Through a Fish's Eye:

The Status of Fish Habitats in the United States

2010

Fish and fishing are integral to the American story. Salmon have sustained Native Americans for centuries. Shad and cod helped the early European colonists survive and were critical trade commodities. However, the tide has turned, and the waters fish inhabit are less able to support them due to effects of human activities. The fish need our help to protect and restore the places where they live. While thousands of projects have improved fish habitat on a small scale throughout the United States in the past three decades, gains have been outpaced by continuing human impacts on the landscape. The need for action has never been greater. Together we can ensure that future generations will be able to enjoy clean and healthy streams, lakes, estuaries, and oceans teeming with fish.

"We have seen Indians in immense numbers, and all those on this coast of the Pacific contrive to make a good subsistence on various seeds, and by fishing." – Junipero Serra

"The charm of fishing is that it is the pursuit of what is elusive but attainable, a perpetual series of occasions for hope." – John Buchan

"May the holes in your net be no larger than the fish in it." – Irish Blessing

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Executive Summary

The United States is home to a diverse array of freshwater and marine fish, shellfish, and other aquatic species. More than 3,000 species of fish inhabit America's streams, rivers, lakes, reservoirs, marshes, swamps, bays, estuaries, coral reefs, seagrass beds, shallow water banks, deep ocean canyons, and other watery habitats. The United States is also home to over 300 million people, all depending on the same water that fish depend upon.

Healthy habitats are essential for sustainable fish populations. Unfortunately, in many places around the United States, fish and the habitats on which they depend are in decline. About 37 percent of the nation's freshwater fish species are considered at risk or vulnerable to extinction. Habitat loss is the most common cause for extinction of freshwater fish in the United States over the past century and many saltwater fish are also in decline due to habitat degradation. In 1997, Congress declared that "one of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats."

This report summarizes the results of an unprecedented nationwide assessment of human effects on fish habitat in the rivers and estuaries of the United States. The assessment assigns watersheds and estuaries a risk of current habitat degradation ranging from very low to very high. These results allow comparison of aquatic habitats across the nation and within 14 sub-regions. The results also identify some of the major sources of habitat degradation. Unfortunately, not all sources of habitat degradation could be assessed, so some important factors such as small dams and abandoned mines could not be incorporated. Marine waters, lakes, and reservoirs were not assessed due to resources and data constraints, so previously published information was used to describe the condition of these fish habitats. Future revisions to the assessment will incorporate the missing data to the extent it is available.

Within the United States, areas of high risk and low risk of current habitat degradation occur in some discernable patterns. Urban corridors, regions with high-intensity agriculture, and locations of heavy industrial use correspond to some of the areas with a very high risk of current habitat degradation. Areas with a very low risk of current habitat degradation include regions with sparse populations and the lands and waters of national parks and other protected areas.

East of the Mississippi River, areas with the lowest risk of current habitat degradation occur principally in northern Maine and the northern Great Lakes area, as well as in sparsely populated parts of the Appalachian Mountain region. Areas with the highest risk of current habitat degradation occur in and around the heavily populated corridor from New York City to Washington D.C., including Long Island Sound and the Chesapeake Bay. Urbanization is a major factor in fish habitat degradation in this area, as is pollution, particularly excess nutrients. Areas with a very high or high risk of current habitat degradation

due to agriculture occur in southern Florida, along the lower Mississippi River, and in the corn belt of Ohio, Illinois, and Indiana.

In the upper and central midwest states as well as Oklahoma and Texas, areas with a low risk of current habitat degradation occur principally in southwest Texas and northeast Minnesota. Urbanization and ranching are responsible for large areas with a very high risk of habitat degradation in eastern Texas. Row crops contribute to areas with a high and very high risk of current habitat degradation in southern Minnesota, Iowa, Indiana, and western Arkansas. Corpus Christi Bay and some other Texas estuaries have a very high risk of current habitat degradation due to polluted runoff from urban areas.

In the western mountains, deserts, and coastal areas, large areas with a low risk of current habitat degradation are interspersed with areas of high risk due to urbanization (California, Arizona, and Colorado), intensive row crops and ranching (Idaho, California's Central Valley, and southeast Washington), and alterations to water flow on the area's rivers such as the Columbia, Snake, and Colorado Rivers. Because the assessment was not able to incorporate the effects of water withdrawals or culverts, habitats in this irrigation-dependent region may be more degraded than the assessment suggests. Estuaries in southern California and some parts of Hawaii have a high risk of current habitat degradation due to pollution from fast-growing coastal urban areas. Alaska has the largest areas with a very low risk of current habitat degradation, but urbanization, forestry, and road crossings are responsible for localized areas with an elevated risk of current habitat degradation.

Marine habitats of the United States generally are most productive near the coasts, which is also where they are most likely to become degraded by human activity. Major threats to marine habitat include pollution; damage to bottom habitat from dredging, fishing gear, or other activities; alteration of migration pathways; invasive species; marine debris; and climate change.

This report provides an important picture of the challenges and opportunities facing fish and those engaged in fish habitat conservation efforts. Urbanization, agriculture, altered stream flow, pollution, and other human impacts have resulted in specific areas of degraded habitat where restoration is most likely needed to bring back the healthy habitats and fishing opportunities that once existed. Addressing degraded habitat also requires reducing or eliminating the sources of degradation mentioned in this report, through best management practices, land use planning, and engaging landowners, businesses and local communities in the effort. This report identifies areas where those efforts are most needed. The report also points to areas where fish habitat is most likely still intact and should be protected to maintain its value for fish and other aquatic organisms. There are limited resources for fish habitat conservation, especially in the next few years. This report illustrates the need for strategic use of those existing resources through partnerships -- such as the Fish Habitat Partnerships established under the National Fish Habitat Action Plan -- that can identify the most effective use of funds and help the nation as a whole make progress in fish habitat conservation.

Steve Brown, WV DNR

Foreword

Healthy waterways and thriving fish populations are vital to the well-being of American society, providing clean water, food, and recreation. They are important for less tangible reasons as well, as anyone who has fished a tranquil stream or paddled a salty bay can attest. Healthy waters sustain their ecological functions and resilience while meeting the social and economic needs of human society.

Unfortunately, in many places around the United States, fish and the habitats on which they depend are in decline. This is a particular concern to the 48 million recreational anglers who pursue fish and to many others who depend upon fish and shellfish for sustenance and commerce. Revenue from recreational and commercial fisheries added more than $125 billion to our nation's economy in 2006 (the latest year for which data are available). About 37 percent of the nation's freshwater fish species are considered at risk or vulnerable to extinction. Habitat loss is the most common cause for extinction of freshwater fish in the United States over the past century. Many saltwater fish are also in decline due to habitat degradation; Congress declared in 1997 that "one of the greatest long-term threats to the viability of commercial and recreational fisheries is the continuing loss of marine, estuarine, and other aquatic habitats."

Galvanized into action by continuing losses of aquatic habitat, an unprecedented coalition of anglers, conservation groups, scientists, state and federal agencies, and industry leaders forged the National Fish Habitat Action Plan in 2006. The Action Plan is an investment strategy for making the most effective use of habitat conservation dollars and achieving real gains in aquatic habitat quality and quantity by protecting, restoring, and enhancing key fisheries habitats.

The objectives of the Action Plan are to:

- Conduct a condition analysis of all fish habitats within the United States by 2010.
- Prepare a "Status of Fish Habitats in the United States" report in 2010 and every 5 years thereafter.
- Identify priority fish habitats and establish Fish Habitat Partnerships targeting these habitats by 2010.
- Establish 12 or more Fish Habitat Partnerships throughout the United States by 2010.
- Protect all intact and healthy fish habitats by 2015.
- Improve the condition of 90 percent of priority habitats and species targeted by Fish Habitat Partnerships by 2020.

This report and the assessments upon which it was based were developed to meet the first two objectives of the Action Plan. The second two objectives have been met through the establishment of 17 Fish Habitat Partnerships throughout all 50 states. Fish Habitat Partnerships involve diverse groups of public and private partners with common interests in fish habitat conservation. Examples of their work are highlighted throughout this report. These efforts are part of a larger strategy that, through the joint efforts of regional and national partners, will result in measurable and sustained improvement in the condition of priority fish habitat in the United States.

How to Read and Understand This Report

This report is the first "Status of Fish Habitats in the United States" report as envisioned in the Action Plan. It summarizes the results of the first detailed national assessment undertaken by scientists working to synthesize information on aquatic habitat at a scale and level of detail never before attempted. This report focuses on the freshwater and estuarine aquatic habitats of the 50 states, which are divided into thirteen sub-regions for discussion. Time and resources did not permit a quantitative assessment of lakes, reservoirs, the Great Lakes, and marine areas, but existing information for those areas is summarized in this report. Future reports will include habitats not addressed in this report as well as those in U.S. territories.

The results of the assessment are characterized as "risk of current habitat degradation," i.e., for any particular area the data suggest some level of risk (high, low, or in between) that the habitat is currently in a degraded condition. The assessment uses "risk" of habitat degradation instead of known habitat degradation because habitat condition has not been objectively or consistently measured for a majority of aquatic habitats in the United States. As a result, the assessments for this report focus on identifying factors that are responsible for degrading habitat, rather than using direct measurements of habitat condition. For example, the rivers assessment uses a measure of the number of roads in the watershed, which is correlated with increased sedimentation and pollution, as opposed to actual measures of turbidity or heavy metals in the rivers. Thus the assessment can conclude that a particular river reach is at high risk of being degraded in its current condition, based on it having a high number of road crossings.

Although a large amount of data went into the assessments, some key information is missing due to the lack of nationally consistent data. Examples of missing information include historical degradation due to past logging or mining practices, detailed water flow information for each stream, and the locations of the millions of culverts[1], diversions, and small dams that fragment streams and obstruct fish passage. Because this information is missing, areas mapped as having a low risk of current habitat degradation due to the factors assessed may be under the influence of factors not included in the assessment, and thus actually may be at a higher risk of current habitat degradation than depicted on the maps.

For the reasons explained above, ***readers should interpret the maps carefully.*** The maps should not be understood as depicting absolute habitat condition. They do serve as a guide to the relative magnitude and geographic distribution of many factors that contribute to aquatic habitat degradation. Future reports, planned for 5-year intervals, will more accurately describe the condition of aquatic habitats, as data sources become more consistent and comprehensive.

[1] *Information on culverts was included in the Alaska stream assessment.*

The assessment methodologies are summarized below. Additional, more detailed information about the assessments can be found at the end of the report, and interested readers should look for the assessment methods and results in future peer-reviewed literature.

Methodology for Rivers Assessment—Lower 48 States

For rivers in the lower 48 states, risk of current habitat degradation was estimated by analyzing how strongly a range of human disturbances to habitats affect river fish, using the logic that fish reflect the quality of the habitat where they live. The results of this analysis were used to give a score to each river reach according to the degree to which each human disturbance type affects that reach. The national datasets used for this assessment included estimates of urban, agriculture, and livestock development intensity; major point sources of water pollution; frequency of dams; and the locations of mines. Some important threats to fish habitat were omitted from the analysis due to data limitations. These include historical land use pressures, habitat fragmentation from barriers other than large dams, ground and surface water extraction, alterations of water temperature, sedimentation, woody structure availability, and highly regional habitat stressors (e.g., natural gas development and oil drilling), all of which will be addressed in future revisions of this assessment. Disturbance scores in streams affected by unmeasured stressors may underestimate the true amount of disturbance.

The following disturbance variables were analyzed as part of river assessments in the lower 48 states:

- Urban/human settlement (percent urban land use, human population density, road density).
- Livestock and grazing (percent grazing and pasture use, measurements of phosphorus from confined and unconfined livestock areas).
- Agriculture (percent row crop agriculture, measurements of phosphorus from farm fertilizer applications).
- Point source pollution data (numbers of National Pollution Discharge Elimination Sites, Toxic Release Inventory sites, and National Superfund sites).
- Mine density.
- Dam density.

Methodology for Rivers Assessment—Alaska and Hawaii

Data on human disturbances, fish populations, and habitat condition were limited in Alaska and Hawaii, so a simplified variation of the basic methodology used for rivers was employed for these two states. Disturbance variables were assigned to categories (e.g., land cover, point source pollution, infrastructure, barriers to fish movement, and industrial activity), and then a single score was calculated using a statistical approach called Principal Components Analysis. Because this methodology differs from the methodology used for the lower 48 states, the results cannot be directly compared—i.e., an area at high risk of current habitat degradation in the 48 conterminous states is not equivalent to an area at high risk of current habitat degradation in Alaska or Hawaii.

Methodology for Estuary Assessment—Lower 48 States

For the estuaries in the lower 48 states, the risk of current habitat degradation in each estuary was assessed by mapping national datasets of disturbance variables measured within estuaries and their adjacent watersheds. Disturbance variables were summarized into the following four disturbance categories:

- River discharge.
- Pollution.
- Eutrophication threat (excessive plant and algal growth as a result of increased nutrient input, often resulting in the depletion of dissolved oxygen).
- Land cover and land cover change.

A relative disturbance index was assigned to each estuary for the four categories. The four indices were then combined to calculate a combined disturbance score for each estuary, which is a measure of the current risk of degradation to that habitat.

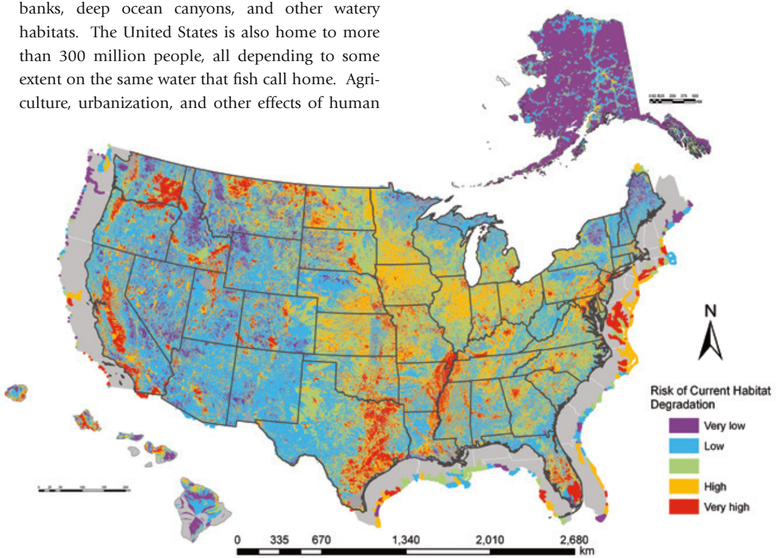
Some important threats to fish and their habitat could not be incorporated in this analysis due to data limitations. These include, but are not limited to, benthic habitat loss and disturbance due to dredging and fishing practices, percentage of shoreline armoring, sedimentation and erosion trends, contaminant concentrations in fish and shellfish tissue, and status of biogenic habitats (e.g. oysters reefs and shellfish beds, coral reefs, kelp forests, and seagrass beds). These additional sources of disturbance will be addressed in future revisions of the coastal assessment.

Methodology for Estuary Assessment—Southeast Alaska

The coastal areas of Alaska have not been mapped at the same level of detail as in the rest of the United States, so the assessment of estuaries in Alaska required that the estuaries first be delineated and entered into a Geographic Information System (GIS). Only the estuaries of southeast Alaska are included in this first assessment, but future assessments will include more coastal areas of Alaska. Data limitations restricted the analysis of southeast Alaska estuarine areas to three disturbance categories as compared to the four that were used in the lower 48 states: land cover, water quality/sediment toxicity, and river flow alteration. Data limitations also prevented the use of Principal Components Analysis for the last two indices; a simple percentile ranking was used instead. A single combined score for each estuary was calculated as the average of the indices. As with the river assessment for Alaska, the results of the southeast Alaska estuary assessment cannot be directly compared to the results of the estuary assessment for the lower 48 states—e.g., an estuary at high risk of current habitat degradation in the mid-Atlantic states is not equivalent to an area at high risk in southeast Alaska.

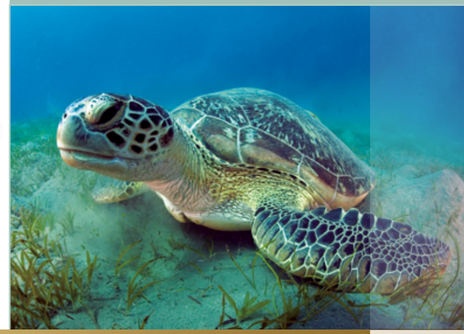
National Overview

The United States is home to a diverse array of freshwater and marine fish, shellfish, and other aquatic species. More than 3,000 species of fish inhabit America's streams, rivers, lakes, reservoirs, marshes, swamps, bays, estuaries, coral reefs, seagrass beds, shallow water banks, deep ocean canyons, and other watery habitats. The United States is also home to more than 300 million people, all depending to some extent on the same water that fish call home. Agriculture, urbanization, and other effects of human inhabitation occur over most of the U.S. landscape, altering to varying degrees water flow, water quality, and many other characteristics of aquatic habitat. Few aquatic habitats in America are unaffected by human activity; some have been severely degraded, and some less so.



Did You Know?

- The United States has 181,000 square miles of aquatic habitat, an area larger than the state of California (not counting marine waters beyond state boundaries).
- The United States is home to 308 endemic fish species (i.e., fish found nowhere else in the world).
- The southeastern United States alone has 1,800 aquatic species: fish, mussels, snails, turtles, amphibians, and crayfish. More than 500 of these 1,800 aquatic species are found only in the southeast.

