Investing in Nature

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Creating Jobs and Restoring Coastal Habitats

Partnerships


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A Partnership for Restoration

Since 2001, The Nature Conservancy and the National Oceanic and Atmospheric Administration (NOAA) have been working together through a National Partnership to restore a diversity of habitats in our nation's coastal waters. All along the coast of the United States, **scores of projects involving thousands of people have yielded tangible, lasting improvements** to oyster reefs and clam beds, underwater grasses, salt marshes, mangroves and coral reefs.

The fragile, green edges and intricate tapestry of habitats along the coast are what make estuaries and coastal waters so productive—providing fish and shellfish that feed us and fuel our coastal economy. These habitats also protect our communities from storm surges and provide a restful place to enjoy when the weather is calm. As more people settle and communities expand along the coast, many of these habitats are suffering and the **habitat loss statistics are shocking.** Studies from around the world show that approximately:

- 20 percent of coral reefs are degraded
- 30 percent of underwater grasses (seagrasses) are lost
- 50 percent of coastal wetlands are filled, ditched or drained, and
- 85 percent of oyster reefs are dredged away, buried with sediment or made unproductive by pollution, diseases and changes to river flows.

In the United States, these statistics also track closely with the losses documented and summarized by Restore America's Estuaries in a recent publication "Hope for Habitats: People, Partnerships and Projects Making a Difference."

A Sea Change for Restoration

In recent decades, huge strides have been made in public awareness about the value of our most important and yet critically imperiled coastal habitats. Since the 1970s, salt marshes, once negatively perceived as "only" swamps and breeding grounds for mosquitoes, are now focal points for bird watching and other ecotourism activities. Their role as nurseries for juvenile shrimp, crab and fish is well documented. Recent studies noting the value of salt marshes as a buffer against storm surges and waves reinforce their value for protecting life and property in our coastal communities. Accordingly, there are federal, state and local laws designed to protect salt marshes, and mitigation is usually required to repair damages caused by unavoidable or accidental impacts.

Other habitats such as underwater grasses (seagrass) and corals are also increasingly protected from direct impacts from activities like channel dredging operations and "scarring" from recreational boats as they navigate across shallow areas. Indeed, regulatory measures resulting from the Clean Water Act and other state and local laws have helped to stem the loss of these habitats, but **there is a profound need to bring back the millions of acres that have been lost so that our coasts continue to feed and protect people.**

Restoration as a National Priority

With increased public awareness of the importance of coastal habitat and the stunning rates of loss, a restoration ethic emerged in the 1990s. People in coastal communities began to want more than mitigation that simply slowed or stemmed the rate of loss.

In 1996, NOAA created the Community-based Restoration Program (CRP), overseen by the NOAA Restoration Center. In the ensuing years, the CRP has provided funding and technical support for thousands of projects around the United States. Through partnerships with organizations like The Nature Conservancy, Restore America's Estuaries, American Rivers and others, the NOAA Restoration Center has shown that **even modest projects can galvanize community support** to open entire rivers to migrating fish, to clean up polluted waters so that bivalves thrive and are safe to consume, and to restore habitats that were lost generations before. It is fair to say that through these partnerships, restoration of coastal habitat rapidly became a priority for many communities.

Recognizing that coastal habitat restoration is emerging as a national priority, Congress passed the Estuary Restoration Act in 2000, creating a federal interagency Estuary Habitat Restoration Council and an additional new funding stream for small-scale habitat restoration (defined as projects costing up to $1 million for implementation). The Council leverages resources and expertise from different agencies to help restoration practitioners – mostly local and state agencies, tribes and non-governmental organizations – implement projects. These projects are designed to help meet an ambitious **restoration goal of 1 million acres by 2010.**

Toward One Million Acres

The American Recovery and Reinvestment Act (Recovery Act) passed by Congress in 2009 provided NOAA with $167 million for mid-scale habitat restoration projects, another step toward the 1 million acre restoration mark. In its public solicitation to allocate these funds, NOAA received more than 800 proposals from organizations across the country totaling more than $3 billion in requests for project funding. This overwhelming response demonstrates that **the need and capacity to carry out restoration of our coasts and oceans far surpasses NOAA's current annual budget** for coastal habitat restoration projects, or the one-time funding made available through the Recovery Act.

Many of the 50 Recovery Act projects that are being implemented are dramatic expansions of restoration work that began as modest community-based projects through the Conservancy-NOAA National Partnership and NOAA's Community-based Restoration Program. Indeed, such pilot-scale projects helped to make the Recovery Act projects possible by providing the successful blueprint for many habitat restoration projects around the nation. These initial pilot projects created community awareness that **habitats can be restored with innovative thinking and collaborative partnerships.** These projects also provided the scientific underpinning for restoration methods and monitoring protocols that will be used to document the ecological outcomes of these projects.

Another exciting facet to the Recovery Act projects is a **direct focus on the economic benefits of the restoration work** itself, recognizing the diversity of skills and materials that are required to plan and implement such large-scale "green" infrastructure projects. The eight Recovery Act projects managed directly by the Conservancy will create or maintain more than 400 jobs. In addition, these projects may involve the production of American-made steel, concrete and other materials, or the construction, transport, sales and maintenance of the boats, barges, trucks and other equipment needed to carry out the projects. These projects are creating future ancillary jobs and benefits by helping to sustain fisheries, providing opportunities for ecotourism and protecting local economies and properties from damages caused from storm surges and flooding.

Habitat Restoration Priorities

The projects described in this publication fall into five broad categories that NOAA developed and used to categorize and prioritize projects for Recovery Act funding:

Fish Passage: Alaska, Washington, Maine

Hydrologic and Tidal Reconnection: Alaska, California, Washington

Shellfish Restoration: Alabama, Louisiana, Virginia

Coral Recovery: Florida/U.S. Virgin Islands, Hawaii

Coastal Resiliency: Alabama, Louisiana, Virginia, Washington

PROJECT GOALS AT-A-GLANCE

Projected jobs created or maintained: 415*

Projected acres restored or enhanced: 1,118

Projected river miles opened and improved: 80*

Habitats improved: salt marshes, underwater grass beds, oyster reefs, coral reefs, rivers and streams that provide juvenile and adult salmon habitat.

* Note that the dam removals and fish passage construction in the Penobscot River project in Maine will increase these numbers substantially once the project is fully implemented. Hundreds of jobs will be supported in the effort to improve access to nearly 1,000 miles of the Penobscot River, supporting the recovery of Atlantic salmon and sustaining many other ecologically and commercially important species.

The Nature Conservancy is privileged to be leading eight of the 50 NOAA Recovery Act projects that are described in greater detail in the accompanying documents. Also included is a ninth project led by the Penobscot River Restoration Trust, in which the Conservancy is an integral partner. As of April 2010, all nine projects are progressing through planning, pre-restoration monitoring and implementation stages.

Even with the solid near-term monitoring plans in place, the full ecological outcomes will not be evident for years. Nonetheless, we can already say with certainty that the projects are providing important ecological and logistical lessons pertaining to restoration, spurring innovation that helps to achieve economy-of-scale savings for restoration, and creating a diversity of jobs in numerous coastal communities.

Since 2001, the Conservancy and NOAA have worked to implement more than 100 restoration projects around the country through a National Partnership for Community-based Restoration and Recovery Act funding.

Perseverance

©Bridget Besaw

The Future of Restoration: Scaling Up

With a decade of experience leading coastal habitat restoration projects at various scales and managing a portfolio of exciting Recovery Act projects supported by NOAA, The Nature Conservancy has observed that:

- **Public-private partnerships provide valuable leverage and motivate communities** to set priorities and take action to improve coastal habitats.
- Projects such as the ones funded through the Recovery Act that provide **restoration at larger scales are engines of innovation and deliver economy-of-scale savings** in project implementation costs.
- **Restoring the "natural infrastructure" of our coasts creates jobs** in many sectors. The Conservancy's eight Recovery Act projects alone will create or support more than 400 jobs including heavy equipment operators, surveyors, engineers, welders, biologists and boat operators.
- **Measuring the ecological outcomes of projects is extremely important** for evaluating and refining restoration techniques, adaptively managing restored habitats, and understanding the full range of services and economic benefits that are returned by restored habitats over time.
- There is a growing appetite for healthier coasts and marine habitat in the United States, and commitments to support **more and larger restoration projects will not only help to sustain the development of a restoration economy, but will provide long-term benefits to communities** both near and far from the coast.

Just as habitat loss occurred incrementally and at various scales over time, meaningful restoration of these critical coastal habitats will need to be addressed at different scales and will require time. Partnerships that support small to modest-scale projects serve as important incubators for project ideas, restoration approaches and new monitoring methods. They also propel communities toward larger-scale projects like those showcased in this publication.

These Recovery Act projects, in turn, are components of larger initiatives designed to revitalize entire coastal regions or ecosystems. For example, restoring the vast network of marshes and barrier islands that protect the Louisiana and Mississippi coast will require a sustained effort involving a variety of restoration approaches and projects that span political boundaries. Likewise, the Chesapeake Bay and Puget Sound are both large ecosystems where habitat restoration has been invoked as being necessary to achieve comprehensive water quality improvements: restoring riparian habitats, shorelines, wetlands and oyster reefs are all steps that can help to buffer the nation's largest estuaries from the overabundance of nutrients escaping from their watersheds. Finally, restoring the ecology and economic benefits of the Everglades and California's vast Sacramento-San Joaquin delta requires a comprehensive approach to restoring and reconnecting vast areas of marsh and floodplains and managing the intricate balance between water flow and delivery of sediments that sustain these wetlands over time. These nine Recovery Act projects are excellent reminders that **the means to restore larger ecosystems exist, and doing so is an excellent way to help people and nature prosper.**

Alabama

Coastal Alabama Restoration Project

RESTORATION

Oyster reefs breakwaters built

Oysters grow on breakwaters and become "living"

MONITORING

Measure growth and success of oyster reefs and seagrass beds

Monitor water quality

Monitor species' use of reefs

BENEFITS TO PEOPLE AND NATURE

PEOPLE

Increased water quality

Recreational fishing

Eco-tourism

Shoreline protection

NATURE

Sustainable commercial fishing

Increased essential habitat for fish

Increased biodiversity

Project Highlights

- **Goals:** Restore and enhance shoreline habitat with a long-term goal of boosting the economy of coastal Alabama communities hit hard by hurricanes, habitat degradation and a struggling economy.
- **Jobs:** This project employed 33 full-time workers and contributed to paychecks for at least 83 positions in the coastal Alabama community, with most of the jobs being in the construction and deployment phases of the breakwater process. Due to significant cost savings in the first eight months of the project, staff has been able to extend the size of the reef by 50 percent.
- **Habitat Restoration:** The project includes 1.54 miles of submerged breakwater, 3.05 acres of oyster reef, and 30.54 acres of seagrass beds. In total, the living shoreline breakwaters will protect approximately 10,000 feet of shoreline.
- **Progress:** As of February 2011, construction of the reefs has been completed and post-restoration monitoring is continuing through summer 2012. Significant oyster growth and sediment accumulation have already occurred on the installed reefs.
- **Outreach:** Project staff has reached out to the community and are planning a number of outreach and educational events to promote the project and inform area residents about the benefits of oyster reefs and coastal restoration. Photographers and videographers have been hired to document the restoration process in all phases which will be used to promote the project throughout the Gulf Coast.
- **Measurement:** A scientific monitoring plan has been developed by local experts to measure both the short and long term success of this project. Contractors will perform a socio-economic analysis of the communities surrounding the project area. Specifically, the analysis will focus on determining which aspects of habitat and shoreline restoration are most valued by coastal Alabama residents.
- **Partners:** Dauphin Island Sea Lab, University of South Alabama, Alabama Department of Conservation and Natural Resources State Lands – Coastal Division, Mobile County, Reef Innovations, Coastal Environments, Inc., J&W Marine Enterprises, Inc.

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Pictured above: Oyster reef. ©Jeff DeQuattro

American Oystercatchers near restoration site in Mobile, AL. ©Jared McKee/DISL

A Vision for Project Success

Short-term goals: To restore and enhance the ecological integrity of Alabama's marine habitat. By creating more than 1.5 miles of submerged breakwater reefs, the project is not only protecting the shoreline from damaging storm surges and wave action, but it is also enhancing vital habitat for fish and invertebrates – species essential to a healthy and sustainable coastal environment.

Long-term goals: To boost the economy of coastal Alabama communities hit hard by hurricanes, habitat degradation and a struggling economy. Not only is the project helping to create local jobs, but it is promoting healthy fisheries that can sustain traditional livelihoods of fishers and those involved in the seafood processing industry.

Coastal Recovery for People and Nature

The years 2004 and 2005 were an unfortunate turning point for the coastal communities of the Gulf of Mexico, including Mobile and Baldwin counties in Alabama. Hurricanes Ivan and Katrina severely degraded estuarine and beach habitat and either destroyed or damaged most of the seafood processing plants and fishing boats – significant sources of income for coastal Alabamians. The historic fishing communities of Bayou La Batre and Coden were devastated, as the majority of residents are tied to the fishing and seafood industries.

Habitat degradation, destroyed equipment and loss of personal property resulting from the storms were soon followed by sky-rocketing gas prices and economic strife, forcing life-long fishers to find other lines of work or collect unemployment. Between 2006 and 2008, federal assistance to these fishers through the Organized Seafood Association of Alabama was nearly $3 million.

