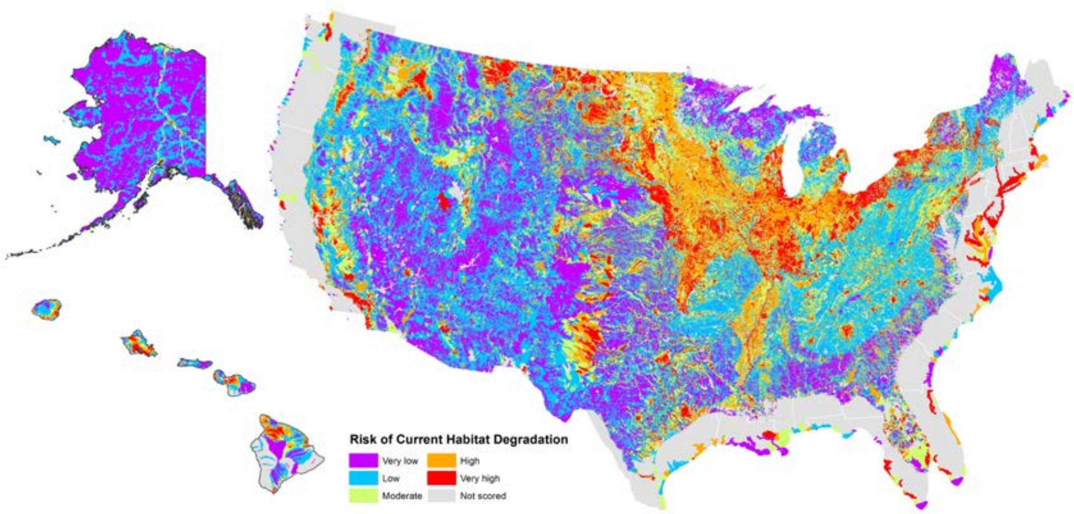
Executive Summary

from

Through a Fish's Eye:

The Status of Fish Habitats in the United States

2015



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The United States is home to more than 3,000 fish species and over 322 million people, and they all depend on the same water. Healthy aquatic resources are vital to the integrity of the United States and essential for sustainable fish populations. Unfortunately, in many places around the United States, fish and the habitats on which they depend are degraded or in decline. Almost 40 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 a continuing unprecedented nationwide assessment of human effects on fish habitat in the rivers and estuaries of the United States and provides a basis for comparing fish habitat condition on a national scale. It should be considered as one diagnostic tool of many, such as fine scale Fish Habitat Partnership assessments of particular waters or river reaches, which should be examined when considering aquatic habitat condition and conservation strategy planning. This national assessment assigns watersheds and estuaries a risk of current habitat degradation score 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 or all aquatic resources could be assessed due to resource and data constraints. In particular, key information on water flows (hydrology), grazing intensity, forest management practices, bottom form (geomorphology), and detailed data on habitat-forming processes on individual reaches and waters is not available on a consistent national basis at this time. These gaps should be kept in mind when examining the results of this assessment. We anticipate generating such assessments every 5 years, and future revisions to the assessment will work towards incorporating the missing data to the extent it is available.

Within the United States, aquatic habitats with both high and low risk of degradation occur in landscapes with specific characteristics. Aquatic habitats tend to have a very high risk of degradation in landscapes with urban areas, high intensity agriculture, and heavy industrial use. In landscapes with sparse populations, including Alaska, national parks, and other protected areas, aquatic habitats tend to have a low risk of degradation. While our national map shows landscapes with such patterns of low and high risk of degradation, many locations throughout the United States may be threatened and would benefit from protection to prevent degradation or rehabilitation if they are degraded at this time.

East of the Mississippi River, streams and rivers with the lowest risk of habitat degradation occur principally in northern Maine and the northern Great Lakes area, as well as in sparsely populated parts of the Southeast. Rivers and streams with the highest risk of habitat degradation occur in and around the heavily populated corridor from New York City to Washington D.C., including Long Island Sound, Delaware Bay and the Potomac River. Rivers and streams with a very high or high risk of habitat degradation due to excess nutrients and sedimentation from agriculture occur in the broad zone of New York, Pennsylvania, Ohio, Illinois, and Indiana, along the Mississippi River, and scattered throughout the Southeastern States. Mining practices in Maine, New Hampshire, Vermont, Pennsylvania, New York, and West Virginia threaten aquatic resources through release of metals and mining by-products into local streams and rivers. The estuaries of the Mid-Atlantic States region are at greater risk than any other region. Urban land use is a major factor in fish habitat degradation in this area, as is pollution, particularly excess nutrients.

Rivers and streams with a low risk of current habitat degradation in the central portion of the country occur principally in northeast Minnesota and the mountain and grassland regions of Texas, Oklahoma, Kansas, and Nebraska. The northern regions of this section of the country are at higher risk than almost any other regions in this assessment. Row crop and cattle farms are responsible for large areas with a very high risk of habitat degradation in northwestern Texas and eastern regions of Oklahoma, Kansas, and Nebraska. Row crop farms contribute to areas with a high and very high risk of habitat degradation in the Dakotas, Minnesota, Iowa, Missouri, and eastern Arkansas. About 36 percent of Texas estuaries assessed have a very high or high risk of current habitat degradation due to polluted runoff from urban areas and low river flows.

There are large areas with a low risk of current habitat degradation in the mountains, deserts, high plains, and coastal areas of western United States. These results should be viewed with some caution as some key drivers of habitat condition, such as water flow (hydrology), forestry practices, and grazing intensity, could not be fully examined in this assessment. *As a result, this assessment likely underestimates the risk of habitat degradation, particularly in the arid West.*This portion of the country is interspersed with areas of high degradation risk due to urban land use (California, Phoenix, Las Vegas, Salt Lake City, the Denver, Portland, and Seattle areas, Anchorage, and the island of Oahu), intensive row crop agriculture and ranching (northern Montana, western Utah, Idaho, California’s Central Valley, southeast Washington, and the northwestern portion of the island of Hawaii), and alterations to water flow on the area’s rivers such as the San Joaquin, Sacramento, Columbia, Snake, and Colorado Rivers. 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 as a result of low human population density and land ownership that leads to habitat protection, but urbanization, forestry, and road crossings are responsible for localized areas in developing areas with an elevated risk of habitat degradation.

This report provides an important picture of the challenges and opportunities facing fish and those engaged in fish habitat conservation efforts. Urban land use, agriculture, dams, culverts, pollution, and other human development have resulted in specific areas of degraded habitat where rehabilitation 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 documents areas where fish habitat is most likely still unaffected by human development and likely intact with the largest amount in Alaska. It is critical that these areas be protected to maintain their value for aquatic organisms and for the recreation of the people that use those waterways. Moreover, it is far more cost effective to protect a pristine area, at minimum a 10:1 return on dollars invested, rather than allow it to become degraded and then have to fund expensive rehabilitation efforts.

Furthermore, our efforts to measure habitat condition and to use this information to conserve fish habitats are limited by the available information. It is critical to have data collected in a consistent, comparable manner across the United States to allow a national assessment to be properly developed and to be fully used in conservation planning. There are a number of geographic areas and key habitat types that could not be evaluated by this assessment due to the lack of available national resources and information including the nation’s lakes, reservoirs, Great Lakes, Alaskan estuaries, and inshore and offshore marine areas. There is a critical need for the collection, standardization, and analysis of data to assess fish habitat in these areas. New sources of information and data are also essential to allow the detailed analysis of water flow patterns (hydrology), grazing intensity, forestry practices, small dams and culverts, sedimentation, riparian management, channel and bottom morphology, water quality (in particular temperature and dissolved oxygen), and the effects of organisms on their environment on fish habitat. This information is crucial to communicating threats to these fish habitats, prioritizing fish habitat conservation efforts, and determining the best strategies to maximize limited resources.

Resources for fish habitat conservation are limited. This report illustrates the need for and the value of the 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. Examples of how collaborative fish habitat action can bring change are included in each regional section.

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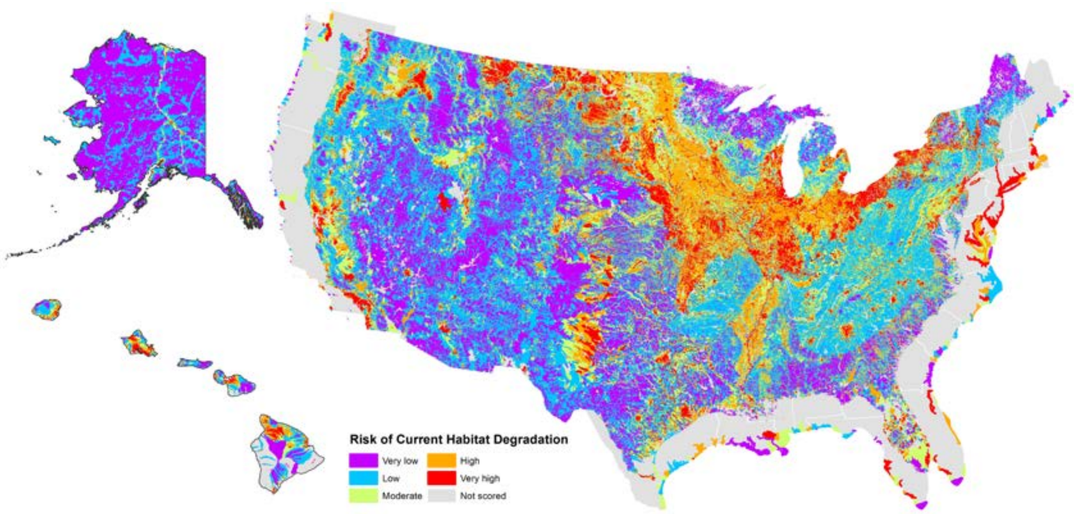

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Introduction

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Introduction

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 aquatic habitats 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. Jelks et al (2008) listed 700 inland fish taxa considered imperiled in North America, including both freshwater and diadromous species. Further, they reported that there was a substantial increase in imperiled inland fishes since 1989. They found that 39 percent of the nation's fish taxa are imperiled and 89 percent of taxa previously listed as imperiled in 1989 were considered to be in the same or worse condition. Habitat loss was one of the main threats to most of those species and is cited as 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 loss. Congress declared in 1997 that one of the greatest long-term threats to the viability of commercial and recreational fisheries is the continued loss of marine, estuarine, and other aquatic habitats.

This is a particular concern to over 46 million recreational anglers who pursue fish and the many others who depend upon fish and shellfish for sustenance and commerce. Marine recreational and commercial fisheries generated more than $199 billion in sales in 2012, while just expenditures by freshwater recreational anglers alone was estimated to be over $33 billion in 2011. Deteriorating waterways not only affect fish communities and anglers but also the millions of aquatic recreational users, such as boaters, tubers, bird enthusiasts, campers, and family picnics, as well as citizens that live on waterways. Declining aquatic environments affect the whole nation.

These threats led to the 2006 development of the National Fish Habitat Partnership, a coalition of anglers, conversation groups, scientists, state and federal agencies, and industry leaders focused on improving America's fish habitat that will result in better fish populations. This group's Action Plan is a strategy for making the most effective use of conservation dollars to protect, restore, and enhance key fish habitats.

The objects of the first Action Plan in 2006 were to:

1. Conduct a condition analysis of all fish habitat within the United States by 2010.
2. Prepare a "Status of Fish Habitats in the United States" report in 2010 and every five years thereafter.
3. Identify priority fish habitats and establish Fish Habitat Partnerships targeting these habitats by 2010.
4. Establish 12 or more Fish Habitat Partnerships throughout the United States by 2010.
5. Protect all intact healthy fish habitats by 2015.

6. Improve the condition of 90% of priority habitats and species targeted by Fish Habitat Partnerships by 2020.

Assessments developed since 2006 have been used to produce the first National Fish Habitat Assessment in 2010 as well as this updated report, and met the first two objectives of the original Action Plan. The second two objectives were met through the establishment of 19 Fish Habitat Partnerships (Figure X) throughout all 50 states. Fish Habitat Partnerships are voluntary groups of diverse public and private partners organized around particular parts of the country, unique species or groups of species, or specific habitats that have a common interest to conserve, rehabilitate and improve fish habitat. Extraordinary restoration efforts, from mountain streams to estuaries and bays throughout the nation, have been implemented by these Partnerships. Examples of their work are highlighted throughout this report.

The Action Plan was updated in 2012 with following objectives:

1. Achieve measurable habitat conservation results through strategic actions of Fish Habitat Partnerships that improve ecological condition, restore natural processes, or prevent the decline of intact and healthy systems leading to better fish habitat conditions and increased fishing opportunities.
2. Establish a consensus set of national conservation strategies as a framework to guide future actions and investment by the Fish Habitat Partnerships by 2013.
3. Broaden the community support for fish habitat conservation by increasing fishing opportunities, fostering the participation of local communities - especially young people – in conservation activities, and raising public awareness of the role healthy fish habitats play in the quality of life and economic well-being of local communities.
4. Fill gaps in the National Fish Habitat Assessment and its associated database to empower strategic conservation action supported by broadly available scientific information, and integrate socio-economic data in the analysis to improve people’s lives in a manner consistent with fish habitat conservation goals.
5. Communicate the conservation outcomes produced collectively by Fish Habitat Partnerships as well as new opportunities and voluntary approaches for conserving fish habitat to the public and conservation partners.

Aquatic resources will continue to come under threat of deterioration, however, application of the Action Plan objectives through the efforts of the Board and the Fish Habitat Partnerships will provide measurable and sustained improvements in the condition of priority fish habitat in the United States.

Rainbow trout *(Oncorhynchusmykiss)*

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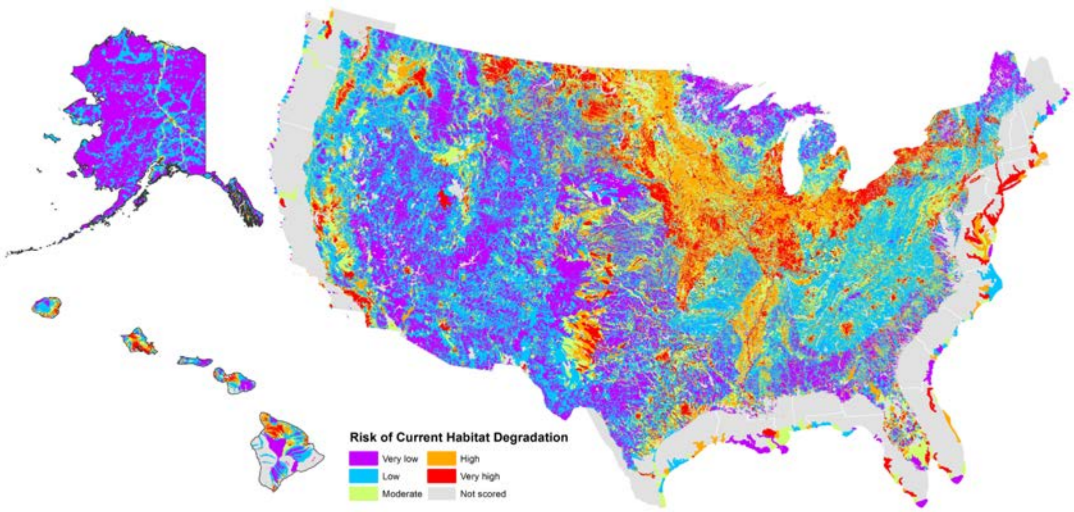

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NATIONAL FISH HABITAT PARTNERSHIP

How To Read and Understand This Report

This report updates and revises the 2010 " Status of Fish Habitats in the United States" that summarized initial results of a comprehensive national assessment of aquatic habitats at an unprecedented scale and level of detail. This 2015 report provides even greater detail and improves our knowledge of the condition of fish habitat in the United States. The 2010 inland streams assessment characterized fish habitat condition using stream fish data from more than 26,000 stream reaches, while the 2015 assessment was based on fish data from more than 39,000 stream reaches nationally. To increase accuracy, the 2015 inland stream assessment incorporated 12 additional human disturbance variables into the fish analysis when compared to the 2010 assessment. Associations between all human disturbance variables summarized in both catchments as well as stream buffers were tested against stream fish metrics to develop assessment scores. Additional variables incorporated into the 2015 assessment and their summary within catchments and buffers allowed for more explicit characterization of the diverse set of disturbances to stream fish habitats occurring across the Nation than what occurred in 2010, and this was made possible due in part to advances in available GIS layers. With incorporation of these additional disturbances, managers and decision makers can use assessment results to more explicitly identify limits to stream fish habitats. Even with the additional disturbances incorporated into 2015 assessment, results may overestimate fish habitat condition, as localized and regionally-specific disturbances are still not available in some cases.

The estuarine assessment evaluated a total of 220 estuaries, with sufficient data available to produce risk scores for 196 estuaries in both the 2010 and 2015 assessments. Five additional human disturbance variables were used to improve accuracy of the 2015 estuarine assessment relative to 2010.

This assessment should be viewed as one complementary tool of many to be used when examining fish habitat condition. Additional fish habitat information from Fish Habitat Partnerships along with other regional and local assessment information should be used to paint a complete fish habitat picture for a particular location or watershed.

This report divides the 50 states into 14 sub-regions based on geographic borders and ecoregions. Time and resources did not permit a quantitative assessment of lakes, reservoirs, the Great Lakes, and marine areas, nor updates to the previous assessment of estuaries in Southeast Alaska. Future reports may include habitats not addressed in this report as well as those in U.S. territories as time and resources become available.

Assessment results are characterized as "risk of current habitat degradation," and this should be interpreted as reflecting the relative degree of threats to aquatic habitats in a particular region (very high, very low, or in between). The assessments use "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 or the processes that influence them in the United States. As a result, the inland assessments for this report focus on identifying factors that have been found to have significant associations with desirable measures of stream fish communities, rather than using direct measurements of habitat condition. For example in the national streams assessment, if numbers of stream fishes sensitive to disturbances decreased with an increase in road density in watersheds drained by streams where those fish were found, the assessment would reflect that all streams in the region having a high density of roads in their watersheds may be at risk of being degraded. Roads can lead to increased sedimentation and pollution in streams, and while such data are not currently available throughout the United States, the sensitivity of fishes to roads suggests that sedimentation, connectivity, and pollution may in fact be problems for streams draining watersheds with many road crossings. The national estuarine assessment focuses on variables representing anthropogenic activities that are known to affect estuary habitats, while the regional estuary assessment incorporates available information on fish presence and distribution to directly measure the influence of these anthropogenic stressors.

Although a large amount of information went into the assessments, **some human disturbance factors are missing due to the lack of nationally consistent data**. Because all information cannot be accounted for, risk scores represent conservative estimates; areas mapped as having a low risk of current habitat degradation due to the factors available for this report 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 example, consistent nationally-available data is not available for water flow patterns or grazing density, and scores in some areas of the western United States are likely overestimates of actual conditions. Similarly, if a problematic area, such as an estuary with a large dairy farm in its watershed, has been mitigated by development of retention ponds to capture waste runoff, this assessment would still rate the aquatic resource as at high risk because we do not have data that characterizes locations and types of mitigation efforts nationally. For the reasons explained above, ***readers should interpret the maps carefully***. **The maps should not be understood as depicting absolute habitat condition.** They instead serve as a guide to the relative magnitude and geographic distribution of many important factors that contribute to aquatic habitat degradation. Future reports, planned for 5-year intervals, will continue to improve the description of aquatic habitat condition, as data sources become more consistent and comprehensive.

The assessment methodologies are summarized below. **More detailed information about how the assessments were developed can be found here .** Interested readers can find peer-reviewed articles of assessment methods and results in the " Supportive Literature" section.

Turquoise darter *(Etheostomainscriptum)*

Big Sauble River draining into Lake Michigan in Ludington, Michigan.

Methodology for Inland Stream Assessment for Lower 48 States

Because fish reflect the quality of the habitat where they live, habitat conditions were evaluated by estimating how strongly various human habitat disturbances affect stream fish in all parts of the country. The national datasets used for this assessment included 26 variables that accounted for different human disturbances to aquatic habitats. These included: the quantity of urban, agriculture, and pasture lands in watersheds; major point-sources of water pollution; frequency of dams and road crossings throughout river networks; and intensity of mining activities in watersheds. Five natural landscape variables were also used to account for their potential influences on stream fishes. Because of broad differences in distributions of stream fish species in different-sized streams and across the United States, we created assessment scores specifically for small and large streams and within nine large ecoregions of the country.

For each of the 26 human disturbance variables, we identified the level at which fish with a strong reliance on high quality habitats showed marked declines in abundance, as well as the level at which additional increases in the disturbance variable would not yield any further decrease in fish abundance. This information was used to score streams according to their most likely condition based on the values of disturbances found in their watersheds. Streams that are expected to be in good condition are assigned a low or very low designation of risk of current habitat degradation, while streams predicted to be in poor condition are described as being at high risk of current habitat degradation.

Some important threats to fish and fish habitat could not be incorporated in the analysis due to data limitations. These include: locations where intensive logging occurs; locations experiencing grazing; high density animal farming; regional habitat stresses (e.g., oil drilling); water diversions from streams (which would change flow patterns); fish passage issues with culverts; and small dams (less than six feet high) that could fragment streams or obstruct fish passage. Legacy land uses, such as historic mining operations, which may still be affecting fishes today, are also missing from the assessment. We are working to address these omissions in future versions of the assessment, and it is important to keep in mind that disturbance scores in streams affected by unmeasured factors may not accurately reflect the true amount of disturbance.

The following disturbance variables were analyzed as part of the river assessments:

- Urban land use /Human settlement (percent urban land use, human population density and road density)
- Percent pasture and hay
- Agriculture (percent cultivated crops)
- Point source pollution data (numbers of National Pollution Discharge Elimination sites, Toxic Release Inventory sites, and National Superfund sites)

•Nutrient and sediment loading to watersheds

•Habitat fragmentation metrics (densities of dams and road crossings)

•Mine density throughout river networks

•Water withdrawal

It is important to recognize that these broadly-defined disturbance variables often act together with other measured or unmeasured threats to degrade habitat. Thus, while we may identify "urbanization" as a major threat to fish habitat in some regions, "urbanization" represents an umbrella term that describes the many facets of urban development that could cause degradation to habitats, such as the amount of pavement that changes stream flows, nutrient runoff from lawns, road salt runoff, trash and detergents getting into the river, etc. Rarely does only one disturbance type act alone.

Cutthroat trout*(Oncorhynchusclarkii)*

Generalized Methodology for Stream Assessments of Alaska and Hawaii

State-wide data on fish populations were limited in Alaska for use in this assessment, as was a detailed spatial (mapping) framework that fully characterizes watersheds throughout the state at the time this assessment was conducted. Because of these factors, we modified our assessment methods to account for these limitations. Twenty-one landscape disturbance variables were assembled from medium-sized watersheds throughout the state (i.e., 12-digit hydrologic unit code watersheds). Variables were then assigned to one of six categories based on their disturbances to stream habitats. Categories include: urban land use, agricultural land use, point source pollution and water quality, barriers to fish movement, human infrastructure including roads or pipelines, and active mines. Individual disturbance variables were summarized within categories to create six different sub-indices of disturbance. A single cumulative habitat condition score was calculated from the summed sub-indices of disturbances.

For the Hawaiian inland assessment, stream reaches were first grouped into ecological categories having similar native fauna, landscape, and climate characteristics. Seven sub-indices of disturbance were created from 20 different disturbance variables. These included urban land use, current agricultural land use, former plantation lands, point source pollution, water quality, barriers to fish movement, and ditches. Within each ecological category, associations between native fauna and specific disturbances were tested. Results were used to weight specific disturbances for particular stream sites. A single cumulative score was calculated from the summed sub-indices of disturbances.

Because these methodologies differ from the methodology used for the contiguous United States, the results cannot be directly compared– i.e., an area at high risk of current habitat degradation in the 48 contiguous states is not directly equivalent to an area at high risk of current habitat degradation in Alaska or Hawaii.

NATIONAL FISH HABITAT PARTNERSHIP

Sockeye salmon *(Oncorhynchusnerka)*

Methodology for National Estuary Assessment

Estuaries are the coastal areas where rivers meet the ocean. These areas provide critically important habitat to many fish and shellfish species, and support a variety of important activities (e.g. fishing, shipping, recreation, etc.). These areas, as the transition zone between the land and the sea, are also at high risk for negative effects from human activities including pollution, habitat conversion and loss, and changes to water flows. Understanding how human activities are affecting estuary habitats is important so resource managers can better manage these impacts, and ultimately, sustain estuaries and the fish populations that they support.

To analyze estuary condition, a cumulative disturbance index was developed for the contiguous United States. We used datasets available at a national scale for anthropogenic disturbances measured within estuaries and their associated upland catchment basins, i.e. watersheds. Twenty-eight variables were combined within habitat stressor categories to develop four sub-indices of disturbance:

1. Land use and land cover change
2. Alteration of river flows
3. Pollution sources
4. Estuary eutrophication

These four sub-indices of disturbance were then combined to develop cumulative disturbance index (CDI) scores for each estuary. This index describes the estimated combined stress on estuarine habitats represented by the measured anthropogenic disturbance categories. The disturbance index class represents the condition of each estuary based on CDI scores and grouped into five condition classes ranging from ’very low’ to ‘very high’. Scores are calculated relative to the other estuaries in the contiguous U.S.

The CDI represents a risk of current habitat degradation and is a conservative estimate of the anthropogenic disturbances affecting estuaries. This assessment includes some of the most important anthropogenic disturbances affecting estuaries, but other stressors could not be analyzed due to data limitations. Some important stressors lacking sufficient data on a national scale include benthic habitat loss, shoreline armoring, and status of living (biogenic) habitats (e.g. shellfish beds, coral reefs, kelp forests, seagrass beds). Work is ongoing with partners to identify and improve data resources available to the National Estuary Assessment.

This assessment provides an updated outlook of the estuary condition that was presented in 2010 and uses the same assessment approach that allows for comparisons across estuaries nationwide. However, results from **the 2010 and 2015 National Estuary Assessments should not be viewed as an indication of change** for several reasons. First, the assessment measures habitat stress relative to other estuaries in the framework; to appropriately measure change, the total extent of habitat stress over time would be needed. Second, several new datasets have been added to the 2015 analysis, as well as improvements to some of the existing datasets updated from the 2010 analysis. It is vital to take advantage of enhancements in the data inputs where available to improve the overall quality of the assessment, but these changes mean that the results between the two assessment time-periods are not directly comparable.

More detailed information about how the national estuary assessment was developed can be found here.

In 2010, an assessment of estuary watersheds in Southeast Alaska was completed. Time and resources did not permit any updates to this portion of the assessment, but results from the previous assessment can be reviewed here.

Methodology for the Regional Estuary Assessment for the Northern Gulf of Mexico

The Regional Estuary Assessment for the northern Gulf of Mexico represents an effort to develop, test, and implement a new assessment methodology for marine habitats that improves the analytical basis for identifying impacts to estuarine fish habitats. This new regional assessment approach offers several advantages:

- Incorporates information on fish/shellfish presence/absence from over 70,000 sampling events collected over two decades, so we can better relate fish habitat condition to natural and anthropogenic variables.
- Better accounts for the high amounts of natural variation found in the marine environment, which can affect the susceptibility of individual estuaries.
- Allows us to take advantage of regional datasets not available on a national level, and collaborate with Fish Habitat Partnerships and other regional stakeholders to better answer their habitat management questions.

This new assessment approach will be applied to other coastal regions of the U.S., but because of limited resources, we are only able to present results for estuaries in the northern Gulf of Mexico in this report. In order to present updated information on estuarine habitats across the U.S., updated results for the National Estuary Assessment initially developed in 2010 (discussed immediately above) are also presented. **For estuaries in the northern Gulf of Mexico, these two analyses are complementary but not directly comparable because of the differing methodologies and data sources**.

Methods for the Regional Estuary Assessment were developed through a collaborative process with regional partners. First, indicator screening models were used to rapidly screen a large number of potential stress variables for each species found in Gulf estuaries and identify the most important variables for further investigation. These models used the probability of fish presence (by species) to assess the significance of each estuary-level stress variable one at a time. These models also controled for natural variables, such as temperature and salinity (collected with fish samples), which might otherwise obscure the effects of the stress variables.

Once the most significant stress variables were identified from the screening models, they were tested using multi-stressor models for each fish species. A statistical process was then used to eliminate variables one at a time from the model, until only variables that were highly significant (i.e. at a 95% confidence level) remained. Using these more refined models, current conditions were then compared to Least Disturbed Condition (LDC) – defined as the minimum observed value of each significant stressor across the whole region. By comparing against LDC, we estimated the current impact of stressors and avoided extrapolating beyond the range of conditions for which the models were developed. Overall, this process allowed us to identify the most influential habitat stressors for each fish species and overall for estuaries in the Gulf of Mexico.

More detailed information about how the Regional Estuary Assessment for the northern Gulf of Mexico was developed can be found **here**.