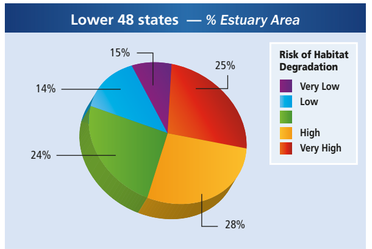


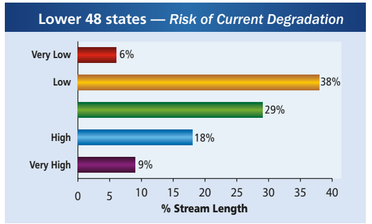
Overall, 27 percent of the miles of stream in the lower 48 states are at high or very high risk of current habitat degradation, and 44 percent are at low or very low risk. Within the land areas of the United States, areas of high risk and low risk of current habitat degradation occur in discernable patterns.

Habitats with a very high risk of current habitat degradation include those in or near urban development, livestock grazing, agriculture, point source pollution, or areas with high numbers of active mines and dams. Specific locations that stand out as regions at high risk of current habitat degradation include: the urban corridor between Boston, Massachusetts and Atlanta, Georgia; the Central Midwestern states of Iowa, Illinois, Indiana, and Ohio; the Mississippi River Basin, including habitats adjacent to the lower Mississippi River in Arkansas, Mississippi and Louisiana; habitats in eastern Texas; and habitats in central California and along the Columbia River in Oregon and Washington.

Areas that stand out as being at very low risk according to the parameters in this report include rural areas in New England and the Great Lakes states; many habitats throughout the Mountain, Southwest, and Pacific Coast States; as well as most of Alaska. It should be noted that not all water and land management issues could be addressed in the assessment, so some of the areas mapped as at low risk of current habitat degradation actually may be at higher risk due to disturbance factors not assessed. For example, most arid regions of the western United States were found to be at low risk of current habitat degradation. Water quantity is a critical limiting factor for 179 species of desert fishes, yet stream flow and water extractions were not accounted for in the assessment. The maps likely overestimate the amount of habitats at low risk of current habitat degradation in the arid west.

The estuaries of the lower 48 states show patterns similar to those of the land areas, which is not surprising because most of the disturbances to estuarine habitats originate on land. Estuaries in the mid-Atlantic have a very high risk of habitat degradation related to polluted run-off and other





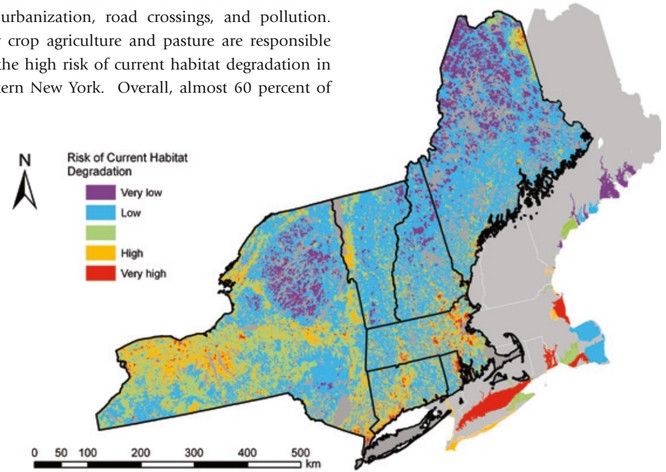
effects of the intense urbanization and agriculture in this area. The estuaries of southern California also have a high risk of current habitat degradation for similar reasons. Estuaries in the north Pacific and north Atlantic have a low risk of current habitat degradation. Overall, 22 percent of the estuaries (by area) in the lower 48 states are at low or very risk of current habitat degradation and 53 percent are at high of very high risk of current habitat degradation. Marine habitats of the United States tend to be most degraded near the coast, where they are most affected by human activity.

Northeastern States

(Maine, New Hampshire, Vermont, New York, Massachusetts, Rhode Island, Connecticut)

Fish Habitat in the Northeastern States

Several centuries of development activities throughout the northeast has resulted in extensive alteration and loss of aquatic habitats in some areas. In general, northern areas are at lower risk of current degradation than southern areas, where population pressures are most intense. The primary sources of current habitat degradation in eastern Massachusetts and central Connecticut are urbanization, road crossings, and pollution. Row crop agriculture and pasture are responsible for the high risk of current habitat degradation in western New York. Overall, almost 60 percent of the miles of streams in the northeastern states have a low or very low risk of habitat degradation; only 16 percent have high or very high risk. In contrast, 44 percent of the estuarine area is at high or very high risk of current habitat degradation, including Massachusetts Bay, Nantucket Sound, Narragansett Bay, and Long Island Sound.



Did You Know?

- The Northeastern states have the second largest value of commercial catch (after Alaska), with more than $830 million catch in 2009. In addition, marine and freshwater recreational fishermen spent more than $2.5 billion on fishing expenditures in these states in 2006.
- More than half of the original wetlands in the northeastern states have been filled or converted to agricultural lands.
- Atlantic salmon were once native to almost every U.S. river north of the Hudson River; remnant wild populations are now known in only 11 rivers.

Robert Michelson

Fish with Habitat Trouble

- Fish that migrate between the ocean and freshwater streams—such as American shad, Atlantic salmon, blueback herring, alewife, American eel, Atlantic sturgeon, and shortnose sturgeon—have declined as a result of culverts, weirs, dams, and other human-made barriers to their migration.
- Lake chub, lake sturgeon, and other lake fish have declined as a result of urbanization, barriers to migration and increased sedimentation in lakes.
- American brook lamprey, channel darter, eastern sand darter, and stonecat have declined as a result of loss of clean stream gravel and rock in spawning habitats from excessive sediment inputs.

Human Activities Affecting Fish Habitat

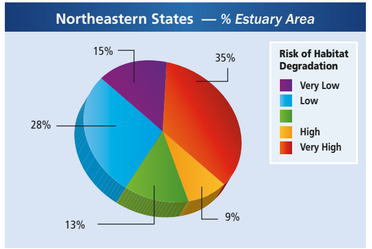
Urban land use

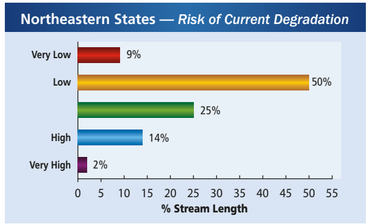
The northeast is one of the most urbanized areas in the country, with a high percentage of impervious surfaces in some of its watersheds. These impervious surfaces alter the hydrology of streams and increase sedimentation in rivers, lakes, and bays. Another effect of urbanization is loss of habitat as wetlands are filled, streams diverted, and channels dredged.

Point source pollution

The northeast once supported numerous industries that discharged contaminants such as heavy metals and PCBs into the region's waters. The number of industrial sites is much lower today, but their legacy—as pollution leaks from abandoned industrial sites or disposal areas—often remains. Over time, these contaminants concentrate in sediments at the bottom of rivers, lakes, and bays. Some of the highest concentrations in the northeast occur in Narragansett Bay, New York/New Jersey Harbor and Bight, and western Long Island Sound, where elevated levels of metals (e.g., arsenic, chromium, mercury, nickel, silver, and zinc), PCBs, and pesticides occur. Contaminants often find their way into the food chain, affecting fish directly by killing them or indirectly by affecting growth and reproduction, and sometimes making them unsuitable for human consumption. Almost one-third of fish tissue specimens collected by the Environmental Protection Agency (EPA) in northeast coastal areas contained concentrations of contaminants above levels recommended for human consumption, reducing our nation's potential seafood supply.

Robert Michelson





Katrina Mueller

Dams and other barriers

The northeastern states contain thousands of dams, most built before 1910 for agricultural and industrial uses, and a few built more recently for flood control, recreation, water supply, and energy generation. In many cases, the dams have outlived their industrial usefulness, but continue to block the passage of migratory fish species to and from their historic upstream spawning grounds. Poorly constructed culverts and other types of road crossings also have negative effects on fish migration, tidal exchange, and stream flow, which directly affect fish growth and reproduction.

Proposed renewable ocean energy projects

Numerous uncertainties are associated with the potential effects of forthcoming renewable ocean energy projects (such as ocean-based wind power and ocean current power) on coastal and marine habitats. Only time, careful evaluation, and monitoring will reveal the effects of these technologies.

Working for Change

The Machias River, Maine

The Machias River system in "downeast" Maine is important habitat for Atlantic salmon and eastern brook trout. With 86 percent of the Atlantic salmon habitat within the Machias River system under permanent protection, restoration efforts have moved to its major headwater tributaries, including the West Branch of the Machias River.

As part of an effort by the Eastern Brook Trout Joint Venture and "Project SHARE," by the end of 2010 all but two of the single road-stream crossings in the West Branch Machias River sub-watershed will be fitted with open-bottom arched culverts that are designed to allow fish to pass and provide for a natural stream channel. This project is a small part of a larger conservation strategy developed by the Eastern Brook Trout Joint Venture to address the current threats to this species.

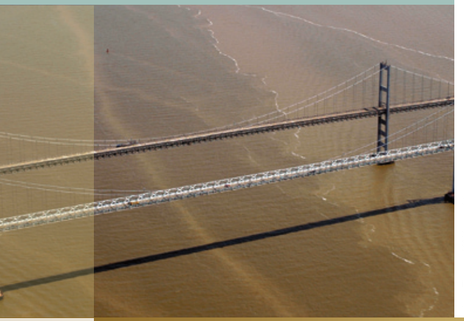
Katrina Mueller

Mid-Atlantic States

(Pennsylvania, New Jersey, West Virginia, Virginia, Maryland, District of Columbia)

Did You Know?

- The Mid-Atlantic states' marine and freshwater recreational fishing expenditures were greater than $3.7 billion in 2006, and the values of commercial fish catch totaled just less than $375 million in 2009.
- The main stem of the Delaware River is the longest undammed river east of the Mississippi, providing unobstructed migratory fish habitat for 330 miles.
- The Chesapeake Bay contains zones of low oxygen, the result of pollution from the surrounding watershed, that threaten crab and other important fish populations in the bay.



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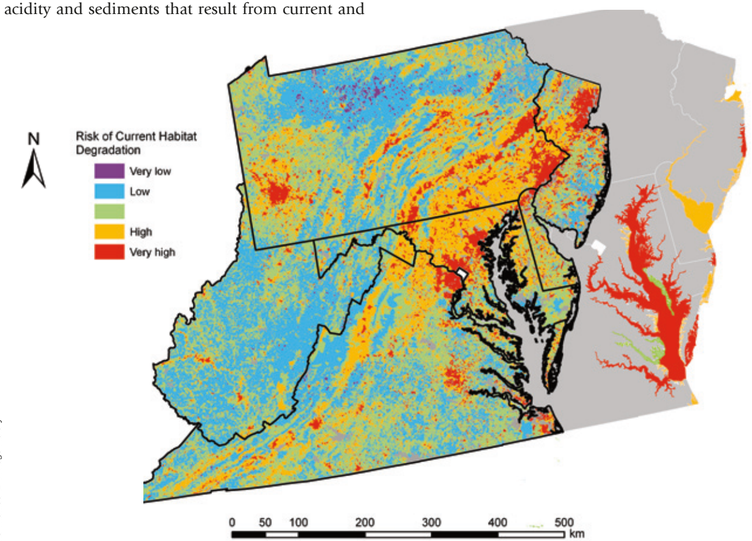
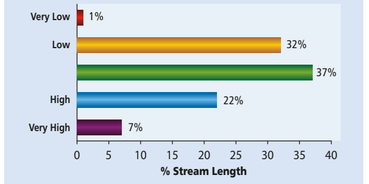
Fish Habitat in the Mid-Atlantic States

The headwater streams of West Virginia, Virginia, Maryland, and Pennsylvania have a low risk of current habitat degradation due to the factors assessed, particularly in central West Virginia and northwest Pennsylvania. Many of these streams, however, are degraded by excess acidity and sediments that result from current and legacy mining activities, which have not been fully analyzed in this assessment. In southeast Pennsylvania, row crops and pasture are responsible for areas with a very high risk of current habitat degradation.



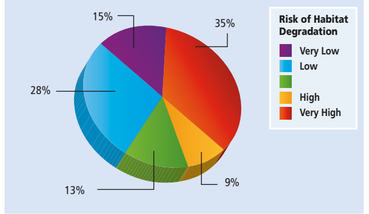
Along the developed corridor that stretches from northeast New Jersey through central Maryland and northwest Virginia, urbanization is a major factor in areas with a very high risk of current habitat degradation. Intensive pasture and road crossings are the major concerns on the Delmarva Peninsula. Reservoirs in the mid-Atlantic states have been degraded by nutrient enrichment and sedimentation. Many rivers in the mid-Atlantic have significant barriers to fish movement. These barriers are related to large reductions in the numbers of spawning American shad, blueback herring, American eels, and Atlantic sturgeon. Overall, the greatest proportion of the rivers in the mid-Atlantic falls into the middle category of risk of habitat degradation from the factors assessed, with slightly less than one-third falling into the "low risk" category.

Mid-Atlantic — *Risk of Current Degradation*



The mid-Atlantic states contain the largest estuary in the continental United States, the Chesapeake Bay, which has a very high risk of current habitat degradation because its surrounding watershed is highly altered by disrupted water flows as well as urbanization and agriculture, which contribute excess nutrients and sediments to the estuary. Ninety-five percent of the estuarine area in the mid-Atlantic states is at high or very high risk of current habitat degradation and these estuaries have some of the highest pollution scores of all the estuaries assessed.

Northeastern States — *% Estuary Area*



Human Activities Affecting Fish Habitat

Urban land use and pollution

Runoff and other land-based pollution from large riverside cities such as Philadelphia, Pittsburgh, Wilmington, and Washington, DC, adversely affect fish habitats in the Delaware, Susquehanna, Ohio, and Potomac rivers. Surrounding these large cities are smaller cities and suburban areas that create a concentration of human population and impervious surfaces extending from New Jersey through southeastern Pennsylvania, Delaware, central Maryland, and southeastern Virginia to the coastal

Fish with Habitat Trouble

- Brook trout populations have been eliminated from 25 to 35 percent of the watersheds in this region because of acid mine drainage, increased water temperature, and sedimentation.
- Populations of Atlantic menhaden, an important forage fish in estuarine marine food webs, have declined 85 percent in the past 30 years, possibly due to human-induced changes in the ocean and coastal bays combined with the effects of overfishing.
- Shad and river herring—important as forage, recreational, and commercial fish—have experienced substantial drops in population due to dams, poor water quality, and overharvesting.

Jane Thomas IAN Image Library

areas of the Mid-Atlantic, including the Delaware and Chesapeake bays. Runoff from urban and suburban areas typically contains many pollutants such as motor oil, heavy metals, pesticides, and sediments. Elevated levels of metals (e.g., arsenic, chromium, mercury, nickel, silver, and zinc), PCBs, and DDT are found in the sediments of the upper Chesapeake Bay and Potomac River.

Mining and other resource extraction

Drainage from coal mines and coal refuse piles is a common problem in the Appalachian coal region. In 2010, 5,475 linear miles of streams in Pennsylvania did not meet EPA-mandated in-stream water quality standards due to over a century of mining. Coal mine drainage releases acid into streams, making them thousands of times more acidic than unaffected streams and eliminating a majority of native aquatic species. For example, in West Virginia, the practice of "mountaintop removal" mining has resulted in the burial of many headwater streams and elevated concentrations of selenium, a toxic element, in downstream waters. Pennsylvania, West Virginia, and New York are also threatened by current and proposed hydrofracture drilling for natural gas, which can release pollutants into aquatic areas.

Dams and other barriers

There are over 5,000 dams in the mid-Atlantic states. The great majority of these dams are small (i.e., less than 15 feet high) and many of these small dams are obsolete and in disrepair. Small dams, as well as many poorly designed culverts and road crossings, fragment habitat for shad and river herring, smelt, American eel, and other fish species that either migrate for spawning or require unobstructed access throughout waterways to complete their lifecycles. Large dams have also resulted in significant changes to aquatic ecosystems in the mid-Atlantic states. The Tappan Dam on the Hackensack River in New Jersey, which diverts water for domestic use, is responsible for the conversion of a unique native white cedar swamp into the 8,400-acre New Jersey Meadowlands, an area now dominated by the common reed.

Working for Change

South Fork Little Conemaugh River, Pennsylvania

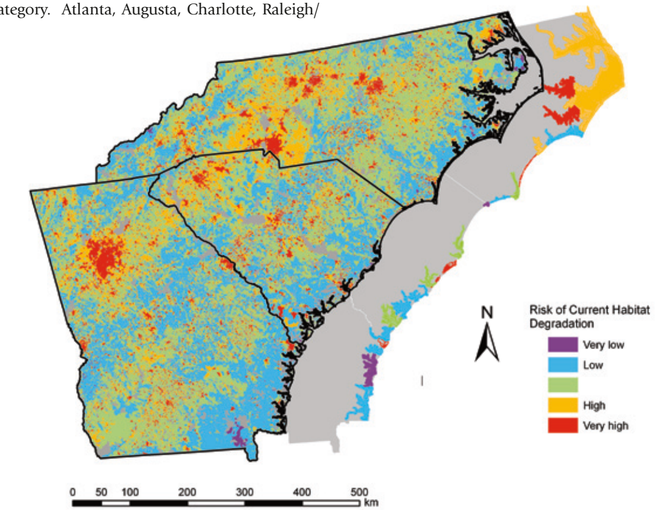
Past mine activities along the Conemaugh River have resulted in chronic acid mine drainage into the stream, which has increased the acidity of the stream and reduced the abundance of brook trout and other aquatic life. In addition, erosion from a 300-foot stretch of the stream bank on the South Fork was greatly increasing sediment inputs to the river. With help from over a dozen partners, the Eastern Brook Trout Joint Venture is using limestone to neutralize the river's acidity and promote the recovery of brook trout populations and other aquatic life. Another phase of the project will stabilize the stream by installing fish habitat structures along the stream banks where there is a significant threat of erosion. This project is a small part of a larger conservation strategy developed by the Eastern Brook Trout Joint Venture to restore brook trout habitat and populations.