Past attempts to protect shorelines from the damaging force of storms and heightened wave activity usually involved the construction of hardened structures like rock jetties, bulkheads and seawalls. But over time, experts have learned that these armored structures reflect wave energy back into the bay instead of absorbing or dampening their impact. In fact, shorelines adjacent to these structures become subjected to even greater wave energy causing erosion along the barrier with subsequent loss of intertidal habitats.

Estimates show that more than 30 percent of Mobile Bay's available coastline is armored and suffering from at least 10 to 20 acres of intertidal habitat loss – a high percentage for this area. Oyster reefs, however, are a promising natural alternative to hardened structures for the long-term protection and sustainability of Mobile Bay's ecology and tradition as a fishing community.

Reef ball fabrication. ©Jeff DeQuattro

Installation site. ©Jeff DeQuattro

Solving a Restoration Challenge

The Nature Conservancy, in collaboration with the Alabama Department of Conservation and Natural Resources, Dauphin Island Sea Lab, Mobile County and the University of South Alabama, is creating a living shoreline along two stretches of eroding shoreline in Mobile Bay and Portersville Bay. Funded through the NOAA-ARRA grant, this project is a vital step to restoring both the ecological integrity and economic stability of Bayou La Batre and the other fishing communities of coastal Alabama.

Using three distinctive techniques, the project is creating 3.05 acres of vertical oyster reefs and 30.54 acres of seagrass beds while protecting about 10,000 feet of shoreline. Unlike traditional methods of vertical bulkheads and other hardened structures, the methods used in this project offer a natural approach to shoreline protection that enhances critical habitats for many species of fish and invertebrates.

As a natural component of the ecological architecture of the coast, the reefs will absorb the impact of wave energy from storms and boat activity, thereby protecting the shoreline from erosion while enhancing habitat for fish, birds and invertebrates. Submerged oysters also filter impurities from water, helping to improve water quality and enhancing the viability of seagrass meadows and salt marshes, essential habitats for juvenile fish and invertebrates.

The project is designed to provide a long-term sustainable solution to restoring coastal habitat that has defined the livelihoods and quality of life for generations of coastal Alabamians. Thirty-five to 40 new jobs will be created through this project, with the majority being in the construction and deployment of the breakwater reefs.

In addition to the restoration work, The Nature Conservancy has contracted with the University of North Florida to perform a socio-economic analysis of the communities surrounding the project area. The goal is to determine how coastal habitats and restoration projects impact coastal communities, with a specific focus on which aspects of habitat and shoreline restoration (i.e., cost, durability, fisheries habitat, aesthetics, etc.) are most valued by coastal Alabama residents.

Shrimping boats. ©Jeff DeQuattro

Shoreline Restoration: Benefits for People and Nature

People: Direct benefits from healthy habitats

Oyster reefs perform a number of ecosystem services including filtering impurities from the water, thus improving water quality; providing essential habitat, shelter and food for recreational and commercial fish and invertebrates; enhancing the viability of seagrass meadows and salt marshes; and protecting the shoreline from storm surges and wave action.

- Marine-related resources such as estuaries, salt marshes, oyster reefs and seagrass meadows support a variety of enterprises along the Alabama coast ranging from the seafood industry to recreational fishing to eco-tourism.
- Recreation and tourism in coastal Alabama have a major economic impact. Coastal tourism accounts for approximately one-third of the total tourism expenditures in Alabama, and the coast is also home to many retirees who are lured by the climate, low cost of living and numerous amenities such as golfing and fishing.
- Over 2,000 Alabama anglers made fishing trips in 2006 that contributed more than $600,000 to coastal economies supporting over 6,000 jobs.
- Alabama's seafood capital of Bayou La Batre is ranked 19th in the nation in value of landings and is the 5th most important port in the Gulf of Mexico.
- Over 21,000 jobs are supported by commercial fishing including harvesters, processors, and distributors in 2006.
- The harvest of marine resources (including fish, crabs, shrimp and oysters) brought into Alabama ports in 2006 was worth more than $49 million.
- Thirty-four nature-tourism businesses operate in Baldwin and Mobile counties, according to current data.

Impact of the Gulf oil spill

As coastlines in Alabama received oil, the project was temporarily interrupted. Two incidents involving oil were recorded during shoreline assessments on the Alabama Port coastline. In the wake of the spill, the Conservancy formed a coalition with the Alabama Coastal Foundation, Mobile Baykeeper and The Ocean Foundation to address the environmental impacts of the oil spill and reverse years of damage along the Alabama coast.

LIVING SHORELINES

- Previous efforts to protect shorelines in this region have involved the introduction of hardened structures, such as seawalls, rock jetties, or bulkheads to reflect wave energy. A major concern with using bulkheads and seawalls to protect coastal property is that they can cause erosion and subsequent loss of intertidal habitats at and adjacent to the hardened structures.
- Recently, shoreline protection efforts have shifted towards using "living reefs," including oyster reefs to protect shorelines as an alternative to bulkheads and other armoring.
- Living shorelines usually involve the planting or restoration of naturally occurring coastal plants or shellfish.
- Living shorelines, especially when oyster or other shells are used, appear to have numerous benefits in addition to providing a buffer for estuarine and coastal shores.

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Alaska

Klawock River, Salmon Passage and Habitat Restoration Project

RESTORATION

Install fish-friendly culvert

Restore natural flow of water and fish

Restore estuary habitat

MONITORING

Observe culvert use by salmon adults and juveniles

Determine change in salinity

Observe change in eelgrass (location and condition)

Determine change in dependent species over time

BENEFITS TO PEOPLE AND NATURE

PEOPLE

Sustainable fisheries and fishery jobs

Recreational fishing

Eco-tourism

Increased water quality in estuary

NATURE

Increased essential habitat for salmon

Expected increased biodiversity

Increased salinity will favor growth of eelgrass

Project Highlights

- **Goals:** Improve salmon habitat and population with a long-term goal of restoring fisheries to historic levels to meet the needs of local residents and others.
- **Jobs:** This project invests in local economies by creating or maintaining 20 jobs and an estimated 10,800 hours of employment for surveyors, planners and designers, administrative staff, road construction crews, scientists and technicians.
- **Habitat Restoration:** The project will restore direct and safe access for salmon and other fish to 460 acres of eelgrass habitat and more than 65 miles of important stream and lake habitat.
- **Progress:** As of January 2011, contracts are in place, permitting is complete and designs for the fish- friendly culvert are approved. Construction, including casting the culvert, will start in March of 2011. Construction and installation of the fish-friendly culvert is expected to be complete by Spring of 2011.
- **Measurement:** A scientific monitoring plan will measure success of this project for salmon, steelhead, and small fish including fish and other aquatic species.
- **Outreach:** Project staff has reached out to the local community with fact sheets, an open house, and signs at the project site explaining details about the work to be conducted.
- **Partners:** Alaska Department of Transportation and Public Facilities, Alaska Department of Fish and Game, Klawock Watershed Council, City of Klawock, Klawock Community Association, Craig Improvement Association, Ducks Unlimited, NOAA Fisheries, U.S. Fish and Wildlife Service, USDA Forest Service, Klawock Heenya Corporation, Keta Engineering, Klawock Hatchery, and the Alaska Trollers Association.

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Pictured above: A black bear catches a pink salmon. ©Bridget Besaw

©TNC

Fishermen net salmon in the coastal waters of Alaska. ©Ami Vitale

A Vision for Project Success

Short-term goals: The primary goal for this project is to enable salmon passage beneath a highway that has blocked all fish passage since 1964, along a historic migration corridor of the Klawock River. Vastly improved habitat conditions for both juvenile and adult salmon are expected to occur following construction of a fish friendly cast concrete culvert measuring 100 feet long, 18 foot wide and 8 feet tall. Secondary goals are to improve salmon habitat by increasing the distribution of eelgrass, and to improve salmon populations by increasing the likelihood of salmon survival.

Long-term goals: The history, culture, and economy of Klawock provide important context for this project. Local residents depend on salmon and desire that the causeway/highway return to a condition that allows fish to pass and salmon stocks to return to historic levels. Salmon are the principal subsistence food of the Tlingit people and this project seeks to restore salmon populations to historic levels to support these and other needs.

People and Salmon: A Tightly-Knit Relationship

The village of Klawock on Prince of Wales Island has a population of 854 people, approximately 50 percent of whom are Alaska Native. Klawock residents adhere strongly to customary and traditional values and practices, including subsistence harvest of fish and wildlife. Historically, commercial, sport fisheries and secondary businesses were all supported by harvest of salmon.

The 29,061 acre Klawock River watershed on the west coast of Prince of Wales Island contains more than 132 miles of streams that serve as important spawning habitat for pink, chum, coho and sockeye salmon, as well as steelhead, cutthroat trout and Dolly Varden char. Sockeye salmon harvests of more than 30,000 fish were typical from the late 1880s through the 1950s. Since 1960, fish counts have seldom exceeded 20,000 sockeye and reached only 10,000 fish in six of the past 50 years. Similarly dramatic declines occurred for pink salmon and chum salmon in the latter half of the 20th century.

The settlement of Tlingit Indian populations at Klawock has spanned uncountable generations. A major attribute in this location has been access to the Klawock River and the Klawock Lake, which together provided an important salmon spawning system. Today, the most important subsistence activity for local residents is the salmon fishery at the mouth of the Klawock River, with sockeye being traditionally the most valued of the four salmon species that return to the river each year to spawn. A 1997 study documented that 69 percent of Klawock households use sockeye salmon, with an average of 117 pounds per household. Subsistence sockeye harvest by residents of Klawock has been relatively steady in recent decades at about 6,000.

Responses to a subsistence fisheries survey in 2001 suggested numerous causes for the modest harvests including: commercial interception, construction of a hatchery, logging, sport charter fishing, the causeway over the estuary, and weather patterns. Continued harvest restrictions remain in place to conserve the Klawock salmon population. The Klawock Watershed Council has played a key role building partnerships to protect and enhance habitat for salmon. A coalition of agencies, elected officials, fishermen and conservationists joined together in earnest nearly a decade ago to address the causeway issue. Opening the causeway to the passage of salmon fulfills a long awaited wish of the people of Klawock.

Sockeye salmon, still grey in color having just transitioned from sea to freshwater. ©Ami Vitale

The isthmus and causeway to Klawock village, today and in the 1930s. (left) ©Alaska ShoreZone and (right) courtesy of Paul Coffey

Solving a Restoration Challenge

Klawock village is reached by a narrow piece of land, or isthmus, and causeway that crosses the Klawock River estuary. Historically, the isthmus was under water at higher tidal stages, frequently enough to allowed out-migrating fish to access eelgrass habitat north of the causeway, and in-migrating fish to move directly up into the Klawock River to spawn. Sea water could mix freely with fresh water in the lagoon creating an estuary and habitat that supported fish that sustained local people. A highway was constructed over the isthmus in 1964, and the elevated roadbed partially blocked hydrologic connectivity between the Klawock River lagoon and Klawock Bay and created a barrier to fish.

One elder, responding to a subsistence fishing survey, remembered the fish moving through the area that is now blocked by the land causeway:

> *"It seems like it was a thoroughfare for the fish. We used to go swimming. Fish would swim down there and when the fish were moving up the stream, my Dad didn't like us going down there because then there was seals and killer whales that would come in and herd them, feed off of them. My Dad didn't like us to go there."*
>
> *Ratner et al. (2006) "Local knowledge, customary practices, and harvest of Sockeye salmon from the Klawock and Sarkar Rivers"*

Some believe the causeway changed the circulation patterns at the peak of the high tide, and suggest the fish previously had more opportunities to avoid predators. Several life long-time residents have pointed out the remains of a wooden fish trap near the causeway site, indicating that fish passed through or schooled nearby.

This project will restore access for fish to Klawock lagoon by installing a fish-friendly culvert, eighteen feet wide and a hundred feet long, beneath the highway and isthmus, allowing for the exchange of seawater and freshwater water in the lagoon. In particular, this will allow juvenile fish leaving the estuary at a vulnerable stage of their life to access 460 acres of eelgrass habitat that lies immediately seaward of the causeway. The project also will allow adult salmon to enter the Klawock River through the causeway, allowing them to more easily reach more than 65 miles of important stream and lake habitat. Improved rearing habitat will result in larger juveniles and increased survival as they leave the estuary, as well as higher ocean survival rates due to their increased size. The project is also expected to increase the salinity in the Klawock River lagoon and promote the establishment of eelgrass beds, which are officially recognized as Essential Fish Habitat for salmon. Expansion of eelgrass beds may also benefit other fish, including juvenile rockfish and forage fish.

Fish Passage and Estuary Restoration: Benefits for People and Nature

People: Direct benefits from healthy habitats

- Protecting the health of estuaries and providing safe passage to rivers for salmon provide humans with recreation and tourism opportunities and jobs, while providing clean water and protecting our coastal infrastructure.
- In particular, restoring habitat for salmon can pay huge dividends: The Alaska fishing industry employed approximately 54,760 people in 2003.
- Sport fishing also provides important benefits to the Alaska economy. Salmon are the most sought after fish for sport fishing in Alaska. A national survey estimated that U.S. residents spent approximately $537 million on fishing trips and equipment in Alaska in 2001.
- Alaska recreational fishing generated 11,064 jobs worth $235 million in wages and generated an estimated total of $960 million in spending.
- Although subsistence and personal uses accounts for less than four percent of the annual salmon harvest in Alaska, salmon is extremely important to many families throughout Alaska who depend on fish as a source of food and a way of life, especially in rural areas. Salmon harvest has deep traditional roots and great cultural value for many Alaskans, including rural residents and Alaska Native people.