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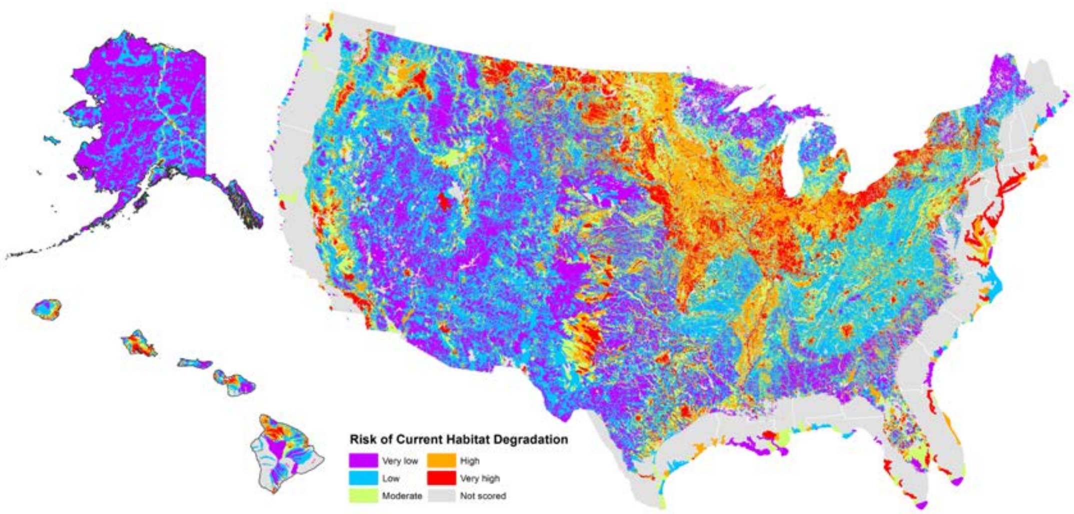

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Habitat Degradation in Inland Streams

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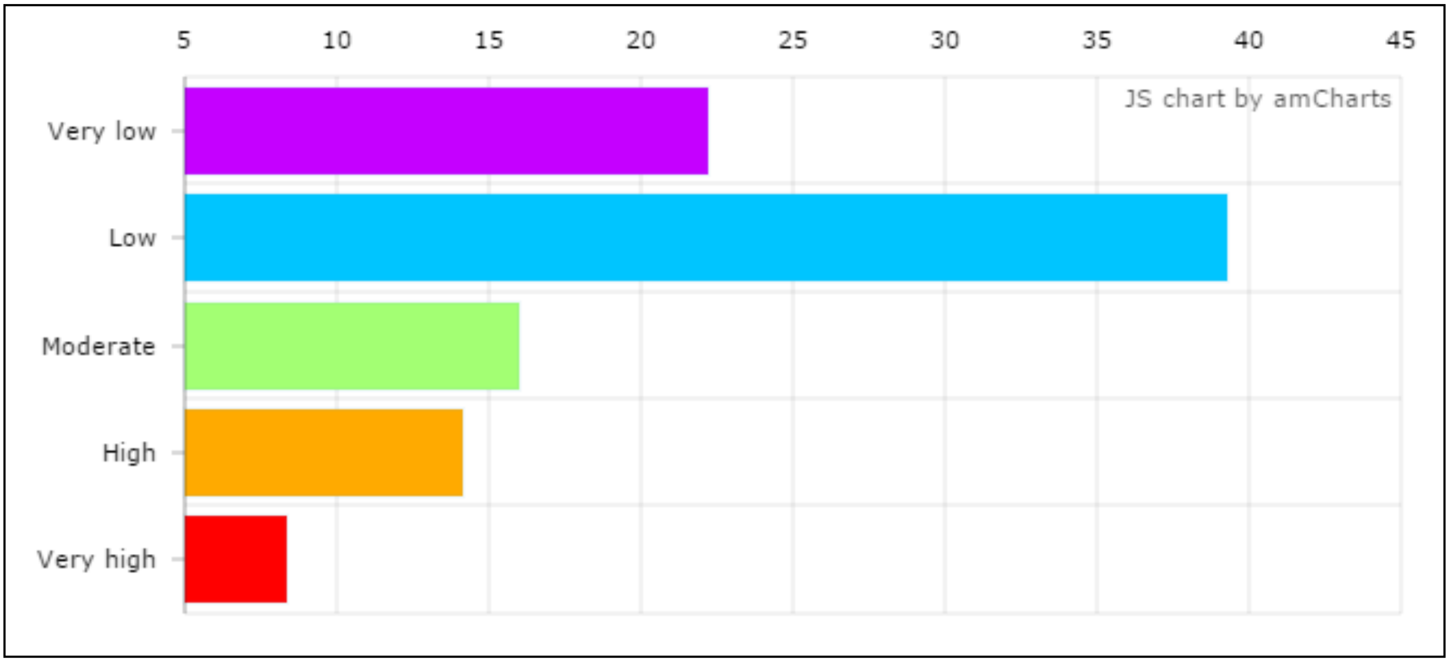

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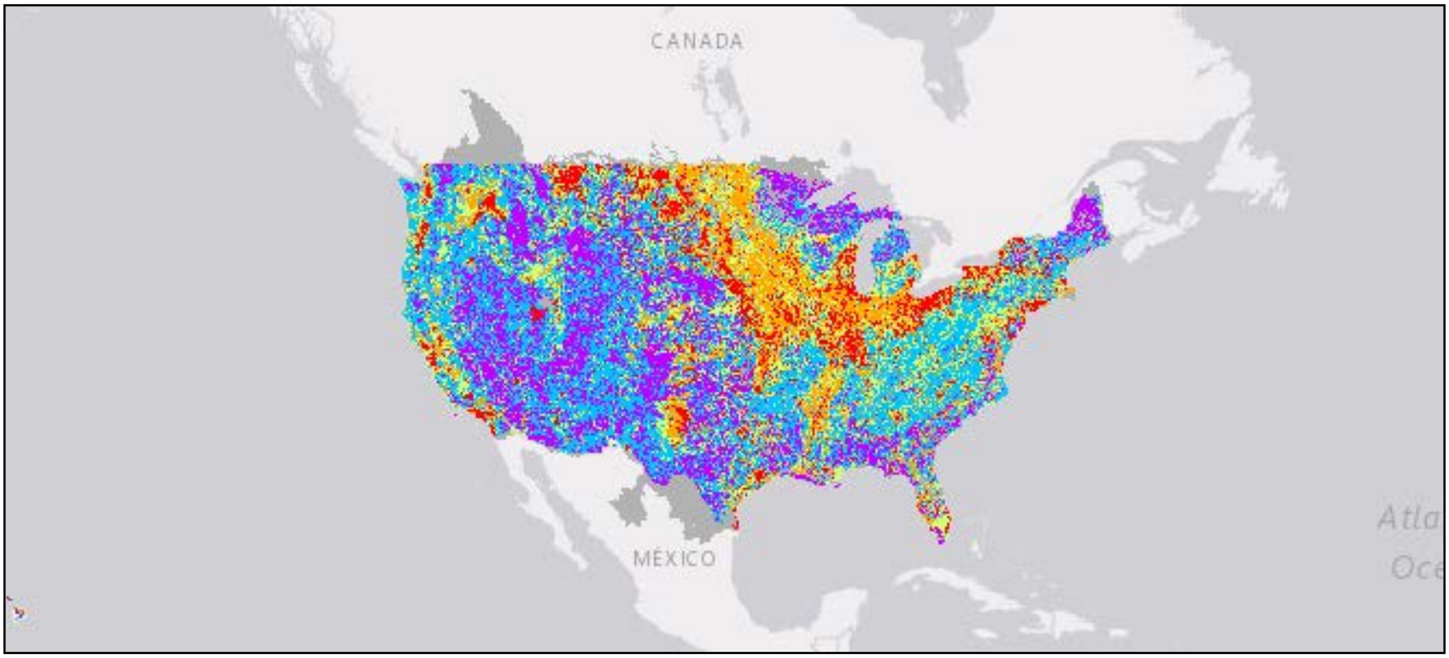
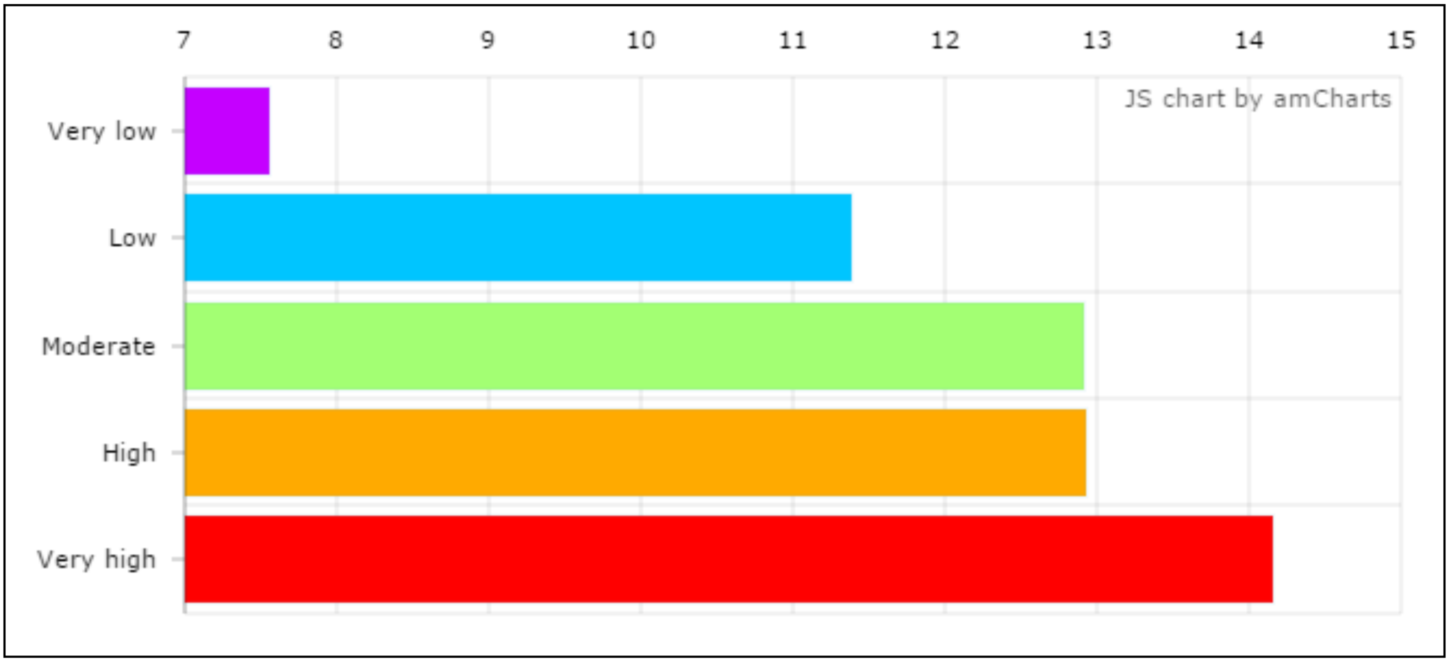


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Habitat Degradation in Estuaries

(a)



(b)

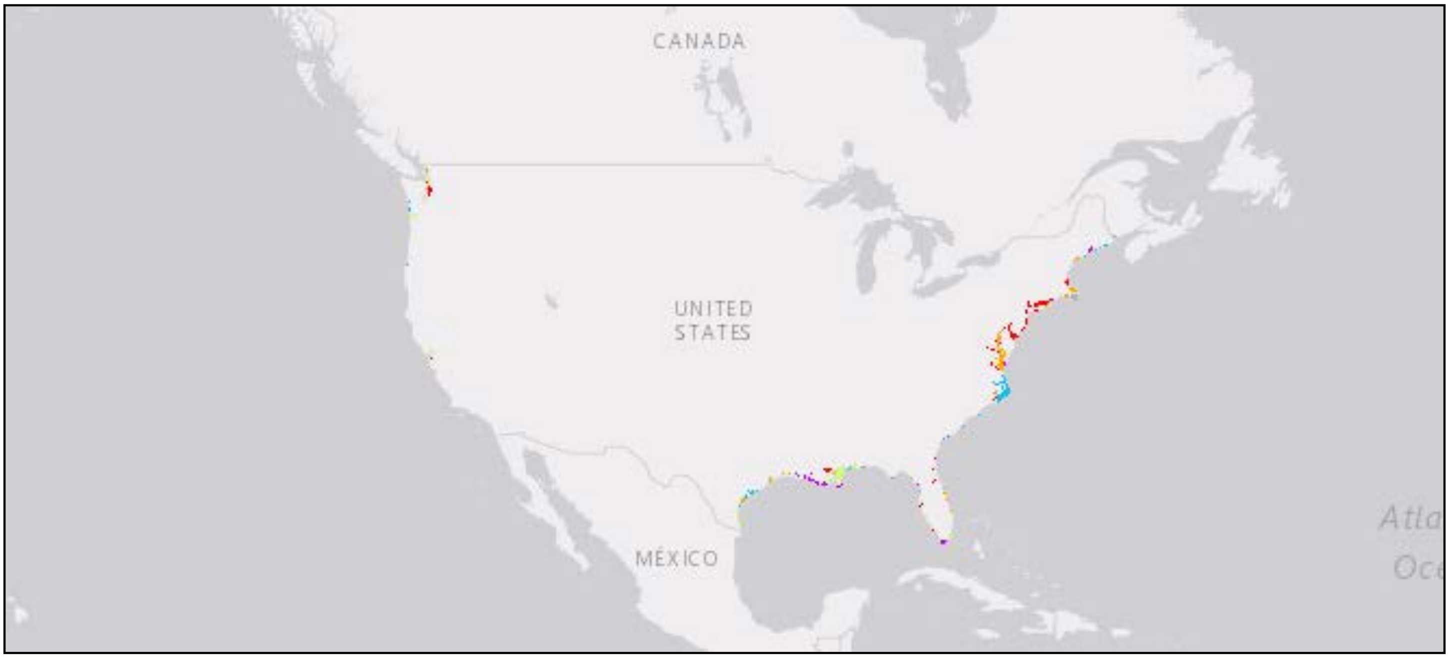
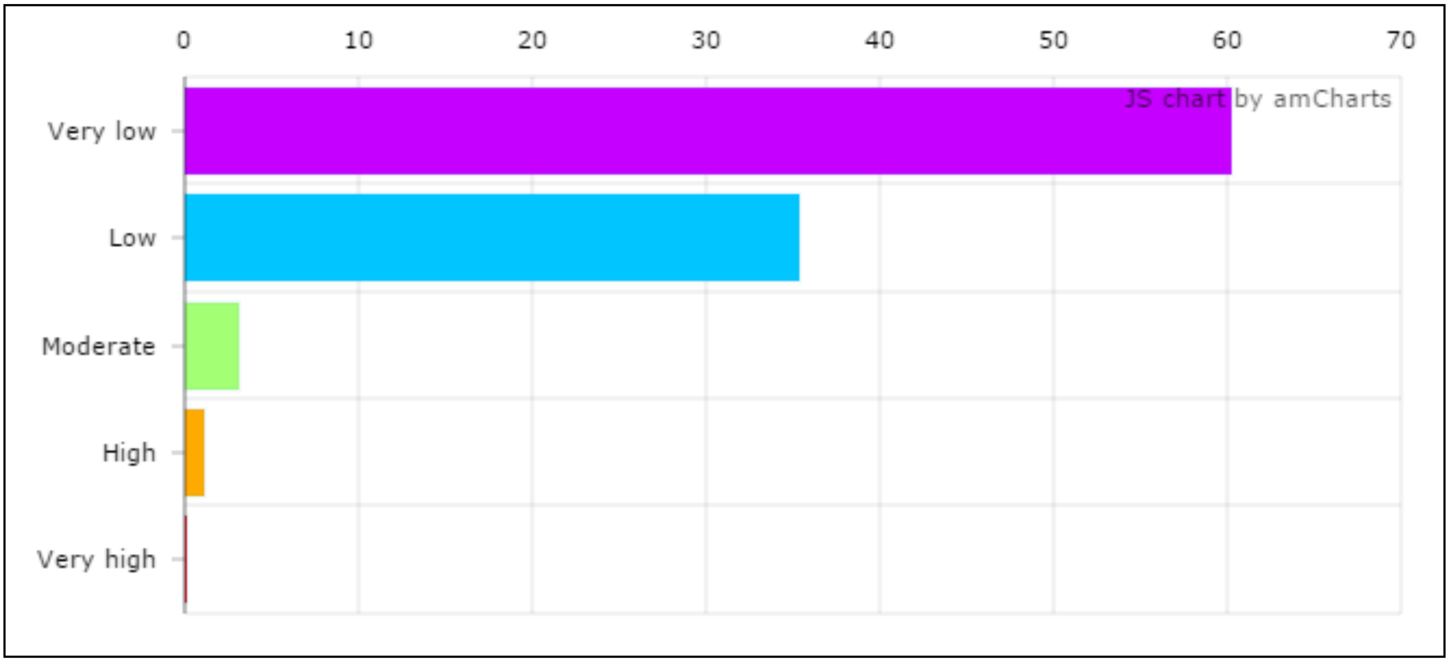


Figure1: This interactive figure summarizes the risk of fish habitat degradation. The currently selected tab shows data from the national estuary assessment. (a) Relative condition of fish habitat in estuaries. Estuary summaries represent percentage of total estuary area in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all estuary condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the national estuary assessment.

Habitat Degradation in Alaska

(a)



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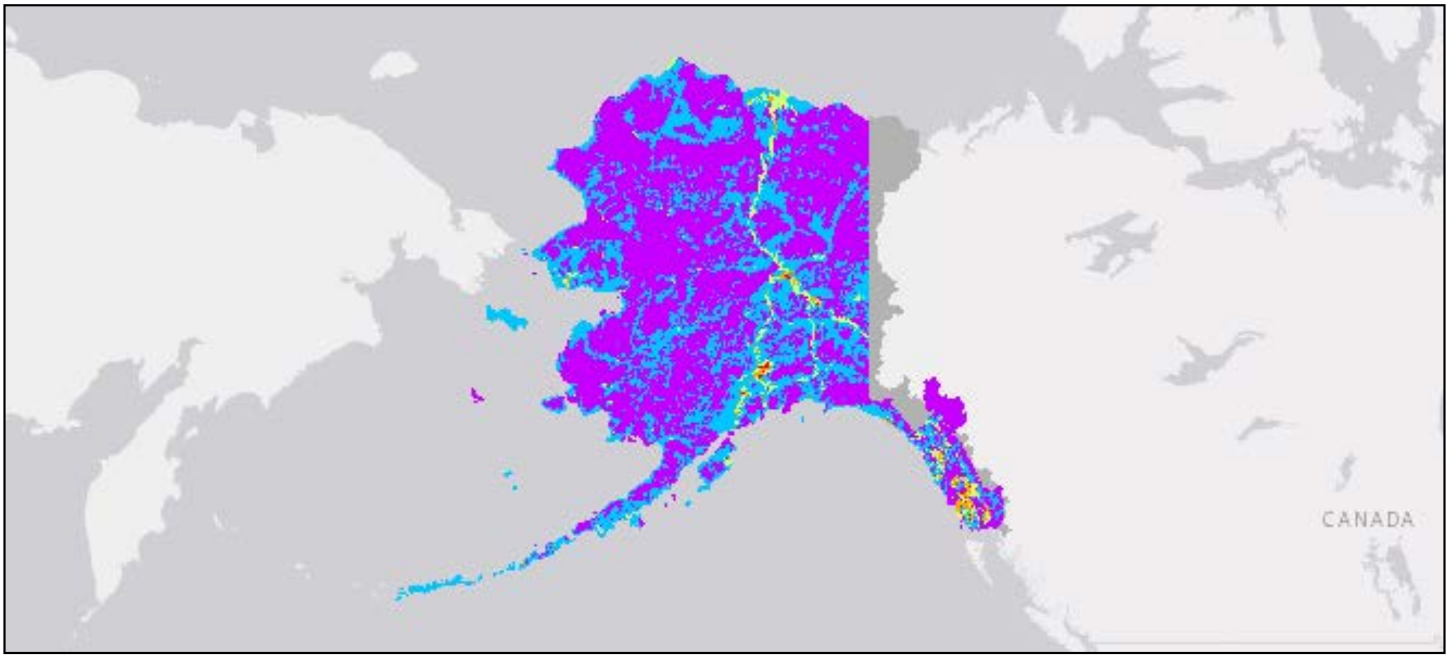
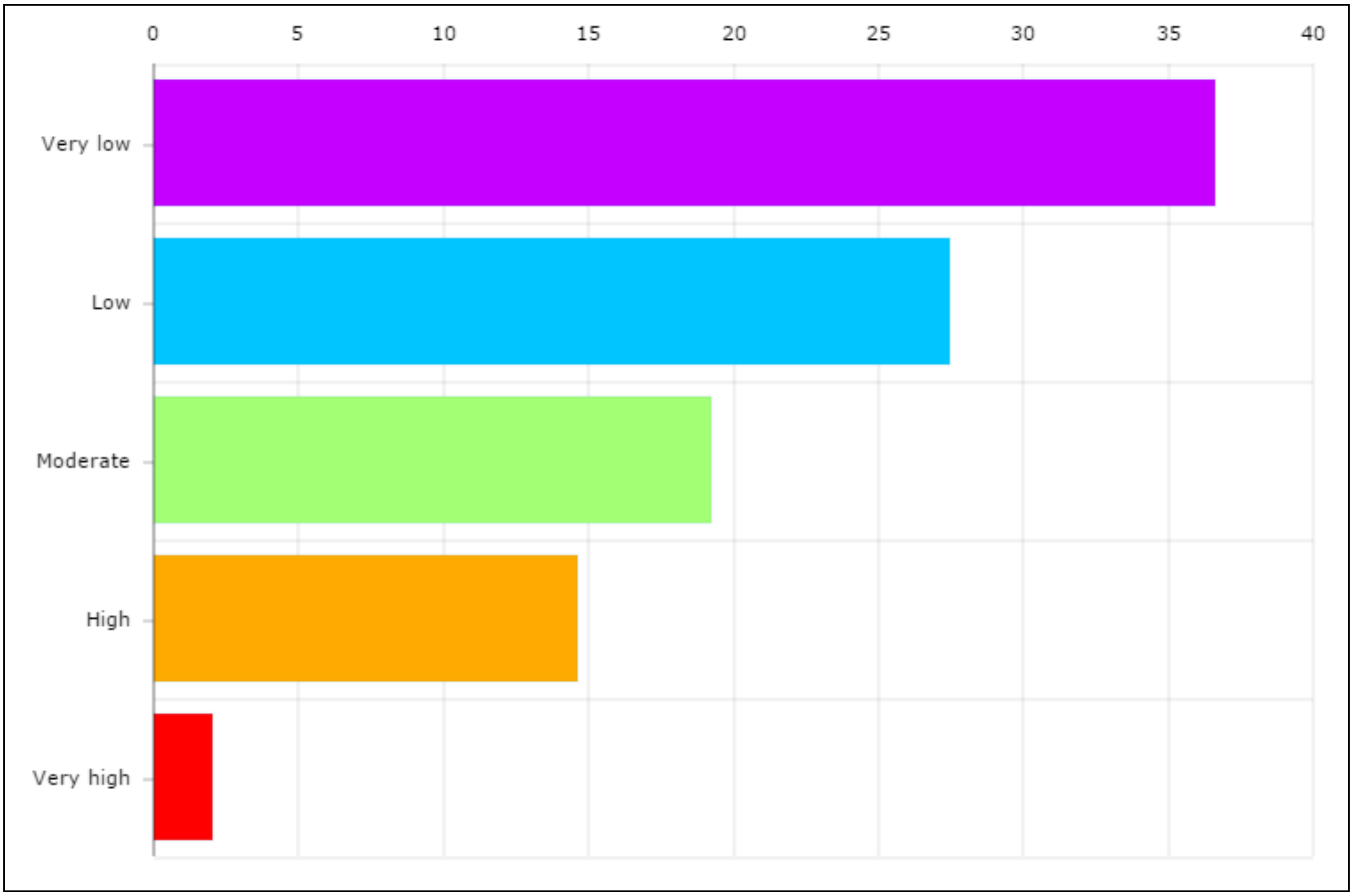


Figure1: This interactive figure summarizes the risk of fish habitat degradation. The currently selected tab shows data from the assessment of streams for Alaska. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of HUC12 area in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the Alaska assessment of

streams.

Habitat Degradation in Hawaii

(a)



(b)

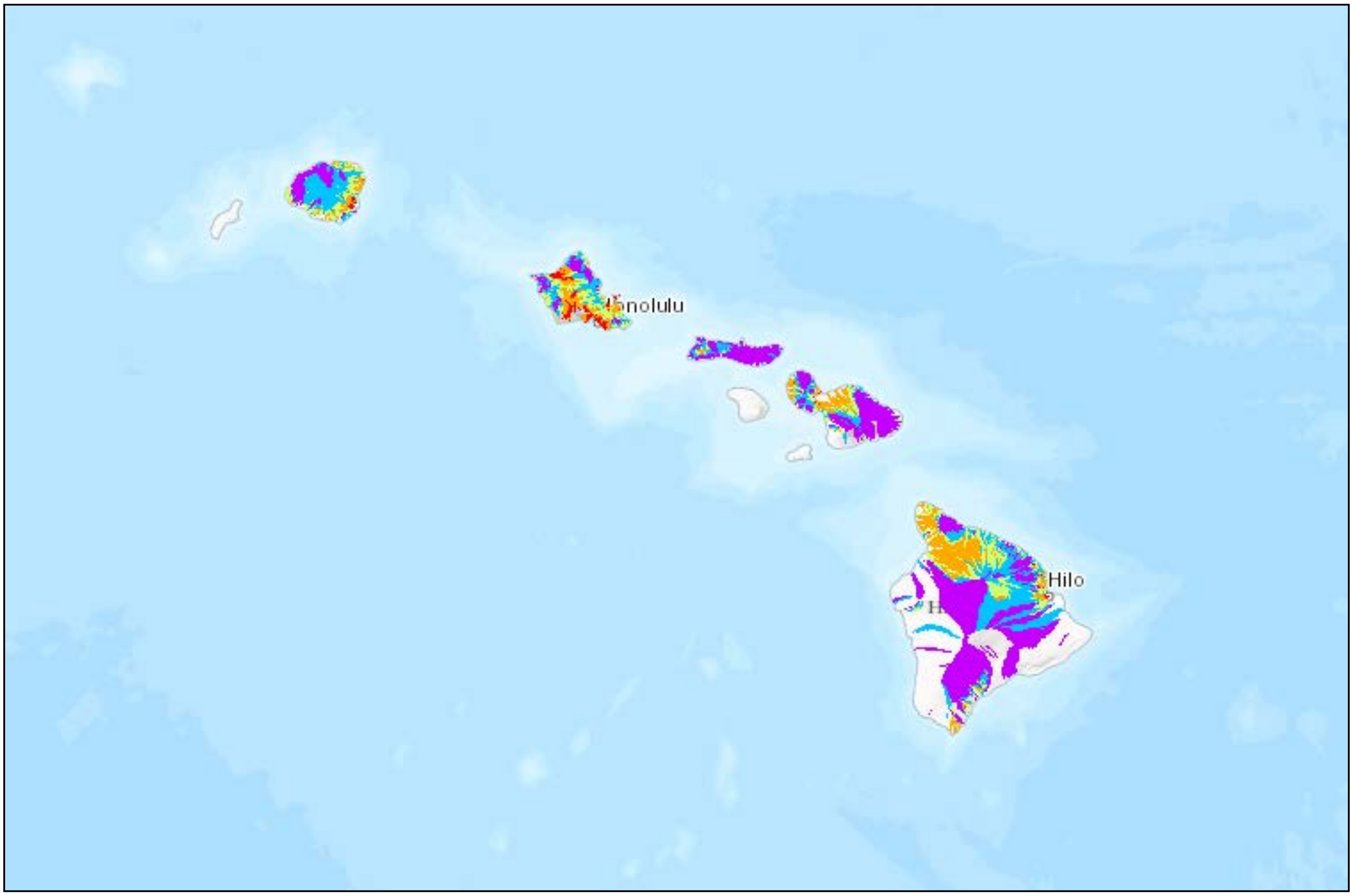


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset. The currently selected tab shows data from the assessment of streams for Hawaii. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the Hawaii assessment of streams.

National Overview from the 2015 National Fish Habitat Assessment

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 aquatic habitats. The United States is also home to more than 322 million people , 39% of whom live near the coasts and all depending on the same water that fish call home. In 2012, approximately 25 percent of the nation's acreage was agricultural and 6 percent was developed. However, these and other consequences of human inhabitation affect much broader areas by altering water flow (hydrology), water quality, and many aquatic habitat characteristics. Few aquatic habitats in America have been or are currently unaffected by human activity and some have been severely degraded. Map 1 depicts the results of the habitat assessments conducted for this report, with the estuarine areas offset for better visibility. Assessments of lake, reservoir, offshore marine, and Great Lakes habitats were not conducted because of resource limitations but are, at least in part, expected to be completed for the 2020 National Fish Habitat Assessment if resources are allotted.