Southeast Atlantic States

(North Carolina, South Carolina, Georgia)

Fish Habitat in the Southeast Atlantic States

The aquatic habitats of the southeast show a wide range of risk of current habitat degradation based on the factors assessed. Overall, the greatest proportion of the rivers in the southeastern Atlantic states falls into the middle category of risk of habitat degradation from the factors assessed, with 31 percent falling into the low risk category. Atlanta, Augusta, Charlotte, Raleigh/Durham, and the suburban corridors between them have a very high risk of current habitat degradation related to urbanization of the surrounding watersheds, road crossings, and agriculture in the outlying areas. The mountains of North Carolina and most of the coastal plain of all three states



Did You Know?

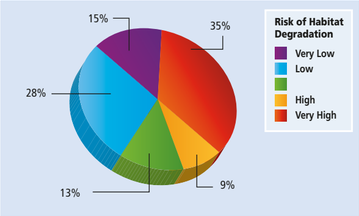
- The southeast Atlantic states' marine and freshwater recreational fishing expenditures were greater than $3.5 billion in 2006 and commercial fish catch totaled more than $108 million in 2009.
- The Albemarle-Pamlico Sound in North Carolina is the second largest estuary in the United States, with a watershed of approximately 30,000 square miles. It provides nursery habitat for 90 percent of fish and shellfish caught by commercial fishermen in the region.
- The human population in the Southeast Atlantic states is projected to grow 76 percent by 2030 which, without careful planning, will further degrade fish habitat and reduce fish populations.

Fish with Habitat Trouble

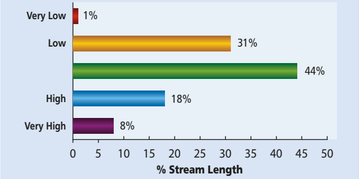
- Annual catch of river herring in Albemarle Sound averaged 12 million pounds from 1880 to 1970, but collapsed to only 100,000 pounds in 2005. A specific cause of the decline has not been identified, but habitat loss is believed to be one of many contributing factors.
- Southern Appalachian brook trout have declined sharply due to the effects of historical logging and the introduction of non-native brown and rainbow trout. Today they face the additional threat of excess sedimentation caused by human alterations to the landscape.
- Roanoke bass and smallmouth bass are losing habitat as a result of sedimentation and human alterations to river flows.

have a low risk of habitat degradation, although development is intensifying on some of the barrier islands of the coast. Although many of the smaller estuaries in the southeast Atlantic states have low or very low risk of current habitat degradation, the largest estuary, Albemarle-Pamlico Sound, has a high or very high risk of current habitat degradation due to agricultural runoff containing excess nutrients and pollutants. Some of the estuaries with overall moderate risk of current habitat degradation have a very high risk of degradation from pollution; these include Charleston Harbor and the Santee River, which had some of the highest pollution risk scores in the region.

Northeastern States — *% Estuary Area*



Southeast Atlantic — *Risk of Current Degradation*



Human Activities Affecting Fish Habitat

Urban land use

The southeastern states contain the urban centers of Columbia, Charlotte, Raleigh, Greensboro, and Atlanta. In these cities and the surrounding suburbs, large areas of impervious surfaces replace natural streamside habitat, increase pollution and sedimentation, and alter hydrology. Declining fish populations are the result, near the cities as well as downstream. Another effect of urbanization is demand for water. From 2007 through 2009, drought conditions in the southeast led to disputes over allocation of water between humans and fish.

Dams and other barriers

Over 1,000 dams impound rivers and streams in the southeast Atlantic states. Dams impede migrations of striped bass, American shad, and herring as they swim upstream from the Atlantic Ocean to spawn. In many cases, these blockages restrict access to historical spawning habitats and limit adequate spawning flows necessary for egg and fry survival.

Agriculture

Since European settlement, the wide coastal plain of the southeast Atlantic states has been used for large agricultural operations producing tobacco, cotton, peanuts, corn, soybeans, and many other agricultural products. Increasing use of irrigation for these row crops has changed water flow in many of the region's streams. More recently, intensive hog and chicken farming have become important as well. Concentrated animal operations can add additional stress because the waste generated by these operations affects streams and estuaries through runoff, or when waste-holding ponds fail. Improperly managed runoff from farms contributes excess sediments and nutrients to streams, which interferes with fish spawning and can lead to potentially harmful algal blooms.

Working for Change

Jockey's Ridge State Park, North Carolina

Before this area became a state park, vegetation was cleared in preparation for planned development in the northern part of what is now Jockey's Ridge State Park. The loss of vegetation allowed sand from the largest active dune system on the U.S. East Coast to blow directly on the fringing salt marsh along Roanoke Sound. The marsh and shoreline have been further weakened by wind and wave erosion. The Southeast Aquatic Resources Partnership along with the North Carolina Coastal Federation and its partners are restoring the natural marsh within Jockey's Ridge State Park by building an oyster reef sill and replanting the marsh grasses and riparian vegetation, establishing natural buffers that prevent both wind and wave erosion. To date, over 139 volunteers have been involved in the planting, which benefits fish such as snook, sheepshead, grouper, redfish, spotted sea trout, and black drum. This project is one of many that are planned to address one of the objectives of the Southeast Aquatic Resources Partnership Aquatic Habitat Plan: "Conserve, restore, and create coastal estuarine and marine habitats."

Friends of Jockey's Ridge

Georgia DNR

Upper Midwest States

(Minnesota, Wisconsin, Michigan)

Did You Know?

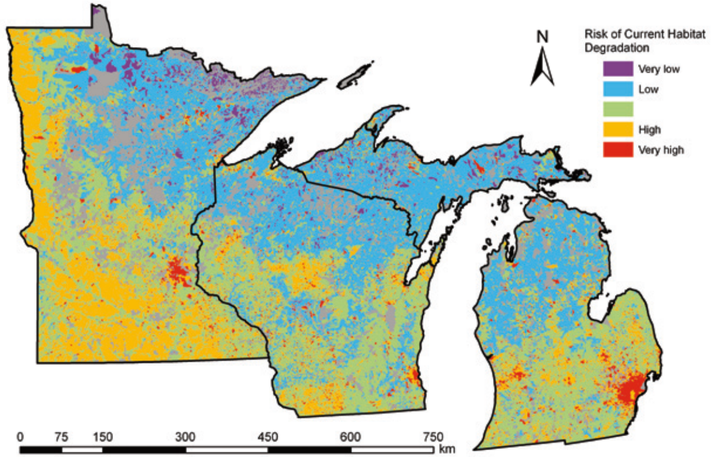
- The upper midwest states had the second greatest total expenditures for freshwater recreational fisheries of all the regions in 2006. More than $6 billion were expended for recreational fisheries, and an additional $13 million was brought into the region through commercial catch in 2009.
- The upper midwest has 33,000 lakes—more than 25 percent of the nation's lake habitat.
- Lake trout, lake whitefish, and lake sturgeon were once key commercial fisheries in the Great Lakes. While lake sturgeon populations are still very depressed, both lake trout and lake whitefish fisheries have been rehabilitated, supporting both sport and commercial fisheries.

Pat Rivers

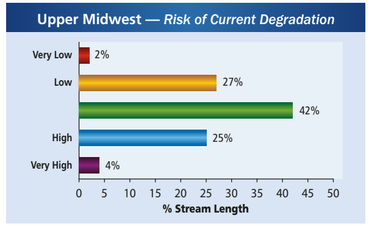
Fish Habitat in the Upper Midwest states

Michigan, Wisconsin, and Minnesota border four of the five Great Lakes (akes Michigan, Superior, Huron, and Erie) and also contain thousands of smaller lakes. The Upper Mississippi River flows through the Upper Midwest states, from its headwaters in Minnesota along the boundary between Minnesota and Wisconsin. A unique region of deeply carved river valleys known as "The Driftless Area" is located in southwestern Wisconsin and southeastern Minnesota.

Lakes and reservoirs in the upper midwest states have seen monumental changes in water quality and fish assemblages over the past 200 years. Agriculture, logging, overharvesting of fish, manufacturing, urban and suburban development, construction of thousands of dams (many abandoned), and the introduction (both accidental and intended) of non-native species have degraded habitat, collapsed food webs, and threatened fish populations and human health. Fortunately, bi-national efforts have resulted in improvements in water quality in all of the Great Lakes, but much remains to be done as urbanization, legacy industrial wastes, and agriculture continue to affect the Great Lakes and the smaller glacial lakes of the region.



Similarly, agricultural runoff and excess sediment threaten upper Mississippi River aquatic resources. The areas with the lowest risk of habitat degradation occur in the northern parts of the region, which have mostly recovered from historical effects of logging and mining. The areas with the highest risk of degradation occur in southwest Minnesota, where row crops dominate the landscape, and in the urban areas around Detroit, Milwaukee, and Minneapolis. Overall, the greatest proportion of the rivers in the upper Midwest states falls into the middle category of risk of habitat degradation from the factors assessed, with 27 percent and 25 percent falling into the low risk and high risk categories, respectively.



Harry and Laura Nohr Chapter of Trout Unlimited

Human Activities Affecting Fish Habitat

Urban land use

Major cities such as Detroit, Milwaukee, Minneapolis/St. Paul, and numerous smaller lake-front cities support a population of about 35 million people in the upper midwest area. The resulting urbanization has reduced fish habitat through wetland fill and the conversion of natural lake shorelines to bulkheads and seawalls. In smaller lakes, vacation communities with multiple tiers of development threaten lake and reservoir habitat through habitat loss and the input of excessive nutrients and sediments.

Fish with Habitat Trouble

- Fish that migrate from the Great Lakes to rivers, like lake sturgeon, have declined because of dams and other barriers.
- In many areas, non-native zebra and quagga mussels have altered food webs for native fish and negatively affected native mussel populations.
- Fish that use native vegetation for spawning, such as northern pike, yellow perch, walleye, and muskellunge ("muskies"), lose habitat when lakefront property owners remove aquatic "weeds."

Pat Rivers

Point source pollution

A major hub for manufacturing and transportation, the Great Lakes were once a dump site for many toxins, including mercury, PCBs, and dioxins. As a result of the Clean Water Act most of these direct pollution discharges have stopped, but the pollutants remain because many are trapped in lake and stream sediments. Other pollutants that stay in the water have long residence times because less than 1 percent of the water in the Great Lakes exits the lake system annually. Discharge from sewage treatment systems remains a problem, particularly where stormwater and sewage systems are combined in large urbanized areas.

Dams and other barriers

Dams and other barriers are having a significant effect on fish habitat in the upper Midwest. For, example, in the Lake Michigan watershed alone, dams, culverts, and road crossings that impede fish migration have reduced nearly 19,000 miles of available stream habitat to only 3,300 miles. With an estimated one-third of all Great Lakes fish using tributaries as their principal spawning and nursery habitats, these barriers are a significant factor in the decline of fish populations in the Great Lakes and other waters with similar barriers.

Agriculture

Corn and other row crops dominate the landscape across southern Minnesota, Wisconsin, and Michigan. Most of this agricultural activity came at the expense of the large wetland complexes that were found across the landscape in this region. The region has been extensively tile drained and streams turned into drainage ditches, devoid of fish habitat. Eroded soil and fertilizer run off the land surface into lakes and rivers, reducing water clarity, stimulating algal growth, and changing the bottoms of river channels and lakes from sandy sediments to mud.

Working for change

Cass County, Minnesota

Cass County's 500-plus high-quality lakes provide critical fish and wildlife habitat, are the basis for many Minnesotans' recreational enjoyment, and are key to sustaining local communities. While some areas of the region lost population in recent years, lake-rich counties like Cass are seeing dramatic increases both in year-round and seasonal residents. Projections for future growth and development of lakeshores show this trend will continue. Cass County's 55 most developed lakes still have approximately 38 percent of the shore undeveloped or minimally developed. A number of these lakes have been surveyed by the Minnesota Department of Natural Resources' (DNR) Sensitive Lakeshore Identification Pilot Project. A partnership between Cass County, the Leech Lake Area Watershed Foundation, the Minnesota Department of Natural Resources, and the Midwest Glacial Lakes Partnership seeks to secure voluntarily donated conservation easements from willing landowners on 12 to 15 of the most vulnerable shoreland properties in the county. As a result, approximately 1,200 feet of shoreline and its fish and wildlife habitats will be protected, and continued recreational enjoyment and economic stability will be ensured.

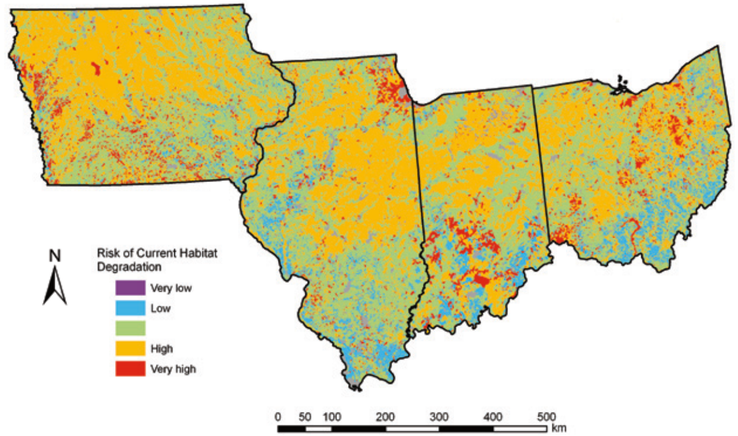
Central Midwest States

(Iowa, Illinois, Indiana, Ohio)

Fish Habitat in the Central Midwest states

The central midwest states include parts of the major watersheds of the Ohio and Illinois Rivers and part of the Upper Mississippi River watershed. These states also border lakes Michigan and Erie, and contain numerous reservoirs and smaller lakes.

The central midwest states have experienced a long history of manufacturing, agriculture, and mineral extraction. As a result, substantial areas (40 percent of the miles of rivers assessed) have a high risk of habitat degradation due to the factors assessed, particularly in Iowa and the northern parts of Illinois, Indiana, and Ohio. Row crops and pasture are the most common factors contributing to the risk of habitat degradation in these



Did You Know?

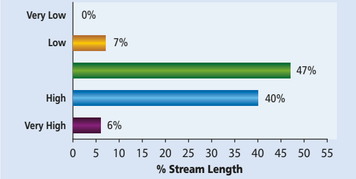
- Greater than $2.7 billion in expenditures were associated with recreational fishing in the central midwest states in 2006.
- Ohio River drainage provides habitat for at least 350 species of fish and more than 120 mussel species—almost half of the freshwater fish and over one-third of all mussel species found in the United States.
- There are 30,700 miles of streams and rivers in the upper Mississippi River basin, a landscape of 189,000 square miles, two-thirds of which supports agriculture.

Fish with Habitat Trouble

- Lake sturgeon and shovelnose sturgeon have declined steadily since lock and dam systems were built on the major rivers of this region. Lack of access to spawning areas, as well as loss of their preferred food (mussels and snails) due to habitat degradation, are thought to be responsible for their decline.
- Native brook trout populations have declined because of landscape changes that affected stream hydrology and temperature and the loss of shaded streamside habitat.
- The pugnose minnow was historically abundant in the central midwest states where clear water with aquatic vegetation was present. Due to this kind of habitat becoming increasingly rare, this species is on the verge of being extirpated from the region.

areas. Areas with a low risk of habitat degradation occur in the southern parts of the region. Overall, the greatest proportion of the rivers in the central midwest states falls into the middle category of risk of habitat degradation from the factors assessed.

Central Midwest — *Risk of Current Degradation*



Human Activities Affecting Fish Habitat

Urban land use

In the 1990s, urban land in Ohio, Illinois, and Indiana increased by about 10 percent. Currently, Ohio and Illinois are among the 10 most populous states in the nation, with Indiana and Iowa in the top 20. Large cities such as Chicago, Indianapolis, Columbus, and Cleveland have created large areas of impervious surfaces and a great amount of urban pollution near the rivers and lakes of this area, degrading fish habitat through changes in hydrology and excessive inputs of nutrients and sediment.

Point source pollution

Northern Ohio, Indiana and Illinois are part of the Factory Belt, an area that was a primary center of manufacturing and industry in the late 1800s and early 1900s. Many of the manufacturing processes resulted in discharges of toxins to locals waterways. PCBs and dioxins, which have been banned for more than a decade, still pose a problem in the area's rivers, lakes, and reservoirs because these industrial chemicals do not break down over time.

Agriculture

Ohio, Indiana, Illinois, and Iowa constitute the majority of what is known as the Corn Belt, the most intensive agricultural region in the midwest where corn and soybeans are the predominant crops. Most of the corn and soybean is fed to livestock, making this a key area for the production of hogs, chickens, and cattle. Runoff and drainage from agricultural fields and feed lots, and from

US Fish and Wildlife Service

US Fish and Wildlife Service

stream banks eroded by cattle, have resulted in elevated levels of nitrogen, phosphorus, and sediments in most of the streams in the area.

Working for Change

Little Turkey River, Northeast Iowa

The Little Turkey River is a popular trout stream in the Turkey River watershed of northeast Iowa. It was identified by the Iowa Department of Natural resources as a top-priority stream in need of water quality and habitat improvements because degraded habitat in the upper 2-mile coldwater portion of the stream limits natural reproduction of trout. Willing landowners in the upper part of the watershed have installed conservation terraces, grassed waterways, erosion control structures, and other habitat improvements in an effort to reduce soil loss and improve habitat quality for fish and wildlife. In 2008–2009, about a mile of actively eroding stream bank was resloped and stabilized, and riparian areas were seeded with native vegetation. The coordination of upland, riparian, and in-channel enhancement efforts on this stream have improved habitat for brook and brown trout, longnose dace, fantail darter, and other fish species. This project is but one of many that will be undertaken by the Driftless Area Restoration Effort as they implement their mission of "Working together to protect, restore and enhance cold, cool, and warm-water streams for fish and other aquatic life in the Driftless Area region for future generations."