Estuaries: Where the rivers meet the sea

- Where freshwater draining from rivers mix with the saltwater of the sea, estuaries offer an ecological bridge for species that move between the ocean and. An estuary's shallow, protected waters provide refuge for a diversity of species and important juvenile nursery habitats for many commercially important marine species.
- Migratory fish migrate between fresh and saltwater habitats for their growth, reproduction and survival. Such species cannot survive when access to spawning grounds is compromised or flow is altered in ways that degrade important nursery habitat.
- Species such as eelgrass depend on the correct ratio of salt to freshwater to survive. Salinities that are too high or too low can cause disease, mortality, and loss of vital habitat.

Eelgrass: The habitat provider

- Underwater grasses like eelgrass act as nursery habitat for fish and crabs and refuge from larger predators.
- Eel grass in Alaskan waters is considered an essential habitat for salmon and early life stages of dozens of other commercially-important species of fish found in Southeast Alaska.
- Eelgrass is known to be of great importance during very early migration of salmon fry, potentially increasing survival by providing protection from predators. Eelgrass may be an important transition habitat for salmon fry moving between estuaries and offshore areas, providing food, cover and protection from currents.

Fish Passage: A critical stage of life

- All fish migrate between feeding and spawning areas and make other seasonal movements to important habitats.
- Thousands of culverts, dikes, water diversions, dams and other artificial barriers were constructed to impound or redirect water for irrigation, flood control, electricity, water supply and transportation. All of these changed the natural features of countless waterways, blocking the natural migration of fish to historic habitat used for reproduction and growth.
- An estimated 2.5 million of these barriers still exist, many of which no longer serve their original purpose and were abandoned years ago.

SALMON BIOLOGY 101

- Pacific salmon are anadromous fish that live in the ocean mostly, and spawn in fresh water
- The Klawock River system supports pink, chum, coho, and sockeye salmon, as well as steelhead, cutthroat trout, and Dolly Varden char, which are taken to varying degrees in sport, commercial, and subsistence fisheries. Sockeye, the most desired subsistence species decreased in abundance in the mid-20th century and have yet to recover. Salmon are born in gravel nests at the bottom of stream and river beds as eggs about the size of a pencil eraser. The eggs are usually red to pink in color and hatch in about two to three months.
- Upon hatching, the new salmon will retain the yolk as a nutrient-rich sac attached beneath its body. The larval fish, called Alevin, will remain in the gravel bed for approximately a month until large enough to swim.
- Once large enough to swim these fish, called fry, begin their journey to the ocean.
- From several months to three years old, or Parr stage, salmon will continue to feed and grow until they are old enough to leave the estuary for the ocean.
- When juvenile salmon lose their vertical markings and turn silvery in color they are considered smolt. At this time the young salmon will transition to saltier waters, allowing them to swim out into the Pacific Ocean to feed and grow into adult salmon, eventually returning to their natal stream to spawn and die.

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California

Big Springs Creek and Shasta River Restoration Project

RESTORATION

Changes in irrigation operations

Cattle excluded from creeks and streams

Native species replanted in riparian zones

MONITORING

Water temperatures decrease and flows increase

Increase in salmon populations

BENEFITS TO PEOPLE AND NATURE

PEOPLE

Fish-friendly irrigation methods for farming

Increased water quality

Sustainable commercial and recreational fishing

NATURE

Increased essential habitat for fish

Increased biodiversity

Project Highlights

- **Goals:** Restore degraded salmon habitat with a long-term goal of demonstrating agricultural practices that benefit both people and fish.
- **Jobs:** This project will stimulate and benefit the economy at both the local and regional level by creating or saving 54 jobs and 18,741 labor hours of employment for construction labor and management, nursery stock providers, landscape laborers, field scientists and irrigation specialists.
- **Habitat Restoration:** The project will restore 70 acres of riparian corridor by restricting cattle from near-river areas and developing solar powered off-stream water sources for livestock. In addition, 20 acres will be planted with 8,000 native trees, 14 acres will be planted with native wetland plants and multiple irrigation system changes will be made including 11 new culverts and irrigation turnouts installed to support sustainable irrigation practices.
- **Progress:** As of December 2010, 75% of the fence construction is complete, 50% of the riparian restoration work is complete and 50% of the fish friendly irrigation projects are complete. Construction will continue through the spring and summer of 2011.
- **Measurement:** A scientific monitoring plan has been developed by the Conservancy and consultants to measure both the short and long term success of this project for fish and other species.
- **Partners:** The Nature Conservancy, California Department of Fish and Game, University of California Davis, California Department of Water Resources, Shasta Valley Resource Conservation District, California Trout, U.S. Fish and Wildlife Service, Bureau of Reclamation, California State Resources Agency, Natural Resource Conservation Service, Regional Water Quality Control Board, National Fish and Wildlife Foundation and the State Water Resources Control Board.

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Pictured above: Carson Jeffres, UC Davis Center Staff Research Associate conducting research in the Shasta River. ©Bridget Besaw

Morgan Knechtle, a fisheries biologist for California Fish & Game, with Whitney Crombie, fisheries tech for Shasta Valley Resource Conservation District, counting salmon along a section of the Shasta River where it was previously heavily grazed prior to The Nature Conservancy's purchase of Shasta Big Springs Ranch. ©Bridget Besaw

A Vision for Project Success

Short-term goals: The project will restore 10 miles of critical spawning and rearing streams and more than 100 acres of degraded salmon stream-side habitat by increasing riparian habitat and increasing the survival of spawning and rearing salmon by reducing average summer daily water temperatures.

Long-term goals: Restoring and protecting key places like the Shasta River and Big Springs Creek will help restore fish runs and ultimately could help revive California's salmon fishery as an important source of wild, locally caught salmon and demonstrate sustainable benefits to both humans and nature. The project will also demonstrate sustainable benefits to both people and fish by deploying agricultural practices at working cattle ranches.

Progress to date: Working with partners and support from NOAA, California DFG, NFWF, USFWS, NRCS, and RWQCB; The Nature Conservancy has been able to significantly improve salmon habitat in less than two years. Improvements include:

- Reduced maximum and average summer daily water temperatures to non-lethal levels for salmon.
- Increased riparian habitat, wetland and aquatic habitat, and
- Increased the quality and quantity of salmon spawning and rearing habitat.

The improvements above have resulted in an increase in suitable spawning and rearing habitat in the Shasta River from around 60 feet to more than 10 miles.

Supporting Salmon While Managing Lands

The Klamath River once produced the third largest salmon run on the Pacific Coast of the continental United States, after the Columbia and Sacramento-San Joaquin River Basins. The Shasta River, a small meandering stream at the base of Mount Shasta, remains a critical salmon producing tributary of the Klamath.

The Shasta River historically was a river dominated by migrating salmon at all months of the year. A conservative estimate as to the average number of all species of salmon spawning in the river prior to development of the Valley is 50,000 to 100,000 fish per year.

Today, only about 5,000 Chinook salmon return to spawn in the Shasta each year. In 2008, less than 30 federally listed threatened coho salmon returned as adults to spawn in the Shasta River and Big Springs Creek. These adults constitute less than one percent of estimated historic run size.

Salmon returning to spawn in the Shasta River running through The Nature Conservancy's Shasta Big Springs Ranch. ©Bridget Besaw

Only a handful of fish are returning to this stretch of river due to years of cattle grazing in the creek. ©Bridget Besaw

Resource experts working in the Klamath River watershed believe the Shasta River is crucial to the restoration of the Klamath Basin salmon populations. Although water resource development has detrimentally affected salmon populations, the cold water springs are still largely intact but their condition has declined. When restored, these springs can provide good quality habitat and essential flows to the Shasta River. If major restoration actions are not taken, the potential to bring back these natural areas and salmon populations will significantly diminish and perhaps be lost.

Solving a Restoration Challenge

This restoration is a prime example of how conservation supports a healthy and prosperous California. Restoring and protecting key places like Shasta River and Big Springs Creek, while managing the ranch to benefit farmers and fish, will help restore fish runs and ultimately could help revive California's salmon fishery as an important source of wild, locally caught salmon.

Water diversions, dams, inefficient irrigation practices and other conditions (e.g., ocean conditions, overfishing, etc.) have all contributed to the degradation and decline of the once productive Shasta River and Big Spring Creek. Big Springs Creek water quality and habitat is degraded due to cattle in the stream and hot irrigation return flows. While stream flows emerge from the ground at about 54 degrees F, in 2008, stream flows were heated up as high as 77 degrees F at its mouth of the Shasta River just over two miles downstream, creating lethal conditions for rearing salmon.

Fourteen tailwater hotspots have been identified along Big Springs Creek. Tailwaters draining from irrigated fields entering Big Springs Creek have been measured at times in excess of 90 degrees F. This in addition to excessive water diversions and uncontrolled grazing near river areas have led to water temperatures that are too warm and lethal for fish, degraded creek bank habitat and aquatic vegetation and inadequate rearing and spawning habitat. Of particular concern is the water temperature and quality during the summer months, when juvenile coho salmon need the cold-water habitat to survive the warm summer temperatures.

Restoration brings more vegetation, better habitat and cooler water to Big Springs Creek. ©Erika Feller/TNC

In order to retain intact and high quality riparian habitat critical to maintaining salmon habitat, The Nature Conservancy purchased the Shasta Big Springs Ranch in March 2009. Adjacent to Conservancy's Nelson Ranch, the combined property totals 6,200 acres including more than 10 miles of critical spawning and juvenile salmon rearing area where restoration will occur.

This project is anticipated to produce measurable conservation results that are tangible and specific. The project proposes to improve 7.8 miles of critical salmon spawning and rearing habitat along the Shasta River and 3.4 miles of Shasta River tributaries-Big Springs Creek by fencing cattle out of all waterways and managing the tailwaters that drain from irrigated fields. By keeping cows out of the creek, a drop in temperature of 13 degrees Fahrenheit was noted in the first year, which provides benefits 15 to 20 miles downstream during the hottest summer months when the salmon need cooler temperatures the most. The fence funded by NOAA will allow this restoration to take place in perpetuity. The project will also restore approximately 90 acres of riparian zone (vegetated creek banks); activities that are critical for providing fish and wildlife habitat as well as maintaining water flows and water quality for cold water fish including salmon.

Salmon Habitat Restoration: Benefits for People and Nature

People: Direct benefits from healthy habitats

- Beyond contributing to the recovery of the $60 to $100 million per year fishing industry in Northern California, the project will help stimulate Siskiyou County's struggling ranching and farming community. According to the Siskiyou County 2005 Crop and Livestock Report, the industry contributes more than 3,000 jobs and $150 million to the regional economy, or about 10 percent of total sales by industry.
- Rising unemployment rates in Siskiyou County suggest that experienced farm workers need work but cannot find it. The Big Springs Restoration project presents an excellent opportunity to put skilled workers, irrigation operators, fence builders and heavy equipment operators back to work.
- In California and Oregon, the commercial and recreational salmon fishery had an average economic value of $103 million per year between 1979 and 2004.
- From 2001 to 2005, average economic impact to local communities was $61 million for salmon fisheries: $40 million in the commercial fishery and $21 million in the recreational fishery (PFMC news release 2008).

Riparian areas: Interface between land and a stream

- Riparian zones and their unique vegetated structure are important because of their role in soil conservation, biodiversity, and the influence they have on shading of river and creeks which lowers water temperatures.
- Unlimited grazing access to the riparian zone and river have led to lethal maximum average daily water temperatures, degraded riparian habitat and aquatic vegetation and trampled important salmon spawning grounds.
- Of particular concern is the water temperature and quality during the summer months, when coho need the cold water habitat to survive the warm summer temperatures. Vegetation shades creeks and waterways and when that vegetation is removed, water temperatures rise.
- Shallow water is more easily heated by the sun's energy. As the river channel is degraded by cattle grazing, it becomes wide and shallow, moving slower downstream and receiving more sun exposure.

SALMON SPECIES IN THE SHASTA RIVER

Coho salmon: Coho salmon of Southern Oregon/Northern California are in severe decline: down to six percent of their historic abundance. They were listed as federally threatened in 1997 and endangered by the State of California in 2004. Coho fry emerge from the gravels in February and March and generally use the stream for rearing for about one year. One of the main concerns regarding the Shasta River coho is that the juveniles are not staying in the Shasta to rear during the summer months, as they historically did. Improvements in stream conditions during the summer to keep the juveniles in the Shasta as they mature will greatly improve these young fish's chances of survival to return as spawning fish when they are adults.

Fall-run Chinook: Historically spring-run Chinook comprised the majority of the salmon runs of the Shasta River. Today however, the fall-run Chinook is the largest salmon run in the Shasta River and the spring-run Chinook has been extirpated. Run estimates have ranged from nearly 82,000 fish in 1931 to a low of 37 fish in 1948. Since 1978, the run has averaged about 5,600 salmon although runs of less than 1,000 fish were experienced in 1990, 1991 and 1992.