Overall, 22 percent of inland stream mileages in the lower 48 states are at high or very high risk of current habitat degradation, and 62 percent are at low or very low risk. Areas of high and low risk of current habitat degradation occur in discernable patterns. Stream habitats with a very high risk of current habitat degradation include: those watersheds in or near urban areas, areas with a high number of pastures and hay fields, areas with high amounts of row crop agriculture, systems with many point sources of pollution, and those with high numbers of active mines or dams in their watershed. Generally, agricultural land use had a broader, negative effect on assessment results than any other variable. However, the accumulation of all development variables typically resulted in the most severe disturbances.

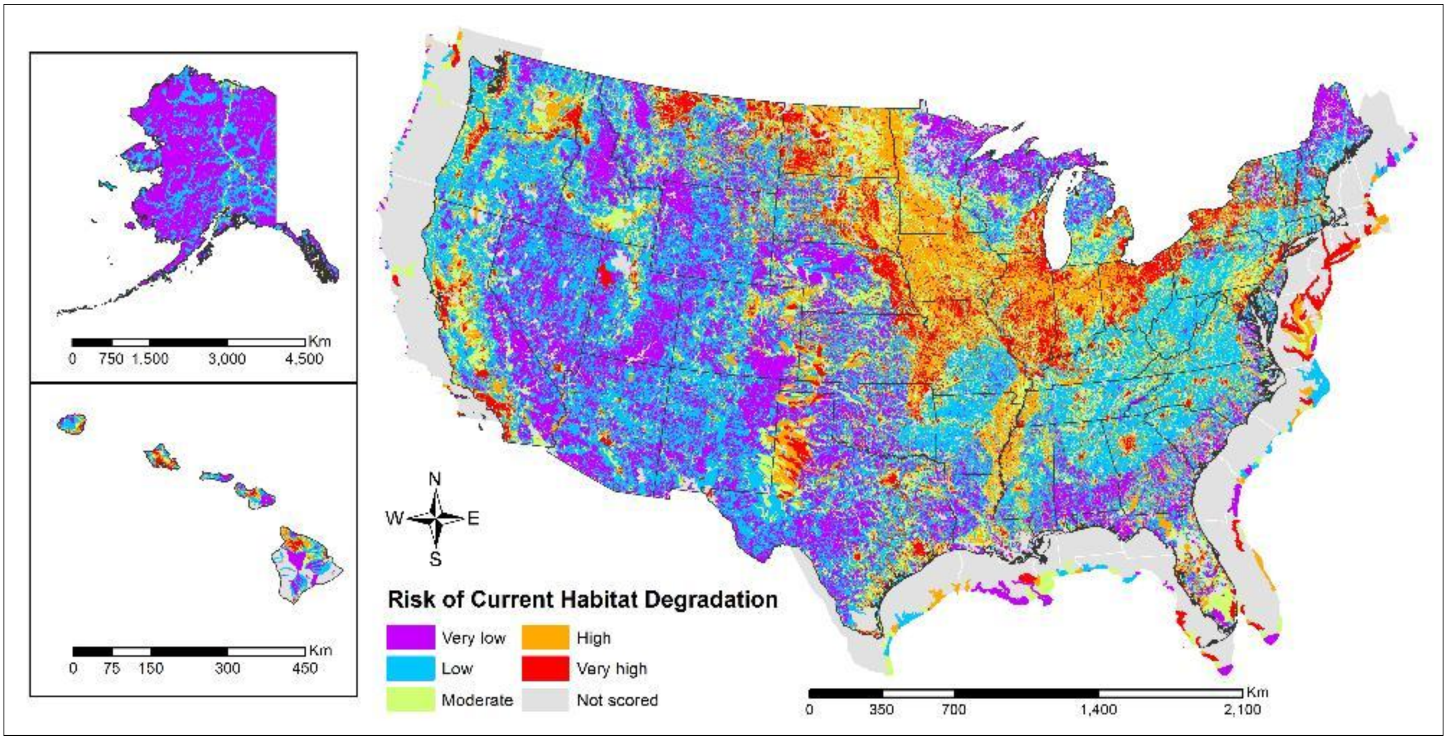
Specific regions of pronounced high risk of current habitat degradation include: the urban centers of Boston to Washington DC, Atlanta, Dallas, Houston, Chicago, Denver, Southern California, San Francisco area, Honolulu, and Seattle to Eugene; and the agricultural regions of the Midwest from Ohio to North Dakota, northwestern New York, the Mississippi River Basin, northwestern Texas, northwestern Utah, southern Idaho, northern Montana, central California, and southeastern Washington. Streams and rivers in the Central Midwest have the greatest risk of degradation in the nation. Even though these are broad areas that are evident on the national scale, many aquatic habitats throughout the country are threatened. Key problematic locations will be noted in the Regional sections of this report.

Areas that stand out as being at very low risk according to the parameters evaluated in this assessment include: rural areas in New England and the Great Lakes states; many habitats throughout the Rocky and Appalachian Mountains; the Southwest; and most of Alaska. Overall, the states of the Southwest have the lowest risk of habitat degradation of the 14 regions assessed using the available landscape data but this is likely an overestimate of the quality of the habitat as a result of our inability to fully include water flow (hydrology) or intensive grazing as variables. **It is critical to note that not all water and land management issues could be addressed in the assessment as consistently measured data are not available for all issues. Many variables are not available nationally, so some of the areas mapped as being 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 water flow (hydrology) was not accounted for in the assessment as hydrology data is unavailable for many river and stream reaches. Additionally, intensive grazing using poor management practices in riparian zones (upland areas next to streams and rivers) has caused significant aquatic habitat degradation in these same areas. The assessment likely overestimates the amount of habitat at low risk of current habitat degradation in the arid West as hydrologic alterations, such as water withdrawals, and grazing are key driving factors that could not be fully assessed in this report. However, if issues of hydrologic alterations and intensive grazing could be improved, the arid West has the potential to be at low risk of degradation.

The estuaries of the lower 48 states show patterns similar to those of the land areas as shown in Map 1, which is not surprising because most of the disturbances to estuarine habitats originate on land. Estuaries in the mid-Atlantic and in Peninsular Florida have a high or very high risk of habitat degradation related to pollution issues and other effects of the intense urban and agriculture land uses. The estuaries of Southern California, the San Francisco area, and the Seattle area also have a very high risk of current habitat degradation for similar reasons. Generally, pollution and land cover were the most limiting stressors of the eastern coastal habitats, and reduced river flow typically had greater effects on estuaries of Texas and the Pacific coast. Nutrient loading, or eutrophication, was also a significant factor leading to higher degradation risk in the estuaries of the mid-Atlantic and Texas.

Many of the estuaries in the northern Pacific States Region, the Florida Panhandle, Georgia, South Carolina, and Maine had a low or very low risk of current habitat degradation. This assessment could not examine Alaskan estuaries as the result of limited funding, but based on the inland assessment of low risk, it is likely that Alaska's estuarine habitats also have low risk of degradation except in a few localized areas near population centers. Overall, 32 percent (by area) of the estuaries in the lower 48 states are at low or very low risk of current habitat degradation, while 46 percent are at high or very high risk of current habitat degradation.

We would like to emphasize that comparisons should not be made between the 2015 and 2010 reports because additional variables were assessed in 2015 and the statistical methodology was greatly improved for determining risk categories. Work is underway to develop additional comparable change metrics to allow comparisons of like data and will be available in the future.



Map1: Map showing risk of habitat degradation.

Alaska Region

from

Through a Fish's Eye:

The Status of Fish Habitats in the

United States

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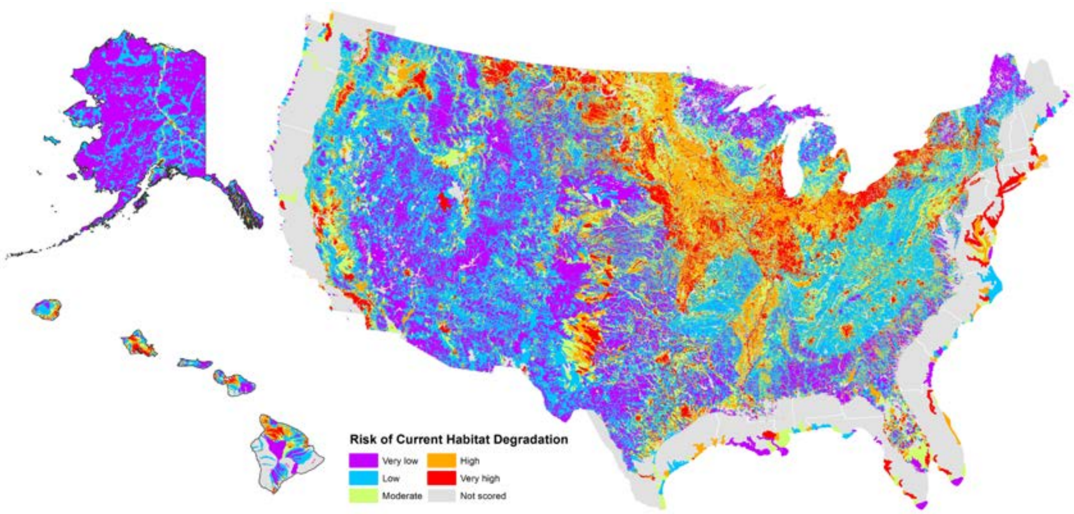

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[1] Retired Florida Fish and Wildlife Conservation Commission

[2] Michigan Department of Natural Resources

[3] Michigan State University, Department of Fisheries and Wildlife

[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Alaska Region

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Regional Summary

Alaska is the largest state in the United States (586,412 square miles) and has a diverse array of fish habitats including **most of the nation's intact and highest condition fish habitat**. Alaska has an estimated 46,882 miles of coastal shoreline, more than 3 million lakes, and at least 365,000 miles of rivers and streams. Pacific salmon (five species), pollock, halibut, Pacific cod, king crab, and many other species support robust subsistence, recreational, and commercial fisheries, nearly all of which come from **self-sustaining wild populations**. For Alaskans, fishing is an integral part of their heritage and culture and an important means of supporting their families.

The inland assessment for Alaska focuses on the current status of its rivers and streams to determine risk of this habitat to being altered. An assessment of the equally important lake habitat in Alaska could not be completed at this time as a result of limited resources; initial analyses are expected in future National Fish Habitat Assessments. The assessment of Alaska's river and stream fish habitat differs from the lower 48 assessment in that data limitations, particularly limitations in fish data and in available stream and river maps, allowed only an estimation of the risk of habitat alteration based on the degree of urbanization, transportation infrastructure, mines and point source discharges at a watershed scale (see the Methodology section for more details). Habitat degradation from two widespread industries (oil/gas development and timber harvest) were not considered in this initial assessment. While the effects of changing climate are pronounced in Alaska, this assessment does not evaluate this key habitat influencing factor as it is beyond available resources at this time.

Overall, the risk of stream habitat alteration is low in Alaska, mostly as a result of land ownership that limits development. However, developing areas and urban centers clearly show higher risks of habitat alteration, and because most of these developed areas are near the coast, they can have a disproportionate effect on overall watershed habitat quality through mechanisms such as fish barriers that prevent anadromous fish from accessing quality spawning and rearing habitats. As rivers flow from protected, naturalized landscapes to those that are unprotected, habitat stress can increase with more human uses of the landscapes. Many of the rivers and streams that show higher risks of habitat alteration begin as small tributaries with very low risks of alteration in protected areas of the state. *Necessary funding has been limited butprotection of Alaska's intact habitats is crucial to ensuring the continued remarkable fish production from self-sustaining populations.*Protection is a key strategy in Alaska to make best use of limited human and fiscal resources as it is far less expensive (at least a 10:1 return on investment) to protect habitat than rehabilitate once damaged.

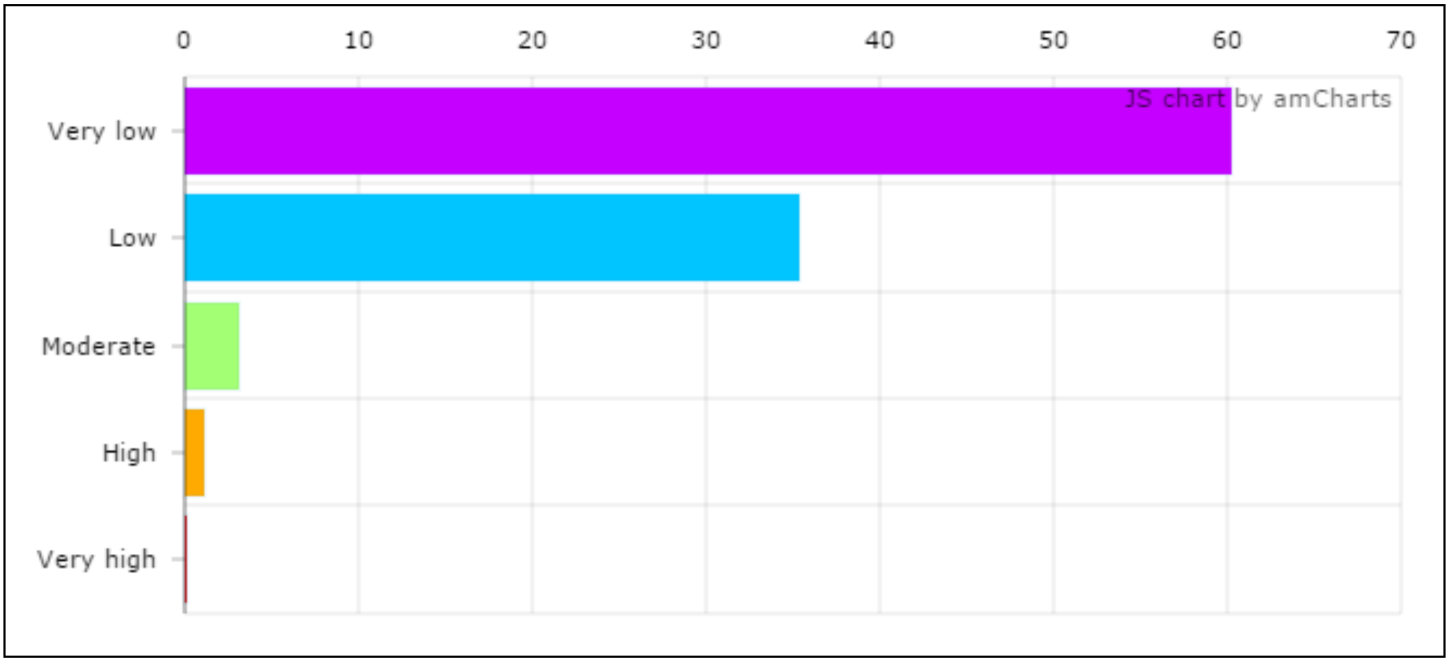
A substantial portion of Alaska's economic activity occurs on or around coastal and marine waters, including commercial fishing, marine transportation, oil and gas exploration, mineral mining, legacy timber harvesting, log storage, and associated road infrastructure. As a result of limited resources, an assessment of Alaska's marine habitats was not completed. An initial assessment of the coastal waters of southeast Alaska was completed in 2010 and is discussed in the 2010 National Fish Habitat Assessment.

Fun Facts

- A greater percentage of Alaskan residents fish (53 percent in 2011) than residents of any other State.
- Alaska’s largest private sector employer is commercial fishing with total annual landings of fish products of 79 billion pounds (36 million metric tons). Nearly all of these fish are from self-sustaining populations.
- In 1867, the United States Secretary of State William H. Seward offered Russia $7,200,000, or two cents per acre, for Alaska.
- The State of Rhode Island could fit into Alaska 425 times.
- Most of America's salmon, crab, halibut, and herring come from Alaska.
- The State's coastline extends more than 6,600 miles.
- Alaska is the largest State in the United States and is more than twice the size of Texas.

Habitat Degradation

(a)



(b)

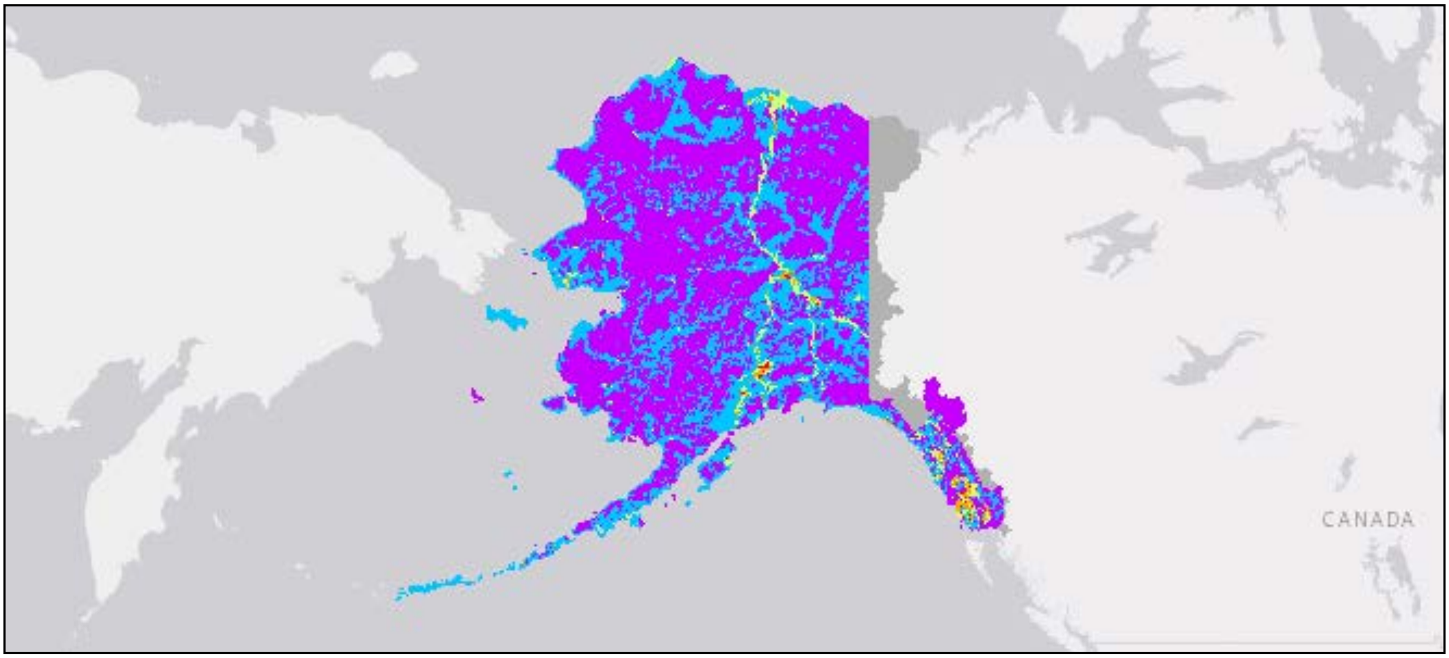


Figure1: This interactive figure summarizes the risk of fish habitat degradation. The currently selected tab shows data from the assessment of streams for Alaska. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of HUC12 area in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the Alaska assessment of

streams.

Competing Freshwater Demands

Most of Alaska has an abundance of unaltered clean fresh water habitat that maintain remarkable self-sustaining fish populations requiring water flows in the proper amount at the right time. These habitats face an increasing number of demands. New hydroelectric projects, such as the recently proposed Susitna-Watana Hydroelectric Project, and the expansion of existing projects can, if not very carefully sited and designed, increase barriers to fish migration and create adverse hydrologic and sediment effects on streams that provide critical spawning and rearing habitat for self-sustaining salmon populations. These potential barriers are not just an issue for fish but the entire ecosystem as everything from trees to bald eagles to grizzly bears in Alaska relies on nutrients provided by fish migrations from the ocean.

Oil exploration and development projects on the North Slope withdraw massive amounts of water, 1 to 1.5 million gallons of water per mile for ice roads and ice pads (also see National Research Council 2003). In addition to the direct effects of water withdrawals from these projects on streams and Arctic lakes, reductions in water flow may also affect nearshore and estuarine water circulation, and in most cases the implications of these changes on nearshore fish habitat have not been assessed, occurring before we fully understand how to mitigate for them.

Resource Extraction and Mining

Alaska's economy depends on extraction of natural resources such as fish, minerals, and timber. Gold, silver, oil, natural gas, and products such as gravel are extracted from streams, riparian zones (shoreline areas), and nearshore waters using a variety of methods that have both direct and indirect effects on fish habitats. A recent study estimated that up to 94 miles of streams and 5,350 acres of other aquatic habitats would be directly destroyed by routine operation of the proposed Pebble Mine in Bristol Bay tributaries. Bristol Bay was forecast in 2015 to produce 54 million sockeye salmon, almost 50 percent of the world's wild sockeye salmon. Another proposed project on the west side of Cook Inlet, the Chuitna Coal Mine, will completely destroy miles of anadromous fish habitat, some of which is important to Chuitna River Chinook salmon which are considered a stock of concern in Alaska (Jessica Speed, Mat-Su Basin Salmon Habitat Partnership Coordinator, personal communication). Timber extraction, and the effect of log transfer stations, although not analyzed in this assessment, also can directly and indirectly affect fish habitats and need to be evaluated in future assessments.

Mine tailing photograph Kuskokwim river drainage in SW AK

Urban Land Use

Forty-three percent of the surface area of Alaska is wetlands. On a state-wide basis, less than 2 percent of all wetlands have been developed. However, in many developing areas and communities, wetlands may be the only land type available for development. In urbanized and developed areas of Alaska, such as the Anchorage Bowl, 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 migration of fish that use wetlands as resting places on their lengthy migrations, and it is also critical rearing habitat for young salmon. Wetland loss is also linked to altered native riparian vegetation, degraded water quality, and water flow changes. These are key processes that form fish habitat, all of which have reached levels in developed areas that may impair wetland ecosystems in the long term.

Another key process, connectivity, is also disrupted by poorly planned development as improperly designed culverts block fish passage and migration. Surveys in the Mat-Su region found that seventy percent of the 567 streams evaluated had road crossings that impeded or blocked salmon from their spawning and nursery territory. Reducing habitat fragmentation is a top priority of restoration efforts in Alaska and many barriers have been removed throughout the state. For example, restoration efforts were successful near Cordova and opened long blocked fish passage at Eccles Creek.

Introduction of non-native plants and animals is another threat that occurs near many urban areas throughout the United States, directly affecting fish habitat quality and energy movement in aquatic systems, and Alaska is not excluded from this threat. Northern Pike, introduced south of the Alaska range in the 1950's, have now reached population sizes that threaten key salmon populations as Northern Pike prey heavily on young salmon and expensive control measures are now being implemented. The rapidly growing, invasive aquatic plant, *Elodea*, was first found in Cordova in 1982 but has rapidly expanded since 2012 and has spread to other water bodies used by salmon as nursery sites. This plant likely came from aquarium releases as it is widely used in the ornamental fish industry in fish tanks. As of 2015, Alaska has 22 known waterbodies infested with *Elodea*, including Lake Hood, the state's largest float plane hub. This plant creates ideal Northern Pike habitat and a great deal of effort and available funding has been used to attempt to eradicate *Elodea*.

Habitat Trouble for Arctic Grayling in Alaska

Although Alaska has substantial intact habitats, issues quickly appear in areas associated with development. The **Arctic Grayling** (*Thymallus arcticus*) requires large intact reaches of river to thrive. Some populations are stressed in developed areas as a result of habitat loss due to poorly designed road crossings that fragment streams along with poorly conducted mining, agricultural, and forestry practices.

Arctic grayling *(Thymallusarcticus)*

Habitat Trouble for Bering Cisco in Alaska

The **Bering Cisco** (*Coregonus laurettae*) is endemic to Alaska and is present primarily along the State's west and north coasts. It is known to spawn in only three river systems – the Yukon, Kuskokwim, and Susitna Rivers. Genetic research indicates that each of these populations is distinct. The Bering Cisco has been observed to migrate more than 1,200 miles into freshwater streams to spawn. Unlike salmon, some of these fish survive spawning runs. Since this species is slow-growing but short-lived, it is highly vulnerable to alterations in stream flow or water quality and large-scale environmental disasters.

Habitat Trouble for Chinook Salmon in Alaska

Chinook Salmon (*Oncorhynchus tshawytscha*) is the largest-sized salmon species in the world and Alaska is a stronghold of self-sustaining populations. Since 2007, Chinook Salmon populations have been returning in fewer numbers to many Alaskan rivers throughout the State. This may be a result of intense fishing, poor ocean survival, and habitat loss and degradation in developing parts of the State, but because declines are so widespread, it could be a marine-derived problem. Scientists are currently working to determine the specific cause.

Chinook Salmon *(Oncorhynchustshawytscha)*

Fish Habitat Partnership Activities for Alaska

Five National Fish Habitat Partnerships are working to protect intact and improve altered fish habitat in Alaska including: 1) Southeast Alaska Fish Habitat Partnership; 2) Matanuska-Susitna Basin Salmon Habitat Partnership; 3) Kenai Peninsula Fish Habitat Partnership; 4) Southwest Alaska Salmon Habitat Partnership; and 5) Western Native Trout Initiative. The results of some of their work includes:

1. Removed 17 fish passage barriers on high priority salmon streams in the Anchorage area, opening 54 miles of upstream habitat and access to 604 acres of lakes, all critical rearing areas for Pacific salmon and other salmonids.
2. Worked with partners and private landowners to voluntarily protect nearly 8,000 acres of estuaries, wetlands, riparian areas, vital for salmon spawning and rearing and sustaining healthy salmon populations in the Matanuska-Susitna Valley. Since 2006, partnerships have funded 72 projects in the Mat-Su Basin.
3. Conserved in excess of 25,000 acres along intact river reaches in Southwest Alaska that have some of the largest self-sustaining salmon populations in the world by fee acquisition or conservation easement.
4. Led efforts to remove the Kenai River from impaired water body status (caused by use of older inefficient outboard motors in a high density recreational fishery that leaked outdoor engine oils) and to achieve full implementation in 2014 of a 50' Riparian Habitat Protection Zone throughout the Kenai Peninsula.
5. The Southeast Alaska Fish Habitat Partnership, founded in 2014, organized a Southeast Alaska Watershed Symposium and an Alaska Fish Film Festival to demonstrate the importance of fish and their habitats in Alaska which has built strong community support for fish habitat.
6. Funded an Alaska Coastal Cutthroat Trout assessment to improve understanding of Coastal Cutthroat Trout (CCT) distribution, life history strategies, abundance, and habitat needs and assessment within the Alaskan portion of their range.
7. The Mat-Su Salmon Partnership has hosted eight annual Salmon Science and Conservation Symposiums with over 25 presenters and more than 100 attendees each year. These events foster collaboration and communication on the latest science, conservation, and restoration of fish habitat in the Mat-Su.

For more about specific waters and projects the Alaskan Fish Habitat Partnerships have been working on, please see the following locations:

•Agulowak River

•Alexander Creek – see featured article

•Big Lake

•Cottonwood Creek

•Kasilof and Anchor River Watersheds
•Koktuli River
•Little Susitna River
•Montana Creek – see featured article
•Moose Creek
•Twelvemile Creek Watershed
•Wasilla Creek

Alexander Creek - Elodea Eradication Program

Partnership - Matanuska-Susitna Basin Salmon Habitat Partnership

Alexander Creek Watershed, a tributary of the Susitna River, was formerly a significant sport fishing area covering hundreds of square miles in the Matanuska-Susitna Borough. In the late 1990s, this system was considered to be a highly productive Chinook and Coho Salmon habitat, and, arguably, the premier Chinook Salmon sport fishing area in the Matanuska-Susitna Valley. Today, however, due to low returns, the Alexander Creek drainage is closed to Chinook Salmon harvest, and Alexander Creek Chinook Salmon are considered a stock of concern by the Alaska Department of Fish and Game. This decline is largely due to the introduction of Northern Pike (Esox lucius), which are native north and west of the Alaska Range, but were introduced into the Susitna River Basin in the late 1950s. They are voracious predators of juvenile salmon and other native resident fish and wildlife and have direct effects on salmon populations and the associated economic activity. Compounding the situation, in August of 2014, the aquatic invasive plant, Elodea, was discovered for the first time in Mat-Su waters by Alaska Department of Fish and Game crews. If Elodeabecomes established in Alexander Creek and spreads throughout Alexander Lake, it would provide excellent habitat quality for predatory Northern Pike, further exacerbating the existing effects of pike predation on juvenile salmon and other fish.

Since Northern Pike are widespread, and the challenge too great in the Mat-Su to fully eradicate them, there will be ongoing suppression in target areas to maintain critical salmon habitat. Project goals are to: 1) create an annual, large scale pike removal protocol on side channel sloughs to remove 80% of Northern Pike; 2) track spatial and temporal movement trends of Northern Pike to and from Alexander Lake; and 3) measure success through monitoring adult salmon returns, resident fish production and juvenile production and movement. The intent is to replenish depleted anadromous and resident fish populations and to restore sport fishing opportunities to this once very popular and productive system. This project has been and will run from 2011 – 2016. In 2015, the Alaska Department of Fish and Game completed the fourth year of a long-term and large-scale annual gill netting project to control Northern Pike on Alexander Creek. They also conducted a radio telemetry study to investigate movement patterns between Alexander Lake and the mainstem of the creek, evaluated Northern Pike diet, and are testing effective control and detection methods such as eDNA. Directed by the Management Plan for Invasive Northern Pike and prioritized through a strategic planning process, the Northern Pike suppression project in Alexander Creek is the largest of its kind ever attempted in Alaska, and preliminary findings from the first four years of this project are encouraging. As of spring 2015, results have been very successful. With each year of pike suppression, Chinook Salmon fry are found farther up the stream system. For the first time, both juvenile and adult Chinook Salmon were observed all the way up to the lake outlet in 2014. Chinook Salmon returns in 2013-14 were the highest observed in a decade.