Central Mississippi River States

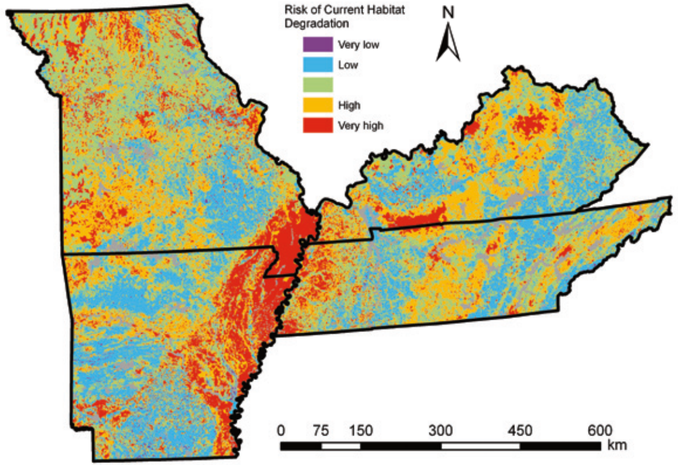
(Missouri, Arkansas, Kentucky, Tennessee)

Did You Know?

- Recreational fishing expenditures totaled more than $2.9 billion in 2006, with a majority coming from recreational fishing in Missouri.
- In Tennessee's Duck River there are more fish species per mile than in any other river in North America.
- Hydroelectric development in the White River has changed the water temperature in portions of the river. Once a coolwater smallmouth bass stream, it is now a cold-water system that supports introduced rainbow and brown trout fisheries.

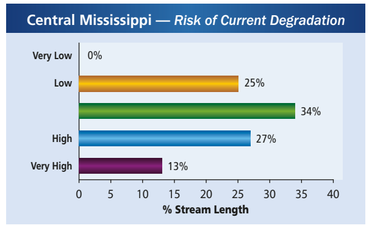
Fish Habitat in the Central Mississippi River states

The Central Mississippi River states contain the confluences of the Mississippi River with the Ohio, Missouri, and Arkansas rivers. Alteration of these large rivers for transportation and flood control has substantially altered their ecological characteristics, eliminating natural floodplains, sandbars, and meanders, and impeding fish migration routes. Other major rivers include the Tennessee, Cumberland, Kentucky, and Osage. Reservoirs on these and other rivers have increased recreational fishing in the area, but are suffering from the highest rates of oxygen deprivation of reservoirs in the country.



Stan Allen

Aquatic habitat close to the Mississippi River has a very high risk of degradation from row crop agriculture. Areas with a high risk of habitat degradation also occur in southwest Missouri and central Kentucky and Tennessee, where pasture is the primary factor contributing to habitat. All four states contain areas with a lower risk of habitat degradation, particularly western Arkansas and eastern Kentucky. Overall, 40 percent of the rivers in the Mississippi River states have a high or very high risk of current habitat degradation from the factors assessed, with 34 percent falling into the middle category.



Human Activities Affecting Fish Habitat:

Agriculture

Kentucky, Tennessee, and Missouri rank in the top five states for number of farms. Cattle and poultry are the most common livestock, and tobacco, cotton, corn, soybeans, and rice are among the most frequently grown crops. Streams degraded by agriculture are most common in the "boot heel" (southeast) of Missouri and eastern Arkansas. Stormwater runoff from agricultural fields carries sediment, fertilizers, and pesticides into the Mississippi River and its tributaries. Atrazine, a herbicide used on corn and soybeans, is ubiquitous in this area. The most ecologically significant effect of the agricultural runoff into the Mississippi River is the "dead zone" created in the Gulf of Mexico each summer where excess nutrients stimulate algal growth, which in turn depletes available oxygen concentrations in the water.

Point source pollution

Regional industries have contributed significant amounts of oil, aluminum, lead, and other industrial wastes such as sulfur dioxide, hydrogen sulfide, and benzene to the flow of the Mississippi. Many chemicals, such as PCBs, have been banned for decades but persist in the river's suspended and bottom sediments. Poorly treated sewage and wastewater is also a concern because it contributes bacteria and detergents to the river water.

Fish with Habitat Trouble

- Many darters (and logperch) are under threat of extinction due to mining, logging, industrial development, and residential development, which increase sedimentation in the fast, clear streams inhabited by darters.
- Pallid sturgeon and shovelnose sturgeon, once common in the Mississippi River, have declined in part from river modifications for navigation.

Working for Change

Little Bourbuese Creek, Meramec River Basin, Missouri

Rural landowners along the Little Bourbuese Creek in Missouri are working together to protect their livelihood and fish habitats in the Meramec River Basin. With the assistance of the State Department of Conservation and Department of Natural Resources, landowners formed a committee to put conservation decision-making in the hands of the landowners. Through tours of farms currently implementing conservation measures, such as off-stream watering practices to improve stream turbidity and decrease soil erosion, other farmers were able to learn about the materials and techniques needed to replicate the projects on their land. Further, local contractors and landowners benefited from cooperation, saving both time and money by completing multiple projects at once. The Little Bourbeuse Creek landowner committee was the first project funded with National Fish Habitat Action Plan Funds after its nomination by the Fishers and Farmers Partnership, showing the importance of conservation partnership to the National Fish Habitat Action Plan. This project illustrates how cooperation between farmers and state conservation professionals can lead to improved stream quality and fish habitat.

US Forest Service

Focus on the Gulf of Mexico

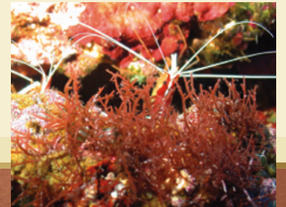
This report focuses first on the Gulf of Mexico, in recognition of the interest in this area generated by the catastrophic Deepwater Horizon oil spill in April 2010. Much is still unknown about the effects of the oil spill, so this report does not assess the effects of the oil spill but instead provides a description of baseline conditions against which to gauge future habitat assessments. In the wake of the oil spill, commercial and recreational fishery closures affected up to one-third of Gulf of Mexico federal waters. The oil visibly affected thousands of birds, fish, and other wildlife, and the extent of the damage beneath the water is unknown at this time. Despite these uncertainties, one thing is clear: never has the importance of healthy fish habitat been more evident. From the fishermen and beachgoers along the Gulf to the President of the United States, there is agreement on the need for continued and deliberate protection and restoration of these aquatic habitats.

Guy Fangoy

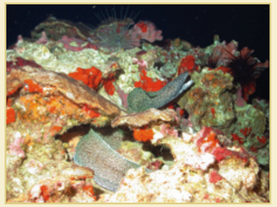
Fish Habitats in the Gulf of Mexico

Coastal and marine habitats of the Gulf of Mexico include submerged aquatic vegetation, mangrove wetlands, mud flats, oyster reefs, estuarine emergent marsh, hard bottom, corals, and water column. Collectively, these diverse coastal and marine habitats provide spawning, nursery, feeding, and shelter habitat for a myriad of recreationally and commercially important fish and invertebrate species in the Gulf of Mexico. The most productive estuarine areas include the Apalachicola, Mobile, Tampa, and Galveston bays, the Suwannee, Atchafalaya, and Mississippi rivers and their associated wetlands.

Fisheries and tourism industries throughout the Gulf of Mexico depend on healthy aquatic habitats. Tourism is the second largest industry in the Gulf, behind oil. About 46 percent of the Gulf economy, or over $100 billion a year, comes from tourism dollars. The Gulf of Mexico also is extremely important to both commercial and recreational fishing. Ports in the Gulf of Mexico states, including Florida's Gulf Coast, took in more than $525 million worth of commercial fish and



shellfish in 2009, 13.5 percent of total national catch value. Approximately 73 percent of total U.S. shrimp landings occurred in the Gulf of Mexico region and 30 percent of total U.S. marine recreational fishing trips were taken in the Gulf of Mexico in 2008.



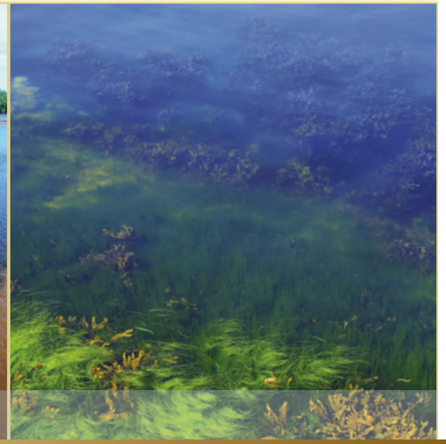
Human Activities Affecting Fish Habitat

Oil and gas exploration

With over 4,000 active oil and gas platforms, the Gulf of Mexico is one of the most important regions for oil and gas production in the United States. Offshore oil production in the Gulf of Mexico accounts for 29 percent of total U.S. crude oil production, and offshore natural gas production in the Gulf accounts for 13 percent of total U.S. production. The effects of this industry on fish and fish habitat in the Gulf of Mexico include wetland loss associated with dredging channels for pipelines and transportation, pollution from oil spills both large and small, and noise effects on fish and marine mammals (whales and dolphins). In contrast to these negative effects, retired offshore oil and gas platforms are sometimes converted to "artificial reefs" that provide additional fish habitat.

Agricultural runoff

Each summer in the northern Gulf of Mexico a hypoxic (low oxygen) zone forms, primarily the result of excess nutrients from Mississippi River Basin agricultural runoff into the Gulf of Mexico. Excess nutrients enhance algal growth. The algae then die and decompose, using up oxygen in the process. In 2009 this so-called "Dead Zone" was 6,600 square miles in size—larger than the state of Connecticut. Most aquatic organisms cannot survive in habitats with severely low oxygen levels, and are forced to move from these areas if they are mobile, or die if they are not.

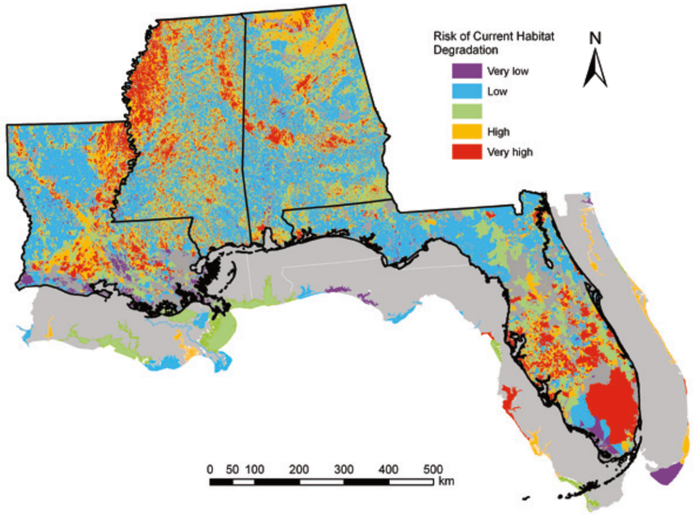


Eastern Gulf of Mexico States

(Louisiana, Mississippi, Alabama, Florida)

Fish Habitat in the Eastern Gulf of Mexico States

The eastern Gulf of Mexico states contain areas where the natural water flows have been substantially altered. South and central Florida has been essentially re-plumbed, first to support agriculture and flood control and more recently to support municipal water demands for its growing human population. Louisiana has also experienced major changes in hydrology as a result of the levees built along the lower Mississippi River and channels dredged through the Mississippi River Delta.



Did You Know?

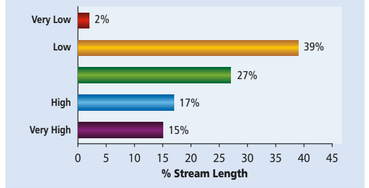
- The eastern Gulf of Mexico states had the greatest total expenditures in 2006 for marine and freshwater recreational fisheries of all the regions described in this report. More than $6.2 billion was expended for marine and freshwater recreational fisheries, and an additional $504 million in commercial catch occurred in 2009.
- Alabama is consistently ranked among the top three to five states in terms of overall biodiversity, yet half of Alabama's aquatic species are considered endangered or threatened.
- The Everglades has been designated as a "wetland of international importance" by the Ramsar Committee, which selects wetlands throughout the world to prioritize for conservation.

Fish with Habitat Trouble

- Gray snapper, spotted seatrout, and red drum inhabit mangrove forests along both coasts of southern Florida. Their habitat is under constant threat from development.
- Saltmarsh topminnows have been affected by the extensive loss of their habitat due to wetland fill and conversion of marshes to open water.
- Blue suckers were once a staple in the diet of people living along the Mississippi River. They are very rare today, due to habitat fragmentation and barriers to this fish's long migration.

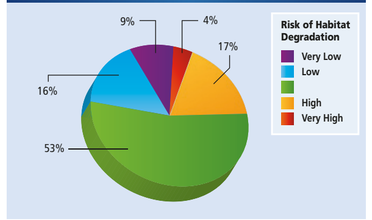
Agriculture is the primary land use in these states, with a wide variety of row crops—including sugar cane, rice, citrus, and cotton—as well as cattle farming. Forestry is the primary agricultural activity in Louisiana, with almost 14 million acres under management. Overall, the largest percentage of rivers in the eastern Gulf of Mexico states is at a low risk of current habitat degradation. Areas with a high risk of habitat degradation from agriculture include central Florida, with its high percentage of land in pasture, and southwestern Louisiana, where row crops are the major factor contributing to habitat degradation.

Eastern Gulf of Mexico — *Risk of Current Degradation*



The highest percentage of estuarine area in the eastern Gulf of Mexico states falls into the middle category of habitat degradation. The Tampa Bay estuary is at high risk of habitat degradation due to reduced water flows and a surrounding landscape that is highly altered and contains numerous sources of pollution.

Eastern Gulf of Mexico — *% Estuary Area*



Human Activities Affecting Fish Habitat

Urban land use

Florida contains some of the fastest growing counties in the country. Ft. Lauderdale, Orlando, West Palm Beach, Pensacola, and Daytona Beach rank among the most sprawled cities. Pollution and disruption of natural water flows have damaged the Florida Keys reef system, degraded fisheries in Florida Bay, and are depriving the Everglades and its dependent aquatic species of the water they need to thrive. Louisiana contains an urbanized corridor that reaches from New Orleans west along Interstate 10 to Baton Rouge, Lafayette, and Lake Charles, and north to Alexandria. The roads and development along this urban corridor contribute pollutants to the wetlands in the area, including the Atchafalaya Swamp.

Jason Kirkpatrick

Agriculture

The draining of the Everglades to create the Everglades Agricultural Area is one of the most well known examples of the effects of agriculture on fish habitat in the eastern Gulf of Mexico. In addition to the physical loss of habitat, the agricultural activities in this area release sediments and nutrients into Everglades National Park and Florida Bay, creating a very high risk of low oxygen zones caused by the decomposition of algae blooms.

Working for Change

Tampa Bay Shoreline, MacDill Air Force Base, Florida

The historical loss of mangroves along the eastern coastline of MacDill Air Force Base has left the shoreline exposed and subject to severe erosion. Construction of near-shore oyster reefs along the coastline, which began in 2004, has helped stem this erosion by reducing wave energy, encouraging sediment build-up, and restoring native vegetation. The inter-tidal oyster reefs improve marine habitat diversity and help restore natural vegetative barriers to stabilize coastal sediments. The structures are quickly colonized by oysters and mussels, which filter the water and provide valuable habitat for fish and other marine life. The ongoing project has been a success thanks to the leadership of the Air Force and support provided by volunteers who provided all of the manual labor to install the oyster domes and oyster shell bags and to plant marsh grass. This project is part of a much larger effort by Tampa Baywatch and partners such as the Southeast Aquatic Resources Partnership to increase oyster habitat and reduce shoreline erosion in the Tampa Bay area. In 2007 and 2008 alone, almost 3,000 oyster domes were installed.

Jason Kirkpatrick

Southern Plains States

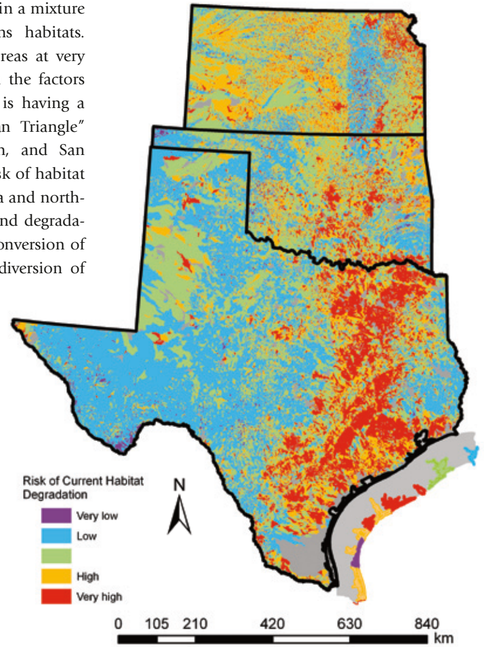
(Kansas, Oklahoma, Texas)

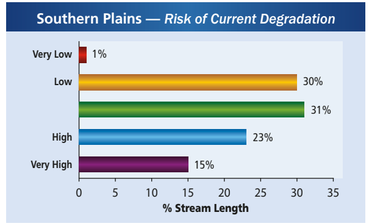
Did You Know?

