring a rat, you must give it up and start over. If your invasive species is out in the open and you encounter a rat trap or are approached by a member of the Biosecurity Team you must give up your rat and start over.

SEABIRD TEAM

Assign 1/3 of the class or members of the school/community to act as protectors of the seabirds. Distribute the puffin images provided or create your own. It is the Seabird Team's job to figure out where the seabirds will reside on the "island". Select different areas to represent nesting colonies and breeding habitat. This information should not be shared with the Invasive Species. The invasive species will have to find them.

BIOSECURITY TEAM

Assign 1/3 of the class or members of the school/community to act as the Biosecurity Team. Distribute the images of rats or something similar to indicate the entry point or area is off limits to invasive species. Using the Biosecurity Plan created in Lab 4.2, go around your "island" (school or classroom) and post signs at entry points or any place you think an invasive species might enter. Think of ways an invasive might enter your "island" (e.g., inside a bag or box, in luggage, ventilation system). You may approach people and ask them if they are harboring a rat.

INSTRUCTIONS

1. Send the Invasive Species Team out of the area to plan their invasion before the Seabird team and Biosecurity Team start setting up.
2. Give each team time to set up and strategize.
3. Biosecurity Team and Seabird Team: Set up the nesting areas. Use one of the Biosecurity Security Plans developed in class to protect your island's seabirds.
4. Assign one person to keep tally of the rats and seabirds.
5. Start the game.
6. 1 seabird is added to the population for every rat that is detected.
7. 2 seabirds die for every rat that enters the nesting or breeding area.
8. 5 rats are added for every rat that encounters a seabird. This rat found food and reproduced.
9. Once a rat finds a seabird and reproduces it stops searching for food.

BE CREATIVE - HAVE FUN!!

Instructions: Record your progress at the end of each day. How many invasive species managed to get past the biosecurity team?

Day	Rats Detected	Rats Not Detected	Seabirds (alive)	Prevention/Elimination Methods
Start	0	0	100	
1				
2				
3				
4				
5				
Total				

Suggestions for improving the Biosecurity Plan.

LESSON FOUR

LAB 4.2 BIOSECURITY GAME





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Least Auklet (*Aethia pusilla*)



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LESSON FOUR

LAB 4.2 BIOSECURITY GAME