The Alaska Department of Natural Resources and partners have been working an Elodeaeradication program and a rapid response protocol for future infestations, and in 2016 the plan will be implemented. Partners will be sampling high priority areas in the Mat-Su Basin, educating priority audiences like pilots, residents of infested lakes, fishermen and guides, and will be providing training *to help build awareness and create a growing body of residents, recreationalists and practitioners who all can recognize Elodeaand know what to do if they do see it. The Mat-Su Salmon Partnership is working with the Alaska Department of Natural Resources to develop and help support future training opportunities as well as an Elodeastatewide management plan.*

Montana Creek - Restoration Project

Partnership - Matanuska-Susitna Basin Salmon Habitat Partnership

Montana Creek, near Talkeetna, Alaska in the Matanuska-Susitna Borough has been identified by the State of Alaska as important for the spawning, rearing, or migration of anadromous fish. This system has high quality spawning gravels and provides critical spawning, rearing, and overwintering habitats for Chinook, Coho, Pink, and Chum Salmon as well as resident populations of Rainbow Trout and Arctic Grayling. It receives heavy angling attention during the summer months and is the focus of a variety of ongoing habitat and fish assessment projects, streambank restoration activities, as well as land conservation activities and community asset planning. This system is also important due to its location within the Mat-Su Basin, its accessibility on one of the main highways in Alaska, and because the Mat-Su Basin currently has the most fish stocks of concern in Alaska.

An example of a project that directly addresses key fish habitat processes is the 2013 project that replaced a 5-foot diameter culvert that caused fish passage barriers and constricted 16-foot wide Buddy Creek (Montana Creek's biggest tributary) with a nearly 20-foot wide embedded fish-friendly culvert. The new culvert lets juvenile and adult salmon and other wildlife move freely under the road and access an additional four miles of spawning and rearing habitat upstream. Partners included the U.S. Fish and Wildlife Service, Mat-Su Borough, and the Alaska Department of Fish and Game. This project was evaluated starting in 2013-14, when the Alaska Department of Fish and Game, with technical support from the U.S. Fish and Wildlife Service and funding from the Alaska Sustainable Salmon Fund, marked juvenile salmon with passive integrated transponder (PIT) tags and observed their movements in the vicinity of the remaining Buddy Creek barrier. These data, collected before and after the last barrier was replaced, evaluated the effectiveness of similar projects in improving habitat connectivity for juvenile salmon. Work continues on other fish passage barriers in this system.

Other issues on this waterbody include landowner development in the floodplain and erosion following a 100-year flood in 2012. Concern was raised over the loss of habitat that includes excessive sedimentation within the lower river due to intense recreational use near the Parks Highway and the potential for residential development to further reduce riparian habitat and to degrade water quality. Due to these concerns, the Alaska Clean Water Action Plan (ACWA) prioritized Montana Creek for the assessment of current water quality and habitat conditions. In 2012, nearshore salmon habitat and riparian function were rehabilitated along 30 feet of Montana Creek's bank with bioengineering, and additional sections in need of restoration were identified and work continues to remove these system impairments. Partners to date include the Mat-Su Borough, Great Land Trust, U.S. Fish and Wildlife Service, Alaska Department of Fish and Game, Aquatic Restoration and Research Institute, and others.

Central Midwest States Region

from

Through a Fish's Eye:

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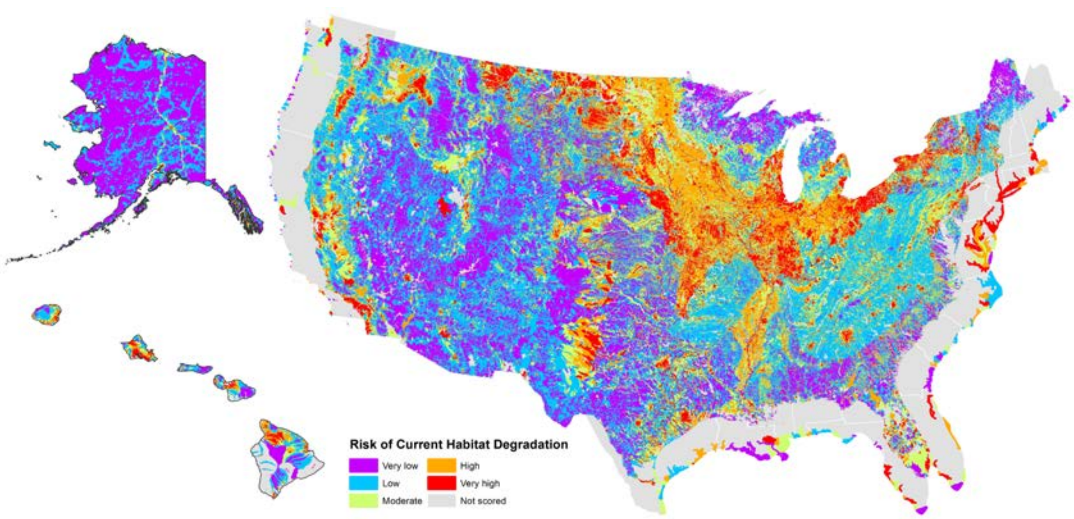

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Regional Summary

The Central Midwest states influence some of the nation's major rivers, such as the Mississippi, Missouri, Ohio, Des Moines, Wabash, and Illinois Rivers. These states also border lakes Michigan and Erie, and contain numerous reservoirs, impoundments, and smaller natural lakes.

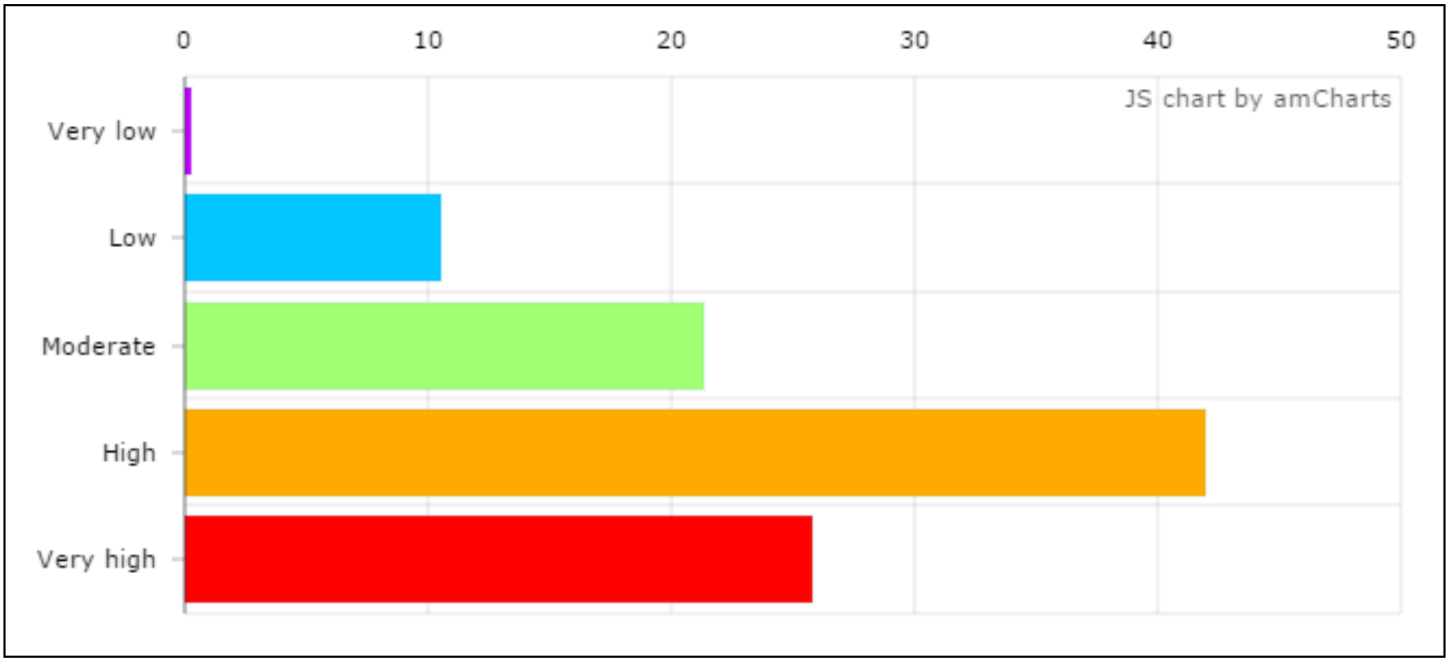
The Central Midwest states have experienced nearly two centuries of urban expansion, manufacturing, agriculture, and mineral extraction. As an example, of the 26,000 miles of streams and rivers in Illinois, only 240 acres of stream and river habitat are now considered high quality natural areas. These factors influenced this assessment, which estimated that 67 percent of the Central Midwestern river and stream miles have a high or very high risk of habitat degradation due to the factors assessed, particularly in Iowa, Illinois, and the northern regions of Indiana and Ohio. This region has the highest proportion of stream reaches in the poorest condition in the country. Only 11 percent of the fish habitat in the Central Midwest states were determined to be at low risk of habitat degradation and this region ranks as the most threatened in the nation. The low risk areas were identified in southern Ohio in the Wayne National Forest and in streams near small pastures interspersed among wooded areas.

Fun Facts

- The Ohio River flows through or borders six States and is 981 miles (1,579 kilometers) long, starting at the confluence of the Allegheny and Monongahela Rivers in Pittsburgh, Pennsylvania, and ending in Cairo, Illinois, where it flows into the Mississippi River. At the confluence, the Ohio River is considerably bigger than the Mississippi River.
- More than 25 million people, almost 10 percent of the U.S. population, live in the Ohio River Basin, and it is source of drinking water for more than 3 million people even though many sections do not meet water quality standards for bacteria and pathogens, PCBs, lead, mercury, metals, organics, and other pollutants.
- There are 20 dams on the Ohio River that are managed by the U.S. Army Corps of Engineers. The dams have greatly changed the flow of the river, which created a series of very slow moving pools rather than a free-flowing river.
- The dams make the river muddier, which is harmful to benthic (bottom-dwelling) organisms. In addition, the U.S. Army Corps of Engineers regularly dredges the river, which changes the channel shape, disrupts wildlife, and increases turbidity.
- Approximately 164 species of fish have been found in the Ohio River; however, the dams have drastically altered the habitat for river organisms and prevented or altered natural fish migrations.
- Eighty species of mussels once lived in the Ohio River. Currently, however, only 50 species live in the river and 5 of those are in danger of extinction.
- Crystal Lake, Iowa, is home to a statue of the world's largest Bullhead Catfish.
- Rathbun Dam and Reservoir is the largest body of water in Iowa.
- Spirit Lake is the largest glacier-formed lake in Iowa.
- West Okoboji, at a depth of 136 feet (41.5 meters), is the deepest natural lake in Iowa.
- At 16 miles (26 kilometers), East Okoboji is the longest natural lake in Iowa.
- Iowa is the only State whose east and west borders are 100 percent formed by rivers—the Missouri and Mississippi Rivers.
- Carlyle Lake is 26,000 acres (10,522 hectares) and the largest manmade lake in Illinois.
- The Illinois River in Illinois was important among Native Americans and early French traders as the principal water route connecting the Great Lakes with the Mississippi River.
- From 1905 to 1915, more freshwater fish were harvested from the Illinois River than from any other river in the United States except for the Columbia River.
- The Illinois River was once a major source of mussels for the shell button industry. Overfishing, habitat loss from heavy siltation, habitat alteration from navigation projects, and water pollution have eliminated most commercial fishing except for a small mussel harvest to provide shells to seed pearl oysters overseas.

Habitat Degradation in Inland Streams

(a)



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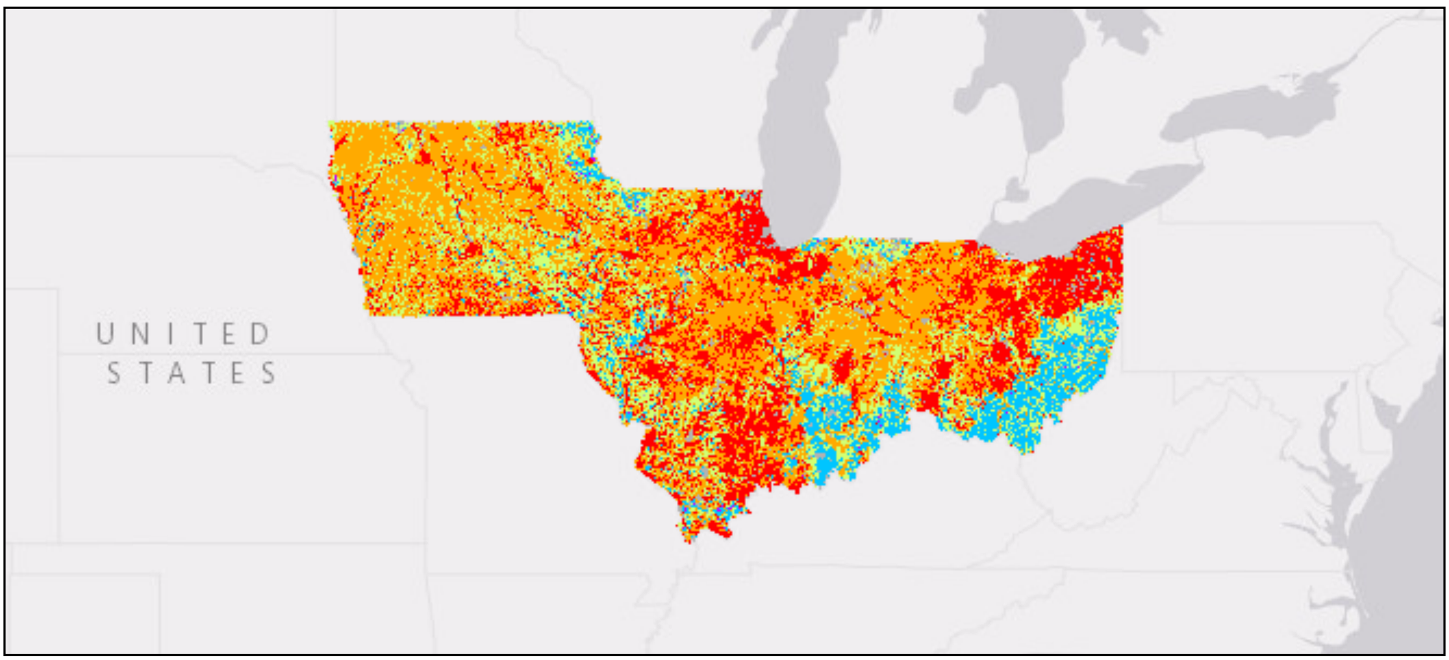


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Most Pervasive and Severe Disturbances for the Central Midwest States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

- •Crop land use
- •Low intensity urban land use
- •Pasture and hay land use
- •Impervious surface cover
- •Population density

Top three most pervasive disturbances to **creeks** (watersheds <100 km^2 in area) **across all** spatial scales:

- •Crop land use
- •Low intensity urban land use
- •Pasture and hay land use

Top three most pervasive disturbances to **rivers** (watersheds >100 km^2 in area) **across all** spatial scales **:**

- •Crop land use
- •Impervious surface cover
- •Pasture and hay land use

Top five most pervasive disturbances to **creeks, specific to** spatial scale:

- •Crop land use in local buffers
- •Crop land use in local catchments
- •Low intensity urban land use in local catchments
- •Crop land use in network buffers
- •Pasture and hay land use in network catchments

Top five most pervasive disturbances to **rivers, specific to** spatial scales:

- •Crop land use in network buffers
- •Crop land use in network catchments
- •Crop land use in local buffers
- •Impervious surface in local catchments
- •Low intensity urban land use in local catchments.

In the Central Midwest state group, only 11.1% of streams are classified as low or very low risk of current habitat degradation and these streams should be where protection efforts are focused. Crop land use makes up the majority of the landscape disturbance leading to the risk of current habitat degradation in all four spatial scales (local catchment, network catchment, local buffer and network buffer) and both stream sizes (creeks and rivers).

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat degradation (red and orange color groups).

Top five overall most severe disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Crop land use

•Agricultural water withdrawal

•Pasture and hay land use

•Road length density

•Low intensity urban land use

Top three most severe disturbances to **creeks** (<100 km ^{2}watersheds) **across all** spatial scales:

•Crop land use

•Agricultural water withdrawal

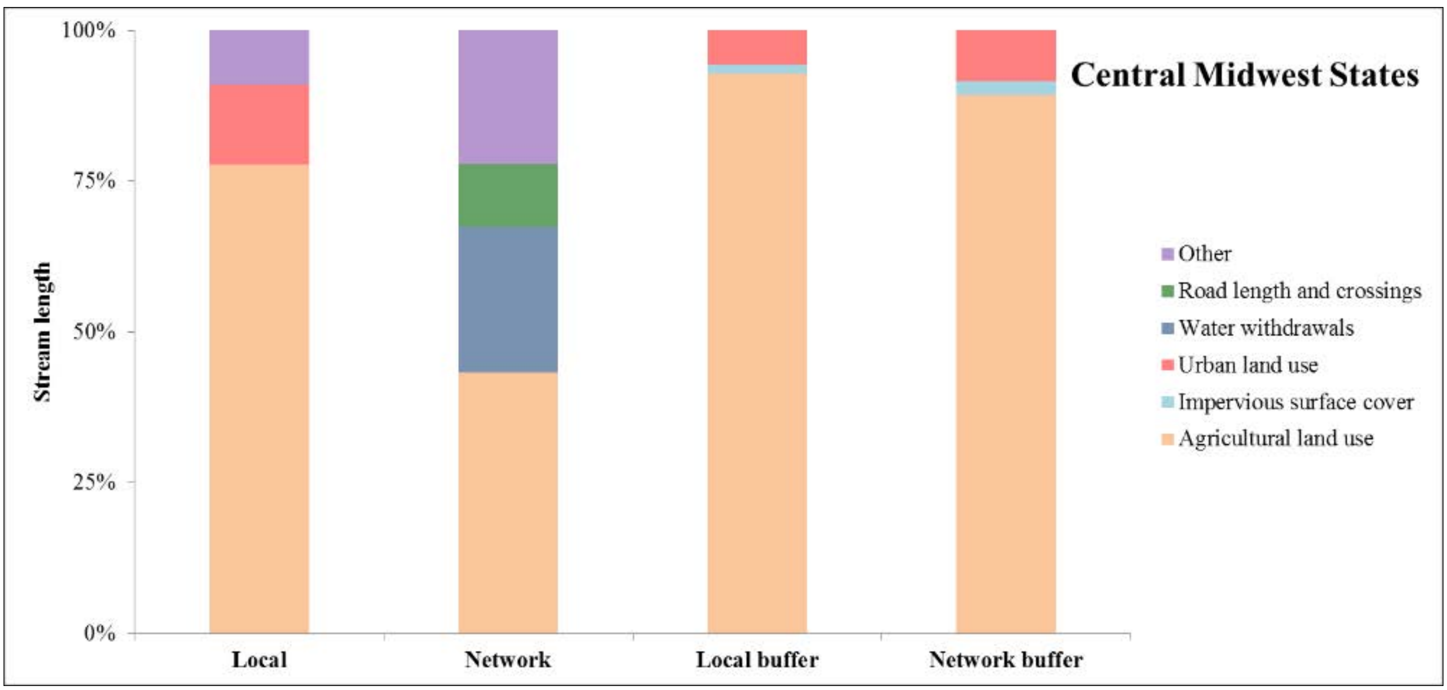
•Pasture and hay land use

Top three **most severe disturbances** to **rivers** (>100 km ^{2}watersheds) **across all** spatial scales:

•Crop land use

•Agricultural water withdrawal

•Industrial water withdrawal



Most severe disturbances in the Central Midwest States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into super categories (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales(local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale; buffers have only urban land use, agricultural land use, and impervious surface cover. See Detailed Methodologyfor more details.

Agriculture

Iowa, Illinois, Indiana, and Ohio constitute the majority of what is known as the Corn Belt, the most intensive agricultural region in the U.S. with corn and soybeans as the predominant crops. According to the U.S. Department of Agriculture 61 percent of the acreage of the Central Midwest region was cropland in 2012. The corn and soybean is fed to livestock, making this a key area for the production of hogs, chickens, and cattle. The production of ethanol as a fuel additive has greatly increased corn production and Conservation Reserve Program land has increasingly become farmed again as agricultural commodity prices have increased from increased product demand. Runoff and drainage from agricultural fields and feed lots and from stream banks eroded by cattle, have resulted in elevated levels of nitrogen, phosphorus, and sediments, and have degraded native habitats in most of the rivers and streams in the area. The United States Department of Agriculture reports that over 12 tons of sediment per acre each year erodes from a large portion of the Central Midwest. A recent study found that this region had the highest contribution to nitrogen loading in the greater Mississippi River drainage area and ultimately results in the " dead zone" in the Gulf of Mexico, degrading fish habitat there.

Dams and Other Barriers

A significant number of dams are located in Iowa (> 4,000), Illinois (> 1,759), Indiana (> 1,088) and Ohio (> 2,600). Dams in the Central Midwest were built to provide mechanical power for mills, hydropower, recreation, water supplies, and water retention for urban and agricultural use. Nearly all of these dams impede fish movements in the region and particularly in the Mississippi River drainage and in the watershed of lakes Erie and Michigan. Some communities are removing dams to deal with obsolete infrastructure issues and to improve water quality, flow, and stream connectivity. For example, the removal of Black Berry Creek Dam near Aurora, Illinois in 2013 opened up 32 miles of the Fox River for fish spawning and rearing.

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 from the late 1800s to the late 1900s. The manufacturing processes resulted in discharges of a broad range of toxins to local 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. For example, the Ashtabula River, in northeast Ohio, flows into Lake Erie and has been severely contaminated by a multitude of hazardous substances from legacy industrial discharges. This resulted in a 45 percent reduction in fish species, a 52 percent reduction in fish density, and an increase in fish health issues.

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, while Indiana is 16th. Over 31 million people live in these three states. Large cities such as Chicago, Indianapolis, Cincinnati, and Cleveland, as well as the suburban sprawl throughout the region, have created large areas of impervious surfaces and urban pollution near the rivers and lakes. These factors are known to degrade fish habitat by changing water flow (hydrology) and by adding excessive amounts of nutrients, pollutants and sediment into the waters in this region.

Habitat Trouble for Crystal Darters in Central Midwest States

The **Crystal Darter** (*Crystallaria asprella*) requires large, clear-water streams with clean sand and gravel bottoms and moderate to swift currents. It is intolerant of siltation and other forms of pollution from various land use practices. Direct habitat degradation from damming, channelization, and dredging has also reduced habitat for this species. Remaining populations have become isolated from one another by dams and impoundments. The Mississippi River most likely no longer serves as a usable corridor for the Crystal Darter because of the silt load. The isolated local populations are then vulnerable to single destructive events such as toxic chemical spills.

Crystal darter *(Crystallariaasprella)*

Habitat Trouble for Greater Redhorse in Central Midwest States

The **Greater Redhorse** (*Moxostoma valenciennesi*) is sensitive to habitat changes, particularly excessive siltation, and pollution. Other threats include river channelization, alterations to flow regimes, dam construction, and removal of riverside vegetation. Barriers are especially problematic as this is a wide-ranging species that has different flow and habitat requirements for different stages of development.

Greater redhorse *(Moxostomavalenciennesi)*

Habitat Trouble for Northern Madtom in Central Midwest States

The **Northern Madtom** (*Noturus stigmosus*) is a small member of the catfish family that requires fast currents and complex rocky habitat. It faces a host of habitat threats including competition with invasive species, climate change, siltation, loss of habitat, excessive turbidity, and poor water quality. Channelization of small streams in this region is a significant threat to this species.

Fish Habitat Partnership Activities for the Central Midwest States

Partnerships - Driftless Area Restoration Effort, Great Lakes Basin Fish Habitat Partnership, Ohio River Basin Fish Habitat Partnership, Reservoir Fisheries Habitat Partnership, and Fishers and Farmers Partnership

1. Restored 738 acres of wetland and over 400 feet of stream habitat in Ohio.
2. Removed 1 barrier in Iowa that reconnected 69 miles of stream habitat for Smallmouth Bass and many coolwater species.
3. Restored 1750 feet of shoreline and added 100 feet of structure to lake shorelines in Illinois.
4. Augmented three mussel populations on four Indiana rivers, giving two federally-endangered species a new foothold in the basin.
5. Launched a basin-wide mussel initiative to identify and address stressors in quality streams to curb or reverse severe population declines.

For more about specific waters and projects the Central Midwest Fish Habitat Partnerships are working on, please see the following locations:

•Eel River, Indiana – see featured article

•Boone River Watershed, Iowa – see featured article

•Diamond Lake, Iowa

•South Pine Creek, Iowa

•Millennium Reserve Initiative, Illinois

•Upper Tippecanoe River, Indiana

•Lake Bloomington, Illinois

Boone River Watershed, Iowa - Oxbow Restoration Project

Partnership - Fishers and Farmers Partnership

The Boone River Watershed is included in the Mississippi River Basin Initiative and is a priority watershed of the Fishers &Farmers Partnership, the Iowa Department of Natural Resources (DNR), and the Nature Conservancy (TNC). The Boone River is a tributary of the Des Moines River in north-central Iowa. Current and past land use practices in the Boone River Watershed have affected both water flows and currents through excessive siltation. As a result, oxbow habitat has been degraded and fragmented and water quality impaired. Oxbows are wetlands, ponds or lakes, often crescent shaped, that form when a stream reach becomes separated from the main stream when sedimentation closes off the reach connections or the stream moves within the valley. Oxbows are critical connections between streams and their floodplains during flooding, help hold back sediment and nutrients from entering streams, and improve water quality by acting as filters. Oxbows provide critical aquatic habitat for the federally endangered Topeka Shiner, which prefer the quiet waters of the oxbows, and migratory waterfowl.

White Fox Creek oxbow is typical example of a degraded oxbow system. Excess sediment removal began on a White Fox Creek oxbow in 2012 and the perimeter was planted with native grasses. Nitrate levels were reduced by an average of 56% and 14 native fish species recolonized the restored oxbow, which provided a winter refuges (Jones et al. 2015). The success of this project has provided opportunities for additional funding to restore additional oxbows in this stream.

In the fall of 2014, a number of partners, in particular The Nature Conservancy (TNC), successfully restored seven oxbows, bringing the number of oxbow restorations in the Boone Watershed up to 12. The 2014 oxbows were funded through the National Fish and Wildlife Foundation, EPA's 319 Lyon's Creek Project, and Coca-Cola. TNC worked with the Iowa DNR, USFWS-Fishers &Farmers Partnership, Iowa Soybean Association, and Iowa Geological Survey, thanks to funding through a state Conservation Innovation Grant, to quantify the benefits that oxbows can provide for wildlife habitat, water quality improvements, and water storage. In September 2015, TNC lead a Field Day to bring more information and attention to local landowners, partners, about fish and wildlife habitat, and water quality benefits of restored oxbows. TNC also received a grant in 2015 from Fishers &Farmers Partnership to work on four more oxbows in 2016-2017.

In 2013, Fishers &Farmers Partnership Received the Governor's Iowa Environmental Excellence Award for this unique work in the Boone Watershed.

For additional information on the Boone River oxbow project, please visit the following: http://fishhabitat.org/news/fishers-and-farmers-partnership-shows-success-restoring-boone-river-oxbows
For additional information on other Boone River restoration work, please visit the following:

http://midwestfishhabitats.org/project/boone-waterworks-dam-modification-des-moines-river-iowa [GEW1]

NATIONAL FISH HABITAT PARTNERSHIP

Eel River, Indiana - Collaborative Conservation of Fish Habitats

Partnership **-** *Ohio River Basin Fish Habitat Partnership*

The Ohio River Basin Fish Habitat Partnership (ORBFHP) identified the Eel River in northern Indiana as a priority area based on their science-based modeling process. Two fish, the Greater Redhorse and the Redside Dace, and a number of mussels that are classified as imperiled in Indiana exist in this river. Partnership involvement in this priority watershed has been instrumental in the establishment of critical conservation partnerships with the goal of a holistic approach to watershed ecological integrity in the Eel River. Partners engaged in collaboration conservation of the Eel River watershed include: the Manchester University Environmental Studies Program; Indiana Department of Environmental Management; Indiana Department of Natural Resources; Local Soil and Water Conservation Districts; Stockdale Mill Foundation; Indiana Corn Marketing Council; Indiana Soybean Alliance; Natural Resources Conservation Service; Environmental Defense Fund; and numerous local agricultural producers. The objective of this watershed approach is to provide scientific data to support conservation strategies. This collaborative approach across scientific and social groups has generated a significant level of interest in the Eel River watershed and has made citizens aware that it is possible to have a fully functioning stream ecosystem in an agricultural landscape. Manchester University students have been actively engaged in all aspects of each project including documenting pre- and post- ecological conditions through each step.