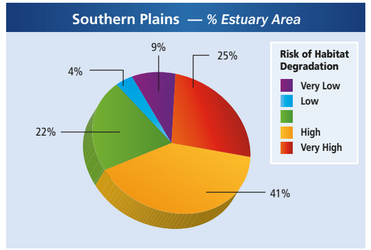
- The southern plains states ranked third in expenditures associated with marine and freshwater recreational fishing in 2006. These expenditures totaled more than $3.9 billion and most were from the state of Texas. Texas also brought in more than $150 million in commercial catch in 2008.
- The Rio Grande begins as a clear spring and snow-fed mountain stream at the continental divide in Colorado, but due to water diversions, it rarely has enough water to complete its journey to the Gulf of Mexico.
- The population of Texas increased by 23 percent from 1990 to 2000. Urban areas in Texas are projected to double by 2050 which, without careful planning, will increase pollution and negatively affect fish habitat.

Fish Habitats in the Southern Plains States

The southern plains states contain a mixture of coastal, desert, and plains habitats. Eastern Texas contains large areas at very high risk of habitat degradation from the factors assessed. In particular, urbanization is having a significant effect in the "Texas Urban Triangle" between Houston, Dallas/Fort Worth, and San Antonio. Smaller areas at very high risk of habitat degradation occur in central Oklahoma and northeast Kansas. Regional habitat losses and degradation are attributed principally to the conversion of native prairie to agriculture and the diversion of water for irrigation. Irrigation diversions on the Rio Grande and Red, Arkansas, and Kansas rivers have changed the flow in these rivers to the point where there are large reaches without water seasonally. A range of factors affect fish habitat in reservoirs, including sedimentation, loss of structural habitat, excessive nutrient inputs, loss of shoreline habitat, and altered water flow. About 31 percent of the river miles in the southern plains states are classified as being at low or very low risk of current habitat degradation and about 38 percent are classified as being at high or very high risk of current habitat degradation.







Two-third of the estuarine area in Texas has a high or very high risk of habitat degradation due to the factors assessed. Galveston Bay was assessed as having a very high risk of degradation from land use factors (urbanization), but did not have an overall high risk of habitat degradation because flushing of the Bay reduces degradation from excess nutrients. Coastal areas in Texas are becoming increasingly urbanized, causing loss of habitat and impaired water quality.

Human Activities Affecting Fish Habitat

Agriculture

Wheat and cotton are the two most commonly grown crops in the southern plains states. Areas with a high risk of habitat degradation in western Kansas correspond to areas of these and other row crops. Nutrient runoff from crop fields flows into streams and eventually ends up in the Gulf of Mexico. This high-nutrient runoff contributes to the low oxygen dead zone in the Gulf of Mexico, described in more detail in the section on the Gulf of Mexico.

Pasture

Cattle and sheep ranching are common in southern plains states. Areas of very high risk of habitat degradation in eastern Texas correspond to areas characterized as pasture. When livestock drink from local streams they trample the stream banks and create excess sedimentation in the streams.

Urbanization

The southern plains states contain one of the fastest-growing urban centers areas in the country—the triangle of Houston, Dallas/Fort Worth, and San Antonio, where 17 million people are spread over 58,000 square miles. In these cities and the surrounding suburbs, large areas of impervious

Fish with Habitat Trouble

- Large river minnows such as the Rio Grande silvery minnow are at significant risk due to streamflow modifications, loss of connectivity, increased water clarity, and establishment of sight-feeding predators and competitors.
- All spring-dependent fish are at risk due to increasing rates of aquifer withdrawals for agriculture and expanding urban areas.
- The ongoing loss of tidal wetlands along the Texas coast is reducing habitat for blue crab, shrimp, speckled sea trout, redfish, and other important commercial and recreational species.

surfaces replace natural streamside habitat, increase pollution and sedimentation, and alter hydrology. Declining fish populations are the result, near the cities as well as downstream. Another effect of urbanization is demand for water. Urban areas in the Texas Urban Triangle initially relied mostly on groundwater to meet their water needs, but as aquifer levels plummet, more and more cities have switched to surface water from streams and reservoirs. Major rivers such as the Colorado, San Jacinto, and Trinity are already heavily used for urban and agricultural water supply, and the San Jacinto was named one of America's Most Endangered Rivers in 1996.

Working for Change

Lake Houston, Texas

Lake Houston is a 12,240-acre reservoir constructed on the San Jacinto River by the City of Houston in 1953 to provide water for municipal and industrial purposes. Its location within the Houston metropolitan area results in heavy recreational use. Lake Houston supports recreational fisheries for crappie, catfish, and largemouth bass. The reservoir is suffering from excess sedimentation related to gravel dredging in the streams that feed into it. The Texas Parks and Wildlife Department is working with the City of Houston, the San Jacinto River Authority, private interests, and regulatory authorities to find solutions to the sedimentation problems at a watershed level. The work will also include constructing wetlands in the project area and outreach efforts to demonstrate the importance of these efforts to the public. This project is one of many the Reservoir Fisheries Fish Habitat Partnership will engage in as they further their mission "To protect and improve healthy aquatic habitat in reservoir systems for the benefit of fish and wildlife and the enhancement of quality of life for people and their communities."

Texas Dept of Parks & Wildlife

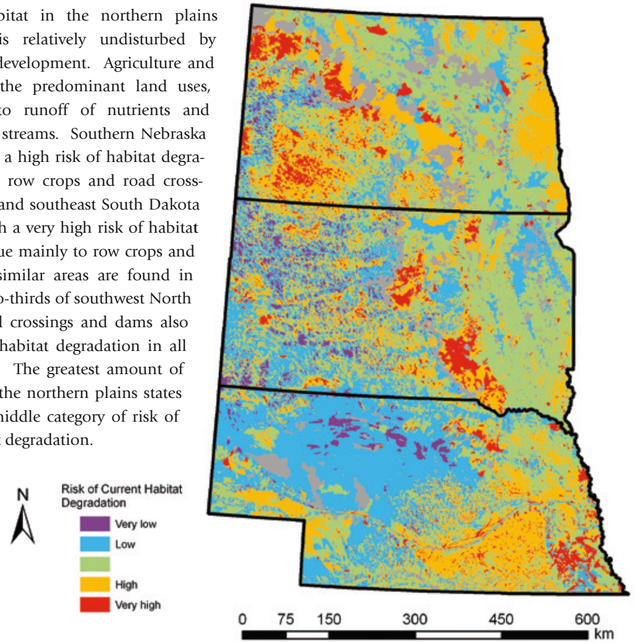
Texas Parks and Wildlife Department

Northern Plains States

(North Dakota, South Dakota, Nebraska)

Fish Habitat in the Northern Plains States

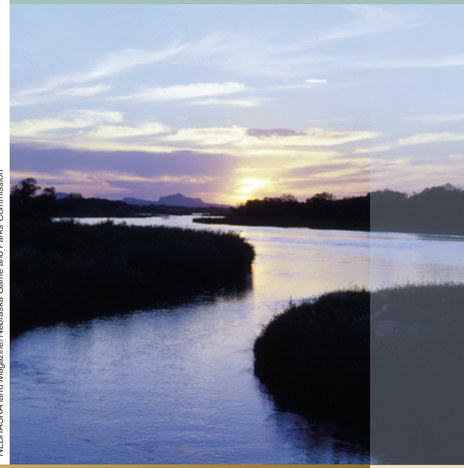
Fish habitat in the northern plains states is relatively undisturbed by urban development. Agriculture and livestock are the predominant land uses, contributing to runoff of nutrients and sediment into streams. Southern Nebraska has areas with a high risk of habitat degradation due to row crops and road crossings. Central and southeast South Dakota have areas with a very high risk of habitat degradation due mainly to row crops and pasture, and similar areas are found in the eastern two-thirds of southwest North Dakota. Road crossings and dams also contribute to habitat degradation in all of these areas. The greatest amount of river miles in the northern plains states fall into the middle category of risk of current habitat degradation.



NEBRASKA land Magazine/Nebraska Game and Parks Commission

Did You Know?

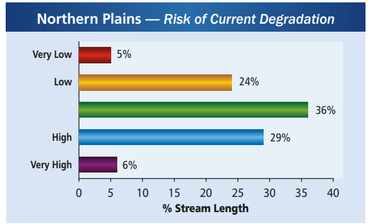
- More than $406 million was expended on freshwater recreational fishing in the northern plains states in 2006.
- The Ogallala aquifer—the largest aquifer in the region—is severely depleted due to irrigation for farmlands, which has so affected water flow in the Platte River that it is now seasonally dry in many reaches.



Sam Stukel SD Game Fish Parks

Fish with Habitat Trouble

- Prior to the construction of dams on the Missouri River, pallid sturgeon had access to hundreds of miles of river to spawn and provide for larval drift. These large fish are rare today, the result of the substantial changes to the Missouri River during the past 50 years.
- The Topeka shiner once lived in Iowa, Kansas, Minnesota, Missouri, Nebraska, and South Dakota. It is still present in these states, but populations have declined greatly due to habitat fragmentation and destruction.



Human Activities Affecting Fish Habitat

Agriculture

Wheat, corn, and soybeans are some of the primary crops grown in the northern plains states. In areas of intense cultivation, streams are often channelized for irrigation, reducing their habitat value for fish as temperature, vegetation cover, and stream flow are significantly changed. In addition, watersheds dominated by row-crop agriculture discharge excess sediment and nutrients to downstream waters. In many areas, water withdrawal to support agriculture is so severe, dry streambeds result.

Pasture

Lands within the watersheds of Great Plains streams that are not used for agricultural crops are often used for cattle grazing and hay production, leading to direct habitat impacts as cattle trample stream banks, increasing sedimentation and nutrient loads. In addition, cattle watering ponds constructed by diverting streams disrupt the connectivity of the streams, potentially interfering with the natural movements of fish.

Sam Stukel SD Game Fish Parks

NEBRASKA land Magazine/Nebraska Game and Parks Commission

Working for Change

Christine and Hickson Dams, North Dakota

The Christine and Hickson dams are located in the upper Red River in Minnesota and North Dakota, just south of Fargo. These two low-head (5 feet and 7 feet) dams block passage of lake sturgeon, walleye, catfish, and many other native river species. Through a partnership between several state, federal, local, and non-profit agencies in Minnesota and North Dakota, the two dams will be replaced with rock arch rapids that will allow fish access to 37 upstream miles and to two upper tributaries. This project will be the culmination of a 10-year effort to replace all of the low-head dams with rock arch rapids, in keeping with the goals and objectives of the Great Plains Fish Habitat Partnership. This effort will restore fish passage, increase fish and native mussel production, and increase recreational fishing opportunities and boating safety on the Red River.

Mountain States

(Colorado, Idaho, Montana, Utah, Wyoming)

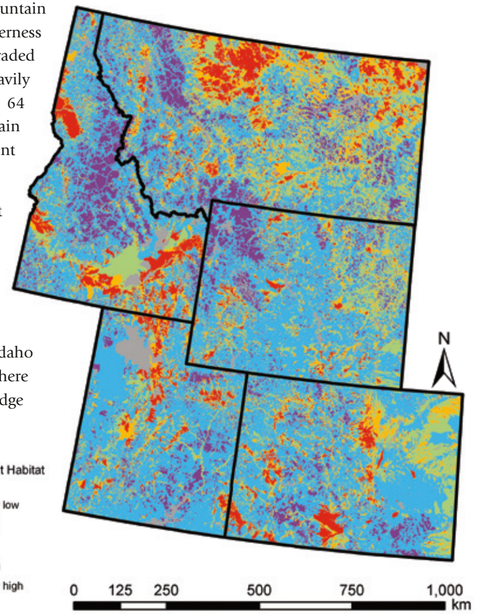
Did You Know?

- More than $1.9 billion was expended on freshwater recreational fishing in the mountain states in 2006.
- The mountain states are home to more varieties of cutthroat trout than anywhere else in the nation.
- The Salmon River in Idaho historically produced 45 percent of all the steelhead trout and 45 percent of spring- and summer-run Chinook salmon in the Columbia River Basin, but now those runs are in serious decline because of the effects of hydroelectric dams on the lower Snake and Columbia rivers, overharvest, hatcheries, and habitat degradation.

Fish Habitat in the Mountain States

In general, fish habitat in the mountain states ranges from pristine in wilderness areas and national parks to degraded in urban areas, mining districts, and heavily grazed or farmed floodplains. About 64 percent of the river miles in the mountain states are at low or very low risk of current habitat degradation.

Areas with a very high risk of current habitat degradation in the mountain states correspond to areas of intensive agriculture (southern Idaho), urban development (Salt Lake City), rivers that have been altered for hydropower and navigation (the Snake River in Idaho and the Colorado River in Utah), or where impacts of grazing, hard rock and dredge mining, and logging have degraded aquatic habitats. In addition, many of the region's rivers and streams have been altered extensively for water uses, including irrigation for agriculture and flood control. Introduced fish species have also played a part in the decline of native fish species in the region. Most recently, energy exploration in Colorado, Wyoming, and Utah has brought new risks and threats to fish habitat from water diversion and direct habitat loss.



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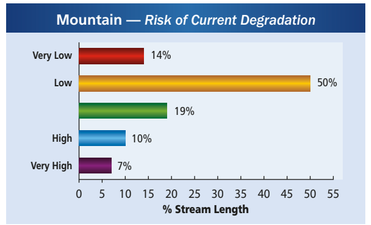


Human Activities Affecting Fish Habitat

Agriculture

The agricultural areas of the mountain states have created a substantial drain on the water resources of this region. Areas where there is a high risk of habitat degradation, such as southern Idaho, correspond to areas with a great amount of row crops and rangeland. Farms and ranches dependent on irrigation require increasing amounts of water diverted from streams and rivers, fragmenting the watersheds and leaving less water in the streams for fish. Agricultural runoff and cattle grazing in unprotected areas near streams and rivers degrade water quality through direct inputs of nutrients and excess sediments, and by altering streamside vegetation and wetlands.

Fish with Habitat Trouble

- Snake River steelhead, Chinook salmon, sockeye salmon, and many other species of fish that migrate between freshwater and saltwater are in serious decline because of the numerous barriers along the Snake River and tributaries, as well as barriers outside the region along the lower Columbia River. Some populations are so low they have been listed as threatened or endangered under the Endangered Species Act.
- Bull trout are in serious decline due to water diversion and withdrawal, water temperature changes, and barriers to migration. They are listed as threatened under the Endangered Species Act.
- Mountain suckers and seven sub-species of native cutthroat trout are threatened by barriers to migration, water diversion, riparian habitat and shading losses, water temperature alteration, and direct habitat degradation.

Dams

Dams and irrigation diversion structures provide power and flood control along the rivers of the mountain states, as well as supply water to the farms, ranches, and cities in these states. Dams also make it difficult, if not impossible, for fish to migrate to and from spawning grounds. The reduced flows from water diversions result in less water in the streams for fish, and they change river habitat by changing sediment and woody debris movement. The decrease in many species of Pacific salmon in the mountain state tributaries to the Columbia River is a direct result of barriers to upstream and downstream migration of fish compounded by other factors such as overharvest and habitat degradation. Similar effects have been documented for bull trout, many of the cutthroat trout sub-species, Pacific lamprey, and white sturgeon, as well as suckers and minnows.

Working for Change

Georgetown Creek, Idaho

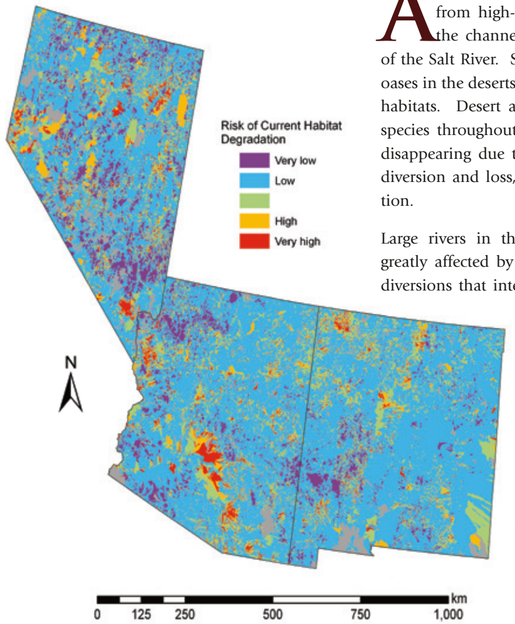
Georgetown Creek is a tributary to the Bear River, identified by the Idaho Department of Fish and Game as a high-priority area for the restoration of Bonneville cutthroat trout. Fish biologists have tracked migratory Bonneville cutthroat trout into lower Georgetown Creek, but barriers block their upstream migration. These barriers include three impassable culverts under a road through the bottom of Georgetown Canyon that not only block fish passage, but also are eroding, causing water quality and sedimentation problems.

Colorado Division of Wildlife

The Georgetown Road Relocation Project, funded by the Western Native Trout Initiative, is a multi-year project to move approximately 2 miles of road (including the three impassable culverts) from the bottom of Georgetown Creek to uplands. The new road was built in 2008, and in 2009 the Caribou-Targhee National Forest initiated removal of the old road. This project has restored water quality and habitat through the removal of the old road and restored fish passage with a fish ladder to allow fish to move around the remaining barriers. Efforts are continuing to reconnect other segments of the stream. This road relocation project is just one component of an overall watershed restoration strategy for Georgetown Creek that also includes fish passage around a hydroelectric diversion headgate on Bureau of Land Management land and passage over an irrigation dam on private land.

Southwestern States

(Arizona, Nevada, New Mexico)



Fish Habitat in the Southwestern States

Aquatic habitats in the desert southwest range from high-elevation mountain streams to the channelized and often dry streambed of the Salt River. Springs, seeps, and wetlands are oases in the deserts that provide unique and fragile habitats. Desert aquatic habitats and desert fish species throughout the western United States are disappearing due to habitat fragmentation, water diversion and loss, and complete habitat destruction.

Large rivers in the southwest states have been greatly affected by the construction of dams and diversions that interfere with fish migration, alter in-stream habitat characteristics including sediment and woody debris movement, change water quality and temperature, reduce access to off-channel habitats, and reduce water flows downstream. The reservoirs behind these dams support tremendously popular sport fisheries

Did You Know?