Winter Steelhead: While counts of adult steelhead are lacking for most of the 20th century, they were historically abundant in the river, as indicated by an egg-taking station that was present in the 1930s.

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FLORIDA/USVI

Coral Recovery and Restoration Project

RESTORATION

Underwater nurseries developed, stocked with growing corals, and maintained

Coral fragments propagated to create larger stock within nurseries

Coral transplanted to help restore existing coral reefs

MONITORING

Monitor nursery operations

Measure success rate, genetic diversity and success of corals at restored reefs

BENEFITS TO PEOPLE AND NATURE

PEOPLE

Sustainable fishery jobs

Recreational fishing

Eco-tourism

NATURE

Sustainable fishing

Increased essential habitat for fish

Increased biodiversity

Project Highlights

- **Goals:** Restore 34 coral reefs in eight locations across two ecosystems, which will increase biodiversity and boost local tourism businesses.
- **Jobs:** This project will create or directly support nearly 60 jobs totaling an estimated 118,759 hours of labor.
- **Habitat Restoration:** This project includes production of 12,000 colonies of threatened staghorn and elkhorn coral within eight shallow in-water nurseries and transplantation of the new colonies to an estimated 34 reef sites in Florida and the U.S. Virgin Islands.
- **Progress:** Coral nurseries have been constructed and are being maintained at eight locations: Broward County, Biscayne National Park, Upper Keys, Middle Keys, Lower Keys, Dry Tortugas, St. Croix and St. Thomas.
- **Measurement:** Direct measurements and photographs are being used to document growth and survival of corals being produced in the in-water nurseries, and genetic samples are being taken to document and track progress with the different strains that are used in the project.
- **Partners:** The Nature Conservancy, Coral Restoration Foundation, Florida Fish and Wildlife Conservation Commission, Mote Marine Laboratory, Nova Southeastern University, University of Miami, Penn State University, Florida Keys National Marine Sanctuary, University of the Virgin Islands, Florida Department of Environmental Protection, U.S. Virgin Islands Department of Natural Resources, U.S. National Park Service and the National Oceanic and Atmospheric Administration.

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Pictured above: Staghorn coral (*Acropora cervicornis*) in the Dry Tortugas, Florida. ©Meaghan Johnson/TNC

Mounting coral clippings in the nursery. ©Meaghan Johnson/TNC

A Vision for Project Success

Short-term goals: The project will expand on previous experimental-scale restoration efforts by producing at least 12,000 colonies of threatened staghorn and elkhorn coral within eight shallow in-water nurseries and transplanting the new colonies to an estimated 34 reef sites in Florida and the U.S. Virgin Islands.

Long-term goals: To increase the natural reproduction of staghorn and elkhorn corals and ensure genetic diversity by increasing successful cross-fertilization between colonies transplanted close together on the reef sites.

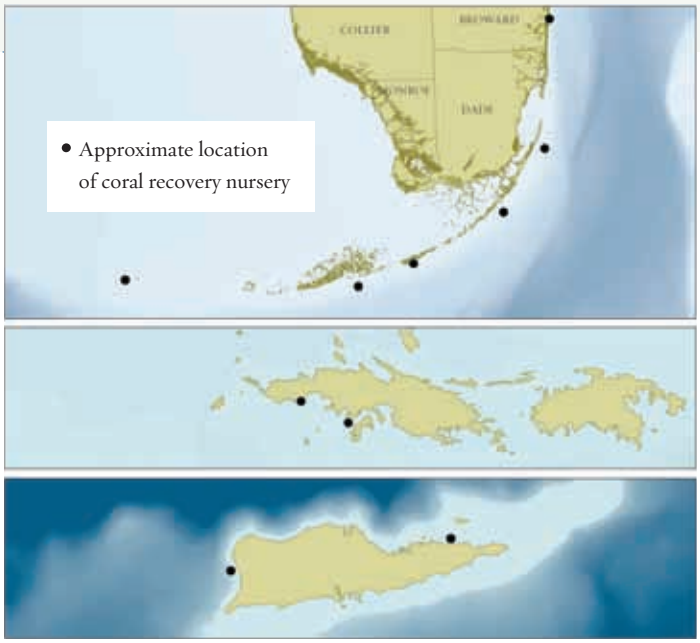
Cuttings of coral are glued to cement blocks in water nurseries around the Florida Keys. ©Ken Nedimyer

A Safety Net for an Imperiled Species

In recent decades, there have been widespread and catastrophic declines in the populations of the important reef building staghorn coral, *Acropora cervicornis* and elkhorn coral, *Acropora palmata*. These species are the main building blocks of reefs in both the Florida Keys and the U.S. Virgin Islands. Their numbers have declined dramatically since the late 1970s and in 2006, staghorn and elkhorn corals were both listed as threatened under the Endangered Species Act.

To help address this decline, the Conservancy and NOAA initiated a staghorn restoration project in 2004 to test approaches for growing and transplanting young coral colonies from in-water nurseries to degraded reef sites in the Florida Keys. At the center of this project was a partnership with a privately-owned live rock farm site within the Florida Keys National Marine Sanctuary that was permitted and equipped to produce corals for the aquarium trade. Using these "farming" techniques, new coral colonies have been grown since 2000 and offspring (clones) of parent colonies in the farm were produced and later transplanted to selected sites across the Upper Keys. The transplanted corals were monitored to evaluate their survival, growth rates, and observations made about the functional and structural changes to reefs themselves.

In 2006, this project was replicated and expanded to three more areas within the Florida reef tract (Lower Keys, Biscayne National Park and Broward County). The expanded project allowed for comparisons across much of the Florida Reef Tract, and provided a solid basis for determining areas where large-scale restoration efforts would provide the greatest returns.



Nurseries in Florida, St. Thomas and St. Croix. ©James Byrne/TNC

Acropora palmata on a reef in St. Croix, U.S. Virgin Islands. ©Kemit Amon Lewis/TNC

The current project builds on the success of these previous projects, helping to increase production of propagated corals, rebuild populations of this threatened species, restore coral reefs, improve ecosystem services, and invest in the infrastructure needed for future restoration activities.

Solving a Restoration Challenge

This current project will dramatically scale up the enhancement of staghorn and elkhorn coral through the maintenance and establishment of nurseries on reefs in Florida and the U.S. Virgin Islands. New in-water nurseries will be established and maintained within eight distinct subregions, with the purpose of propagating the species and creating as many new colonies as feasible given limits on resources. Thousands of nursery-reared coral colonies will then be transplanted out onto reefs that are known to have supported these species in the past, with the expectation that these corals will contribute to the further re-establishment of the species over even more reef areas over time.

In addition to the direct restoration of corals, this project will work toward determining the genetic strains that are most resilient to various environmental stresses and to identify the optimum environmental factors which foster the best coral recovery. Additional corals will be maintained in the nurseries beyond the end of this project in anticipation of ongoing restoration needs.

Our long-term goal is to increase the natural reproduction of staghorn and elkhorn corals and ensure genetic diversity by increasing successful cross-fertilization between colonies transplanted close together on the reef sites. This will help increase the health and resilience of both coral species and increase the overall abundance of coral larvae within the region. Coral larvae can travel one kilometer or more, so the project could potentially have a long-term restoration footprint of 2,500 hectares. Genetic information collected as part of this project will provide information will result in significant ecological gains toward the recovery of imperiled corals.

Coral Restoration: Benefits for People and Nature

People: Direct benefits from healthy habitats

Coral reefs and associated habitats provide critical habitat for fishery resources that represent a critical source of food for humans, providing as much as $375 billion per year around the world in goods and services. Within Florida and the U.S. Virgin Islands the benefits and impacts of healthy coral reefs are also clear and compelling:

- Florida Keys Commercial Fishermen's Association reported seafood and related industries earned upwards of $70 million in 2006.
- During a 12-month period from June 2000 to May 2001, reef related expenditures generated $1.3 billion in sales in Miami-Dade County and $504 million in Monroe County, Florida. These expenditures provided thousands of jobs supporting tourism and fisheries each year – more than $1.2 billion in the Florida Keys alone.
- In Monroe County, the commercial fleet supports approximately 1,200 families, which is close to five percent of the county's population.
- In 2006, Monroe County was ranked the fifth most valuable port in the nation with a dockside of approximately $54.4 million, excluding retail sales or profits made by wholesalers who marketed seafood products.
- Fishers in the U.S. Virgin Islands reported landings of just under 1.2 million pounds of fish with a direct monetary value of $4.8 million in 1999 (Hinds, Unlimited, 2003).
- Many visitors are attracted to the U.S. Virgin Islands because of snorkeling, diving and fishing opportunities. Tourism is the primary economic driver, accounting for more than 70 percent of the gross domestic product (World Resources Institute, 1998)
- Approximately 32 percent of all employed residents of the U.S. Virgin Islands are engaged in retail sales or in service provided by recreation, hotels, guest houses, and restaurants.

Coral reefs and associated habitats provide fishery resources that represent a critical source of food for people. Coral reefs are among the oldest ecosystems on Earth and are the largest living structure on the planet.

- Although coral reefs cover less than one percent of the Earth's surface, they are home to 25 percent of all marine fish species.
- Corals provide substrate in an otherwise flat world – corals grow in 3-D structures that provide habitat for many other species including recreational and commercial fish.
- Coral reefs create nursery habitat for fish and crabs and can provide small animals shelter from larger predators. Reefs provide attachment points for other colonizing species which can be important food sources for fish, shrimp and crabs.
- Coral reefs form natural barriers that protect nearby shorelines from the eroding forces of the sea, thereby protecting coastal dwellings, agricultural land and beaches. Without the existence of coral reefs, parts of Florida would be under water.

Challenges Faced

The two main challenges we have faced in the first 18 months of this project were weather-related. In January of 2010, an extended cold front moved through the Keys. Cold water from the Florida Bay moved out through channels along the Keys and along the nearshore areas of the reef. Significant damage was caused to both the natural reefs of the Florida Keys and the Upper, Middle and Lower Keys nurseries.

One of the benefits of having coral nurseries became apparent during this event – material that had previously been harvested from the Middle Keys and was being maintained in the Upper Keys survived in the nursery even as the parent colonies died in the wild. The nursery now serves as the only remaining repository of coral fragments from those genotypes and plans are being made to move some of those fragments back to the Middle Keys nursery and eventually back out to the reefs where they originated.

The second weather-related challenge we faced was Hurricane Earl, which passed through the Virgin Islands last summer. It caused a significant amount of damage in the Perseverance Bay nursery and limited damage in the Lindquist Bay nursery, both of which are located on St. Thomas. Since that event, new rebar has been added to the nursery to add stability to the blocks and prevent damage during future hurricanes.

Accomplishments to Date

- Hosted Dr. Jane Lubchenco and other NOAA dignitaries for a celebration of Earth Day, which included a tour of the Upper Keys nursery.
- All nurseries stocked with fragments from at least 20 parent colonies.
- Currently have approximately 9500 coral fragments in the nurseries, with more fragmenting planned for this winter.
- Starting to develop an Outplanting Plan.

CORAL REEF BIOLOGY 101

- Reef-building corals are animals that form a living colony of polyps that secrete limestone skeletons.
- Corals can reproduce not only sexually, by releasing sperm and eggs directly in to the water column, but also asexually when fragments are broken off and can continue to grow into another colony.
- Corals share a symbiotic relationship with zooxanthellae, single-celled organisms that live within corals themselves. Zooxanthellae help corals grow their calcium carbonate skeletons and give corals most of their color – without them coral tissue is almost white.
- Corals are sensitive to water temperatures. The optimal temperature range for staghorn and elkhorn corals is between 77 and 84 degrees F, although colonies in the Virgin Islands have been known to tolerate warmer temperatures for short periods of time. Both warm and cold water can cause bleaching and/or mortality to corals.
- The first sign of stress, caused by temperature or other factors, is bleaching, in which the coral expels its zooxanthellae. Unless the stress is reduced the corals will eventually die without their symbiotic zooxanthellae.
- How quickly a reef grows depends on conditions like food availability, water temperature and disturbances like storms.

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HAWAI'I

Maunalua Bay Reef Restoration Project

RESTORATION

Reefs cleared of alien algae

Increase in community participation and leadership for ongoing Bay stewardship

MONITORING

Measure the effect of new stewardship activities

Monitor clearing operations, monitor for re-invasion of alien algae, measure return/growth of native species

BENEFITS TO PEOPLE AND NATURE

PEOPLE

Sustainable jobs and businesses

Improved subsistence and recreational fishing

Restored recreational use

NATURE

Clean water, healthy bay with native corals, algae and native fish

Increased essential habitat and native biodiversity

Restored ecosystem functions

Project Highlights

- **Goals:** Take a major step forward in restoring Maunalua Bay to a healthy marine environment by strengthening community and local businesses efforts to remove invasive algae from near-shore waters.
- **Jobs:** This project has supported 75 jobs totaling an estimated 100,000 hours of labor. Through increased volunteer efforts, the project also provided an estimated 7,000 hours of community service. Local small businesses are converting the algae into marketable compost or fertilizer.
- **Habitat Restoration:** The project reclaims native coral reef and seagrass habitats in Maunalua Bay by clearing invasive algae from 23 acres of near-shore reefs habitat.
- **Measurement:** A scientific monitoring program will measure both the short and long term impacts of this project on water quality, native algae, corals, sea grass, and other marine life in the Bay.
- **Community Capacity:** This project will build community capacity for expanded and sustained management of the Bay by strengthening and expanding community leadership, public awareness and community involvement. The community organizations involved in this project hope to share this model of natural resource management with other communities in Hawai'i.
- **Collaborators:** The Nature Conservancy, Mālama Maunalua, University of Hawai'i, NOAA National Marine Fisheries Service, Polynesian Voyaging Society, Hui Nalu Canoe Club, Mālama Hawai'i, Aloha 'Āina 'o Kamilo Nui, Pono Pacific, Chrysanthemums of Hawai'i. and the University of Hawaii's College of Tropical Agriculture and Human Resources (UH CTAHR), Kokua Kalihi Valley, and a local compost manufacturing firm Hawaiian Earth Products.