Ongoing work and studies in the Eel River watershed include:
1)*Re-establishing populations of two federally endangered freshwater mussel species in the upper Wabash River drainage;*
2)*Removal of a low-head dam and fish passageway barrier in the Eel River near Mexico, Indiana;*
3)*Construction of a two-stage ditch in Beargrass Creek: A cooperative conservation partnership to improve stream ecological integrity of an agricultural drainage ditch,*
4)*Determining the efficacy of fall cover crops as they relate to stream habitat and water quality: A paired watershed approach; and*
Developing a new approach to fish passage over low-head dams: Design for fish passage at the Stockdale Dam on the E el River of north central Indiana has been completed.

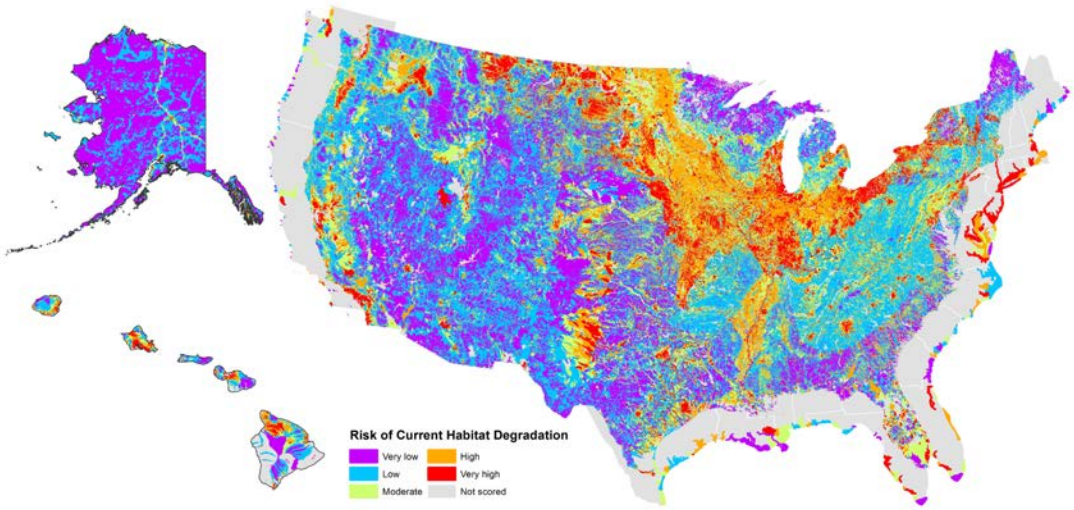
Central Mississippi River States Region

from

Through a Fish's Eye:

The Status of Fish Habitats in the United States

2015



Steve Crawford[1], Gary Whelan[2], Dana M. Infante[3], Kristan Blackhart[4], Wesley M. Daniel[3], Pam L. Fuller[5], Tim Birdsong[6], Daniel J. Wieferich[5], Ricardo McClees-Funinan[5], Susan M. Stedman[7], Kyle Herreman[3], and Peter Ruhl[5]

[1] Retired Florida Fish and Wildlife Conservation Commission

[2] Michigan Department of Natural Resources

[3] Michigan State University, Department of Fisheries and Wildlife

[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Central Mississippi River States Region

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NATIONAL FISH HABITAT PARTNERSHIP

Regional Summary

The Central Mississippi River states contain the confluences of the Upper 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 tributary rivers include the Tennessee, Cumberland, Kentucky, and Osage, all very large rivers in their own right. Large reservoirs are common in the landscape of this region and have increased recreational opportunities for sportfish as well as many other activities, but typically suffer from dissolved oxygen issues in both the reservoirs and in the release water, which can also affect water quality and aquatic life downstream of these reservoirs. Additionally, these reservoirs have completely altered the annual flow of water in these river systems with severe effects on river and stream life that are evolved to respond “natural” flow patterns. There are more than 8500 dams in the Central Mississippi River States, heavily fragmenting river systems that have eliminated fish migration in many rivers, and although many are in poor condition, only two were removed from 2010 to 2014 (www.americanrivers.org).

Aquatic habitat close to the Mississippi River in all four states has a high risk of degradation from row crop agriculture. Areas with a high risk of habitat degradation also occur in northwest Missouri, north-central Kentucky, and central Tennessee. Overall, 29 percent of the rivers and streams in the Mississippi River States have a high or very high risk of current habitat degradation. The most common risk factors throughout the region were associated with development, road crossings, and pasture land. However, there are numerous mines in the very high risk portion of northwest and in the Appalachian Mountains portion of eastern Kentucky. Very high threat to fish habitat also occurs in major metropolitan areas including St. Louis, Memphis, Nashville, Knoxville, and Louisville. Developed land increased by almost four million acres in this region from 1982 to 2012, but only amounts to 3 percent of the total regional land area.

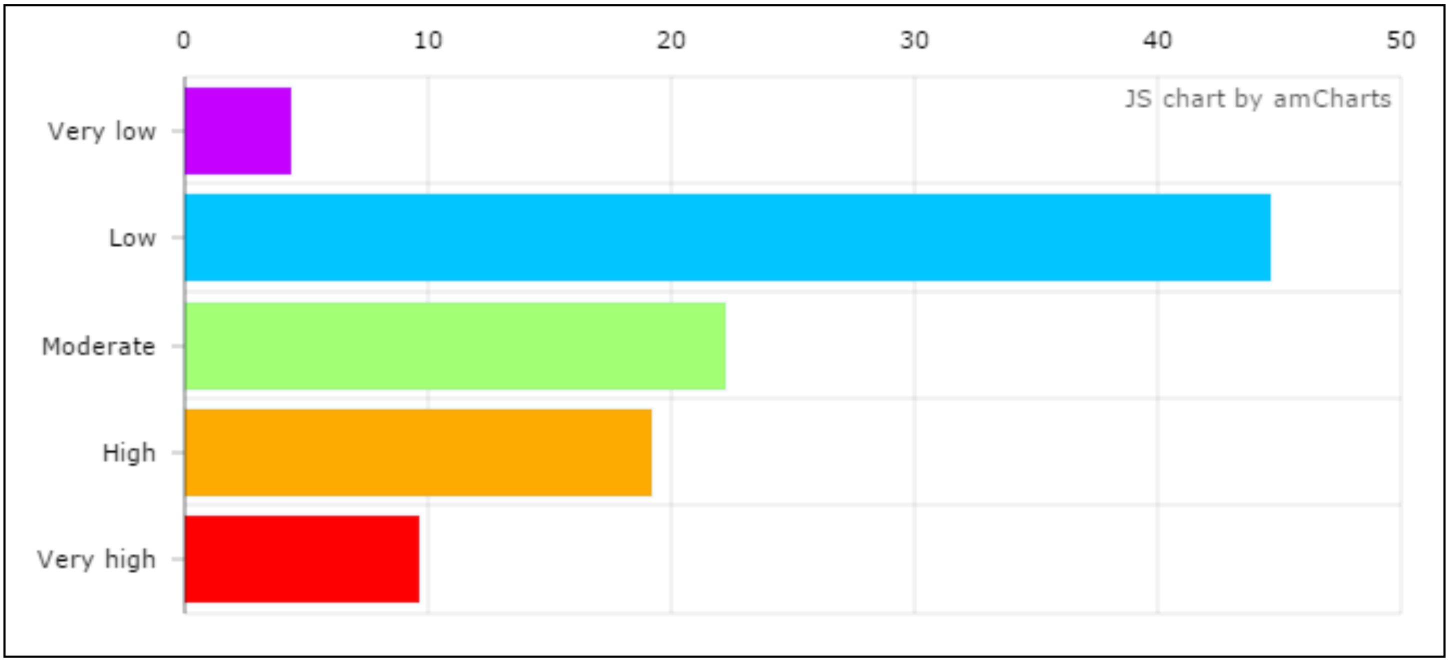
The most severe disturbances associated with the high risk scores were crop and pasture land, stream sediment loading and water withdrawals associated with agricultural practices, and suburban sprawl. All four states had moderate areas with lower risks of habitat degradation, particularly in south and western Arkansas, the south-central, Ozarks portion of Missouri, and portions of central Tennessee. Almost 49 percent of the region was ranked at low to very low risk, mostly in areas without urban development or agriculture, which are in the higher elevation extents of these states that generally have poor soils. When compared to the other regions in the conterminous United States, the threat to aquatic resources in the Central Mississippi States is well above average.

Fun Facts

- There are nine large dams on the 652-mile (1,049-kilometer) Tennessee River. There are another 23 large dams on the tributaries to the Tennessee River.
- Protected areas in the region ensure the recovery of endangered and threatened species of animals and plants, including the Longnose Darter, Ozark Cavefish, and Ozark Cave Crayfish.
- Six large reservoirs were created by dams in the White River Basin, Arkansas, from 1911 through 1960 and required the displacement of a large number of people. Nearly 400 people in Baxter County, Arkansas, were displaced to make way for the reservoir created by the Norfork Dam. The town of Forsyth, Missouri, was relocated in its entirety to a spot 2 miles (3.2 kilometers) from its previous location.
- Ozark rivers and streams are typically clear water, with base flows sustained by many seeps and large springs, and flow through forests along limestone and dolomite bluffs.
- The Neosho National Fish Hatchery, Missouri, was built in 1888 and is the longest-operating Federal fish hatchery.
- Forests that were heavily logged during the early to mid-20th century have recovered and much of the remaining timber in the Ozarks is second-growth forest; however, deforestation of frontier forest and the resulting runoff of excessive sediments have added huge amounts of materials from the hillsides and bluffs into the rivers. This has increased gravel bars along Ozark waterways in logged areas, and as a result stream channels have become wider and shallower along with a loss of deepwater fish habitat.

Habitat Degradation in Inland Streams

(a)



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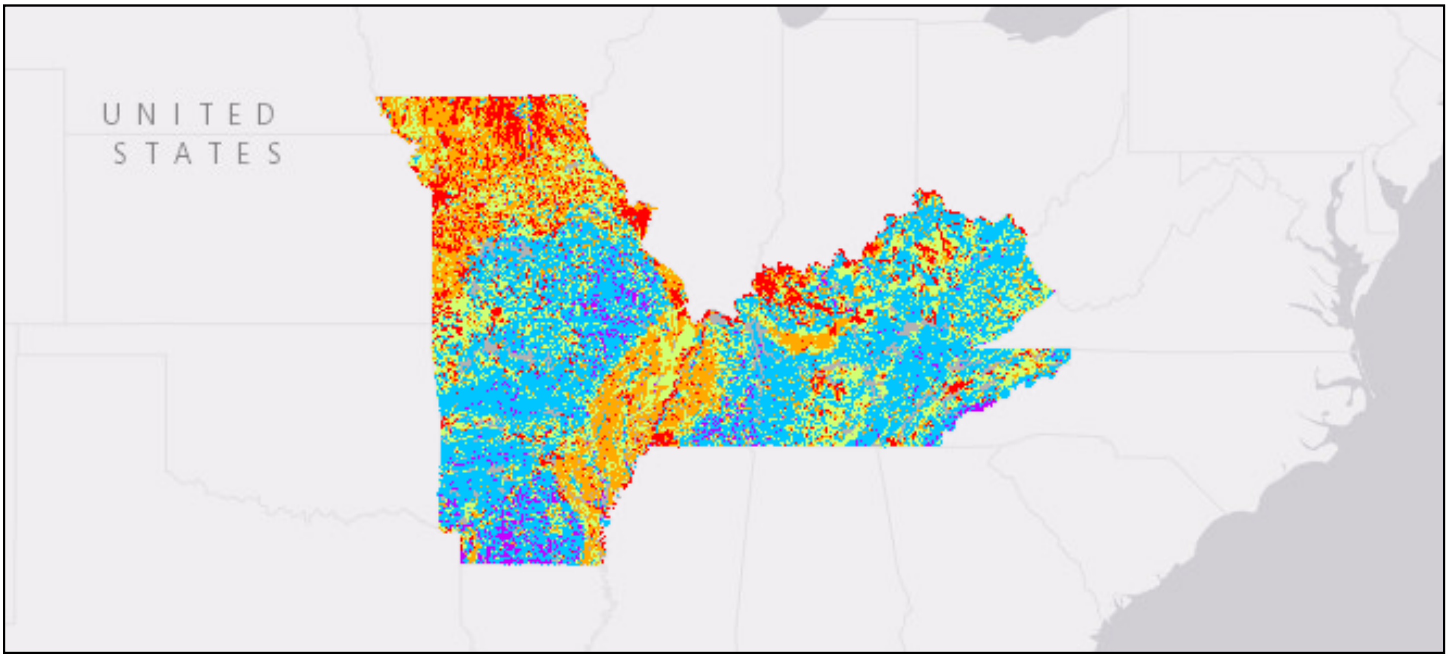

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Most Pervasive and Severe Disturbances for the Central Mississippi River States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Impervious surface cover

•Pasture and hay land use

•Population density

•Road density

•Low intensity urban land use

Top three most pervasive disturbances to **creeks** (<100 km^2 watersheds) **across all** spatial scales **:**

•Impervious surface cover

•Population density

•Road density

Top three most pervasive disturbances to **rivers** (>100 km^2 watersheds) **across all** spatial scales **:**

•Pasture and hay land use

•Upstream dam density

•Mine density.

Top five most pervasive disturbances to **creeks, specific to** spatial scale:

•Road length density in network catchments

•Road crossing density in network catchments

•Impervious surface cover in network catchments

•Low intensity urban in local catchments

•Downstream dam density in network catchments.

Top five most pervasive disturbances to **rivers, specific to** spatial scale:

•Pasture and hay land use in network buffers

•Pasture and hay land use in network catchments

•Upstream dam density in network catchments

•Mine density in network catchments

•Crop land use in network buffers.

Pasture and hay land use makes up the majority of the landscape disturbance leading to the higher risk of current habitat degradation in rivers and streams in this state grouping.

In the Central Mississippi River state group, 48.8% of streams are classified as low or very low risk of habitat degradation.

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat

degradation (red and orange color groups).

Top five overall most severe disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Crop land use

•Pasture and hay land use

•Low intensity urban land use

•Total excessive sediment yield

•Agricultural water withdrawals

Top three most severe disturbances to **creeks** (<100 km ^{2}watersheds) **across all** spatial scales:

•Pasture and hay land use

•Crop land use

•Low intensity urban land use.

Top three most severe disturbances to **rivers** (>100 km ^{2}watersheds) **across all** spatial scales:

•Crop land use

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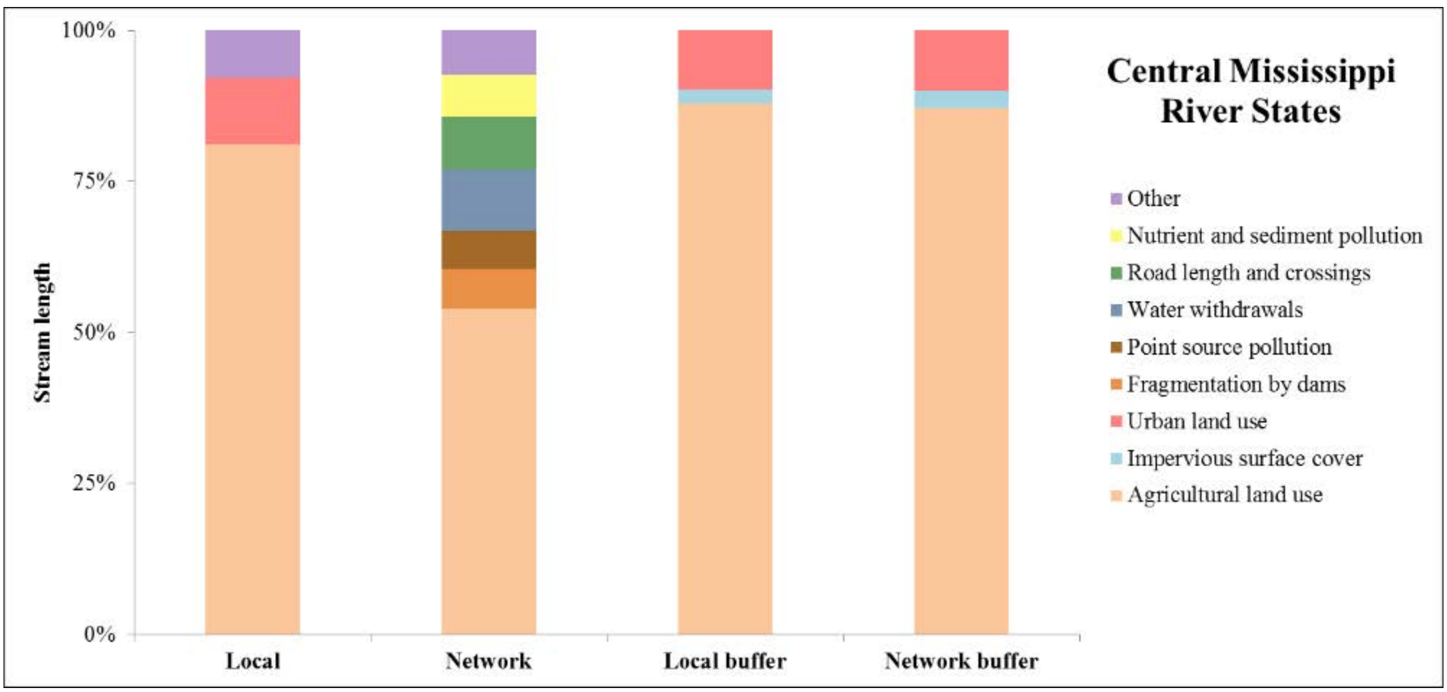
•Upstream dam density.



Most severe disturbances in the Central Mississippi River States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into large groups (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales(local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale; buffers have only urban land use, agricultural land use, and impervious surface cover.

See Detailed Inland Stream Methodologyfor more details.

Agriculture

Kentucky and Missouri rank in the top five states in the number of farms. Cattle and poultry are the most common livestock in the region and corn, soybeans, cotton, tobacco, and rice are among the most frequently grown crops. Rice farming is the dominant agriculture in southeast Missouri and northeastern Arkansas, an area of high risk of stream degradation. Nearly 66 percent of Missouri is farmed and north Missouri, another high risk area, is predominately cattle farms, row crops, and hay fields. Cattle farms account for increased risk of habitat degradation in central and east Tennessee as well as Southern Kentucky. Runoff from agricultural fields carries sediment, fertilizers, and pesticides into tributaries and rivers. The herbicide atrazine, which is heavily used on corn and soybeans throughout this area, is often found in water samples in agricultural regions. Nutrient rich agricultural runoff not only affects local streams but enters the Mississippi River and ultimately creates the " dead zone" the Gulf of Mexico each summer where excess nutrients stimulate algal growth, which in turn depletes available oxygen concentrations in the Gulf of Mexico.

Sedimentation of streams was identified as a severe disturbance in the Central Mississippi States. The Environmental Protection Agency reported that sedimentation was one of the most prominent causes of impairment in the states of this region. The United States Department of Agriculture reported that in 2012 erosion of agricultural land in this region, particularly cultivated land, was significantly higher than the national average. Water erosion caused over five tons of sediment per acre in 2012 to be lost from cultivated land in both Tennessee and Missouri. These soils were transported into local streams and rivers damaging habitats of fish and benthic organisms, reducing biotic productivity, filling small tributaries, and forming unnatural deltas.

Point Source Pollution

Regional industries have contributed significant amounts of oil, metals, and other industrial wastes such as sulfur dioxide, hydrogen sulfide, and benzene to the Mississippi River. Imperiled waters abound in Missouri and metals such as lead, zinc, and cadmium were historically released into streams from mines in multiple counties, particularly in the old lead mining belts. Over 1,321 miles of Tennessee rivers and streams, 1,507 miles in Kentucky, and 1,493 miles in Arkansas were impaired in 2012 due to release of metals, pesticides, and PCBs. Many chemicals, such as PCBs, have been banned for decades but persist in suspended and bottom sediments of aquatic environments. Poorly treated sewage and wastewater is also a concern because it contributes bacteria and detergents to the river water. The US Environmental Protection Agency reported that 7,365 miles of rivers and streams were impaired by pathogens in Tennessee in 2012. Restoration activities from 2010 to 2015 resulted in significant improvement in 112 rivers and streams in the region so that they were no longer impaired.

Habitat Trouble for Checkered Madtom in Central Mississippi River States

The **Checkered Madtom** (*Noturus flavater*) is found in moderate to high gradient, clear, small to medium rivers with strong flow and uses deeper, quiet pools or backwaters of these streams. This type of habitat has been eliminated from part of its former range in the White River, Arkansas, due to dam construction.

Habitat Trouble for Ozark Cavefish in Central Mississippi River States

The **Ozark Cavefish** (*Amblyopsis rosea*) is found in specific cave systems with clean flowing groundwater. These systems suffer from human use of and (or) alterations to the cave systems. Recreational cavers can damage the cave ecosystem or interrupt breeding, causing this species to leave the cave, unlikely to return. Some caves have been flooded by the creation of reservoirs or have dried up because of lowered water tables from excessive groundwater pumping or water diversion.

Ozark cavefish*(Amblyopsisrosae)*

Habitat Trouble for Ozark Shiner in Central Mississippi River States

The **Ozark Shiner** (*Notropis ozarcanus*) requires creeks and small rivers with gravel or rocky bottoms and strong, permanent flow. The Ozark Shiner has disappeared from many stream reaches that are below impoundments and receive cold-water releases. These dams and reservoirs also serve as barriers that prevent colonization of suitable habitat. Increases in turbidity, siltation from land practices, gravel removal operations, and nutrient enrichment from poultry and swine farms are additional threats to this unique minnow species.

Habitat Trouble for Paddlefish in Central Mississippi River States

The **Paddlefish** (*Polyodon spathula*) has declined across its entire range due largely to loss of breeding habitat and overharvest, with much of it as illegal harvesting for caviar. Although conservation efforts have stabilized this species in the Central Mississippi States, a continued decline is expected due to overharvest, introduced species (particularly Asian Carp), and pollution. Other threats include channelization and dam construction that have blocked seasonal migration to suitable spawning sites which isolates individual populations and lead to breeding issues. Some characteristics of its life history, such as length of time to reach sexual maturity, make it susceptible to decline and slow to recover.

Fish Habitat Partnership Activities for the Central Mississippi River States

Partnerships - Reservoir Fisheries Habitat Partnership, Southeast Aquatic Resources Partnership, and Fishers and Farmers Partnership

1. Partners improved 10 miles shoreline and 150 acres of cove habitat in Arkansas.
2. Cooperators planted and protected about 22,000 native plants, removed 8,000 acres of invasive plants, and constructed 60 brush or rock piles in Arkansas reservoirs.
3. Provided improvement for 1,875 feet of reservoir shoreline habitat in Missouri.
4. Funded efforts to install 30 brush piles in Mozingo Lake, Missouri.
5. Worked with farmers in the Peno Creek Watershed, Missouri to develop innovative practices that benefited both natural resources and farmers.

For more about specific waters and projects the Central Mississippi Fish Habitat Partnerships are working on, please see the following locations:

- Harpeth River, TN – see featured article
- Green River, KY – see featured article
- Table Rock Lake, Missouri
- Meramec River Basin, Missouri
- Upper Duck River, Tennessee

Harpeth River, Tennessee - Low dam removal

Partnership - Southeast Aquatic Resources Partnership

The Harpeth River drains nearly 900 square miles in middle Tennessee and flows through one of the fastest growing regions in the country. It is a state designated Scenic River in Davidson County, within 30 minutes of downtown Nashville. The river is one of the most archeologically and historically significant rivers in the state. However, the project area was listed on the U.S. EPA Section 303(d) list for siltation and habitat alteration, nutrient enrichment and low dissolved oxygen. Low dissolved oxygen was particularly an issue above a 6.2 foot low head dam near Franklin, Tennessee. Dissolved oxygen measurements at this dam were below state standards, and fish are unable to migrate freely past this barrier. In the headwaters, agricultural activity and failing septic systems are the primary causes for low dissolved oxygen, siltation and habitat loss.

The Harpeth River is incredibly biodiverse. Below the low head dam site, 54 species of fish have been recorded, as well as two federally listed endangered species of mussel (the ***Tan Riffleshell -*** *Epioblasma florentina walkeri and the* ***Pink Mucket Pearlymussel -*** *Lampsilis abrupta). Restoring the river to a free-flowing state was crucial to the survival of these species as nearly all of them need good water quality and the ability to migrate freely. The Harpeth River Watershed Association (HRWA) secured $350,000 from collaborative funding programs of the U.S. Fish and Wildlife Service, Southeast Aquatic Resources Partnership, and the National Fish Habitat Partnership and $70,000 from the city of Franklin that together were used to improve fish habitat and water quality and remove the fish passage barrier. The project was completed in April 2013, removing the only fish movement barrier on the Harpeth River. The dam was replaced with a double cross-vane low boulder structure, which rehabilitated two miles of river habitat, reconnected 36 miles of river, and restored riffle/run aquatic habitat that was formerly submerged. Eroding banks were stabilized and vegetation was planted in the previously impounded area, reducing the sediment load from this unnatural erosion. Restoration efforts improved dissolved oxygen levels and benefited species of concern found in the sub-watershed. Additionally, a canoe access was installed that has allowed additional public access to this unique gem.*

This project was given the 2013 Governor's Environmental Stewardship Award as well as the National Fish Habitat Partnership "10 Waters to Watch" Award for the year 2012. The removal of this dam has made the Harpeth River one of the only rivers in Tennessee that is entirely free flowing through its entire length.

Green River Wildlife Management Area, Kentucky - Green River Enhancement

Partnership – Southeast Aquatic Resources Partnership

The Green River and Green River Lake provide aquatic habitat in the Green River Wildlife Management Area near Campbellsville, KY. The river is in declining condition due to severe erosion over almost four decades. Its rehabilitation will allow it to support improved populations of white bass, smallmouth bass, rock bass, flathead catfish, walleye, and muskellunge along with providing important sportfishing opportunities for anglers.

A 1,400 linear foot section of the river bank was chosen as the site for restoration, due to its rapid rate of erosion - a rate of 20 feet per year. Sediment loss from this section of the river bank fell into the river and eventually moved into Green River Lake. The adjacent field historically was used as cropland and more recently managed for wildlife habitat and public access/use.

This project stabilized 1,400 feet of outside bank of the Green River in Adair County, Kentucky. This was accomplished by using rock and log structures to divert flow and alleviate bank stress, creating a more stable flow pattern while providing habitat for fish. Stabilization techniques included the construction and installation of a bankfull bench, terrace grading, rocktoe protection, erosion control blanket, and riparian zone plantings. The riparian zone plantings included 1,550 live stakes of black willow, dogwood, and buttonbush. In addition, the KDFWR Wildlife Division reforested the adjacent field with several mast producing species. The site continues to be stable and the planted riparian vegetation has been successful. The project has stopped the excessive erosion and reduced sediment loading into the Green River.

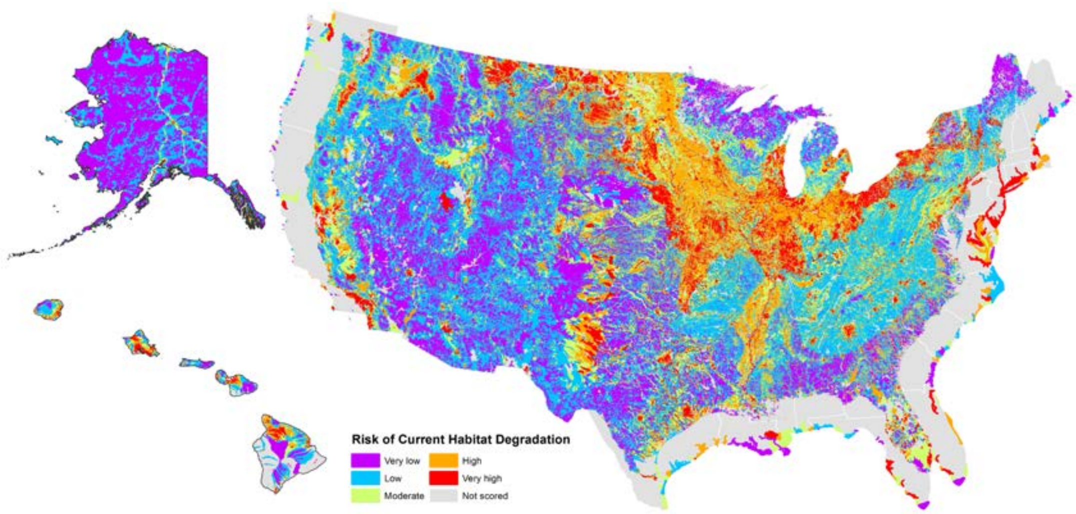
Eastern Gulf of Mexico States Region

from

Through a Fish's Eye:

The Status of Fish Habitats in the United States

2015



Steve Crawford[1], Gary Whelan[2], Dana M. Infante[3], Kristan Blackhart[4], Wesley M. Daniel[3], Pam L. Fuller[5], Tim Birdsong[6], Daniel J. Wieferich[5], Ricardo McClees-Funinan[5], Susan M. Stedman[7], Kyle Herreman[3], and Peter Ruhl[5]

[1] Retired Florida Fish and Wildlife Conservation Commission

[2] Michigan Department of Natural Resources

[3] Michigan State University, Department of Fisheries and Wildlife

[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Eastern Gulf of Mexico States Region

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Regional Summary

The landscape of the Eastern Gulf of Mexico States ranges from the plateaus and highlands of northern Alabama to the coastal marshes along the Gulf, with the dominant inland forest type being pine and oak forests. This variety of habitats allows for a high diversity of fish species as evidenced by Alabama alone being home to more than 450 fish species. Over 64 percent of the inland fish habitat of Eastern Gulf Coast states is estimated to be at low or very low risk of degradation. While only 19 percent of the stream area in this region was estimated to be at high or very high risk, factors that threaten aquatic resources in the region are diverse and significant areas have been substantially altered as a result of agriculture and urban expansion. Louisiana has experienced major changes in water flow patterns and movement (hydrology – a key habitat-forming process) as a result of both the levees built along the lower Mississippi River and the channels dredged through the Mississippi River Delta.