- More than $1.2 billion was expended on freshwater recreational fishing in the southwestern states in 2006.
- Desert aquatic habitats support 179 species of native fish, 54 of which are listed under the Endangered Species Act.

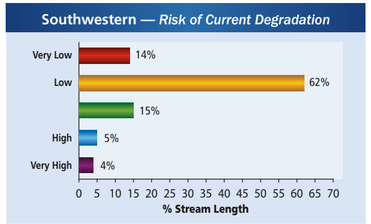
BLM

Fish with Habitat Trouble

- Apache and Gila trout have been greatly diminished in their range and numbers because of direct habitat loss from overgrazing, introduced salmonids, and water loss. Recent efforts have stabilized their range and some improvements in their number have occurred.
- Currently 30 percent of desert fish are so imperiled they are federally listed as threatened or endangered.
- The majority of native desert fish (82 percent) are endemic to the desert west, a testimony to the unique nature of the fauna and the habitats on which they depend.

based on introduced species that often outcompete and prey upon native desert fish.

Water projects that include large dams and water withdrawal systems alter seasonal flows and temperatures, adversely affecting desert species that are adapted to the natural cycle. Combined with water diversions for domestic and agricultural use, extended and ongoing drought conditions in the southwest have adversely affected all desert aquatic habitats. Water diversions and drought were not among the factors assessed, so most of the river miles in the Southwestern states fall into the "low" and "very low" risk categories of current habitat degradation from the factors assessed (urbanization, agriculture and grazing, pollution, mines, and dams).



Human Activities Affecting Fish Habitat:

Dams and other barriers

Areas with a very high risk of habitat degradation in the desert southwest occur in southwest Arizona, where road crossings and dams associated with urbanization fragment habitat and interrupt fish migration. Large rivers like the Rio Grande and Colorado River have been greatly affected by dams and diversions, both impediments to fish movement.

Agriculture and water use

The agricultural areas of the desert states demand ever-increasing amounts of water from an over-allocated regional water supply. Farms dependent on irrigation and growing populations use increasing amounts of water diverted from streams and rivers, leaving less water for fish and impairing connectivity of their habitats. Spring systems are drying up due to development of groundwater, as well as through physical alterations for the use and diversion of surface water outflows.

Working for Change

Red Rock Cíenega Restoration, New Mexico

"Cíenegas"—wetland habitats unique to the desert west—are rapidly disappearing due to changes in the availability of groundwater and invasion of non-native vegetation. This habitat loss has led to severe imperilment of cíenega species, including the Gila topminnow and Gila chub. To provide habitat for these fish, the New Mexico Department of Game and Fish, working with the Desert Fish Habitat Partnership, has restored the cíenega in the Red Rock Wildlife Management Area near the Gila River. The project involved removing non-native vegetation, planting native vegetation, and restoring a groundwater connection to the wetland. Additionally, a pump was installed to provide an emergency source of water during drought years. In 2010, as the cíenega habitat recovered, the New Mexico Department of Game and Fish worked with the Arizona Game and Fish Department and the U.S. Fish and Wildlife Service to establish populations of Gila topminnow and Gila chub, thereby doubling the populations of both species in New Mexico. The cíenega will provide habitat not only for fish, but also for neotropical birds, waterfowl, and amphibians. An interpretive trail is also being constructed to increase the educational and recreation value of the Wildlife Area. This project is one of many that will be undertaken by the Desert Fish Habitat Partnership as they pursue their mission of "Bringing together people and organizations with a common interest in voluntary conservation of desert fishes and their habitats."

Arizona Game & Fish Dept.

Tom Cappiello

Pacific Coast States

(Washington, Oregon, California)

Did You Know?

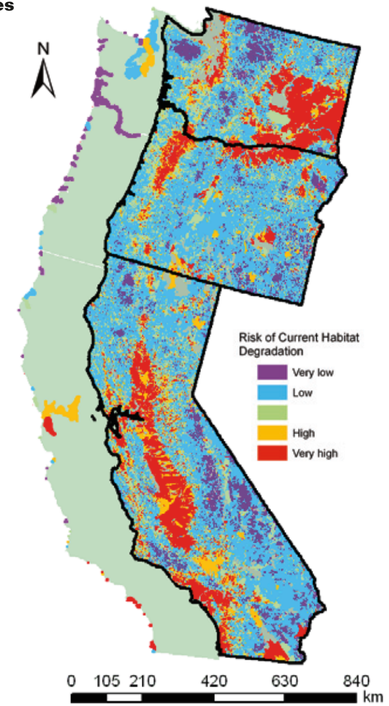
- In 2008, the Pacific coast states brought in more than $490 million in commercial fish catch, and had more than $3.8 billion in expenditures associated with marine and freshwater recreational fishing; these are the fourth largest amounts of all the regions described in this report.
- Pacific salmon swim immense distances in their migrations. For example, Chinook and sockeye salmon travel over 900 miles and climb nearly 7,000 feet from the Pacific Ocean as they return to central Idaho to spawn.
- Nearly 75 percent of the available water in California originates in the northern third of the state (north of Sacramento), whereas 80 percent of the demand occurs in the southern two-thirds of the state.

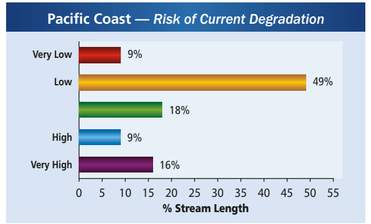
Stan Allen

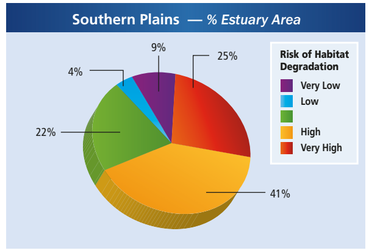
Fish Habitat in the Pacific Coastal States

Fish habitat in California's Central Valley, the Palouse Hills of southeast Washington, and western Washington and western Oregon has a high risk of current habitat degradation due to row crops and pasture that require substantial irrigation. Urban areas such as Los Angeles, San Francisco, and the corridor from Eugene through Portland to Seattle are also at a high risk of current habitat degradation due to urban land use and road crossings that do not allow the passage of fish or sufficient amounts of water. Habitat in the Cascade Mountains, parts of National Forests in eastern California and northwest Washington, and southwest Oregon is at low risk of current degradation due to the factors assessed. Overall, a majority (58 percent) of the river miles in the Pacific coastal states are at low or very low risk of current habitat degradation from the factors assessed.

Estuaries in central and southern California including San Francisco, San Diego, and San Pedro bays are at high risk of current habitat degradation due to altered water flows and pollution in the surrounding watersheds, but other estuaries in the Pacific coastal states have the lowest risk of current habitat degradation of all the estuaries assessed. Fifty-three percent of the estuarine area in the Pacific coast states has a low or very low risk of current habitat degradation form the factors assessed.







Human Activities Affecting Fish Habitat

Dams and agriculture

The rivers of the Pacific coast states are heavily altered by dams and diversions. The dams generally are used for hydropower generation, irrigation, and transportation, all essential to supporting the region's extensive agricultural and manufacturing (aluminum, aircraft, shipbuilding) industries. Dams create problems for fish such as salmon and steelhead, which live in the ocean as adults but reproduce in the upper parts of rivers, by interrupting or halting their migration upstream and killing large numbers of young salmon as they move downstream through powerhouses or spillways. Numbers of salmon and steelhead have declined drastically from historic levels, and many populations are listed as threatened or endangered under the Endangered Species Act. Dams have also reduced the amount of off-channel habitat avail-

Fish with Habitat Trouble

- Many populations of Pacific salmon are in serious decline and are listed as threatened or endangered under the Endangered Species Act due to habitat loss and degradation, barriers to migration, overharvest, and other factors.
- White and green sturgeon, Pacific lamprey, and Pacific smelt populations have declined in much of this region from migration barriers, water quality degradation, and water diversion.
- Many unique species of chub, sucker, and pupfish are also in serious decline due to the effects of water withdrawals, geothermal development, and agricultural pollution, including the threatened Warner sucker, endangered Borax Lake Chub, and several endemic Goose Lake fish.

able for fisheries, and have reduced connectivity between the main river channel and these habitats.

The dams provide water for irrigation and domestic water supplies, which directly compete with fish for the same water. When changes in rainfall, snowmelt, or other factors reduce the amount of water in streams, fish can be the first users to feel the bite. Water in the western United States is governed by a complicated system of water rights that does not usually adequately balance the needs of native fish with human demands. Accordingly, only a few voluntary or litigious efforts to resolve these competing-use issues have been successful so far.

Urban land use

Two of the nation's 10 largest metropolitan areas occur on the California coast: Los Angeles and San Francisco. These two areas, along with the Puget Sound area, are expected to continue to grow rapidly in population and size, increasing the area of impervious surfaces and the amount of sewage discharge, sediments, and other pollutants associated with urbanization. Los Angeles, which is located in a semi-arid plain, affects habitat in the Colorado and San Joaquin Rivers through its water withdrawals to supply a large urban city via aqueducts. Adjacent to Los Angeles is the Port of Los Angeles, originally an area of shallow mudflats but now an active commercial deepwater port. A large amount of wetlands and other fish habitat have been lost and continue to be lost due to port expansion and dredging projects throughout the Pacific coast states.

Robes Parrish

Stan Allen

Working for Change

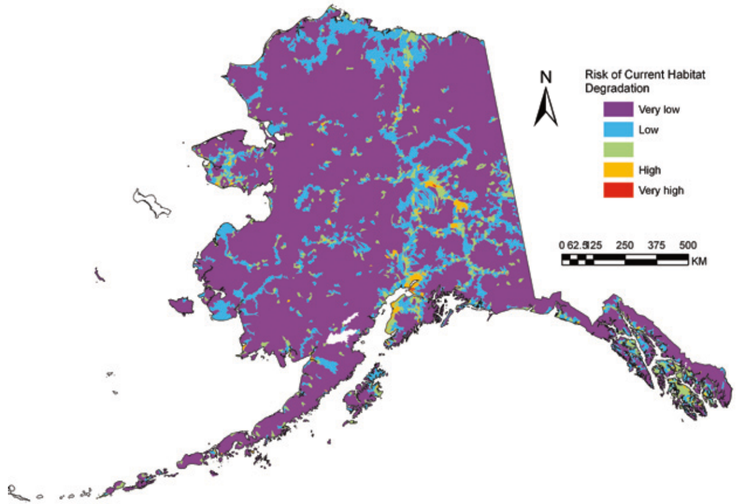
Indian Creek culvert replacement, California

Indian Creek is a tributary to the Mattole River in northern coastal California. This tributary was once important habitat for coho salmon and steelhead, but a culvert near the mouth of Indian Creek blocked passage to over 1.5 miles of important spawning and rearing habitat. In September 2010, the California Fish Passage Forum replaced the culvert barrier with a clear span bridge that allows unimpeded fish passage upstream and natural downstream movement of sediment and woody debris in Indian Creek. This project is one of many that will be prioritized by the California Fish Passage Forum in their strategic plan so that funding can be sought to continue opening up rivers to fish.

Alaska

Fish Habitat in Alaska

At 586,412 square miles in area, Alaska is the largest state in the United States and has a diverse array of fish habitats. Alaska has an estimated 46,882 miles of coastal shoreline, more than 3 million lakes, and countless rivers that drain into a variety of drainage basins. Salmon, pollock, halibut, king crab, and many other species support robust subsistence, recreational, and commercial fisheries. For Alaskans, fishing is an integral part of their heritage and culture, and an important means of supporting their families.

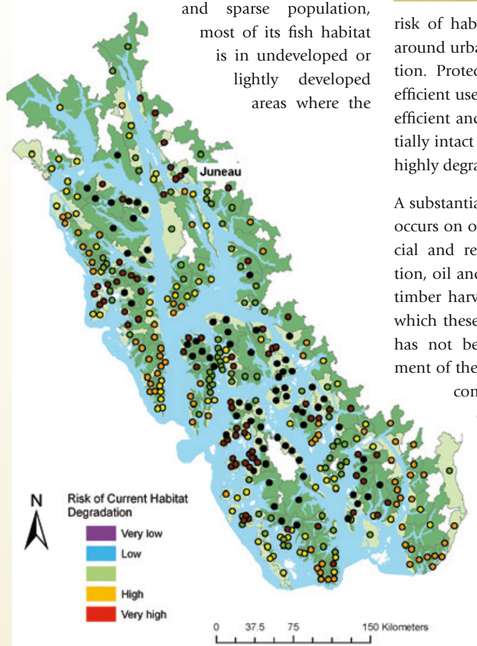


Did You Know?

- Alaska has 46,882 miles of coastline—half of the entire U.S. coastline.
- Alaska commercial fishery catch was worth more than $1.3 billion in 2009, 34 percent of all U.S. commercial catch. In 2007, Alaska had more than $1.4 billion in expenditures associated with marine and freshwater recreational fishing.
- Alaska produces 62 percent of the seafood harvested in the nation, and 80 percent of the world supply of wild sockeye, Chinook, and coho salmon.

The assessment of Alaska's inland fish habitats differs from the lower 48 assessment in that data limitations allowed only an estimation of the risk of habitat degradation based on the amount of urbanization, transportation infrastructure, and point source discharges (see the Methodology section for more details). Due to Alaska's large size and sparse population, most of its fish habitat is in undeveloped or lightly developed areas where the risk of habitat degradation is low. Fish habitat around urban centers has a higher risk of degradation. Protection of Alaska's intact habitats is a very efficient use of limited resources. It is much more efficient and effective to protect and restore essentially intact habitats than it is to attempt to restore highly degraded areas

Stan Allen



A substantial portion of Alaska's economic activity occurs on or around the water, including commercial and recreational fishing, marine transportation, oil and gas exploration, mineral mining, and timber harvesting and log storage. The extent to which these activities negatively affect fish habitat has not been thoroughly assessed. An assessment of the coastal waters of southeast Alaska was completed for this report, using a methodology different from either the coastal assessment of the lower 48 states or the assessment of Alaska's rivers. In the map of southeast Alaska, each dot on the map represents an estuary, with the color indicating which habitats are more and less degraded. The assessment results indicate that the highest risk of current habitat degradation occurs in areas with the highest concentration of roads (including forest roads) and high-intensity forest harvest. High amounts of sediment in the estuaries are also linked to areas with high risk of current habitat degradation. A high risk of degraded habitat also is associated with the few urban areas such as Juneau, the state capital.

Human Activities Affecting Fish Habitat

Urban land use/wetland loss

Forty-three percent of the surface area of Alaska is wetlands. On a state-wide basis, less than 2 percent of these wetlands have been developed. However, in many communities, wetlands may be the only land type available for development. In urbanized and developed areas of Alaska, such as Anchorage, it is estimated that over half of the wetlands have been lost to transportation corridor construction, utility installation, buildings, and other development projects. Wetland loss fragments habitat and disrupts the migration of fish that use wetlands as resting places on their lengthy journeys upstream. Wetlands are also critical rearing areas for some salmon species. Wetland loss is also linked to altered native riparian vegetation, degraded water quality, and water flow changes, all of which have reached levels that may impair wetland ecosystems in the long term.

Competing freshwater demands

Most of Alaska has an abundance of fresh water, but there are an increasing number of demands placed on this resource. New hydroelectric projects and the expansion of existing facilities increase barriers and other adverse effects on streams that provide spawning and rearing habitat for salmon. Oil exploration and development projects on the North Slope withdraw massive amounts of water for ice roads and ice pads. In addition to the direct impact of water withdrawals from these projects on streams, reductions in water flow may also affect nearshore and estuarine circulation, and in most cases the implications of these changes on near-shore fish habitat have not been assessed.

Resource extraction

Alaska's economy depends on extraction of natural resources such as fish, minerals, and timber. Gold and silver, oil and natural gas, and products such as gravel are extracted from stream and near-shore waters using a variety of methods that have both direct and indirect impacts to fish habitats. Timber extraction, and the effect of log transfer stations, although not analyzed in this assessment, also can directly and indirectly affect fish habitats.

Working for Change

Little Susitna River

Little Susitna River is one of the focal areas for the Matanuska-Susitna Basin Salmon Habitat Partnership. In 2008 and 2009, projects supported by the Mat-Su Partnership replaced 13 barrier culverts on the largest tributaries, opening many miles of new habitat in about half of the affected tributaries of the river. These projects and those undertaken by the other Fish Habitat Partnerships in Alaska (Kenai Peninsula Fish Habitat Partnership and Southwest Alaska Fish Habitat Partnership) and Candidate Fish Habitat Partnerships (Pacific Marine and Estuarine Fish Habitat Partnership, Salmon in the City [of Anchorage], and Salmon Stronghold Fish Habitat Partnership) will help ensure that Alaska remains a healthy habitat for fish.

Fish with Habitat Trouble

- Fish populations in Alaska are generally self-sustaining, healthy, and in the best condition of any in the United States. However, substantial changes have been noted in the abundance of some species of commercial and subsistence importance. These include Pacific herring in southeast Alaska and Prince William Sound; Chinook salmon in Norton Sound, the Yukon River, the Nushigak River, and Upper Cook Inlet; blue king crab in the Pribilof Islands; Opilio tanner crab in the Bering Sea; and red king crab in southeast Alaska and around Kodiak Island. The life history of each of these species includes a near-shore phase during which they are vulnerable to land-based pollution and other human effects on their habitat. Additional factors that have been implicated in these declines include large-scale changes in ocean circulation, climate change, and overfishing.