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Pictured above: Native sea grass and marine life like this eel are returning to Maunalua Bay. ©Jeff Milisen

The Maunalua Bay region is home to more than 60,000 residents. ©Ryan Tabata

A Vision for Project Success

Short-term goals: Expand small-scale community volunteer efforts to a broader and more biologically meaningful level by removing a large amount of invasive algae from Maunalua Bay. Employ area residents and engage a larger proportion of local businesses and families in ocean stewardship.

Long-term goals: Leverage government funding and support to make rapid progress on one of the three major threats to a healthy Bay, while bolstering community efforts and building a stronger base of interest, knowledge and commitment.

Leather mudweed thrives in the sediment that has accumulated in Maunalua Bay, but can be removed by hand. ©Grady Timmons/TNC

Alien Invaders: Smothering Native Ecosystems

Maunalua Bay, located in urban Southeast O'ahu, extends from *Kawaihoa* to *Kūpikipiki'ō* (also known as Portlock to Black Point). The Bay includes nearly 8 miles of shoreline and 6.5 square miles of ocean waters. Just a few generations ago, families living in the area harvested meals almost daily from the Bay.

Today, the once productive reef areas are enjoyed primarily for recreational activities such as boating, diving, parasailing, outrigger canoe paddling, stand-up paddle boarding, and surfing. Recreational fishing provides enjoyment too, but the populations of culturally important marine life, such as surgeonfish, parrotfish, goatfish, eels and lobster are dramatically lower than they once were. The shallow reef flats of the Bay also once housed native algae and seagrass that have now become rare.

Despite their biological, ecological, and cultural importance, Hawai'i's marine ecosystems continue to be severely degraded by human activity. Hawai'i's coral reefs and shoreline habitats were once a primary source of food for island residents, providing fish, limu (algae), and other resources. While some harvesting continues today, the abundance of healthy, native marine life in Hawai'i's nearshore waters is 75 percent less than it was 100 years ago.

The primary threats responsible for the decline of the reefs in Maunalua Bay are overharvesting, land-based pollution, and invasive species. The worst of the invasive species is an alien alga called *Avrainvillea amadelpha* (known locally as "leather mudweed"), which outgrows, outcompetes, and smothers native algae, coral and seagrass. Leather mudweed is found in near-shore reefs as well as waters 70 meters deep. In shallow waters, it grows well and traps sediment, forming a thick carpet that smothers the native corals and holds sediment in place. This degrades the entire reef ecosystem by displacing all other native species, and by creating an oxygen-poor environment which prevents native marine life from flourishing.

Invasive algae has been removed from 22 acres of Maunalua Bay. ©Manuel Mejia/TNC.

A. amadelpha was first reported in Hawai'i by scientists in the early 1980s. It has since spread along the southern shores of O'ahu, but is most widespread in Maunalua Bay where it is found in very thick density in more than 54 acres.

The good news is that reefs are resilient – if we act in time, we can restore them.

Solving a Restoration Challenge

Removing the invasive algae by hand is the most efficient and environmentally sensitive way to clear areas. By employing local people from the area, this project has made both a significant environmental and community impact. The visual results of clear water, and the anticipated re-growth of native species will motivate community groups to expand efforts to address the other threats in the Bay, which include land-based pollution and unsustainable fishing practices.

Coral Reef Restoration: Benefits for People and Nature

- Corals are one of the oldest life forms on earth and have existed for tens of millions of years. Hawai'i's 300,000 acres of nearshore coral reefs are home to more than 7,500 forms of marine life, more than a quarter of which are found nowhere else on earth.
- Coral reef ecosystems provide many goods and services to coastal populations, such as fisheries and tourism. The reefs contribute more than $350 million a year to Hawai'i's economy – that's roughly $1 million a day.

Eagle rays, once commonly found in Maunalua Bay, have been seen frequenting the cleared areas in Paiko reef flats. ©NOAA

- Hawai'i's reefs are also an integral part of our Islands' cultural heritage, supporting local residents who rely on healthy nearshore fisheries for food, income, and recreation. With a primary resident population of 1.2 million people and 7 million visitors annually – the majority of whom engage in ocean-related activities – Hawai'i's reefs are strained beyond capacity.
- Today, many scientists, fishermen, local communities and native Hawai'ians are working together to restore our marine resources – through enhanced management, stepped-up enforcement, and a new spirit of cooperation that serves the greater good.

Conservancy and Mālama Maunalua staff are working together to restore Maunalua Bay. ©John DeMello and TNC

More than 50 people were hired to remove the invasive algae from Maunalua Bay. ©Manuel Mejia/TNC.

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LOUISIANA

Grand Isle and St. Bernard Marsh Shoreline Protection Project

RESTORATION

Bio-engineered oyster reefs installed
Oysters grow naturally over time and become living reefs
Fish and shellfish species numbers increase
Reefs trap suspended sediment and Marsh naturally develops
Marsh replanted

MONITORING

Measure growth and success of oyster reef
Monitor water quality
Monitor species' use of reef
Monitor shoreline change

BENEFITS TO PEOPLE AND NATURE

PEOPLE

Water filtration
Shoreline protection
Sustainable fisheries and jobs
Recreational fishing
Eco-tourism

NATURE

Increased essential habitat for fish and shellfish
Increased biodiversity
Increased water quality

Project Highlights

- **Goals:** Construct oyster reefs to protect and restore shoreline habitat with a long-term goal of increasing public awareness and use of oyster reefs as a sustainable option for reducing erosion of coastal marshes, which help protect communities from storm surge.
- **Jobs:** This project is helping to enhance local and state-wide economies by either creating or maintaining 57 jobs, totalling 61,982 hours of employment.
- **Habitat Restoration:** This project is restoring vulnerable shorelines by installing oyster reefs along 3.4 miles of shoreline at the Grand Isle/Fifi Island area and St. Bernard Marsh, which border approximately 350 acres of existing marsh.
- **Progress:** Permits, contracts, design for reefs and their placement and "most of the" reef construction is complete. Reef installation began in April 2010 but was put on hold due the Deepwater Horizon spill. Deployment of Reefblk© at the Grand Isle project area began again in December 2010 and will be completed by March 2011. St. Bernard Marsh reefs will be fully installed by October 2011. Pre-construction monitoring is complete, and two years of post-construction monitoring will be conducted.
- **Measurement:** Louisiana State University Agricultural Center developed a scientific monitoring plan to determine the short and long-term success of this project by monitoring reef establishment, species use, vegetation growth and shoreline changes.
- **Outreach:** Project staff have reached out to the community, held a Earth Day event on Grand Isle in April 2010 and are organizing a Oyster Reef Rodeo on Grand Isle for April 2011. The rodeo is a fishing event designed to educate and engage the public. Staff are also working with students to grow marsh grass in the school nursery.

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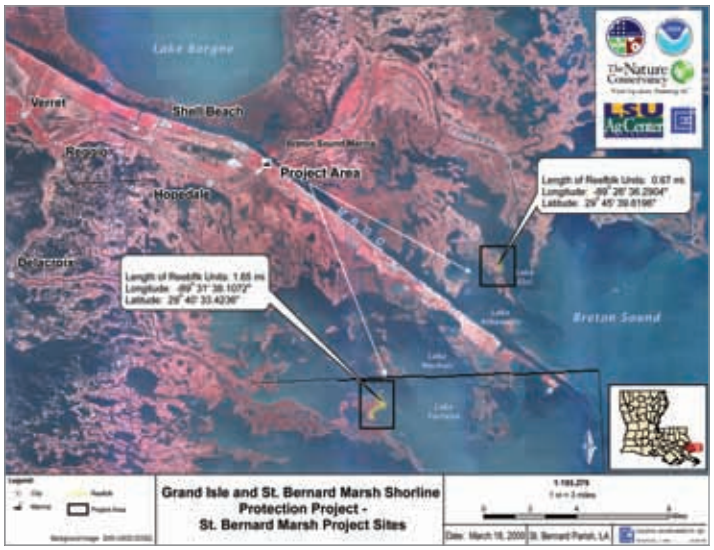
Pictured above: Oyster reefs. ©Barry Truit/TNC



St. Bernard Marsh project sites.

Grand Isle and Fifi Island project sites.

- **Partners:** The Nature Conservancy, Coastal Environments Inc., Louisiana State University Agricultural Center, NOAA, private landowners, town of Grand Isle, Grand Isle Levee District, Grand Isle Port Commission, Louisiana Department of Wildlife and Fisheries, Louisiana Dept. of Natural Resources, St. Bernard Parish Government, Jefferson Parish Government and U.S. Army Corps of Engineers.

A Vision for Project Success

Short-term goals: To protect and restore Louisiana's shoreline and historic oyster reefs by creating 3.4 miles of living shorelines. To protect vulnerable shorelines from wave energy and erosion, enhance water quality and fish habitat and facilitate the natural development of marsh. To create jobs in areas that were hit hard by hurricanes and help boost the local economies.

Long-term goals: To collaborate with partners to complete additional shoreline protection in coastal Louisiana and greatly increase the awareness and use of oyster reefs as a sustainable option for shoreline protection.

Coastal Habitats: Essential for People and Nature

The value of Louisiana's coastal marshes is well established as essential habitat for numerous fish, birds and marine mammals. Marshlands provide critical habitat for species that support valuable commercial and recreational fishing industries that result in millions of dollars in state revenue each year in Louisiana. Approximately 75 percent of the nation's commercial fish and shellfish and 80 to 90 percent of fish caught for recreation depend on estuaries at some stage in their life cycle.

Without estuaries and their associated wetlands, these fish and shellfish cannot survive. While salt marshes are among the most productive habitats in the world, in Louisiana they are changing forever. Because of complex problems such as shoreline erosion, between 20 and 25 square miles of Louisiana's coast are lost each year, representing 80 percent of the total coastal wetland loss in the entire continental United States. The ecological and economic repercussions of this land loss are profound.

Coastal marshes are valuable for their role in storm protection, shoreline stabilization, flood attenuation, and hurricane protection to the Louisiana coast, protecting billions of dollars of infrastructure and the lives of citizen who live on our coast. With the devastation of hurricanes Katrina and Rita, scientists, managers, policy makers and the public witnessed the direct link between coastal habitats, fishing and Louisiana's economy. Nearly $168 million in seafood revenues and an estimated 3,400 fishing fleets were lost (Caffey et al., 2007).

The eye of Hurricane Katrina passed within miles of both Grand Isle and St. Bernard Parish. Consequently, these and surrounding communities suffered much of the loss and are still recovering. These communities have historically supported a thriving fishing economy; however, many people who remain are now trying to find employment in other industries, such as construction, welding and other skilled labor positions.

Solving a Restoration Challenge

Oyster reefs are common features in coastal Louisiana and throughout the Northern Gulf of Mexico and have been heavily harvested throughout the last century. The potential for oyster reefs to protect against shoreline erosion and therefore protect marshes has been recognized for some time. Until now, building reefs to protect and restore shorelines, estuaries and their marshes has been under utilized as a restoration strategy.

Workers prepare a site for installing ReefBLKtm, a proven technique for growing oyster reefs. ©Amy Smith Kyle.

ReefBLKtm, interlocking steel cages filled with recycled shells, are being used in Louisiana and other Gulf states to grow oyster reefs. ©Amy Smith Kyle

Welding to create the Reefblk© units. ©Richard Greig

This project will protect and restore vulnerable shorelines, and hence valuable marsh by installing bio-engineered oyster reefs along approximately 3.4 miles of shoreline in the Grand Isle area and St. Bernard Marsh. Reefblk©, a proven reef design made from American steel, will form the basis of the oyster reefs. The reef units will be constructed in local welding shops in Grand Isle and St. Bernard Parish.

The reefs act as natural coastal buffers by absorbing wave energy, reducing erosion and trapping suspended sediment. The shorelines that will be protected border approximately 350 acres of existing marsh and this treatment will potentially facilitate the creation of an additional 35 acres of emergent marsh. Recycled oyster shell will fill mesh bags inside the steel frames. These artificial reefs will become living reefs as oysters attach to the oyster shell and grow.

The reefs will also provide important habitat – more than 170 marine species have been documented at oyster reefs in the Northern Gulf of Mexico including shrimp, crabs and fish. This project will help stimulate the local commercial and sport-fishing industries. Because oysters remove nitrogen when filtering water to feed on plankton, they also help improve water quality.

Oyster Restoration: Benefits for People and Nature

People: Direct benefits from healthy habitats

Healthy coastal marshes and reefs provide people with recreation and tourism opportunities and jobs, while providing clean water and protecting our coastal infrastructure from damaging storms and sea level rise. The natural beauty of coastal wetlands attracts millions of dollars in recreation and tourism money to the state and local economies.