Urban sprawl highly influenced assessment results in the Eastern Gulf Coast states and the state most affected by development was Florida, with a human population that ranked third nationally in 2014. The urban centers of New Orleans/Baton Rouge, Jackson, Mississippi, and Birmingham, Alabama also had negative influences on surrounding areas of fish habitat.

The coast of the Eastern Gulf States also varies greatly and includes the Atlantic beaches of Florida, warm-water coral reefs in South Florida, Gulf beaches in all four states, mangrove forests of southern Florida, vast seagrass meadows on both coasts of Florida, salt marshes and oyster reefs throughout the region , barrier islands, and large bays. Based on the results of the national estuary assessment update, 35% of the estuarine area of the Eastern Gulf states were estimated to currently be at low or very low risk of fish habitat degradation and were typically found in areas of limited development. In contrast, 25 percent of the region's coast was determined to be at least high risk. The majority of the highly critical areas were typically located in dense urban areas, such as the bays of Sarasota and Tampa in Florida and Lake Pontchartrain near New Orleans. Several exceptions were the remote Upper Ten Thousand Islands in southwestern Florida and the Lower St. Johns River in northeastern Florida. While nitrogen loading threatens both areas, altered river flow patterns are also expected to negatively influence the Ten Thousand Islands, and land cover and pollution increased risk estimates for the St. Johns River.

Additional information on the status of estuaries along the Gulf Coast are available in a separate section detailing the results of the detailed regional estuary assessment for the northern Gulf of Mexico. This separate detailed assessment uses a different methodology from the national scale assessment and the results are therefore not directly comparable to those presented here. Although not explicitly investigated in this assessment due to data limitations, climate change and specifically sea level rise is recognized as a significant threat to Gulf Coast states. For example, 1.3 million homes in Florida are less than 4 feet above sea level, preventing coastal fish habitat from migrating upland with rising sea levels. Because of this, climate change not only threatens coastal human communities but coastal fish communities.


Gores Landing Unit of Ocklawaha River.

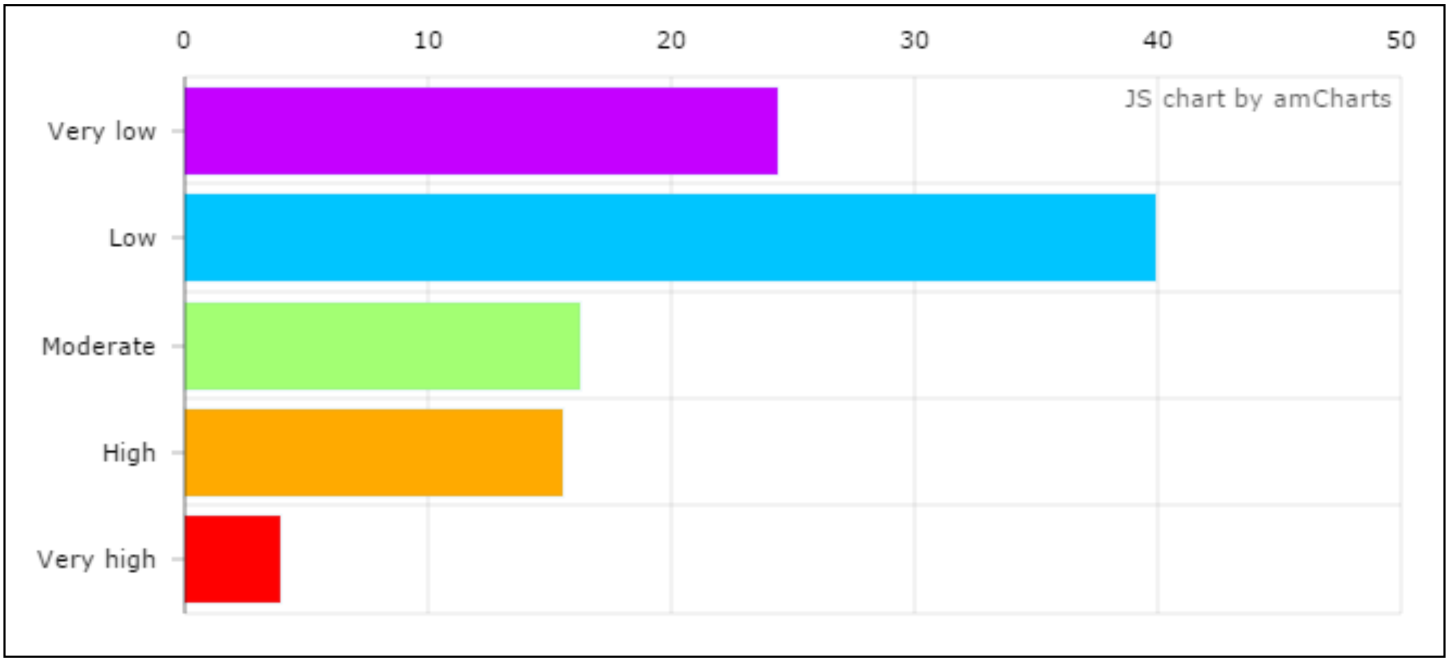
Fun Facts

- Mississippi designated the Largemouth Bass as the official State fish in 1974, and it is the State freshwater fish in Florida, Alabama, and Georgia.
- The Pascagoula River is a unique resource because it is the only nearly completely free flowing (undammed) river in the region. With more than 10 cubic kilometers (2.4 cu mi) of water flowing per year into the Gulf of Mexico, it is the largest (by volume) undammed river in the contiguous 48 States. In fact, it is also the largest undammed river in the warm, humid region (Köppen climate classification zone), with southeastern Brazil claiming the second and third largest rivers in the climate zone. As a result, there continues to be a concerted effort to prevent dam construction on the Pascagoula River.
- The Pascagoula is often called the "Singing River." According to legend, the peace-loving Pascagoula Indian tribe sang as they walked hand-in-hand into the river to avoid fighting with the invading Biloxi tribe. It is said that on quiet nights you can still hear them singing their death chant.
- The Mississippi Sound extends from Louisiana to Alabama, spanning the entire Gulf coast of the State of Mississippi. The Sound is separated from the Gulf of Mexico by a series of narrow islands and sand bars including Cat, Ship, Horn, Petit Bois, and Dauphin Islands. Water exchange with the Gulf takes place through many passes. Numerous coastal bays are contained within the system including St. Louis Bay, Biloxi Bay, Pascagoula Bay, and Grand Bay. The Escatawpa, Pascagoula, Tchoutacabouffa, Biloxi, Wolf, and Jourdan Rivers (east to west) provide freshwater to the estuary.
- The Mississippi Department of Natural Resources maintains more than 20 marine reserves in the Mississippi Sound.
- The Tallapoosa River, especially its lower course, was a major Creek Indian population center before the early 19th century. The contemporary name of the river is from the Creek words "Talwa posa," which means Grandmother Town. The Creek Indians consider the Tallapoosa branch of their tribe to be one of the oldest.
- The Coosa River is one of Alabama's most developed rivers. Most of the river has been impounded by dams that produce hydroelectric power but also negatively affect some species native to the Coosa River.
- In the Middle Coosa River Watershed, 281 occurrences of rare plant and animal species and natural communities have been documented, including 73 occurrences of 23 species that are federally or state protected.
- According to research, 26 of the 82 species of aquatic gastropods historically known to live in the Coosa River Basin are now considered extinct. In 2014, the U.S. Fish and Wildlife Service listed two snails and one mussel found in the Coosa River drainage system as endangered: the Georgia Pigtoe mussel, the Interrupted Rocksnail, and the Rough Hornsnail. In 2004, Alabama Department of Conservation and Natural Resources researchers discovered two snails that were previously thought to be extinct, the Coosa Elimia and the Teardrop Elimia, in a stretch of the Coosa River below Lake Neely Henry.

- The Georgia Department of Natural Resources has been recently reestablishing Lake Sturgeon in the upper Coosa River system, which were abundant until the early 1900s. Only remnant populations could be found in the 1960s and these subsequently disappeared.
- North American freshwater mussels have the highest diversity in the Southeastern United States, particularly in Alabama (180 species), Tennessee (approximately 130 species), and Georgia (approximately 126 species). Alabama, with about 180 species, has one of the richest and most diverse assemblages of mussels in the world. Approximately two-thirds of North American mussel species have been reported from Alabama.
- Mangrove wetlands along the South Atlantic coast are limited to Florida because of their sensitivity to freezing temperatures and include all three main species of mangroves: red mangrove, black mangrove, and white mangrove.
- Tampa Bay is the largest open-water estuary in Florida, but has an average depth of only 12 feet (3.7 meters). More than 200 species of fish are found in Tampa Bay. Each square meter of bay sediment contains an average of 10,000 animals. Ships carry more than 4 billion gallons (15 thousand cubic meters) of oil, fertilizer components, and other hazardous materials through Tampa Bay each year.

Habitat Degradation in Inland Streams

(a)



(b)

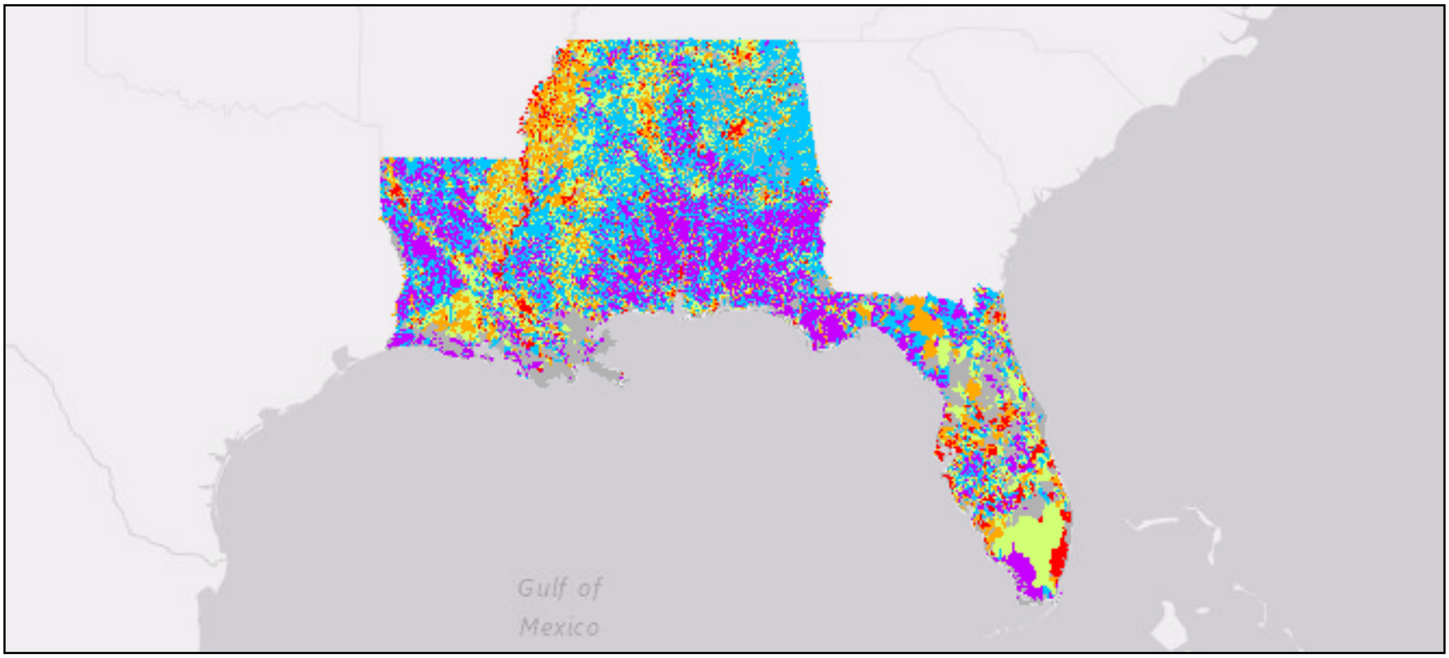
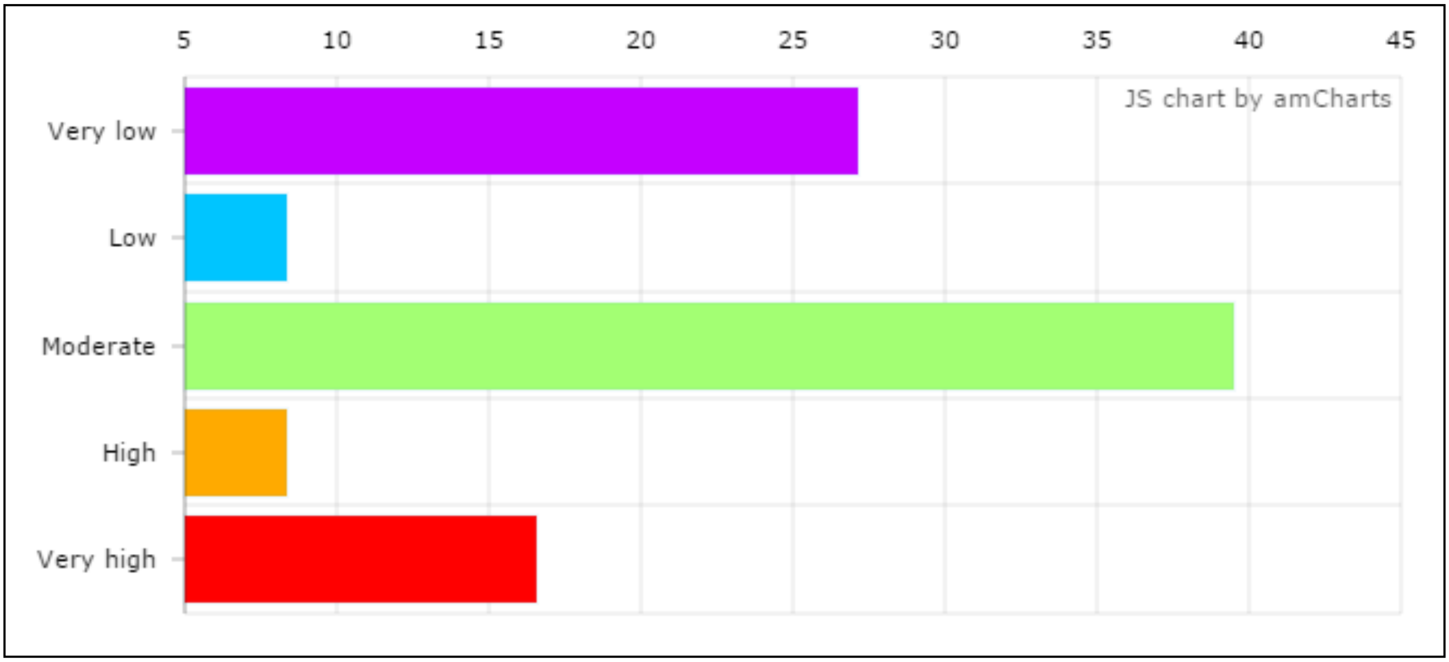


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Habitat Degradation in Estuaries

(a)



(b)

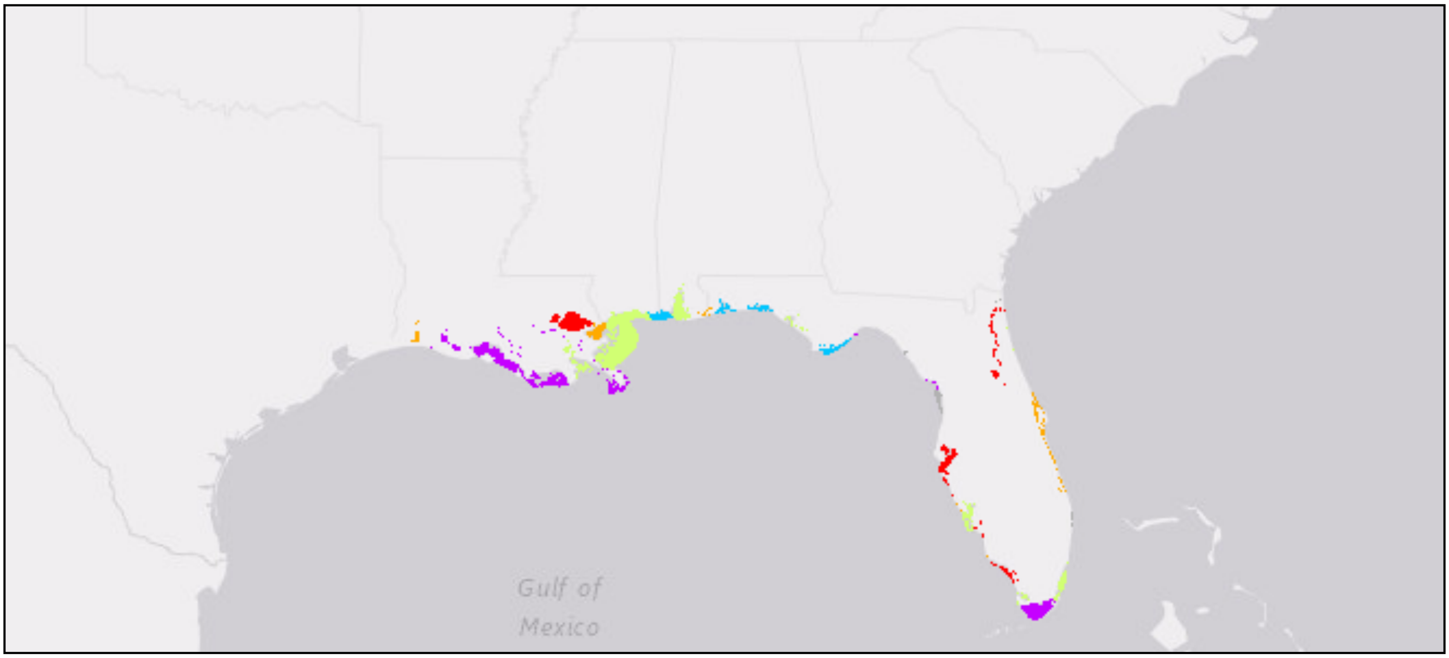


Figure1: This interactive figure summarizes the risk of fish habitat degradation. The currently selected tab shows data from the national estuary assessment. (a) Relative condition of fish habitat in estuaries. Estuary summaries represent percentage of total estuary area in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all estuary condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the national estuary assessment.

Most Pervasive and Severe Disturbances for the Eastern Gulf of Mexico States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Total excessive (anthropogenic or man caused) sediment yield

•Impervious surface cover

•Road crossing density

•Population density

•Pasture and hay land use

Top three most pervasive disturbances to **creeks** (<100 km^2 watersheds) **across all** spatial scales **:**

•Total excessive sediment yield

•Impervious (hard) surface cover

•Road crossing density

Top three most pervasive disturbances to **rivers** (>100 km^2 watersheds) **across all** spatial scales:

•Upstream dam density

•Pasture and hay land use

•Impervious surface cover

Top five most pervasive disturbances to **creeks, specific to** spatial scale:

•Excessive sediment yield in network catchments

•Road crossing density in network catchments

•Impervious surface cover in network catchments

•Crop land use in local buffers

•Downstream dam density in network catchments

Top five most pervasive disturbances to **rivers, specific to** spatial scale:

•Upstream dam density in network catchments

•Pasture and hay land use in network catchments

•Pasture and hay land use in network buffers

•Impervious surface cover in network catchments

•High intensity urban land use in network catchments

In the Eastern Gulf of Mexico state group, 64.4% of streams are classified as low or very low risk of habitat degradation.

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat degradation (red and orange color groups).

Top five overall most severe disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Crop land use

•Pasture and hay land use

•Upstream dam density

•Total excessive sediment yield

•Low intensity urban land use

Top three most severe disturbances to **creeks** (<100 km ^{2}watersheds) **across all** spatial scales:

•Crop land use

•Pasture and hay land use

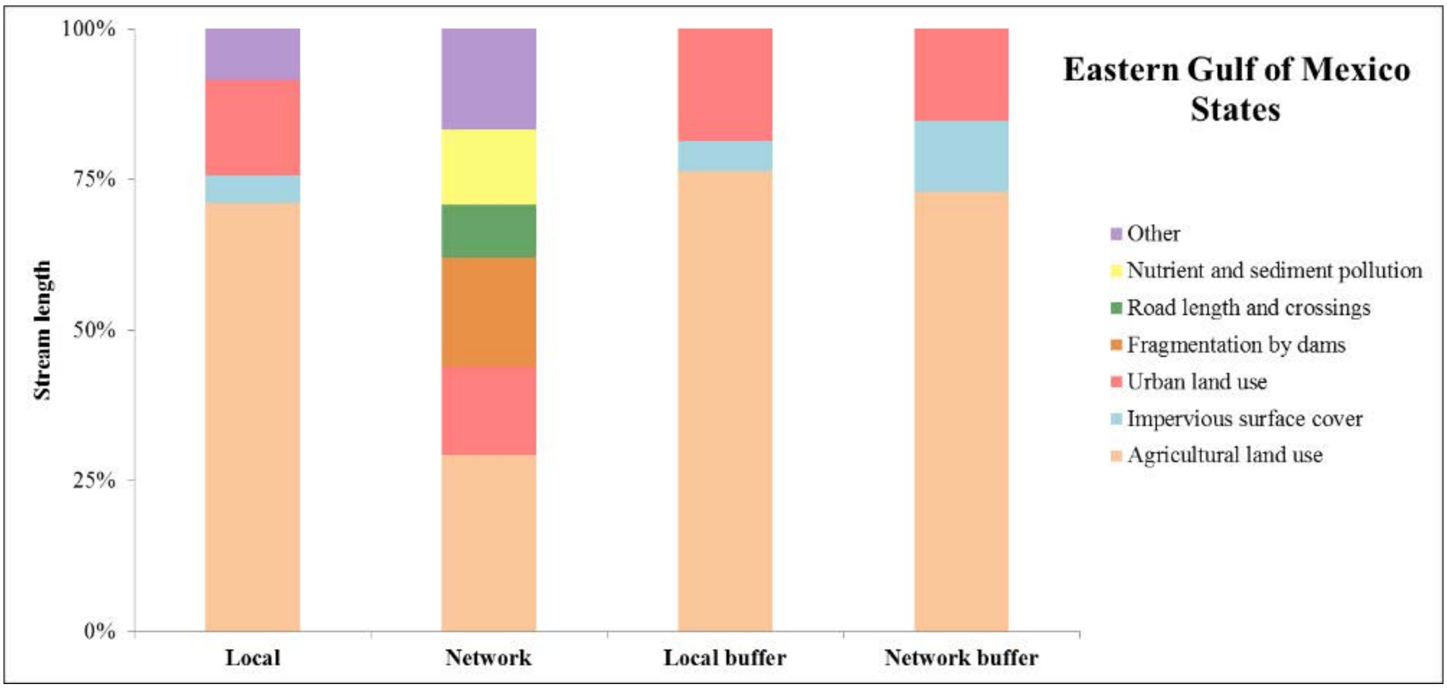
•Total excessive sediment yield.

Top three most severe disturbances to **rivers** (>100 km ^{2}watersheds) **across all** spatial scales:

•Upstream dam density

•Pasture and hay land use

•Crop land use



Most severe disturbances in the Eastern Gulf of Mexico States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into super categories (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales(local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale; buffers have only urban land use, agricultural land use, and impervious surface cover. See Detailed Inland Stream Methodologyfor more details.

NATIONAL FISH HABITAT PARTNERSHIP

Agriculture

Agriculture is the primary land use in these states. A wide variety of row crops are grown throughout the region and there is also a substantial amount of managed industrial forests. Dominant crops are soybeans and corn in Louisiana, peanuts and cotton in Mississippi and Alabama, and citrus and sugarcane in Florida. Cattle farms are common in Mississippi, Alabama, and Florida. Rice is a major commodity in Louisiana and Mississippi. Aquaculture is also a significant practice in all four states and can alter wetland habitat, water flow patterns, and discharges nutrients into these systems. Phosphate mining (for fertilizer) in wetland areas throughout Florida has interrupted natural water flow and breaks in retention dikes have seriously impaired rivers, such as the Peace River east of Sarasota. Although the Eastern Gulf Coast states have a greater supply of water than the West, agricultural practices place high demand on both surface and groundwater supplies. In addition, the resulting runoff from farms carries high nutrient loads and pesticides into waterways.

The Mississippi River drainage area through Mississippi and Louisiana, as well as southwest Louisiana, southern Mississippi, and south-central Florida have been seriously altered by agriculture and were estimated to have a high risk of habitat degradation. It has been estimated that 70 percent of the nitrogen and phosphorous that enters the Gulf of Mexico is contributed by agriculture.

The draining of the Everglades to create the Everglades Agricultural Area is another example of the direct effects of agriculture on fish habitat in the eastern Gulf of Mexico. In addition to the physical loss of valuable and rare aquatic habitat, the agricultural activities in this area release sediments and nutrients into Everglades National Park and Florida Bay. These activities create algal blooms, and when these blooms die and decompose, low oxygen zones result. Furthermore, alteration of natural water flow patterns has resulted in a “dead zone” in Florida Bay, where salt concentrations are much higher than seawater (Kelble et al. 2007), and has also led to excessive freshwater in estuaries on both coasts.

Urban Land Use

Miami, Tampa, Orlando, and Jacksonville rank in the top 50 largest cities in the nation by area. Atlanta and New Orleans are the only other top 50 cities in the Eastern Gulf States region. These four Florida urban centers anchor what is known as the Florida Megaregion, one of eleven recognized in the United States. New Orleans and Baton Rouge are part of the Gulf Coast Megaregion. The growing urban sprawl throughout the Gulf States leads to increasing areas of impervious surface, which results in altered water flows and more urban runoff that transports high levels of nutrients and pollution to aquatic resources. For example in central Mississippi, pathogens, litter/trash, nutrients, and pesticides from increasing urban development were identified as threatening aquatic habitats.

Expanding development also increases the number of roads with associated river/stream crossings and water control in wetlands, which disrupt stream flow and connectivity. Natural water flow patterns in South Florida have been completely altered. These systems have been essentially re-plumbed, first to support agriculture and flood control and more recently to support municipal water demands. 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 Shreveport. The roads and development along this urban corridor contribute pollutants to the wetlands in the area, including the Atchafalaya Swamp. Finally, the dredging and hardening of coastal environments to facilitate transportation destroys native habitats and allows salt water to advance further upstream, which will likely occur in the St. Johns River in northeastern Florida as Jacksonville deepens its port.

Another facet of the influence of urban communities on aquatic habitats is pet owner release of exotic species, which alters energy flow in aquatic systems, a key habitat forming process. The exotic plant, *Hydrilla*, which has infested a significant portion of the country, was initially released from an aquarium in Florida and has drastically altered fish and native plant communities nationally, impeded recreational use, threatened water control and bridge structures, and costs an immense amount of money to control. Various non-native lizards have denuded waterways of emergent plants and caused erosion and sedimentation problems in South Florida. A popular saltwater aquarium fish, the Lionfish *Pterois spp.,*is now established in the Gulf of Mexico, Caribbean, and South Atlantic and is decimating some native reef fish species, substantially altering food webs and putting additional stress on coral reef ecosystems.

Habitat Trouble for Alabama Sturgeon in Eastern Gulf of Mexico States

The **Alabama Sturgeon** (*Scaphirhynchus suttkusi*) has suffered from habitat loss and fragmentation caused by dredging for navigation, peaking hydropower projects, and dam construction. This species requires clean hard substrate with stable daily flows for spawning, and needs connected river reaches for long-distance spawning migrations. Both of these needs have been disrupted by human activities in their range. This fish has disappeared from about 85 percent of its historic range in the Alabama and Tombigbee River systems. The Alabama Sturgeon was placed on the endangered species list in 2000.

Habitat Trouble for Alligator Gar in Eastern Gulf of Mexico States

Historical pictures and accounts document the substantial decline of **Alligator Gar** (*Atractosteus spatula*) throughout its range. A number of factors likely contributed to the decline, including angler overharvest and habitat loss resulting from dredging and damming southern rivers. Alligator Gar was a highly sought sport and commercial fish by some but was targeted for eradication or control by others as a “trash fish.” Studies in Alabama, Mississippi, and Louisiana have shown that the Alligator Gar is susceptible to overfishing. It has been classified as rare in Missouri, threatened in Illinois, and endangered in Arkansas and Kentucky, and is expected to soon to be classified as endangered in Tennessee. Populations in Louisiana are considered to be stable and healthy.