Hawaii

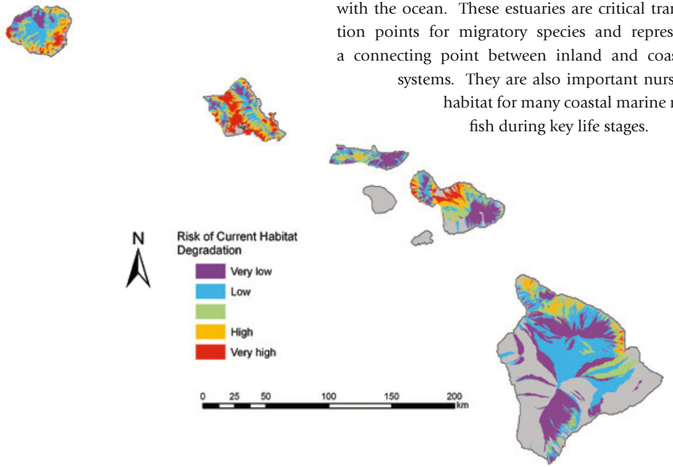
Did You Know?

- Marine and freshwater recreational fishing expenditures totaled more than $110 million in 2006 and commercial catch brought more than $71 million to Hawaii in 2009.
- The larger native fauna of Hawaiian streams include five species of fish, two species of mollusks (snails), and two species of crustaceans (prawn and shrimp). These species are migratory and must travel between freshwater and the ocean at two vulnerable life stages.

Fish Habitat in Hawaii

An ancient Hawaiian term, *ahupua`a*, refers to an entire watershed and its associated streams, estuary, and near-shore waters, as well as the sea out to and including the coral reef. An ahupua'a approach to aquatic conservation is appropriate in Hawaii because the life cycles of all the native freshwater fish, mollusks, and crustaceans include a period of time in the ocean, which is strongly affected by runoff and stream discharge from land.

The largest of the eight main Hawaii Islands—Hawaii, Maui, Molokai, Oahu, and Kauai—have well-defined watersheds and perennial streams. About 370 perennial streams occur on the five largest Hawaiian Islands. Forty large stream systems form stream-mouth estuaries at their confluence with the ocean. These estuaries are critical transition points for migratory species and represent a connecting point between inland and coastal systems. They are also important nursery habitat for many coastal marine reef fish during key life stages.



Barrier reefs and fringing reefs surround much of the main Hawaiian Islands coastlines, with coral atolls predominating in the geologically older northwestern Hawaiian Islands, from Nihoa Island to Kure Atoll. Often called "the rainforests of the sea," coral reefs support an abundant and diverse suite of aquatic species. Large schools of herbivorous fish such as parrotfish and tang feed on the algae living on the reef. Some species of tang and surgeonfish also feed on decaying plant material. Butterflyfish eat the live corals, and wrasse and goatfish feed on small invertebrates. Jacks and snappers are primarily carnivorous, feeding on shrimp, crabs, and other fish. Together, these various fish families form an intricate food web that is tightly woven into the survival of the reef.

Gordon Smith

Gordon Smith

The assessment of Hawaii's fish habitats differs from the lower 48 rivers assessment in that data limitations allowed only a preliminary estimation of the risk of habitat degradation (see the Methodology section for more details), and only for the watersheds that drain to rivers. Inland aquatic habitats in Hawaii have been altered extensively due to demands for drinking water and agricultural uses, urban development, and flood control. The results of the assessment suggest that the areas most at risk for habitat degradation coincide with areas of urbanization on the islands of Hawaii, Oahu, and Maui.

Human Activities Affecting Fish Habitats

Urbanization

Major population centers exist on all of the islands, particularly on Oahu which has a densely populated urban core. Urbanization results in physical loss of aquatic habitat as well as polluted runoff and altered hydrology. Sediment transported from urban areas, agricultural lands, and mountain slopes is the most damaging pollutant in Hawaiian waters because coral reef animals are particularly sensitive to the effects of smothering. Other common coastal pollutants are fecal bacteria and nutrient contamination, specifically nitrogen and phosphorous runoff. Fecal bacteria from sewage and septic systems may sicken swimmers, surfers, and other recreational water users. Nutrient contamination, often caused by fertilizer runoff, can have a detrimental impact on coastal water quality and damage coral reef ecosystems.

Fish with Habitat Trouble

- Freshwater gobies (called *o`opu* in Hawaiian), most of which climb vertical waterfalls, are of concern due to loss of habitat, as are shrimp of enclosed brackish water bodies known as anchialine pools.

Gordon Smith

Reduced flows

Human-caused modifications to surface and ground water systems throughout Hawaii have profoundly altered natural hydrologic regimes. Fifty-eight percent of perennial streams have reduced flows due to water diversions. The original inhabitants of the islands diverted streams to convert many acres of coastal and valley lowlands to taro production; however, the effect of this type of water use was probably minimal. In the modern era, complex irrigation systems have been built to support the cultivation of sugar cane, transferring large volumes of water out of natural watercourses and into networks of ditches, tunnels, flumes, reservoirs, and, ultimately, to fields. Many structures divert all stream water at low to moderate flows, leaving the downstream channel completely dry. In recent years, regulatory action by state agencies and voluntary efforts by some landowners and irrigation system operators have resulted in partial flow restoration in a few ecologically important stream systems.

Working for Change

Mahuahua `Ai o Hoi Project He'eia watershed, Oahu

In the lower He'eia watershed on Oahu, a long history of taro and rice cultivation resulted in loss of the native wetland vegetation. Agricultural production ceased in the early 1900s and since then a lack of land management has resulted in the current dominance of non-native species within the stream, wetland, and estuarine ecosystems, which has diminished the extent of suitable habitat for a diversity of native plants and animals. The Nature Conservancy Hawaii Marine Program and the Ko'olaupoko Hawai'ian Civic Club are working with the Hawaii Fish Habitat Partnership to restore the biological and cultural features of 420 acres of lowland riparian, stream, coastal wetland, and estuarine habitat in the He'eia watershed. The project will remediate aquatic habitat by restoring native vegetation in the wetland; restoring stream banks in the lower reaches of the stream and estuary; and improving water quality conditions in the wetland, stream, and estuary complex. Conservation initiatives that rely on partnerships and cooperation among several entities are well accepted in Hawaii. The *Mahuahua `Ai o Hoi* project is only one of many that are contributing to the protection and restoration of aquatic habitats in the Hawaiian Islands.

Marine Waters

A quantitative assessment of marine fish habitats of the United States was not completed for this report, but will be conducted for the 2015 update of this document. Marine habitats are well-studied in a few parts of the nation, but the condition of most marine habitats in U.S. waters has not been studied in detail. To facilitate understanding of marine areas throughout the world, the United Nations initiated a study of Large Marine Ecosystems (LMEs)—large areas of ocean, most of them adjacent to the continents—where the production of biological material like algae is generally higher than in open ocean areas. Five of the 11 LMEs in the United States are described below.

Northeast Large Marine Ecosystem

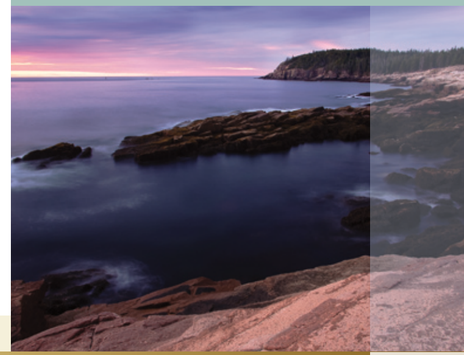
The Northeast LME extends from the Gulf of Maine to Cape Hatteras, encompassing 28 major estuaries and river systems. It is bounded on the seaward side by the Gulf Stream. The combination of circulation patterns in the northern part of the LME and nutrient enrichment from estuaries in the southern part results in relatively high levels of plankton that provide food for menhaden, herring, mackerel, sand lance, and butterfish, which in turn become prey for larger fish and other marine predators.

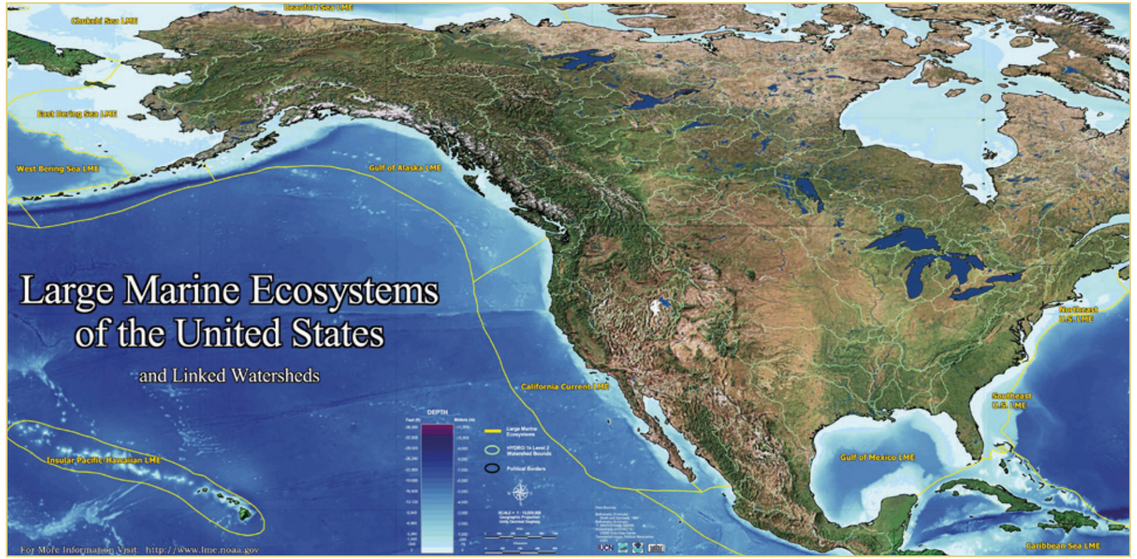
The Mid-Atlantic Bight, the southern portion of this LME, is a transition zone between the glacial till, rocky shores, and steep gradients of the New England states and the wide, gently sloping coastal plains of the southeastern United States. The coastal ocean is a shallow, nutrient-rich, productive environment. Numerous inlets allow larval, juvenile, and adult fish to move between estuarine and oceanic waters, contributing greatly to the biological productivity of the region.

The Northeast LME supports important commercial and recreational fisheries such as haddock, Atlantic

Did You Know?

- Commercial marine fisheries in 2008 brought in 8.3 billion pounds of fish and shellfish valued at $4.4 billion.
- American eels spawn in the open Atlantic Ocean, in an area known as the "Sargasso Sea" (named for all the sargassum seaweed that collects there).
- The Gulf of Mexico supports "cold seep" communities of tube worms, clams, and mussels that live off rare species of microorganisms that metabolize, seeping hydrogen sulfide, methane, and other hydrocarbons.





cod, summer flounder, winter flounder, and pollock. Shortnose sturgeon and Atlantic salmon are listed as endangered and populations of anadromous species are generally low except for the recent resurgence of striped bass after several years of fishing restrictions. American lobster and sea scallops are also important fisheries in this area.

The northeast coast is the most densely populated coastal region in the country. Major river systems contribute nitrates and phosphates to coastal waters from agriculture and sewage. For the LME as a whole, water clarity is good but the increasing extent of eutrophication (low oxygen levels caused by excess nutrients) is cause for concern. Eutrophic conditions are predicted to worsen overall based on expected increases in nutrients from wastewater, septic tanks, agriculture, and urban runoff as the coastal population continues to increase.

Southeast Large Marine Ecosystem

The Southeast LME extends from Cape Hatteras to the Straits of Florida, encompassing 18 estuaries and river systems and extending seaward to the edge of the continental shelf. A dominant feature of oceanic habitats in the Southeast LME is the Gulf Stream, a warm river meandering through the ocean along the eastern seaboard to Cape Hatteras, North Carolina, where it turns seaward on a trans-oceanic path toward England. Sometimes the Gulf Stream branches to form smaller loops of warm water known as "gyres," of which the Charleston Gyre is an example. Gyres are often associated with upwelling of nutrient-rich cold water and localized short-lived plankton blooms, but the upwelling in this LME s not as intense as it is farther north.

Coral reefs are a habitat of particular significance in the Southeast LME. The reefs in Florida include a diversity of stony corals, soft corals, sponges, polychaetes, mollusks, crustaceans, echinoderms, fish, turtles, and marine mammals. Species associated with coral reefs number in the hundreds or even thousands.

The estuaries at the landward edge of the Southeast LME provide nursery habitat that promotes the production of juvenile fish and shellfish important as commercial and recreational species or as prey for these species. Major species caught in commercial and recreation fishing include mackerel, swordfish, tuna, Atlantic menhaden, shrimp, crabs, sharks, and reef fish.

The Southeast LME has experienced a significant loss of wetlands and other shallow-water nursery habitat from human activities such as residential construction and industrialization. Wetland degradation has also occurred due to the diversion of

freshwater for agricultural, domestic, and industrial uses as well as channeling, dredging, damming, and ditching, and the draining of rivers and their floodplains. Coastal development has greatly contributed to the quantity of pollutants in near-shore marine waters as well as the deposition of sediments. Eutrophication of many southeastern estuaries is high and is expected to increase in future decades.

Gulf of Mexico Large Marine Ecosystem

The Gulf of Mexico LME is the largest semi-enclosed coastal sea of the western Atlantic. About 30 percent of this LME consists of an extensive and topographically diverse continental shelf. Around the lower peninsula of Florida the continental shelf is primarily carbonate and supports extensive coral reefs. In the western Gulf of Mexico southeast of Galveston, Texas, two salt domes support an area

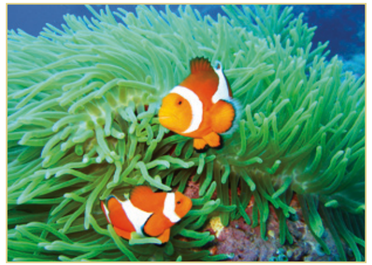
of brightly colored corals that have been designated as the Flower Garden Banks National Marine Sanctuary. In the northern Gulf the continental shelf is dominated by mud, but even here offshore petroleum platforms and wrecks create artificial reefs that, like naturally occurring ones, attract a diverse assemblage of fish and shellfish.

With 47 estuaries, this area is heavily influenced by freshwater input, particularly from the Mississippi River which accounts for about two-thirds of the freshwater flow in to the Gulf of Mexico. Water circulation in the Gulf of Mexico is driven by the Loop Current, a warm water current that enters the Gulf through the Yucatan Straits. Circulating clockwise in the eastern Gulf, it exits through the Florida Straits to become the Gulf Stream. A ring of current called the "Loop Current Eddy" often separates from the Loop Current, drifting into the western Gulf of Mexico where it also circulates water in a clockwise direction. These two currents create many areas of upwelling and turbulence that serve as prime spawning habitat for over 100 families of fish.

The Gulf of Mexico LME is considered a moderately productive ecosystem, supporting diverse commercial, recreational, and subsistence fisheries. Economically important species include shrimp, Gulf menhaden, mackerel, grouper, snapper, sea trout, and tuna. Commercial catches also include large amounts of herring, sardines, and anchovies.

The Gulf of Mexico LME is under considerable stress from shoreline development, oil and gas extraction, pollutant discharges, and excess nutrients. Wetlands, which are extremely important nurseries for shrimp and other species, are undergoing severe and continuing losses due to local human activities coupled with global changes such as sea-level rise. Coastal Louisiana loses about 16,000 acres of wetlands a year, and the entire U.S. Gulf Coast lost about 60,000 acres of wetlands a year between 1998 and 2004.

Estuaries in the northern Gulf of Mexico are characterized by excess nutrients and low oxygen levels. The most well known area of low oxygen is the so-called "Dead Zone," an area the size of New Jersey where excess nutrients from the Mississippi



River feed algae blooms that deplete the water of oxygen. Fish and other mobile organisms will avoid these areas, but bottom-dwelling species such as clams and slow-moving crabs are killed by the lack of oxygen. Excess nutrients are also associated with "Harmful Algal Blooms," which can contaminate fish and shellfish and endanger human health.

California Current Large Marine Ecosystem

The California Current LME extends along the western coast of the United States from southern California to northern Washington. It contains more than 400 estuaries, bays, and river mouths including the Columbia River, San Francisco Bay, and Puget Sound. The continental shelf is narrow, extending between 5 and 25 miles from the coast. Rocky areas in depths less than 130 feet often are covered by extensive kelp beds and other marine algae, sponges, sea stars, brittle stars, and other invertebrates. Seaward of the continental shelf and slope are complex deepwater habitats including seamounts, volcanic ridges, and hot springs, which support diverse and often unique fauna.

Circulation is dominated by the southward-flowing California Current and the seasonal northward-flowing Davidson Current, which brings warmer water close to the coast in the winter. At the boundaries between these two major currents and other smaller currents, seasonal upwelling of colder nutrient-rich waters creates areas of localized high productivity. The overall productivity of this LME is considered low and varies over a 20- to 30-year cycle as the Pacific Ocean shifts between a warm regime and a cooler regime, which strongly influences growth and survival of Pacific salmon.

The California Current LME supports numerous small fish species such as sardines, mackerel, and anchovies as well as larger species including Pacific hake, rockfish, sole, lingcod, and five species of salmon. Near-shore areas support recreational

and commercial fisheries for these species as well as crabs, shrimp, abalone, clams, scallops, and oysters.

Many Pacific Coast habitats have been dramatically altered from their original pristine state. Major habitat trends include reductions in freshwater flows and access due to dams, estuarine habitat loss, damage to seafloor habitats during fishing, and increased loading of organic nitrogen compounds into coastal waters from urban and agricultural runoff.