- Approximately 180 million people visit the coast for recreational purposes each year. Coastal tourism and recreation comprise the largest and fastest-growing sector of the U.S. service industry, accounting for 85 percent of all tourism-related revenues generated by coastal states.
- Oyster reefs provide habitat for numerous marine species including recreational and commercial fishes—Atlantic croaker, blue crab, black drum, naked oyster, toadfish, pinfish, red drum, sheepshead, skilletfish, southern kingfish, speckled trout, striped blenny, stone crab, and white trout.
- The 2008 dockside value of commercial landings of Louisiana's oysters alone was $38.8 million. Finfish and shellfish (shrimp and crabs) landings totaled greater than $64 million and $210 million respectively.
- Recreational fisheries also contribute substantially to the state's economy, generating almost $49.9 million dollars in state and local sales tax revenue in 2006. During that same year, anglers spent more than $472 million on saltwater recreational fishing in Louisiana. This activity supported 7,733 jobs with nearly $229 million in earnings.
- Louisiana is second only to Alaska in commercial fisheries landings.
- Three of Louisiana's commercial fishing ports are in the top ten landings ports for the United States: Empire-Venice, Intracoastal City, and Cameron.
- One of out every 70 jobs in Louisiana can be attributed to commercial fisheries (Southwick 2006).
- Louisiana is second only to Florida in recreational harvest among states surveyed by NOAA Fisheries' recreational creel survey. According to data collected by NOAA in 2006, 19 percent of saltwater recreational fishing trips occurred in Louisiana.

Grand Isle project site. ©Amy Smith Kyle

Oysters: the water filter, the habitat provider and the shoreline protector

- Oysters are filter feeders – they filter suspended particles (sediments, algae) out of the water column, leading to increased water clarity.
- Increasing water quality can enable more sea grass to grow providing more juvenile fish and crab habitat. Healthy oyster reefs filtering coastal waters could decreases number of harmful algae blooms, and associated fish kills and beach closures.
- Oysters provide substrate in an otherwise flat world – oysters grow in 3-D structures that provide habitat for many other species including recreational and commercial fish, create nursery habitat for fish and crabs and can provide small animals shelter from larger predators.
- Reefs provide attachment points for other colonizing species which can be important food sources for fish, shrimp, and crabs.
- Shellfish reefs are natural breakwaters that can stabilize shorelines, help to build wetlands, reducing runoff and the amount of suspended sediment in the water column, thus increasing water quality.

Impacts of the Gulf oil spill

After the spill, the demobilization of the contractor from Grand Isle and the necessity of the project staff to address immediate oil spill activities caused additional project expenses and delays. Given the potential ecological ramifications of the spill, it is critical to complete this restoration and shoreline protection project along. With the underpinnings of how to accomplish effective large-scale oyster reef and marsh restoration in place, the Louisiana ARRA project is helping to kickstart recovery in the Gulf Coast.

OYSTER BIOLOGY 101

- Oysters, mussels, and clams are bivalves – their body is compressed and enclosed into a two-valved shell.
- While larval clams, mussels, and oysters swim through the water column only adult clams remain truly mobile and can dig through sand and mud.
- Oysters release eggs and sperm into the water column where fertilization occurs.
- A “veliger” is a larval stage oyster which can swim in the ocean for days to weeks feeding and drifting until they settle to the bottom to their permanent habitat.
- Adult oysters permanently attach themselves to other hard surfaces, cementing their left shell, preferably to another oyster.
- Oysters will grow on a number of surfaces but grow the most successfully on other oysters.
- How quickly an oyster reef grows depends on conditions such as food availability, water temperature, salinity, and disturbances like storms. Conditions are particularly suitable for oyster growth in Louisiana which produces 34 percent of the nation’s oysters. A healthy or mature oyster reef is one that has many different ages of oysters on it, and is three dimensional in structure with significant vertical height.

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MAINE

Penobscot River Restoration Project: Great Works Dam Removal

RESTORATION

Dam removal

Connected habitat for movement of fish and other species

Essential fish habitat restored

MONITORING

Pre-deconstruction measures of fish populations, water quality and habitat

Monitor biological impacts and water quality during removal

Track recovery of diadromous populations, bank revegetation, and changes in fish communities, water quality and channel features

BENEFITS TO PEOPLE AND NATURE

PEOPLE

Sustainable fisheries and fishery jobs

Penobscot Nation fully exercise treaty fishing rights

Recreational fishing

Recreational tourism

Hydro-generation

NATURE

Increased access to spawning and rearing habitat for fish

Increased abundance of fish and wildlife

Increased resilience of river system to climate change

Project Highlights

- **Goals:** Dam removal, job creation and scientific monitoring with long-term goals of restoring sea-run fisheries and creating additional jobs and economic benefits.
- **Jobs:** The vast majority of this investment directly supports restoration-related construction activity, including labor for on-the-ground restoration-related work. The project will create or maintain 102 construction, engineering, scientific, and project management jobs employing 368 people and assisting a region facing above-average economic challenges worsened by the recent economic downturn. Engineering and heavy construction activities alone will create 88 jobs employing a nearly 350 people.
- **Habitat Restoration:** When fully implemented, this project will significantly improve access to nearly 1,000 miles of historic habitat for fish and remove several barriers as well as restore six miles of currently impounded river to its natural state.
- **Benefits to People:** The project will render meaningful the Penobscot Indian Nation's federally recognized sustenance fishery rights and revitalize river-related cultural and spiritual and economic practices.
- **Progress:** Pre-removal monitoring underway, permitting is complete and dams are now owned by Penobscot Trust, allowing de-construction to begin.
- **Measurement:** The Penobscot Project is an unprecedented restoration effort in scale, scope, and approach that requires discrete measures to examine outcomes. More than 20 scientists have begun baseline and long term monitoring so that project benefits can be documented and shared.
- **Partners:** Members of the Penobscot River Restoration Trust are the Penobscot Indian Nation, American Rivers, The Atlantic Salmon Federation, Maine Audubon, The Natural Resources Council, Trout Unlimited and The Nature Conservancy. The project agreement is also with PPL Corporation and a number of federal and state agencies.

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Pictured above: Osprey catching alewife as the fish migrate upstream to their spawning habitat. ©Linwood Riggs

The Great Works Dam on the Penobscot River in the towns of Old Town and Bradley, Maine. ©Bridget Besaw

Using drilling equipment, workmen build a 17 step and pool waterway, which will allow thousands of alewife to access an adjoining stream for spawning. ©Bridget Besaw

A Vision for Project Success

Short-term goals: Dam removal, job creation, scientific monitoring, fish passage.

Long-term goals: Restored sea-run fisheries and new jobs and additional economic benefits.

People and Fish: A Tightly-Knit Relationship

This project is poised to rebuild the Penobscot River's migratory (or diadromous) fisheries and to create a sustainable balance between native fish and human needs for the river. The project will restore lost ecological connections and renew ecological function to the Penobscot River watershed that was diminished severely with the advent of dams more than two centuries ago.

For the Penobscot Nation, migratory fish continue to play important ceremonial and religious roles. The river is intertwined with the Tribe's survival and identity. For decades, tribal members have not been able to fully exercise treaty fishing rights, as few sea-run fish currently reach their Reservation.

The Penobscot once supported vast populations of 11 species of native diadromous fish including shad and the federally endangered Atlantic salmon. These species return home to spawn in the river where they came from and depend on these habitats for their development.. These fish provided food and income for settlers that built communities along the river giving rise to current riverfront towns that exist even today.

Baseline monitoring occurring on Penobscot River. ©Bridget Besaw

Solving a Restoration Challenge

The Penobscot River's native diadromous fish populations are at or near all time lows. Dams, poor water quality, log drives and overfishing all contributed to the decimation of native fisheries. Today, log drives have ended and water quality and harvest management are vastly improved. Yet a series of outdated dams on the Penobscot impede and block fish migrations and have eliminated critical habitat for fish.

Restoring the Penobscot will restore species in a web of life with a vast reach. The Penobscot watershed covers one quarter of Maine – 8,570 square miles. It provides tremendous freshwater input to the Gulf of Maine and has an extensive system of forests and wetlands. Restoration of the Penobscot River is considered critical for the continued survival of spawning stocks of Atlantic salmon in the United States. Restored diadromous fish will benefit near-shore coastal fish, seabirds and marine mammals. Diadromous fish provide food for a wide variety of fish and wildlife inhabiting the Gulf of Maine, including commercial species such as haddock, pollock, and tuna; recreational fisheries such as striped bass and bluefish, and for bald eagles.

This Recovery Act funding is allowing the Trust to finalize the engineering of and to deconstruct the Great Works dam, while providing monitoring to measure the effects of the dam's removal on habitat and species. Great Works Dam, the second dam on the river, is 1,353 feet long, up to 19 feet high, and creates a 128 acre impoundment that extends upstream 1.7 miles to below the tailrace of the Milford Dam. All spillway sections will be removed by mechanical demolition. The powerhouse will remain.

Fly fishing in early morning mist on the Penobsot River. ©Bridget Besaw

Fish Passage Restoration: Benefits for People and Nature

People: Direct benefits from restored rivers

Commercial Fisheries:

- Restoring diadromous fish will greatly increase the food available for struggling commercially valuable fish populations, including cod haddock, pollock, and tuna.
- NMFS data on commercial fishing landings indicate that groundfish that feed on diadromous fish contributed $10,893,479 to Maine's economy in 2007.
- Opportunities for in-river commercial fishing will also increase. After the removal of the Fort Halifax dam, the alewife harvest in 2009 on the Sebasticook River went from near zero to a $79,000 market value providing valuable local bait to lobstermen.
- In 2005, the Main Department of Fish and Wildlife issued 26 permits to net alewives for lobster bait, an industry that contributed nearly $300 million to Maine's economy in 2006.

Recreation, Aesthetics and Tourism

- Revenues from anglers can be an important part of the local economies where they fish. A restored Penobscot will renew angling opportunities for prized species such as striped bass, shad and Atlantic salmon as they migrate farther upriver and their populations recover.
- Tourism, including bird and wildlife watching and fishing will increase. According to the Maine Office of Tourism in 2006, tourism directly and indirectly generated roughly $1 in $5 of sales throughout Maine's economy and supported one in six Maine jobs.
- Paddling-related business opportunities will increase when removal "uncovers" seven sets of rapids shown on historic maps, renewing opportunities for whitewater and down-river canoeing and kayaking, permitting a paddle from Old Town to the sea for the first time in centuries.

Why Fish Passage Matters Nationally

- Dams, inadequate culverts, and water withdrawals alter a river's natural course and block the pathways used by migrating fish, reduce and rearrange the patterns of flowing water that have choreographed aquatic life cycles for thousands of years, and change water quality.
- These changes can have significant effects on the social fabric and economic well-being of people and communities, particularly among those whose livelihoods are closely connected to nature.
- In the United States alone an estimated 2.5 million of these barriers still exist, many of which no longer serve their original purpose and were abandoned years ago.
- Fish migrate between feeding and spawning areas and make other seasonal movements to important habitats. Such species struggle or crash when access to spawning grounds is reduced or flow is altered in ways that degrade important nursery habitat.
- Every person requires fresh water to survive. Beyond our direct need for drinking water, water is critical to the global food supply and in meeting our energy needs. To serve these multiple demands, more than 45,000 large dams and an exponentially larger number of smaller dams have been constructed on the world's rivers.

MIGRATORY (DIADROMOUS) FISH SPECIES ON THE U.S. EAST COAST

- Migratory (or diadromous) fish migrate between fresh and saltwater habitats for their growth, reproduction, and survival. Anadromous fish spend the majority of their life in ocean waters and return to rivers to spawn. Catadromous fish do exactly the opposite, they span in the ocean and return to rivers to grow to adults.
- Probably the best know example of an anadromous fish are salmon who life the majority of their life in the ocean and return to freshwater rivers to spawn. Atlantic salmon return to the same river year after year.
- On the east coast of North America, other diadromous fish species include alewife, striped bass, blue-back herring, shortnose sturgeon, Atlantic sturgeon and naturally occurring American shad, tomcod, rainbow smelt, American eel, sea lamprey and sea run brook trout.
- Shortnose sturgeon is a federally endangered species. Atlantic sturgeon is under consideration for listing. The current status of short nose and Atlantic sturgeon in the lower Penobscot was not well known until recent studies by the University of Maine documented 800 shortnose sturgeon and close to 80 Atlantic sturgeon.
- The only catadromous species in the eastern US is the American eel. It spawns in the Sargasso Sea and the offspring return to eastern rivers to mature for up to 50 years. Anadromous fish, such as the American shad and the blueback herring, travel from the salt waters of the Atlantic Ocean to spawn in the freshwater rivers and streams along the east coast.
- Migratory fish are a "conveyor belt" of nutrients from the ocean to the river and from the river to the ocean. Increases in herring and alewives would expand the food supply for many species, like cod, in the Gulf of Maine that prey on smaller fish. Conversely, nutrients from the oceans are transported with fish to freshwater habitats enriching the food chain in and around rivers.