Alligator Gar *(Atractosteus spatula)*

Habitat Trouble for Bluenose Shiner in Eastern Gulf of Mexico States

The **Bluenose Shiner** (*Pteronotropis welaka*) inhabits a variety of habitats from backwaters and swamps to spring-run streams. It is often found in deep pools with aquatic vegetation. Population losses have been observed where either aquatic or streamside vegetation was removed. Other threats include changes in water quality and quantity, impoundments, dredging, urbanization, and both point source and non-point source pollution.

Bluenose shiner *(Pteronotropiswelaka)*

Habitat Trouble for Gulf Sturgeon in Eastern Gulf of Mexico States

The **Gulf Sturgeon** (*Acipenser oxyrinchus*ssp. *desotoi*) as the name implies lives in the estuaries of the Gulf of Mexico but migrates up coastal rivers to spawn (anadromous). It is found in rivers from spring until fall and in the Gulf during the winter. It feeds heavily while in the Gulf, but adults eat very little (or not at all) while in the rivers. The species declined dramatically after the late 1800s. It fell victim to overharvest for its meat and roe, dam construction, and dredging activities. The largest population is currently in the Suwannee River in Florida.

Fish Habitat Partnership Activities for the Eastern Gulf of Mexico States

Partnerships - Atlantic Coastal Fish Habitat Partnership, Reservoir Fish Habitat Partnership, and Southeast Aquatic Resources Partnership

1. Almost 10,000 ft (over 15,000 plantings) of native mangrove and salt marsh plants, as well as oyster shells were put in the Atlantic-side estuaries of Florida. These plantings helped to stabilize sediment and shoreline, improve water clarity, provide nesting areas for birds such as the Roseate Spoonbill, and provide habitat for species such as Red Drum, Tarpon, Mangrove Snapper, and snook. In addition, five acres of invasive Brazilian pepper trees were removed to allow for native plantings.
2. Fish Habitat Partnerships provided funding for: the creation of 750 acres of wetland, planting over 17,200 native trees, and removing 50 acres of invasive Brazilian pepper tree that were all done in conjunction with building a new reservoir in Fellsmere, Florida.

For more about specific waters and projects the **Eastern Gulf of Mexico** Fish Habitat Partnerships are working on, please see the following locations:

•Mackeys Creek, Mississippi – see featured article
•Tolomato River Coastal Restoration Project, Florida – see featured article
•Ulele Springs (Hillsborough River), Florida
•Chipola River, Florida
•Jefferson Parish-Lafitte Terrace-Barataria Bay Marsh Establishment, Louisiana
•Whitewater to Bluewater Project
•Friends of Reservoirs Organization

Florida - Tolomato River Coastal Restoration Project

Partnerships - Southeast Aquatic Resources Partnership and Atlantic Coastal Fish Habitat Partnership

Both the Southeast Aquatic Resources Partnership (SARP) and Atlantic Coastal Fish Habitat Partnership (ACFHP) supported marsh restoration/living shoreline projects on the Tolomato River in the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR) near St. Augustine, Florida. These projects are located on the southern portion of the Guana Peninsula and are creating a contiguous swath of restored marsh that is: improving and enhancing fish habitat; preventing shoreline erosion; and fostering opportunities for community stewardship and involvement that will provide benefits for years to come.

The near shore of the Guana Peninsula along the Tolomato River in northeast Florida has provided habitat for the Eastern Oyster, Crassostrea virginica, for centuries. In recent years, the frequency and density of oyster reefs in the area have dwindled significantly. As in many coastal and estuarine areas, the effects of over-harvesting, the expansion of human occupancy near the waterways, water pollution, and increasing wave action as a result of river traffic and channel dredging along the Intracoastal Waterway have reduced the habitat for these important shellfish and associated species. The disappearance of oyster reefs along the southern portion of the Guana Peninsula has created a domino effect of environmental destruction, with the elimination of the reefs contributing to the breakdown of the Spartina alterniflora(cord grass) salt marsh, and the disappearance of Spartina allowing shoreline erosion to eat away at the upland habitat as well.
Specifically, the goals of the SARP/NOAA Cooperative Research Program (CRP) funded project were to:

1. Restore shellfish habitat to sustain and improve ecological benefits and ecosystem services;
2. Improve habitat hydrology and riparian areas of estuarine and inshore habitats to benefit threatened and endangered marine species or species of concern associated with the watershed including the Shortnose Sturgeon (*Acipenser brevirostrum* - endangered), Atlantic Sturgeon (*Acipenser oxyrinchus* – candidate for listing), and the Opossum Pipefish (*Micropphis brachyurus* – species of concern) among others;
3. Establish an oyster recycling program for the GTMNERR region; and
4. Provide educational and community service opportunities for St. Johns Technical High School Students.

The SARP project (2012 to 2014) successfully resulted in the construction of 0.071 acres of oyster reef, 1.8 acres of restored salt marsh, and 1.16 acres of enhanced benthic habitat. The project also fostered the development of a successful oyster shell recycling program in St. John's County that through 2015 had reclaimed a total of 185,643 lbs. from participating restaurants and an additional 40,485 lbs. from other local donations for a grand total of 226,128 lbs. of oyster shell. Through the work and dedication of many, this reclaimed shell was saved from the county landfill, was used to *build and restore shoreline within the Reserve, and is now the source for more research and providing material for upcoming restoration efforts.*

The ACFHP project (2013 to 2015) used students from two universities and volunteers to monitor and construct more than 1,000 linear feet of eroding shoreline with a living shoreline (using oyster shell reefs and coconut fiber logs). These were constructed separately to allow analysis of their relative effectiveness on: erosion reduction; sediment capture and enhancement of success of Spartina plantings; marsh accretion; and fish and invertebrate habitat usage by researchers and volunteers. Unfortunately, wave action destroyed most of the fiber logs but researchers were able to develop an alternative approach and reconstructed the site with oyster bags.

The SARP and ACFHP projects reduced shoreline erosion and rehabilitated a damaged salt marsh. Ongoing monitoring is showing that there has been a positive trend in both the abundance of animals and species richness at the project site over time and that oysters quickly recolonized the constructed oyster reefs.

The level of community involvement through the participation of volunteers on the project was outstanding. The SARP/NOAA CRP project, included the participation of: 489 volunteers (3,238 hours) doing the on-the-ground restoration; outreach and education in the classroom with St. John's Technical High School student volunteers (estimated at 930 hours); and restaurant staff participation in collecting oyster shells (3,097 hours). The students and volunteers on the ACFHP project contributed 874 hours of time towards installment of materials and monitoring.

Partners:
SARP/NOAA CRP Project *- Friends of the GTM Reserve, GTMNERR, St. Johns County School District/St. Johns County Technical High School, SARP, NOAA*

ACFHP/NFHP/USFWS Project *- Friends of the GTM Reserve, GTMNERR, University of North Florida, Bethune Cookman University, ACFHP, US Fish &Wildlife Service*

http://fishhabitat.org/partnership/southeast-aquatic-resources-partnership
http://fishhabitat.org/partnership/atlantic-coastal-fish-habitat-partner...


University of North Florida

Mackeys Creek, Mississippi - Restoration Project

Partnership **-** *Southeast Aquatic Resources Partnership*

A population of the Gulf Coast strain (GCS) of Walleye (Stizostedion vitreum) in Mackeys Creek, a headwater stream of the Tombigbee River, had been in decline since the 1970s. Due to downstream modifications of the stream channel, the stream bank had washed out and excessive sedimentation (a key process that forms and controls fish habitat) has degraded habitat and reduced water quality, which did not support spawning or juveniles. Additionally, the existing habitat compromised a number of native species including the Crystal Darter, Alabama Hog Sucker, Southern Sand Darter, Tombigbee Darter, Rock Darter, Freckled Darter, and Spotted Bass.

The Southeast Aquatic Resources Partnership (SARP), under the National Fish Habitat Action Plan through the Mississippi Department of Wildlife Fisheries and Parks (MDWFP) developed a restoration plan to improve the spawning and rearing habitat by stabilizing a section of stream bank and stopping a head cut from advancing upstream. The cooperative project was completed with the U.S. Fish and Wildlife Service's Pvt. John Allen National Fish Hatchery assistance to stabilize a section of stream bank and improve habitat for GCS Walleye on Mackeys Creek in Prentiss County.

A 80-ft long rock dike was constructed, with fill material backfilled behind it to restore the natural slope. The bank was seeded, and planted with willow tree shoots. Washed gravel bars were placed in the adjacent shoal to create a potential GCS Walleye spawning site. Plans include creating or enhancing more GCS Walleye spawning habitat in about seven miles of river. Additionally, hatchery-reared GCS Walleye were stocked in the Hardin-Moore Waterfowl Impoundment, which drains into Mackeys Creek. The waterfowl impoundment serves as a nursery pond for juvenile walleye and all fish raised there were subsequently released into Mackeys Creek when they reached six inches in length. The larger size fish were expected to have much improved survival rates over the 2-inch fish typically stocked from a hatchery. The NMFH and the PJA Fish Hatchery also stocked GCS Walleye in the upper reaches of the Tombigbee River and its primary tributaries since the renovation project.

Hawaii Region

from

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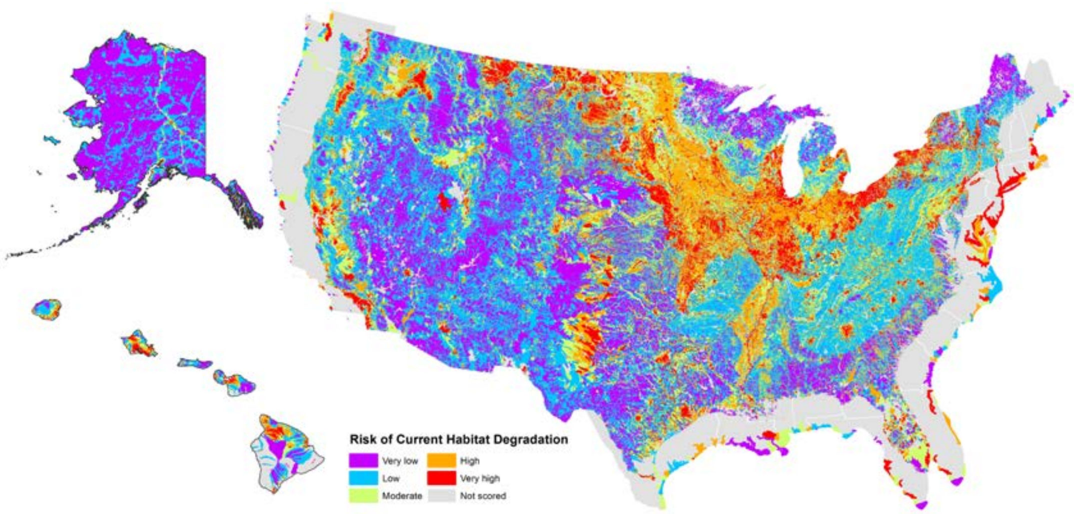
2015



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[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Hawaii Region

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Regional Summary

The largest of the eight main Hawaii Islands— Hawai'i, Maui, Molokai, O'ahu, and Kaua'i—have well-defined watersheds and perennial streams. There are 376 perennial streams on these islands, most of which start high in the mountains and high numerous waterfalls before they reach the ocean. Forty large stream systems form small stream-mouth estuaries at their confluence with the ocean. These estuaries are critical transition points for migratory fish species and represent the connecting point between inland and coastal systems. They are also important nursery habitat for many coastal marine reef fish during key life stages. Furthermore, Hawaii's aquatic resources are considered to be absolutely vital to the islands' tourist industry.

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 that are tightly woven into the survival of the reef.

The assessment of Hawaii's fish habitats differs from the lower 48 rivers assessment in that data limitations allowed an analysis 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 for drinking water and agricultural uses, urban development, and flood control. Most regions at risk for habitat degradation in this assessment coincided with areas of urban land use and agriculture on the islands of Hawai'i, O'ahu, Kaua'i, and Maui. The island of Moloka'i generally was at low to very low risk due to a low human population.

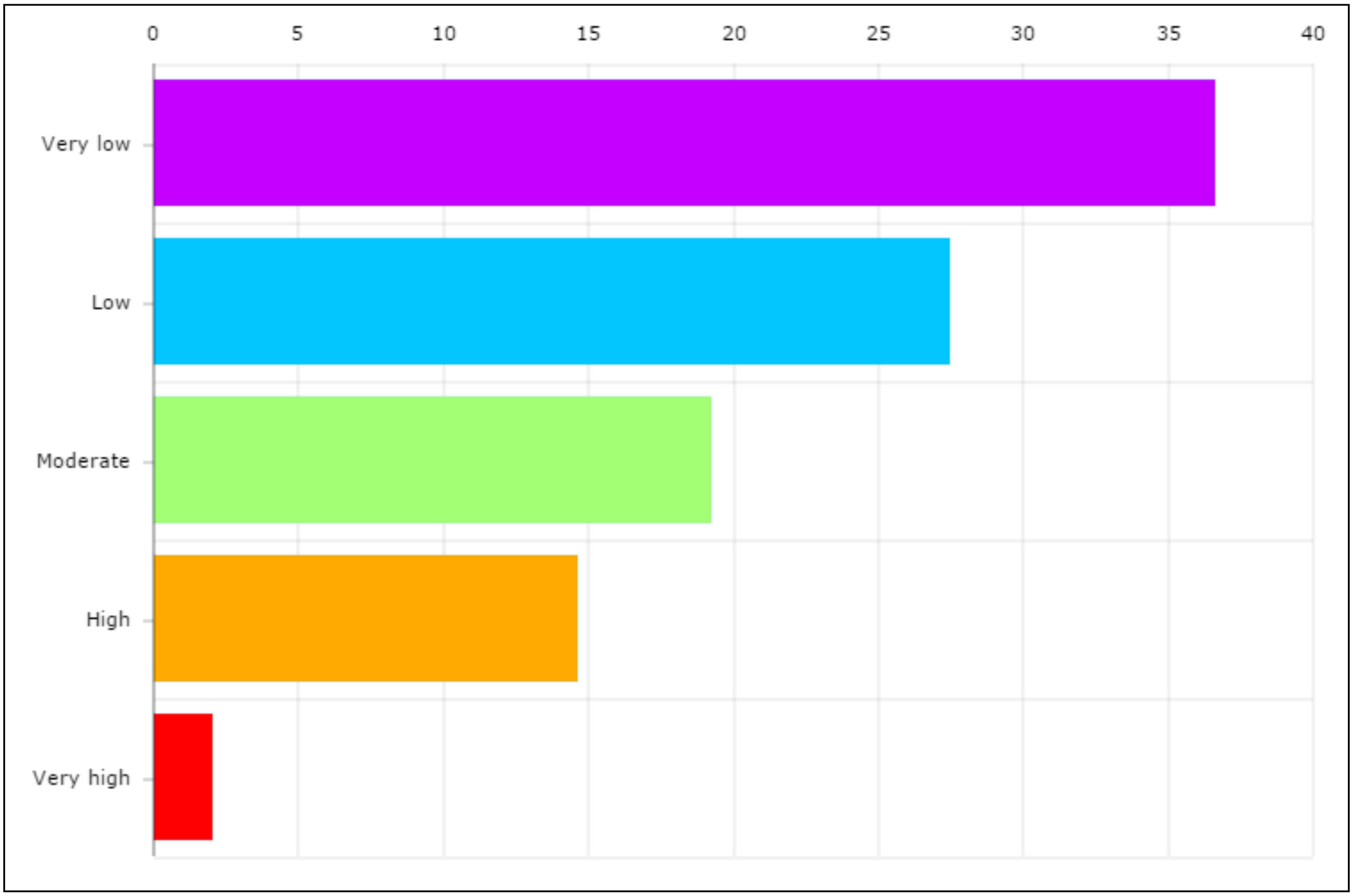
Humuhumunukunukuapua`a *(Rhinecanthus rectangulus)*

Fun Facts

- The saltwater triggerfish, humuhumunukunukuapua'a, is Hawaii's State fish and is well known for its long name.
- Hawaii is the only State in the United States with a tropical rain forest.
- Hawaii is the most isolated population center on the face of the earth. Hawaii is 2,390 miles (3,846 kilometers) from California; 3,850 miles (6,196 kilometers) from Japan; 4,900 miles (7,886 kilometers) from China; and 5,280 miles (8,497 kilometers) from the Philippines.
- The Waialua River is one of five navigable rivers in Hawaii. It drains off Waialeale Mountain, which averages 488 inches (1,240 centimeters) of rain per year and is considered the wettest spot on earth.
- Honolulu is the largest city in the world (it has the longest borders). According to the State constitution, any island (or islet) not named as belonging to a county belongs to Honolulu. This makes all islands within the Hawaiian Archipelago, the stretch to Midway Island (1,500 miles or 2,414 kilometers northwest of Hawaii), part of Honolulu. Honolulu is about 1,500 miles (2,414 kilometers) long, which is more than halfway across the 48 contiguous States.
- The Hawaiian Islands are the projecting tops of the biggest mountain range in the world.
- The Northwestern Hawaiian Islands are home to more than 7,000 marine species, a quarter of which are found nowhere else in the world.
- Only two types of mammals are native to Hawaii: the hoary bat and the monk seal.
- Hawaii has lost more species and has more endangered species than any other State in the United States. Nearly all of the State's native birds are in danger of becoming extinct.
- There are only 13 letters in the Hawaiian alphabet and every word and syllable ends with one of five vowels.

Habitat Degradation

(a)



(b)

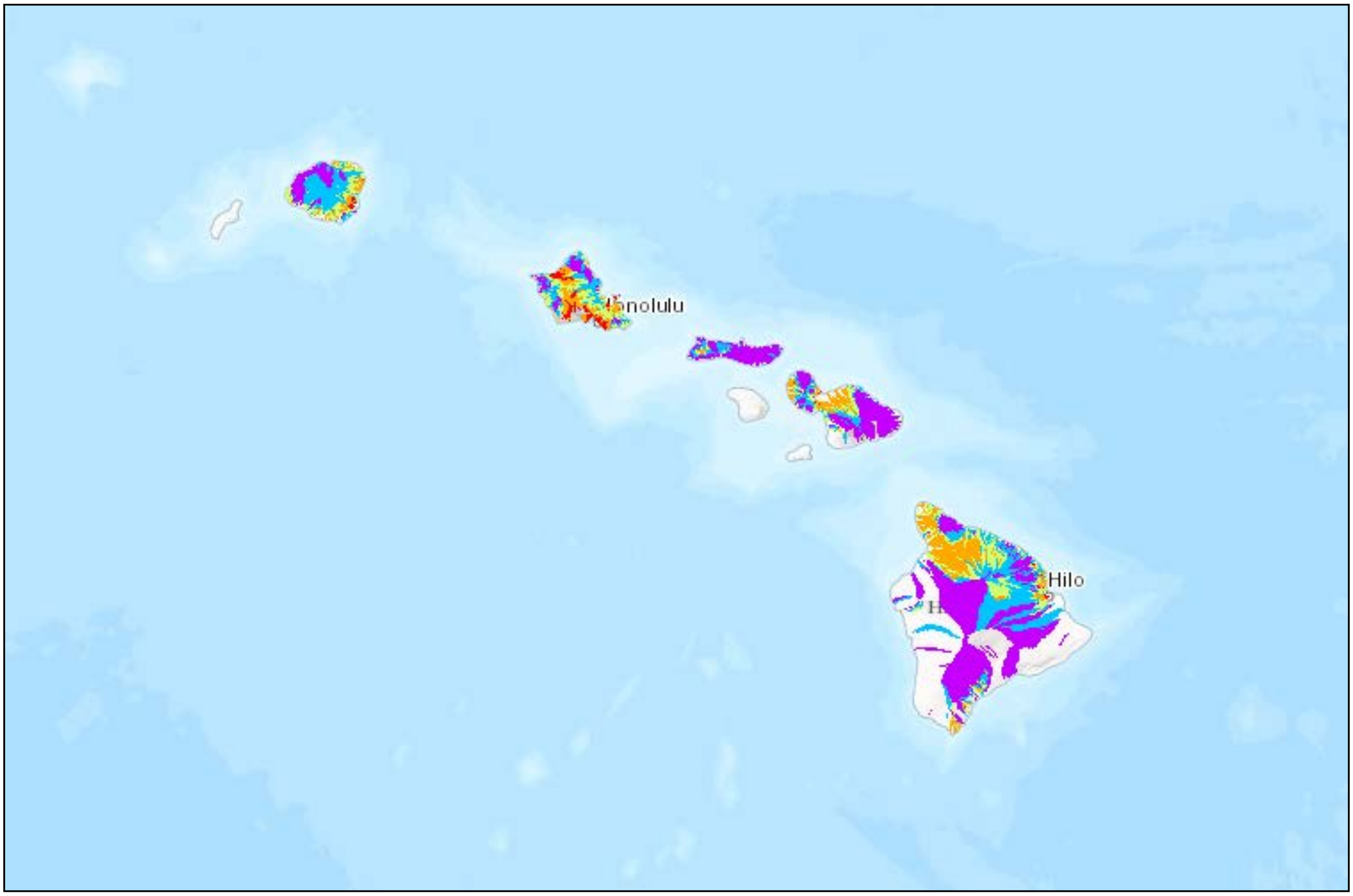


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset. The currently selected tab shows data from the assessment of streams for Hawaii. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the Hawaii assessment of streams.

Agriculture

Almost 46 percent of the land in Hawaii is agricultural and includes most of coastal Kaua'i, western Maui, and the perimeter of the island of Hawai'i, which are areas assessed to be at high risk of aquatic habitat degradation. The dominant agricultural products are corn, vegetables, nuts, potted and landscape plants, and cattle. Poor farming practices lead to excessive sedimentation due to open, cultivated soil being exposed to erosion from rainfall and cattle overgrazing and trampling stream banks. The United States Department of Agriculture reported that nearly 5 tons/acre of soil eroded from agricultural land in Hawaii during 2012, an amount that is similar to Central Midwest. Sediment transported from agricultural lands, as well as urban areas and mountain slopes is the most damaging pollutant in Hawaiian waters because coral reef animals are particularly sensitive to the effects of smothering from excessive sedimentation. Agriculture also results in runoff of nutrients and pesticides, alteration of stream flow patterns, and direct water withdrawals. More than 45 percent of the waterbodies were considered impaired in Hawaii in 2014 as a result of high nutrients or chlorophyll *a*(a measure of the amount of algae in the water) levels that result from nutrients. Excessive nitrogen from agricultural development has led to increasing coastal algal growth, which has in turn been reported to be responsible for deadly tumors of endangered green sea turtles.

Invasive Vegetation

Several species of riparian plants including the non-native red mangrove (*Rhizophora mangle*) and hau bush (*Hibiscus tiliaceus*) proliferated along lower stream channels and estuary banks, disrupting energy flow in affected systems (a key fish habitat process). These invasive plants excessively shade estuarine shorelines, add large amounts of decomposing leaf litter that reduces water quality, create physical barriers to fish and invertebrate migration, and displace native fish and bird species. A pilot project in Wai ‘Opae, Hawai’i evaluated if red mangrove could be controlled and ultimately eradicated 20 acres of this plant. A cooperative Partnership project was initiated in 2015 to remove a large stand of invasive riparian trees and restore native vegetation in the tidally influenced portion of Heeia Stream and its adjacent estuary.

Photograph of the invasive Hau bush in Waipa Stream, HI.

Reduced Water Flows

Human-caused modifications to surface and ground water systems throughout Hawaii have drastically altered natural hydrologic regimes (a key fish habitat process), which in turn have profoundly limited the distribution and population sizes of native aquatic fauna. Most water for cities comes from wells, although stream water is used in Upper and East Maui. However, smaller communities and agriculture often rely on surface water obtained through diversions. Irrigation systems have been built to support the cultivation of row crops, such as corn, tomatoes, sugar cane, and nut trees. They transfer large volumes of water from natural watercourses and groundwater and into networks of ditches, tunnels, flumes, reservoirs, and, ultimately, to fields. Water diversion structures such as dams and intake grates often block fish migration, critical to native Hawaiian fishes and prawns that require a broad range of habitats to complete their life cycles, and severely limit the support of healthy fish populations in inland stream reaches. Many structures divert all stream water at low to moderate flows, leaving the downstream channel completely dry. One study in West Maui found that a majority of streams lost flow downstream due to diversions and that six of 15 streams evaluated were dry at least 50 percent of the time. Conditions worsened during most of 2010 through 2013, when up to 31 percent of Hawaii was in extreme drought. An important management goal for ecological restoration of aquatic systems in Hawaii is modification or removal of migration barriers to allow passage of native fish and invertebrates between the sea and interior watershed areas. The Hawaii Fish Habitat Partnership has funded fish passage projects on Waihe'e Stream, O'ahu, Waipa Stream, Kaua'i, and Iao Stream, Maui. 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 and this work continues to be emphasized as a key method to rehabilitate Hawaiian systems.

Urban Land Use

Major population centers exist on most of the islands, particularly on O'ahu which has a densely populated urban core. Urban sprawl increased by 76,000 acres from 1982 to 2012, which equals about two percent of Hawaii's land mass. Urbanization results in physical loss of aquatic habitat as well as polluted runoff and altered hydrology. The Hawaiian Department of Health in 2015 listed sediment, nutrients, and bacteria as the most common threats to aquatic ecosystems and human health and that the vast majority of impaired sites are marine areas. Development contributes excessive sedimentation through improperly constructed roads and drainage systems, poor construction practices, and to nutrient loading through landscape fertilization and sewage effluent. Nutrient contamination, specifically nitrogen and phosphorus, often caused by fertilizer runoff, can have a detrimental impact on both inland and coastal water quality and damage coral reef ecosystems. Fecal bacteria are a common pollutant from sewage and septic systems and sicken swimmers, surfers, and other recreational water users. The Hawaii Department of Health reported in 2015 that there were about 88,000 open sewage cesspools throughout Hawaii and that 56 aquatic sites were impaired due to high bacteria levels. The islands of Kaua'i and O'ahu had the most sites that were considered impaired from bacteria concentrations. The state of Hawaii has a multifaceted plan to significantly reduce harmful runoff by 2020, particularly in Northeast O'ahu, West Maui, and North Kaua'i.

Habitat Trouble for Freshwater Goby in Hawai'i

Hawaii is home to several unique freshwater goby species (called o`opu in Hawaiian), most of which are highly adapted and specialized to climb vertical waterfalls to get to spawning habitat. These species are under stress as the result of direct habitat loss from development and water withdrawal along with competition with non-native species and habitat fragmentation from barriers. Similarly, native prawns that are residents of enclosed brackish water bodies. known as anchialine pools, are also under stress from development pressures.

Fish Habitat Partnership Activities for Hawaii

For more about specific waters and projects the Hawaii Fish Habitat Partnership is working on, please see the following locations:

- Community-Based Restoration of the Kiholo Estuary-Fishpond Complex, Hawaii – see featured article
- Waipa Stream, Kauai – see featured article
- Lower He’eia Stream, Hawai’i
- Waipa Stream, Hawai’i

Hawaii - Restoration of the Kiholo Estuary-Fishpond Complex

Partnership *- Hawaii Fish Habitat Partnership*

Anchialine pools represent an inland waterbody type that is widespread but threatened throughout the Hawaiian Islands and is a key habitat type of concern to the Hawaii Fish Habitat Partnership. Anchialine pools, also known as fishponds in Hawaii, are near the coast and are land-locked bodies of water that have connections both to the sea, typically by high tides, as well as to local freshwater. These systems have been used for thousands of years for fish production by Native Hawaiians. The majority of remaining fishpond pools are located on the Kona coast and southern coastlines of the Big Island, the southeast coast of Maui, and on several small and widely separated coastal sites on Oahu. In Hawaii, fishponds function as coastal estuaries, which are very limited in the volcanic island topography of Hawaii, and provide habitat for native plants and fauna estuarine species including fish, marine and aquatic invertebrates, and birds; and may be managed to provide a dependable source of fish products separate from wild stocks. Currently, there are six endemic anchialine pool shrimp (prawns) that are considered to be threatened or endangered.

Many fishponds were filled in the past, and remaining pools continue to be affected by development, particularly resort and golf course construction along the Kona coast of the Big Island. Withdrawal of groundwater for domestic or irrigation use, polluted runoff, and non-native plants and fish are a continuing threat to these unique and rare systems.

One such site is Kiholo on the northern shore of the island of Hawaii. Kiholo is part of a larger coastal area that was once coveted by Hawaiian chiefs for its productive nearshore reefs and offshore fisheries, its fishponds and anchialine pools and remains a culturally important site. Kiholo is a fishpond estuary with abundant marine life, includes two large, interconnected freshwater spring-fed pools containing numerous native fish species, hapawai(mollusk) and opae(shrimp). At Kholo, between three and five million gallons of submarine groundwater flow to coastal waters through the fishponds each day, supporting populations of green sea turtles, estuarine fish and marine fish species associated with coral reef habitats.