The California Current LME is home to a large number of anadromous fish species that spawn in rivers and streams, so the loss and degradation of freshwater habitat in the watersheds adjacent to the California Current LME affects the productivity of this LME. In the Columbia River basin more than half of the streams historically used by salmon are no longer accessible due to construction of large dams. In the past 10 years, efforts have been made to restore access to some of these areas, but many, such as those above Grand Coulee Dam, will remain inaccessible to Pacific salmon. Estuarine habitat in the California Current LME also has been dramatically affected by human activities. More than 70 percent of the estuarine habitat both in the Pacific Northwest and in California has been lost or degraded due to diking, filling, polluting, and other human activities. As much as 90 percent of the coastal wetlands, including bays, estuaries, and salt marshes, have been degraded in southern California alone. Other effects on fish habitat in the California Current LME include bottom-trawling

fishing gear and changes to ocean circulation and temperature, which are poorly understood right now.

Gulf of Alaska Large Marine Ecosystem

The Gulf of Alaska LME extends along the coast of southern Alaska and western Canada. It is separated from the California Current LME by the cold waters of the eastward-flowing Subarctic Current, which divides to form the northward-flowing Alaska Current and the southward-flowing California Current. The Alaska Peninsula separates the Gulf of Alaska LME from the East Bering Sea LME.

The Gulf of Alaska LME is considered to be a moderately productive ecosystem whose cold nutrient-rich waters support a diverse assemblage of marine life. Species of economic importance include crab, shrimp, salmon, scallops, walleye pollock, Pacific cod, rockfish, and halibut. In addition to commercial fishing, the area supports a large amount of recreational and subsistence fishing.

Five species of salmon (Chinook, coho, sockeye, pink, and chum) are present in the Gulf of Alaska LME. These anadromous fish spend a portion of their lives in rivers, streams, and estuaries, so the health and productivity of this LME is closely tied to human alteration of the landscape. Although barriers to fish migration (dams, culverts, etc.) are not as widespread in the Gulf of Alaska watershed as they are in other parts of the nation, there are localized effects near urban centers, transportation corridors, and logging operations.

Other ecological problems affecting this LME include invasive species (mitten crab, Atlantic salmon), industrial and agricultural pollutants, and discharges of oil products. The largest tanker spill in U.S. history occurred where the Exxon Valdez went aground off the Port of Valdez, spilling 11 million gallons of crude oil into Prince William Sound. More common than large spills, however, are smaller discharges of refined oil, crude oil, and hazardous substances.

Pacific-Hawaiian Large Marine Ecosystem

The Pacific-Hawaiian LME (technically called the Insular Pacific-Hawaiian LME) extends 930 miles northwest from the main Hawaiian Islands, encompassing countless islands, atolls, islets, reefs, and banks. Lacking a continental shelf, it does contain four major estuaries, all within the Hawaiian Islands. It is considered a low-productivity ecosystem due to the limited nutrients in its oceanic waters, but is also a very stable oceanic environment that, unlike most other parts of the world's oceans, has not experienced significant warming over the past 50 years. This LME contains a high diversity of marine species, of which 25 to 30 percent are found only in this area. It is a major habitat for the North Pacific humpback whale.

The most characteristic habitat of the Pacific-Hawaiian LME is coral. Coral reef ecosystems are among the most diverse and biologically complex ecosystems on Earth, harboring a richness of corals, reef invertebrates, and fish, and a variety of other flora and fauna. Coral reefs and their associated habitats play an important cultural role in the U.S. Pacific islands, where community-based conservation, subsistence fisheries, and protected areas have been successfully managed for generations.

The Pacific-Hawaiian LME supports commercial, recreational, and subsistence fisheries on a smaller scale than in the rest of the United States. Species of economic importance include tuna, lobsters, shrimp, squid, octopus, and armorhead, a fish caught only around seamounts.

Trends in fish habitat condition in the Pacific-Hawaiian LME have not been well-studied. Localized degradation of estuarine habitat can be seen around developed areas, and most of the shoreline of the Hawaiian Islands has been altered. Introduced algal species are becoming a serious concern, particularly in the Hawaiian Islands. Intensive fishing in and around seamounts may have negative effects on these habitats, but little is known about this issue. Marine debris is a serious issue but it is also almost invisible because the concentrations of floating trash or garbage-choked beaches are so remote they are rarely visited by humans. Finally, global climate change is a primary concern for corals. Two mass coral bleaching events have occurred since 2002 and the documentation of 10 coral diseases throughout the Pacific-Hawaiian LME indicates that the health condition of reefs needs to be monitored closely.

Summary

Marine habitats of the U.S. encompass more than 4 million square miles, the largest Exclusive Economic Zone in the world. They range from the ice-filled waters of the Arctic Ocean to the tropical coral reefs of the Caribbean and Hawaiian Islands, providing an array of fish and shellfish as diverse as the ecosystems. Most of the productivity of these marine areas is concentrated near the coasts, which provide habitat for species that migrate to freshwater, in areas of nutrient-rich upwelling, and in shallow waters where bottom-dwelling plants and animals create complex ecosystems.

Marine habitats near the coast are most likely to be adversely affected by human activity. Many of the nation's most productive marine habitats are still intact, but many more have become degraded, some to an alarming extent, and can no longer support the fisheries they once did. Major threats to marine habitat include pollution; damage to bottom habitat from dredging, fishing gear, or other activities; alteration of migration pathways; invasive species; marine debris; and climate change. Many of these threats can be reduced or avoided through sustained proactive efforts locally, but in other cases the problems are global and can only be addressed through global efforts. If ongoing threats to marine fish habitat are not addressed, the productivity of U.S. marine habitats is at risk.

Challenges and Opportunities

There are many threats to the health of fish habitat in freshwater, estuarine, and marine waters throughout the United States. Fortunately, many public and private efforts are underway to counteract these threats, although these efforts are limited by funding, expertise, and public understanding. The National Fish Habitat Action Plan helps to focus and leverage available funds, pool technical expertise, and enlist new partners to address the challenges to fish habitat.

Urbanization

More than half of all Americans live in the 39 largest metropolitan areas (those with populations of 1 million or more). Urbanization results in the loss of floodplain and natural stream habitat critical to the health of freshwater systems. Urbanization of the landscape increases impervious surfaces and decreases the infiltration of rain and snowmelt into the soil, where nutrients and pollution can be filtered out. Urban runoff contains oils, fertilizers, and detergents, which negatively affect fish habitat when washed into adjacent aquatic habitats. Increased nutrients can lead to algae blooms and low dissolved oxygen, making it difficult for fish to survive. Development in floodplains, along lakeshores, and along coasts degrades wetlands that are important as fish habitat and as a filter for stormwater runoff. Development in floodplains and along coasts removes habitats that protect these areas from flooding from storms, storm surges, and erosion from river flows and wave action. Development in floodplains and high-hazard coastal areas is accompanied by the development of levees and seawalls—structures meant to protect these developments that can also exacerbate flooding and interrupt key natural processes.

We cannot erase the effects of urban and suburban areas from the landscape, but many efforts are now underway to minimize negative effects. Cities are implementing programs that encourage residents to keep pollutants out of storm drains, to not over-use fertilizer, and to plant native vegetation along streams. Urban planners are recognizing the value of the rivers that flow through their cities and are working to restore habitat and fisheries for the benefit of urban residents.

Agriculture

Agriculture is a major factor in the degradation of fish habitat throughout the country. Depending on the type of agricultural practice, negative effects on fish habitat can include excess nutrients in rivers and estuaries, increased sedimentation, decreased water flows when water is diverted for irrigation, physical alteration of streams including channelization and

impoundment, warmer stream temperature, loss of woody in-stream habitat, and loss of wetland and off-channel habitats. In addition, agriculture can convert valuable floodplain areas from natural forests and grasslands to farmed fields, decreasing the amount of habitats critical to maintaining water quality and providing important habitat areas for fish and other aquatic organizations. Levees to protect farm fields further disconnect floodplains from their rivers, depriving freshwater fish and other species of access to these valuable habitats and disrupting key natural processes on which they depend.

Over the past few decades major efforts to reduce the loss of fish habitat to agriculture have resulted in some gains, but much remains to be done. The 2008 Farm Bill supports numerous programs to help farmers and ranchers conserve soil, water, and wildlife. Voluntary efforts such as the Fishers and Farmers Fish Habitat Partnership will be essential in finding common ground for sustaining agriculture and fish together at a watershed scale. Establishing goals, objectives, and strategies that not only target the well-being of fish but the well-being and prosperity of farmers is key to keeping soil and nutrients on the land, rather than losing them to nearby streams and lakes.

Pollution

Pollution from many sources affects fish habitats across the country. Some of this pollution is a legacy of past industrial practices. Heavy metals and other

toxins in sediment and the water column threaten fish in coastal and river systems. Some polluted sediment can be removed through dredging, but re-suspension of the pollutants that may occur through dredging can create a worse problem than leaving the sediments where they are. Pollutants from wastewater treatment plants include bacterial contamination as well as a wide range of pharmaceutical chemicals whose effects on aquatic organisms are just now being studied.

The Federal Clean Water Act and numerous state laws have resulted in major strides toward cleaning up the nation's waters. Created wetland systems are being used to remove pollutants from runoff and treatment facilities before they enter natural systems. Where funds are available, cities are converting old stormwater systems to systems that pollute less.

Dams and Other Barriers

Dams built for industrial use, flood control, irrigation, and energy production are located on rivers and streams throughout the country. Dams have created thousands of reservoirs that provide recreational opportunities such as fishing, boating, and swimming. These structures also create barriers to fish migration and interrupt the flow of sediment and nutrients downstream, altering fish habitat for long distances below the dams. Many old dams are obsolete, and no longer serve their original purposes. Other barriers to stream flow and fish migration include road crossings where culverts or bridges are not designed to accommodate the natural flow of the river, and tidal gates in coastal areas that have similar effects.

Many technologies have been and continue to be developed to help fish pass over barriers unharmed. Removal of dams is the best solution in cases where the cost (both economic and ecological) of

maintaining the dam outweighs its benefits Local citizens and non-governmental organizations have been instrumental in getting funding to replace culverts and bridges that impede stream flow and fish movement. Given the large number of these barriers across the country, much more must be done to address this source of habitat degradation.

Invasive Species

Fish habitats throughout the United Statesare affected by the introduction of non-native species. Some of these introductions, such as salmon in the Great Lakes, were purposeful, served a specific goal (in this case controlling alewife) and have resulted in additional benefits (the salmon sportfishing industry in the Great Lakes). Invasive non-native species, such as Asian carp, were imported into ponds and escaped into natural systems, and still others, such as the zebra mussel, were introduced unintentionally through ballast water or other pathways.

Aquatic invasive species have negative impacts on ecosystems, economies, and, in some cases, human health. Control of Zebra mussels, one of the best-known invasive aquatic species, cost municipalities and industries tens of millions of dollars. Mitten crabs are a well-known species on the West Coast, threatening dikes and levees with their burrows and competing with native crayfish.

Prevention and control are necessary to prevent invasive species from causing additional damage to aquatic ecosystems. Public outreach and education are substantial parts of the solution, because many invasive species are spread through contaminated boats and waders. Effective regulations on the release of ballast water are also needed.

Climate Change

A changing climate affects water resources and fish habitats in many ways. Many scientific studies conclude that the current and future effects of ongoing climate change include rising sea level; warmer temperatures in streams, lakes, and reservoirs; changing patterns and amounts of rainfall and snowfall; and increasing acidity in the ocean.

Sea-level rise will erode coastal habitats and push saltwater into coastal freshwater resources. Thousands of acres of coastal freshwater marsh, salt marsh, and sea grass beds that are home to egg, larval, and juvenile stages of commercial and game fish will be affected. Higher water temperatures in streams, lakes, and reservoirs may lead to the loss of cold-water fish communities and the northward expansion of warm-water fish communities.

Models of climate change reviewed by the U.S. Geological Survey predict that most western states will experience less rainfall and more frequent drought conditions. Competition for water, already extremely contentious, will increase as supplies diminish. Reduced snowpack in the west and northeast United States will change the flow patterns and amount of water in streams and may have substantial impacts on reservoirs.

The challenges posed by climate change are great, but much can be done to build resilience to the effects of global warming. Protecting high-quality habitats and healthy fish populations will help fish adapt to changing habitat conditions imposed by a changing climate.

Methodology

The goal of the inland assessment was to estimate disturbance levels to fish habitats in river reaches from information about human activities occurring in the catchments (drainage basins) that affect each river reach. This approach is supported by a large body of scientific research, which shows causal linkages between human disturbances to the land, river channels upstream and downstream of a reach, and stressors to fish habitats. To meet their goal, the inland assessment team (composed of scientists from Michigan State University) pursued two objectives with their analysis: (1) to create a numeric *cumulative disturbance* score where all river reaches are assigned a score according to the level of disturbance in the upstream landscape; and (2) to identify the primary causes of habitat degradation. Because different human activities in catchments have different potentials to affect habitats, the assessment team used multivariate statistics to assess the influence strength of human disturbance variables on habitats.

Methods for Rivers Assessment—Lower 48 States

The first step in the process to create a disturbance score for rivers in the lower 48 states was to assemble mapped data of the locations of human activities, including, urban, agricultural, and pasture land cover, industrial activity, pollution discharge points, dams, atmospheric deposition of pollutants, and nutrient applications in domestic and agricultural settings. Once these data were mapped they were summarized in the catchment areas affecting each river reach in the lower 48 states. Next, indicators of habitat condition were identified from fish data collected at more than 20,000 sites across the country. The indicators represented characteristics of fish that are linked to habitat condition. These included measures of species diversity, the percent of species dependent on healthy habitat conditions (e.g., clean substrates), and the proportion of species at a site that are sensitive to pollution.

Next, a statistical analysis was undertaken to identify the relative influence of each of the mapped human disturbance variables on the fish indicators of habitat condition. The results of this analysis were used to calculate the numeric cumulative disturbance scores for each river reach by adjusting the levels of each disturbance variable by its influence strength and summing to estimate cumulative disturbance. The final step in the assessment was to map the scores. The assessment did not

include some key information due to the lack of a nationally consistent data set for historical degradation due to past logging or mining practices; detailed water flow information for each stream; and the locations of the millions of culverts, diversions, and small dams that fragment streams and obstruct fish passage. For this reason, the scores are characterized as representing the risk of current habitat degradation from the factors assessed, as opposed to a comprehensive measurement of habitat condition.

Methods for Rivers Assessment—Alaska and Hawaii

Data were even more limited in Alaska and Hawaii, which led to a different assessment approach for these areas. The Alaska and Hawaii approach relied on mapped data about human activities in catchments but had to proceed without fish data to use as indicators of habitat condition. Instead, the mapped disturbance variables were put into stressor categories (e.g., land cover, point source pollution, infrastructure, barriers to fish movement, and industrial activity), and combined into a single gradient of landscape disturbance intensity for each category. A multivariate statistical approach (Principal Component Analysis) that distills the information from many variables down to one variable was used to identify these gradients in each category. This resulted in indices of landscape disturbance intensity for different classes of human activity, which were mapped individually and combined into a single score.

Methods for Estuary Assessment—Lower 48 States

For the assessment of estuaries in the lower 48 states, national datasets of disturbance variables measured within estuaries and their surrounding watersheds were assembled and mapped using NOAA's Coastal Assessment Framework, a spatially explicit framework that incorporates estuarine water bodies, state and federal marine waters not associated with estuaries, and their surrounding watersheds. Disturbance variables were screened for data quality and spatial coverage and were combined into four disturbance categories (river discharge, pollution, eutrophication threat, and land cover). Multiple component datasets often contributed to each category. "River discharge" included trends of river flow magnitude and pulse duration and density of dams. "Pollution" summarized the density of point source pollution sites including National Pollution Discharge Elimination Sites, Toxic Release Inventory sites, National Superfund sites, and mines. "Eutrophication threat" summarized measurements of chlorophyll a concentrations, occurrence of algal blooms, and dissolved oxygen and nutrient levels. "Land cover" summarized percent coverage and trends of urban, agricultural, and wetland land cover.

Component datasets were combined either by direct summation if the datasets were similar or statistical approaches to create one index for each of the four disturbance categories in each estuary. These four disturbance indices were rescaled from 0 to 100 by calculating the percent rank (a score of 0 was assigned for estuaries with the highest degree of disturbance and 1 for the lowest disturbance). The combined score for each estuary was calculated by taking the geometric mean of the four disturbance indices (a disturbance score of zero was reassigned a value of one half the next lowest score so it could be included in the geometric mean calculation), which was then rescaled from 0 to 100 by calculating the percent rank. Due to data limitations, not all estuaries had an index for all four disturbance categories, so a combined score was assigned only when the estuary had at least three of the four disturbance indices. For the report maps, the final scores were divided into equal quintiles: 0-20 (very high risk of degradation), 20-40 (high risk of degradation), 40-60, 60-80 (low risk of degradation), 80-100 (very low risk of degradation).

Methods for Estuary Assessment—Southeast Alaska

The approach for assessing estuarine areas in southeast Alaska differed from the estuarine assessment for the rest of the country in a number of ways. The NOAA Coastal Assessment Framework was not available for Alaska, so an independent spatial framework had to be developed using 12-digit HUCs, elevation, and bathymetry to define estuarine and coastal drainage areas. Because of data limitations, the Alaska analysis used three categories instead of the four used in the rest of the United States. One of these was a land cover/land use category comprising eight variables: four urbanization variables (open, low, moderate, and high), two agricultural variables associated with timber production (moderate and high), and two land protection variables (protected and wilderness area). The second category combined five water quality variables with sediment toxicity. The final category was scores of river flow alteration. Only the land cover/land use dataset had sufficient spatial coverage for statistical analysis using Principal Components Analysis. The other two datasets were converted to percentile ranking. The indices from the land cover/land use analysis were converted to a percentile rank for each coastal unit. As with the national coastal assessment, combined scores for each unit were only assigned when a unit had scores for two or more sub-indices. Combined scores were calculated as the mean of the indices.

Suggestions for Further Reading

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