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Virginia

Seaside Bays Restoration Project

RESTORATION

Oyster reefs restored and protected

Seagrass meadows increased

MONITORING

Measure growth and success of oyster reefs and seagrass meadows

Monitor water quality

Monitor use of oyster and seagrass habitats by other species

Measure success of scallop reintroductions

BENEFITS TO PEOPLE AND NATURE

PEOPLE

Eco-tourism

Improved water quality

Improved recreational and commercial fishing

NATURE

Increased essential habitat for fish and other species

Increased biodiversity

Project Highlights

- **Goals:** Restoration of oyster reefs and seagrass meadows with the reintroduction of native bay scallops.
- **Jobs:** A total of 57 jobs will be maintained or created through this project with 59,927 labor hours supporting research scientists and students, marine contractors, boat and barge operators, seagrass seed curing facility operators, divers and watermen.
- **Habitat Restoration:** Twenty acres of functional oyster reefs will be restored at 9 sites and 100 acres of seagrass will be planted in Spider Crab Bay.
- **Progress:** To date, restoration of 18 acres of intertidal oyster reefs has been completed utilizing 363,784 bushels of shell, resulting in 5405 hours of employment. A record number of 20 million seagrass seeds were collected and 12.25 million viable seeds were broadcast into 100 one-acre plots spread across Spider Crab Bay.
- **Measurement:** Seagrass meadows are monitored for success via aerial photography. Areas where scallops are released will be monitored to determine survival, growth and movement of hatchery raised scallops within restored seagrass beds. Restored oyster reefs will be monitored for areal extent and size and density of oysters.
- **Partners:** The Nature Conservancy, Virginia Institute of Marine Science, VA Marine Resource Commission, Virginia Coastal Zone Management Program.

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Pictured above: Blue eyes and white tentacles. ©Scott Marion, VIMS

Healthy reef. ©Sarah Morehouse/TNC

Oyster reefs in the process of being restored by The Nature Conservancy and partners at the Conservancy's Virginia Coast Reserve. ©Bowdoin Lusk/TNC

Conservancy sign protecting oyster reefs restoration site. ©Mark Godfrey/TNC

A Vision for Project Success

Short-term goals: To improve and enhance the ecological health and resiliency of Virginia's seaside bays by restoring oyster reefs and seagrass meadows and to test the reintroduction of native bay scallops.

Long-term goals: Once restored the oysters. eelgrass, and bay scallops will provide long term goods and services to people and nature by improving water quality, improving recreational and commercial fishing, increasing and sustaining benefits to local eco-tourism, increasing essential habitat for fish and other species, and increasing biodiversity.

The Importance of Healthy Coastal Habitats

The ecosystems of the coastal bays on the seaside of the Eastern Shore of Virginia are renowned for their local, regional and global value to migratory birds and an abundance and diversity of marine life. The seaside bays serve as critical nursery areas for numerous animals and provide essential habitat for coastal fishes. Native oyster reefs and productive seagrass meadows in the seaside bays are considered keystones upon which clean water, innumerable plants and animals, and a healthy natural system depend.

The seaside bays, however, have suffered two ecosystem state changes in the last century: the loss of eelgrass (*Zostera marina*) in the 1930s due to a wasting disease and concurrent hurricanes, and the more recent commercial extinction of the native eastern oyster (*Crassostrea virginica*) in the 1990s due to overharvest and disease. The reduction in native oyster populations has resulted in the loss of critical ecosystem services such as water filtration, fish habitat and biomass provided by the oysters. The loss of seagrass has likewise resulted in the loss of critical ecosystem services and the provision of food and nursery habitat for numerous avian and marine species. Among the most severely impacted species relative to human utilization of the ecosystem was the bay scallop (*Argopecten irradians concentricus*) which disappeared from the seaside bays after the loss of eelgrass in the 1932.

A Conservancy volunteer examines a bay scallop while collecting Eelgrass (seagrass) in the shallow coastal waters of Virginia's Delmarva Peninsula. ©Mark Godfrey/TNC

Measuring oyster recruits. ©Margaret Van Clief/TNC

Solving a Restoration Challenge

This project will restore 20 acres of native oyster reefs at 9 different sites within the seaside bays of Virginia, plant more than 100 acres of seagrass, and begin evaluating methods to reintroduce bay scallops to the restored seagrass meadows. In the long term, the restored native oyster reefs and seagrass meadows will provide ecosystem services including water filtration, trapping sediments, the provision of critical nursery habitats for numerous commercial and recreationally important species, and contributions of biomass to the overall ecological health of the seaside bays.

Availability of suitable substrate to build reefs is the major limiting factor to ramping up the scale of native oyster restoration in the seaside bays of Virginia's Eastern Shore. Most of the shell for this project will come from a federal and state approved dredge site for fossil shell in Virginia's James River.

The seagrass restoration component will follow a series of distinct tasks that have proven to be successful during the last six years. Flowering shoots with seeds from healthy wild seagrass meadows are harvested and held in curing facilities for approximately 6 weeks. Seeds are then released in the fall into areas suitable for future seagrass meadows.

The restoration partnership is extremely excited at the opportunity to reintroduce bay scallops to the seaside bays in Virginia more than 75 years after their local extinction. Bay scallops for planting in the seaside bays will be produced from brood stocks acquired from North Carolina, spawned and grown in hatcheries until they are large enough, and then released into seagrass meadows. The highest rate of survival occurs for the largest scallops, but larger scallops cost more to rear in the hatchery. Researchers and hatchery operators are working together to determine at what size scallops should be released to ensure the highest rate of survival per dollar spent. To date, field surveys of planted scallops reveal excellent growth and survival of caged scallops in seagrass beds, confirming an effective strategy for scallop restoration for the remainder of the project.

The results of this project should benefit local commercial and recreational fisheries and the local ecotourism industry. A healthy and productive marine ecosystem in the seaside bays also offers the best hope of resiliency to the anticipated impacts of future climate change.

Shellfish and Seagrass Restoration: Benefits for People and Nature

People: Direct benefits from healthy habitats

- Critical ecosystem services include water filtration, and the provision of habitat for recreational and commercial fishes including bluefish, summer flounder, black sea bass, king mackerel, Spanish mackerel, cobia, black drum and red drum and numerous life stages of coastal shark species including sand tiger, Atlantic sharpnose, brown, dusky, and spiny dogfish.
- These species are of tremendous economic importance to the local commercial and recreational fishing communities including charter boats fleets and fishing guides.
- Restored oyster reefs and seagrass meadows are also important feeding habitat for numerous species of waterfowl, seabirds, and shorebirds, including the Atlantic brant, least tern, and American oystercatcher.
- The seaside bays are part of the Seaside Water Trail, a 70-mile long series of day-use paddling routes designated and developed as one of many ecotourism opportunities.
- In 2009, the U.S. Fish and Wildlife service estimated that bird watching contributed more than $36 billion to our nation's economy and that one in every five people in the U.S. bird watch.
- Seagrass meadows provide important nursery habitat for blue crabs, a traditional commercial fishery in this region which provides seasonal employment for many local watermen.
- A healthy and productive marine ecosystem in the seaside bays offers the best hope of resiliency to the anticipated impacts of climate change to the area.

Shellfish reefs and seagrass meadows: water filterers, habitat providers, and shoreline protectors

- Oysters and scallops are filter feeders – they filter suspended particles (sediments, algae) out of the water column, leading to increased water clarity. Increasing water quality can enable more seagrass to grow providing more juvenile fish and crab habitat. Healthy oyster reefs filtering coastal waters could decrease the number of harmful algae blooms.
- Oysters are ecosystem engineers and provide substrate in an otherwise flat world – oysters grow in 3-D structures that provide habitat for many other species including recreational and commercial fish, create nursery habitat for fish and crabs, and can provide small animals shelter from larger predators. Reefs provide attachment points for other colonizing species which can be important food sources for fish, shrimp, and crabs.
- Shellfish reefs are natural breakwaters that can help to buffer wetlands, reducing runoff and the amount of suspended sediment in the water column, thus increasing water quality.
- Seagrass meadows stabilize bottom sediments, create nursery grounds for endangered and commercially important species, help oxygenate the water, and dampen wave action which can lessen shoreline erosion. The physical presence of seagrass on the sediment surface causes drag on flowing water which alters circulation patterns within coastal bays.

Oyster monitoring equipment. ©Sarah Morehouse/TNC

OYSTER BIOLOGY 101

- Oysters, mussels, and clams are bi-valves – their body is compressed and enclosed in a two-valved shell.
- While larval clams, mussels, and oysters swim through the water column only adult clams remain truly mobile and can dig through sand and mud.
- Oysters release eggs and sperm into the water column where fertilization occurs.
- A 'veliger' is a larval stage oyster which can swim in the ocean for days to weeks feeding and drifting until they settle to the bottom to their permanent habitat.
- Adult oysters permanently attach themselves to other hard surfaces, cementing their left shell, preferably to another oyster.

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WASHINGTON

Fisher Slough Marsh Restoration Project

RESTORATION

Marsh restoration

Floodgate replacement and reoperation

Relocation of irrigation ditch, levee setback

MONITORING

Monitor floodgate operations, hydrological connection and water quality

Increased fish passage and animal use of restored habitat

BENEFITS TO PEOPLE AND NATURE

PEOPLE

Sustainable commercial and recreation fishing

Increased flood storage

Decreased levee maintenance, dredging

NATURE

Increased essential habitat for salmon

Increased biodiversity

Project Highlights

- **Goals:** Restore degraded fish habitat while improving flood control and flood storage capacity within an agricultural landscape.
- **Jobs:** Working in collaboration with a diverse array of partnerships, this project will create 58 new jobs and maintain full or partial salary for 13 additional positions with approximately 41,289 labor hours for on-the-ground construction and landscaping jobs, skilled laborers, engineering, environmental and archaeological support during construction, project management, and monitoring activities.
- **Habitat Restoration:** This project will restore 60 acres of marsh habitat and 15 miles of tributary habitat by installing new floodgates, relocating and consolidating drainage infrastructure and setting back levees to make room for tidal freshwater marsh habitat restoration and create storage for floodwaters.
- **Progress:** The floodgates have been replaced and are operating in fish-friendly mode as of early 2010. During summer and fall of 2010, the installation of an inverted siphon under Fisher Slough opened the way for marsh restoration. Construction of the setback levee will be completed in summer and fall of 2011.
- **Measurement:** Pre-and post-project monitoring is planned for a total of seven years (funding dependent). Monitoring began in January 2009 and includes analyses of fish usage, hydrology, floodgate operations, and impacts to marsh restoration. A study is planned to better understand the project's community benefits, such as flood storage.
- **Partners:** Skagit County Dike District No. 3, Skagit County Drainage and Irrigation District No. 17, Skagit County, National Fish and Wildlife Foundation, Salmon Recovery Funding Board , US Environmental Protection Agency, Washington Department of Fish and Wildlife/Estuary and Salmon Restoration Program, Skagit Watershed Council.

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Pictured above: Chinook salmon. ©Zureks

Soil testing work at The Nature Conservancy's Fisher Slough project site. ©Bridget Besaw

A Vision for Project Success

Short-term goals: The ultimate aim of this restoration project is to restore degraded fish habitat by restoring tidally influenced marsh, to restore fish passage while improving flood control and flood storage within a working agricultural landscape.

Long-term goals: Successful completion of the Fisher Slough project is essential to advancing additional landscape-scale infrastructure projects that will create jobs while restoring habitat. This project will build trust between conservation and agricultural interests by demonstrating that restoration be good for both fish and farmers. This project will also leverage funding and partnerships to expand restoration while supporting existing community priorities.

Managing Lands and Water to Benefit People and Nature

The Skagit River produces approximately 50 percent of the wild Chinook salmon in the Puget Sound. One reason the river is so productive is because of the wide array of habitats available to salmon. As the Skagit River meets Puget Sound in northwestern Washington state, the vast and open Skagit River delta is formed. This delta is a complex landscape of tidal and non-tidal wetlands that, in turn, supports a diverse array of fish a wildlife species.

Fisher Slough is a tidally influenced wetland and farmland complex within the Skagit River delta and is one of the last estuarine habitats available to juvenile Chinook salmon in Puget Sound. Juvenile Chinook salmon traveling down the Skagit River use the delta's estuary habitats to feed and grow before venturing into Puget Sound and the Pacific Ocean. Since Chinook salmon rely heavily on estuarine habitat for certain portions of their life cycle, the quality and quantity of habitat currently limits how many Chinook are produced in the Skagit every year.

This same area that is vital to Chinook salmon is also critical to the economy of the Skagit River delta. Starting in the 1800's, the rich soils of the delta were converted to support a strong local agriculture industry. The nation enjoys the agricultural success of this region in the form of berries, ornamental bulbs, potatoes, vegetable seed and various other crops. Unfortunately this land conversion also resulted in a 73 percent loss of historic tidal wetlands and waterways affecting the once-abundant populations of Chinook salmon and other delta-dependent species. Today, the loss of estuarine and tidally influenced (or freshwater tidal) habitat is one of the biggest factors limiting Chinook recovery and the balance between farming and fisheries has been, at times, contentious.

Solving a Restoration Challenge

Floodplains and their connections to the river are also important to estuaries downriver that depend on sediment and nutrients delivered from the floodplain. Today those historic natural connections between the river, floodplain and estuary are almost non-existent. The floodplain in the vicinity of Fisher Slough was modified prior to the 1930's with the installation of a floodgate/levee system designed to claim land for agricultural purposes.

New floodgates installed on Fisher Slough in Washington's Skagit Delta. ©Jenny Baker/TNC

Fishing for salmon on the upper Skagit River near Mount Vernon Washington. The Nature Conservancy has been working to preserve the mighty Skagit River for more than 30 years. ©Bridget Besaw

The Fisher Slough project will also benefit local farmers and the community by improving flood storage to protect agricultural uses of adjacent properties and restoring a diverse array of native vegetation. ©Bridget Besaw

The historic management and operations of the system has resulted in reduced transport of sediments and severely muted the tidal processes that are important to shaping habitat. The result of the infrastructure has been poor accessibility for fish, stream routing that causes levee erosion, degraded water quality, and a reduction of water storage capacity for these areas during floods.

This project is a great example of how environmental restoration can provide multiple benefits by restoring natural connections between the river, floodplain and estuary while preserving the surrounding farmlands for productive agriculture management. By fixing the floodgates and setting back levees at Fisher Slough, this project will restore approximately 60 acres of marsh habitat for juvenile Chinook salmon, and provide spawning access to 15 miles of tributary habitat for other populations such as Coho, chum and pink salmon, and cutthroat and steelhead trout. This project will not only provide juvenile Chinook and other salmon rearing habitat but will enhance floodplain function, natural stream and tidal processes, improve water quality and reduced erosion within the project site. The project will also benefit the local farmers and the community by improving flood storage to protect agricultural uses of adjacent properties and restoring a diverse array of native vegetation. Additional flood storage provided by this project is predicted to contain a five-year flood event, thereby reducing damage and costs associated with the most frequent floods affecting surrounding private property and farmland.

The project is intended showcase the feasibility of restoration that provides multiple community benefits. The outcomes of this project go beyond acres restored. The trust forged between parties that were once embattled adversaries in "farmers vs. fishermen" is already moving community dialogue and project development beyond conflicts of the past. It will demonstrate that restoration can achieve multiple goals and meet critical community needs such as farmland viability, public safety, flood protection and ecosystem conservation.

Fish Passage and Estuary Restoration: Benefits for People and Nature

People: Direct benefits from healthy habitats

- Flood control and drainage capabilities of agriculture infrastructure will be maintained and improved, which will result in decreased costs for levee maintenance and repair and improved operations.
- Setting back levees and re-establishing the floodplain for the tributaries will eliminate costs for levee erosion repair and channel dredging and result in additional flood storage. This will decrease flood-related damages and costs for landowners resulting from the most frequent and costly five-year flood events.
- Over the long-term, community benefits will include increased fish abundance and decreased costs for drainage maintenance or costs due to flood-damage.
- Once achieved, Chinook recovery will ultimately lead to increased fisheries opportunities (tribal, recreational and commercial) and income generating opportunities for local businesses.
- Skagit County currently has a 9.8 percent unemployment rate, making job retention in other sectors an important aspect of this project. Agriculture is an anchor industry in Skagit County and the surrounding region. More than 3,300 people are engaged in full-time equivalent employment directly in agricultural activities and 5,650 people are engaged in employment generated overall by the local agriculture industry.
- Direct economic impact of agriculture in Skagit County exceeds $500 million with an additional $100 million generated by farm related tourism such as hunting, fishing, wildlife watching and agro-tourism.
- Reconnecting Fisher Slough and existing high-quality habitat in the Skagit Delta will also act as a buffer to the predicted effects of climate change and sea level rise.

Estuaries: Where the rivers meet the sea

- Where freshwater drainages meet the saltwater of the ocean, estuaries offer an ecological bridge. Their shallow, less saline waters are sheltered from ocean extremes, allowing for high species biodiversity and nursery habitats for many organisms.
- Estuaries and their tidally influenced (or freshwater tidal) marshes act as an important transitional habitat for salmon and other fish species that pass through the estuary during their spawning migrations.
- Just upriver from estuaries, healthy functioning floodplains provide essential nutrients and a sediment supply for estuaries as receding floods carry sediments and nutrients to the estuary. Without functioning floodplains, estuaries can themselves become negatively changed.
- Migratory (or diadromous) fish migrate between fresh and saltwater habitats, depending on each type of habitat, ocean, estuary, and river for their growth, reproduction, and survival. When salinities are not in balance and these habitats are changed or not existent – these fish cannot survive.
- More than half of the marshes in the United States are destroyed by draining, diking, dredging, filling, and similar practices. Loss of marshes has declined in recently history due to regulation and restoration.

  From 1954 to the 1970s, marsh loss averaged 19,000 hectares per year. From the 1970s to the 1980s marsh loss averaged 2,900 hectares per year. Now we can move beyond stopping the loss to actually restoring these vital wetlands.
- Over the past 100 years, more than 70 percent of historic tidal wetlands, including about 85 percent of freshwater tidal wetlands in the Skagit Delta have been lost as a result of human settlement and development activities. This loss of wetland habitat has resulted in the loss of 88 percent of historic tidal channels, which are preferred by juvenile Chinook salmon for rearing.

Fish Passage: A critical stage of life

- All fish migrate between feeding and spawning areas and make other seasonal movements to important habitats. Thousands of culverts, dikes, water diversions, dams, and other artificial barriers have been constructed to impound or redirect water for irrigation, flood control, electricity, water supply and transportation. All of these have changed the natural features of waterways, blocking the natural migration of fish to historic habitat used for reproduction and growth.
- An estimated 2.5 million of these barriers still exist in the United States alone, many of which no longer serve their original purpose and were abandoned years ago.

SALMON AND THE SKAGIT RIVER

- U.S. west coast salmon are anadromous fish that live in the ocean mostly, and breed in fresh water.
- The Skagit River supports a significant abundance of Pacific salmon. It produces approximately 50 percent of the wild Chinook salmon for the Puget Sound. Additionally, the Skagit produces the largest pink salmon, chum salmon and bull trout runs in Washington State and is one of the only rivers in the lower 48 states that supports all eight species of anadromous salmon.
- With declines in Chinook populations, fisheries experts determined that restoration of estuarine habitat is one of the highest priorities for Chinook salmon recovery. Because estuarine habitats are currently limited, this project is expected to produce an additional 16,000 Chinook smolts annually. Juvenile Chinook salmon are consistently found in estuarine habitats from February through October, with the highest use from March through mid-July in the Skagit River delta.
- Coho spawning occurs in the upper watershed area of Fisher Slough and adult migrations typically occur during the months of October through February. Coho salmon fry emerge in March and April, and spend a full year in the watershed before migrating as smolts to salt water.
- Cutthroat trout are known to utilize the Fisher Slough tributaries for spawning and rearing life cycle periods. Adult chum salmon spawn in tributaries to Fisher Slough, and juvenile chum utilize the slough for rearing. Pink salmon and steelhead trout may pass through Fisher Slough as they make their way down the Skagit River to Puget Sound.

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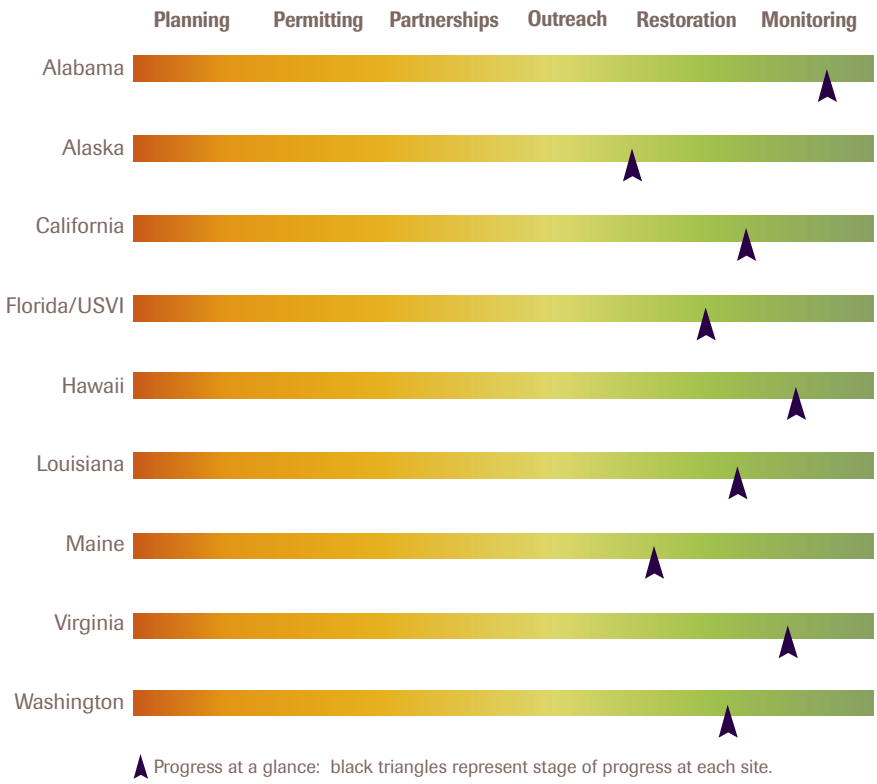
Projects Underway

Progress on the ground and in the water

"Work is underway at all of the Conservancy's Recovery projects and each site is making significant progress toward their project completion and restoration goals. In-water restoration has begun at many sites while plans for post-restoration monitoring are in place to enable us to document outcomes once construction is complete. Despite differences in logistics based on habitat type and geography, overall progress indicates that the projects are on track to achieve their projected outcomes within their proposed timelines."



Progress at a glance: black triangles represent stage of progress at each site.

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Leveraging for Larger Outcomes

In Southeast **Alaska**, a restoration economy grows. A multi-agency and partner ecological assessment have already identified important areas for restoration and habitat protection in Southeast Alaska including two watersheds on Prince of Wales Island. As Southeast Alaska searches for new jobs to support its communities in the 21st century, the ARRA project has demonstrated that restoration of habitat delivers benefits for people and wildlife.

With the underpinnings of how to accomplish effective large scale oyster reef and marsh restoration in place, the **Alabama** and **Louisiana** ARRA projects are helping to kickstart recovery in the Gulf. In the wake of the Deepwater Horizon oil spill, four leading conservation organizations – Alabama Coastal Foundation, Mobile Baykeeper, The Nature Conservancy, and The Ocean Foundation – formed a coalition to address the environmental impacts of the oil spill and reverse years of damage from pollution, storms, development practices and erosion along the Alabama coast.

This demonstration project is a prime example of how conservation supports a healthy and prosperous **California**. This successful ecological restoration work illustrates that very promising results can be achieved in only a short period of time while continuing to run 500 head of cattle on the property. By using a strategy of change by doing and demonstrating success, these efforts could become the model for neighboring ranches and properties beyond the region.

In **Florida**, the project has put in place the partnerships, protocol, and basic understanding of how to scale up restoration of two important coral species in the U.S. and Caribbean. This project has laid the groundwork for coral restoration to continue in Florida and in the future may lead to answers about how to do coral restoration on places like Hawaii, or answer restoration questions about deepwater corals in places like the Gulf of Mexico.

In **Hawaii**, community organizations will share this method of natural resource management with other communities across the state. This project also demonstrates how active management of marine habitat can work towards decreasing marine invasive species in Hawaii, a model that is being imported to restoration projects at other sites in Oahu and other islands.

The eastern shore of coastal **Virginia** is riding the wave of restoration caused by the large scale efforts of the ARRA funded work. With partnerships, protocol, and understanding in place; the eastern shore is now well positioned for large scale seagrass, oyster reef, and scallop restoration including living shorelines.

For more information contact:
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or visit: nature.org/restoration or noaa.gov/recovery

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The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

ACKNOWLEDGMENTS

This document was prepared by The Nature Conservancy's Recovery Act Central Support Team: Amanda Wrona Meadows, Rob Brumbaugh, Erica Rychwalski, Jena Carter, Jennifer Greene and Boze Hancock. It provides a glimpse at some mid-scale marine habitat restoration projects funded through the American Recovery and Reinvestment Act through the National Oceanic and Atmospheric Administration. In particular, we highlight projects that are either being led by or conducted in partnership with The Nature Conservancy in nine states and in the U.S. Virgin Islands. These projects touch on a variety of habitats – marshes, rivers and streams, seagrass meadows, oyster and coral reefs – and would not be possible without the involvement of dozens of partner organizations and collaborators. More than 400 people will be involved in implementing these projects, but we wish to acknowledge in particular a number of Conservancy staff who are not only managing this suite of exciting projects, but also provided valuable insights and comments that improved this document: Jenny Baker, Rob Bosworth, Cindy Brown, James Byrne, Kate Dempsey, Jeff DeQuattro, Amy Hoss, Meaghan Johnson, Bo Lusk, Caitlin Lustic, Amy Smith-Kyle, Barry Truitt and David Ziemann.


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"This project was made possible through support provided by the National Oceanic and Atmospheric Administration, U.S. Department of Commerce and The Nature Conservancy, under Cooperative Agreements NA09NMF4630301, NA09NMF4630303, NA09NMF4630304, NA09NMF30332, NA09NMF4630308, NA09NMF4630312, NA09NFM4630314 and NA09NMF4630317. The content and opinions expressed herein are those of the author(s) and do not necessarily reflect the position or the policy of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and no official endorsement should be inferred."

For more information, contact marine@tnc.org or visit: nature.org/restoration or noaa.gov/recovery

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Date: April 2010