Since 2011, partners, led by the Nature Conservancy and spurred to action by the Hawaii Fish Habitat Partnership, have worked to return the Kholo fishpond to a sustainable and productive system that provides habitat for estuarine species and to monitor indicators of success. Guided by historical information and an inclusive approach to restoration, partners and hundreds of volunteers have removed: invasive fish species that have reduced native species; invasive vegetation around the ponds to reduce decaying leaf litter; and sedimentation that has built up within the ponds. The Conservancy is measuring the effects of these efforts on water quantity and quality as well as fish abundance, biomass and recruitment. Additionally, the Nature Conservancy convened a network of coastal fishpond managers in Hawaii to share knowledge and support regional fishpond restoration and conservation initiatives.

For additional information on the efforts of The Nature Conservancy and partners to conserve fishpond estuaries, please visit the following:

http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/hawaii/placesweprotect/kiholo-preserve.xml

Kauai, Hawaii - Waipa Stream Restoration Project

Partnership - ***Hawaii Fish Habitat Partnership***

The Waipa Stream flows from lower Mount Waialeale to Hanalei Bay on the north shore of Kauai, Hawaii. Much of the upper Waipa Stream system still exhibits good quality aquatic habitat. However, the lower reaches of Waipa Stream were significantly degraded due to widespread and dense overgrowth of an invasive riparian tree known as hau (Hibiscus tiliaceus). The in-stream habitat available for native aquatic fish and invertebrates was reduced by hau growth in the stream causing sediment and plant debris to fill up a stretch of the stream channel and creating unnatural barriers for migrating native fish and prawns that have to pass through this section of the stream at least twice during their life cycle. Stretches that were not filled with debris also impeded movements of aquatic species due to diminished stream flow, increased darkness due to dense foliage, and increased exposure to predation.

The overall goal was to restore a 7.5-acre corridor along the stream. The restoration project began in 2011 and by March 2013 partners, led by the Waipa Foundation, had cleared several acres of hau bush from the densest stretch of Waipa Stream. Much of the cleared hau material was chipped on-site to create mulch used for erosion control in the clearing areas. In flood-prone areas where mulching was not suitable, hau was burned and the ash was used for local gardens. Approximately 1,000 feet of the stream channel was cleaned of hau debris, and fish passage conditions in the project area improved. The cleared areas were planted with native Hawaiian plants. There has been a strong focus on cultural plants that will produce food or other resources that can be used for the Waipa Foundation's various educational and cultural activities and programs. This project has benefited the public by increasing production of recreationally, commercially and culturally important fish and invertebrates as well as improving the chemical and physical characteristics of the Waipa watershed. The Waipa Stream Restoration project has become a model for future restoration work in Hawaii. Restoration of Waipa Stream continues at the time of this report and received additional funding from the U. S. Fish and Wildlife Service in 2016.

An important element of the Waipa Stream Restoration Project is monitoring the effects of the restoration work on the stream's water quality and aquatic life. To accomplish this, monitoring programs were established to regularly measure streamflow and water quality at various points along the stream. Also, net surveys are being performed in the Waipa Stream Estuary and snorkel surveys are being conducted in the stream at several sites to collect habitat quality data and evaluate habitat use by native and non-native species. Interns funded by AmeriCorps and the Hawaii Youth Conservation Corps have been important in carrying out the project's monitoring programs as have the 1000s of volunteers.

Mid-Atlantic States Region

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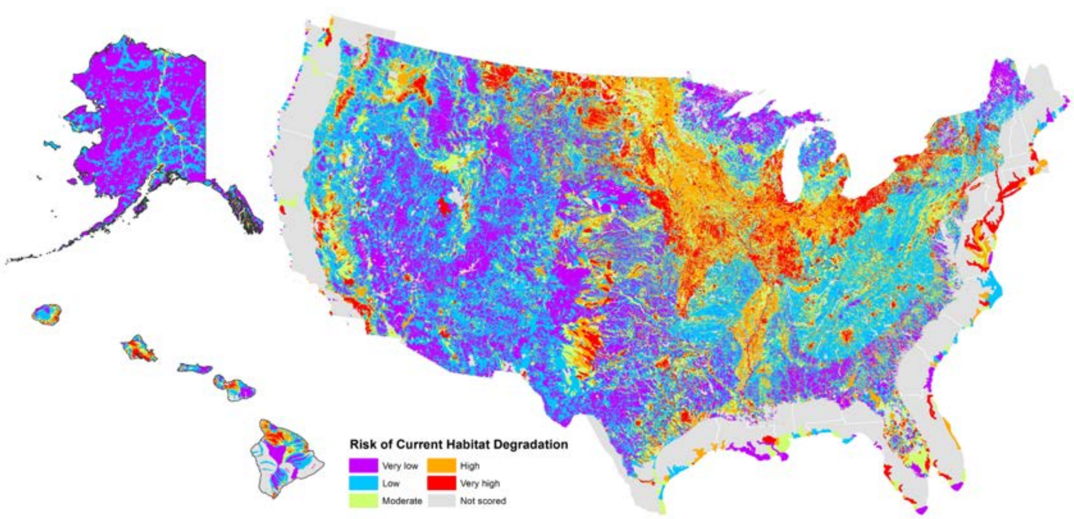

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Mid-Atlantic States Region

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Regional Summary

The majority of streams, particularly in the headwater reaches, in the Mid-Atlantic States have a low risk of current habitat degradation using the factors assessed, with most of these streams located in heavily-wooded West Virginia, Delmarva Peninsula, southern New Jersey, rural portions of central and eastern Virginia, and central Pennsylvania. Overall, 55 percent of the rivers and streams in the mid-Atlantic fall into the low and very low categories of risk of habitat degradation from the factors assessed. However, an examination of water flow patterns (hydrology) was not included, thus some of the areas scored as low risk may in fact be at higher risk.

The most common disturbances in this region are associated with development and dams, whereas urban sprawl, agriculture, and roads were the most severe disturbances in the streams and rivers with high or very high scores. Higher degradation scores were often found in the lower parts of stream and river systems. Many streams in the western part of this region (Pennsylvania, West Virginia and Virginia) are degraded by acidic runoff and excessive sedimentation from current and legacy mining activities, particularly coal mining. Streams of Northwest Pennsylvania from Erie to the Allegheny National Forest were predicted to be at very high risk due to grain and cattle farms. In southeast Pennsylvania, row crops, such as corn, wheat, and fruit, as well as pasture, are responsible for areas with a very high risk of current habitat degradation. Pennsylvania Department of Environmental Protection reported in 2014 that almost 16,000 miles of streams surveyed in that state were considered impaired chiefly due to agriculture and mines. 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 excessive sedimentation from poor land practices. Most rivers in the mid-Atlantic have dams or other significant barriers to fish movement that have caused large reductions in the numbers of spawning American Shad, River Herring, American Eel, and Atlantic Sturgeon.

The estimated risks to estuaries on the coast of the Mid-Atlantic States stand in stark contrast to the inland risk assessment. Eighty-nine percent of the estuarine area in the Mid-Atlantic States is at high or very high risk of current habitat degradation and ranks overall as the poorest condition marine habitat in the country. The 2015 assessment determined that four of the five most threatened estuaries in the country are located in this region. Mid-Atlantic estuaries have some of the worst eutrophication and pollution scores of all the estuaries assessed. The Eastern Lower Delmarva estuary was the only coastal area evaluated that had a low or very low risk of fish habitat degradation. The greatest anthropogenic (human caused) threats found by this Assessment and from other sources to Mid-Atlantic States estuaries are water quality and withdrawal, dams and other barriers, urban land use, and dredging and coastal maintenance.

Fun Facts

•Approximately 90 percent of the drinking water for the Washington, D.C. area comes from the Potomac River. An average of approximately 486 million gallons (1.8 million cubic meters) of water is withdrawn from the Potomac River daily in the Washington area for water supply. This is equivalent to a mid-size river with a flow of 750 cubic feet per second.

•At 464 miles (747 kilometers) long, the Susquehanna River is the longest river on the American east coast that drains into the Atlantic Ocean. When its watershed area is included, it is the 16th largest river in the United States and the longest river in the continental United States without commercial boat traffic today.

•The Susquehanna River:

•is almost a mile (1.6 kilometer) wide at Harrisburg

•watershed is 60 percent forested.

•comprises 43 percent of the Chesapeake Bay's drainage area (the river itself provides more than 50 percent of the fresh water that enters into the Bay).

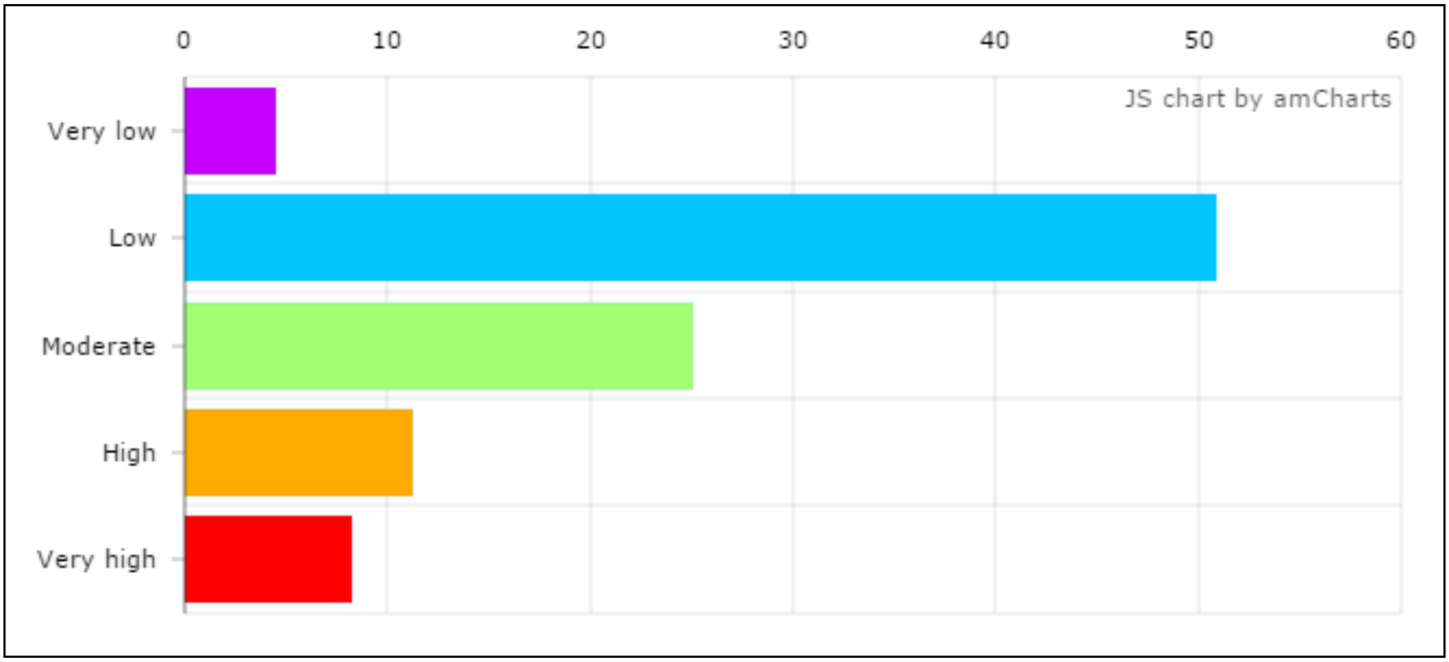
•is the largest river lying entirely in the United States that drains into the Atlantic Ocean.Basin is one of the most flood-prone areas of the United States as a result of the amount of surface bedrock in the drainage area, which sheds water immediately. Major floods occur every 20 years.

•The Delaware River flows free for 330 miles (531 kilometers) from New York through Pennsylvania, New Jersey, and Delaware on its way to the Atlantic Ocean. Although the main stem is undammed and is therefore one of the few remaining large free-flowing rivers, water from the tributaries is diverted for the New York City water supply.

•Though the watershed drains only four-tenths of 1 percent of the total continental U.S. land area, 15 million people, about 5 percent of the Nation's population, rely on the Delaware River Basin for their drinking water. This includes the largest and fifth-largest cities in the nation—New York and Philadelphia.

Habitat Degradation in Inland Streams

(a)



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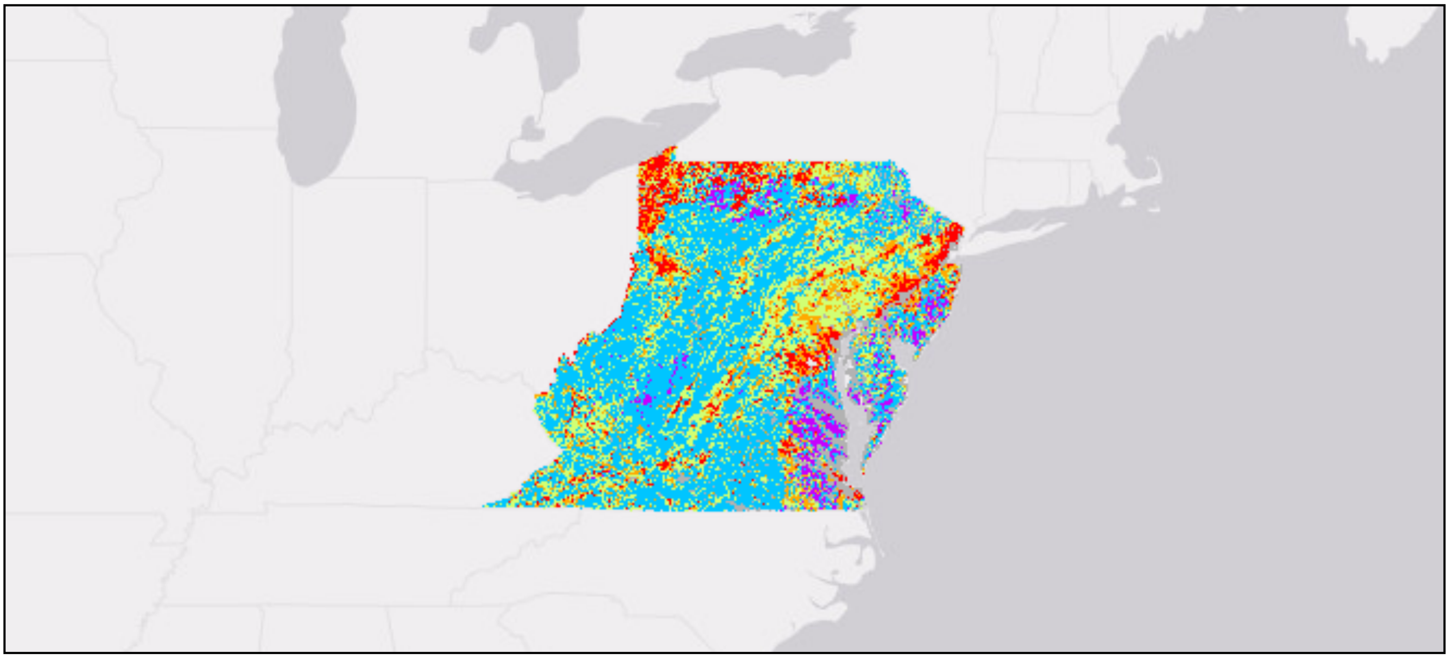
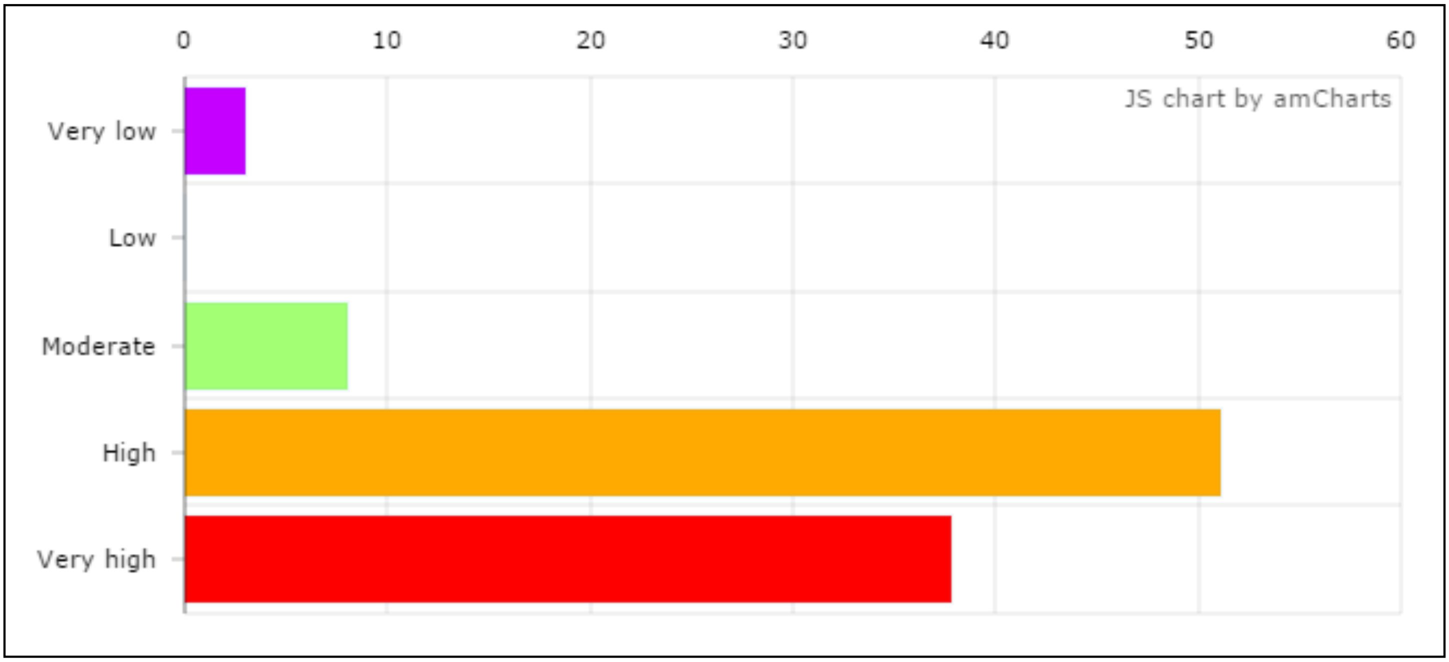


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Habitat Degradation in Estuaries

(a)



(b)

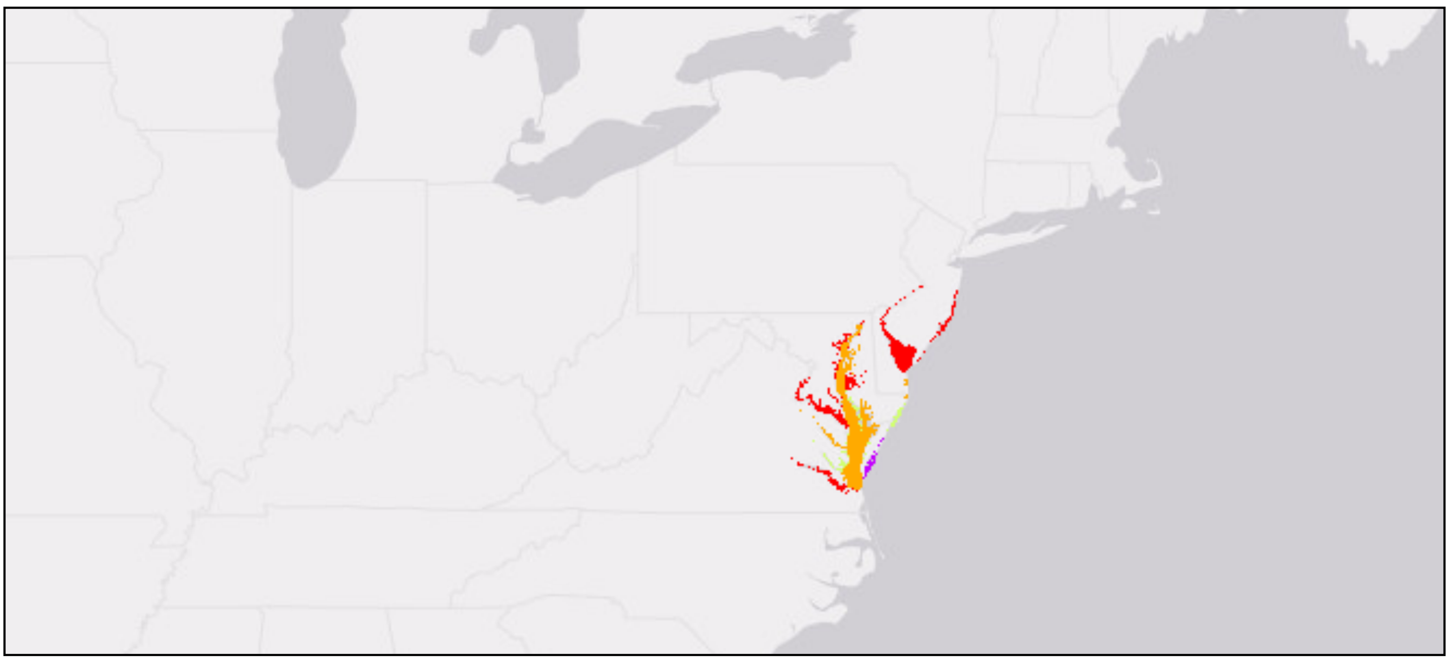


Figure1: This interactive figure summarizes the risk of fish habitat degradation. The currently selected tab shows data from the national estuary assessment. (a) Relative condition of fish habitat in estuaries. Estuary summaries represent percentage of total estuary area in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all estuary condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the national estuary assessment.

Most Pervasive and Severe Disturbances for the Mid-Atlantic States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Impervious surface cover

•Population density

•Road length density

•Low intensity urban land use

•Downstream dam density

Top three most pervasive disturbances to **creeks** (<100 km^2 watersheds) **across all** spatial scales **:**

•Impervious surface

•Road length density

•Low intensity urban land use

Top three most pervasive disturbances to **rivers** (>100 km^2 watersheds) **across all** spatial scales **:**

•Pasture and hay land use

•Impervious surface

•Population density

Top five most pervasive disturbances to **creeks, specific to** spatial scale **:**

•Road length density in network catchments

•Downstream dam density in network catchments

•Road crossing density in network catchments

•Low intensity urban land use in local catchments

•Impervious surface cover in local catchments

Top five most pervasive disturbances to **rivers, specific to** spatial scale:

•Pasture and hay land use in network buffers

•Pasture and hay land use in network catchments

•Crop land use in network buffers

•Medium intensity urban land use in network buffers

•High intensity urban land use in network buffers

In the Mid-Atlantic state group, 55.0% of streams are classified as low or very low risk of habitat degradation.

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat degradation (red and orange color groups).

Top five overall most severe disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Low intensity urban land use

•Crop land use

•Road length density

•Pasture and hay land use

•Road cross density

Top three most severe disturbances to **creeks** (<100 km^2 watersheds) **across all** spatial scales:

•Low intensity urban land use

•Road length density

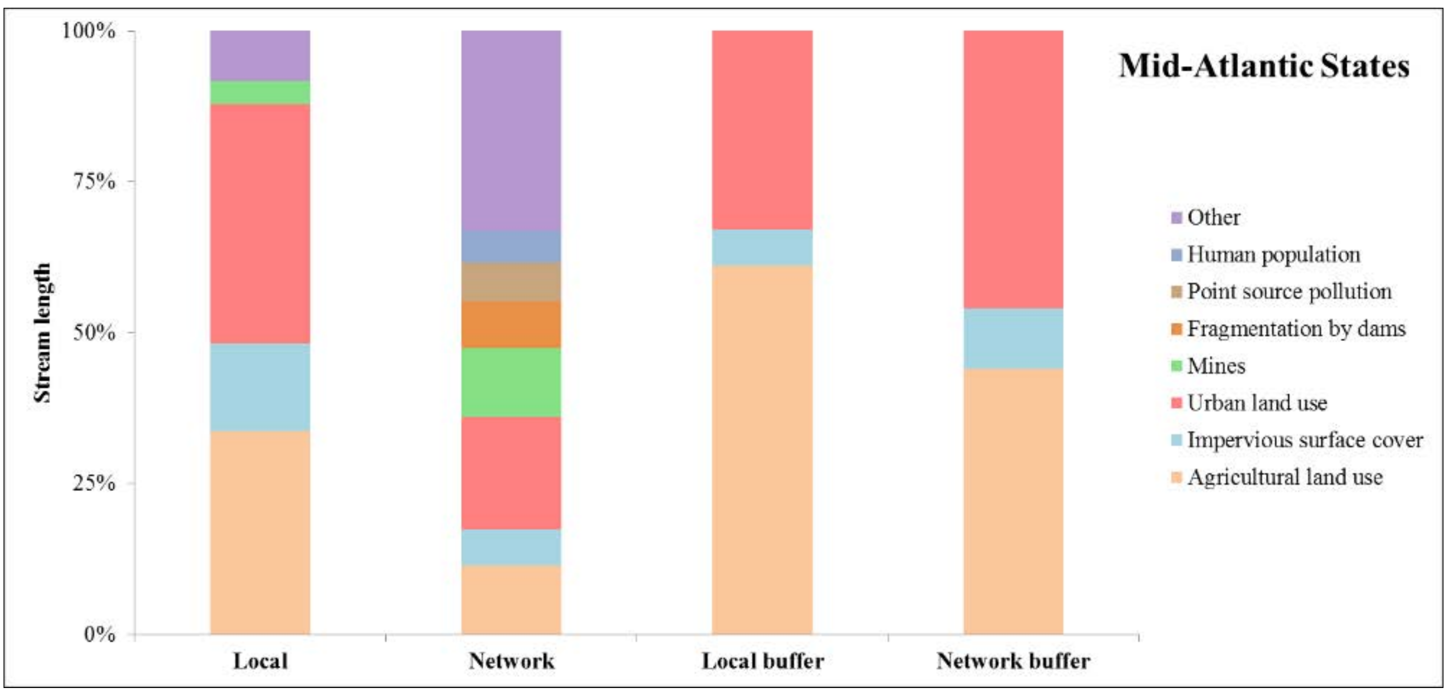
•Crop land use

Top three most severe disturbances to **rivers** (>100 km^2 watersheds) **across all** spatial scales:

•Pasture and hay land use

•Upstream dam density

•Low intensity urban land use



Most severe disturbances in the Mid-Atlantic States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into super categories (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales (local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale; buffers have only urban land use, agricultural land use, and impervious surface cover. See Detailed Inland Stream Methodology for more details.

Dams and Other Barriers

There are over 9,000 dams in the Mid-Atlantic States. The great majority of these dams are small (i.e., less than 15 feet high), old, and obsolete mill dams that are in disrepair. Dams, as well as many poorly designed culverts and road crossings, fragment habitat and stop fish migrations for a range of species. Fish species, such as American Shad, river herring, Atlantic and Shortnose Sturgeon, Rainbow Smelt, American Eel, Striped Bass, and many other fish species must migrate for spawning or require unobstructed access throughout watersheds to complete their life-cycles. Most fish that require migrations in this region have populations that are only a fraction of what they were historically.

During 2010 to 2014, at least 109 dams were removed from the Mid-Atlantic States and at least 83 of these were in Pennsylvania. Dam removal on the Patapsco River in Maryland will restore approximately 183 river miles for American Eel, while the removal of Harvell Dam on the Appomattox River, Virginia increased connectivity for American and Hickory Shad by 127 miles. Large dams have also resulted in significant changes to aquatic ecosystems in the Mid-Atlantic States. The New York water supply system on the Upper Delaware River has completely altered the water flow pattern on that system. The 22-foot high Oradell Dam was built on the Hackensack River in New Jersey during 1921 – 1923 to supply water to Northeast New Jersey, but allowed saltwater intrusion to the dam. As a result, a unique native white cedar swamp, approximately 20 miles downstream of the dam, was converted into 8,400 acres that consisted primarily of common reed, and is now known as the New Jersey Meadowlands. Lone skeletal white cedars could still be seen into the 1980s.

Mining

Coal is mined throughout southern West Virginia, southwestern Virginia, and western Pennsylvania; mining activities account for elevated risks of aquatic habitat degradation throughout this zone. Drainage from coal mines and coal refuse piles is a common problem in the Appalachian coal region. Pennsylvania Department of Environmental Protection reported in 2014 that streams surveyed in the western portion of the state, such as the Monongahela River, were considered impaired due to sulfates from mining. Coal mine drainage also releases acidic water into streams, making them thousands of times more acidic than unaffected streams and eliminating a majority of native aquatic species in the process. The practice of “mountaintop removal” mining in West Virginia has resulted in the burial of many headwater streams directly destroying fish habitat and disrupting subsurface water flow patterns, and has elevated concentrations of toxic elements such as nickel, lead, cadmium, iron, and selenium in downstream waters and aquatic organisms. Pennsylvania and West Virginia are also threatened by the use of hydrofracture drilling (fracking) for natural gas, which can release pollutants into rivers and streams if waste products are not properly disposed of away from these waters.

Urban Land Use and Pollution

Runoff and other land-based pollution from large riverside cities such as Philadelphia, Pittsburgh, Wilmington, and Washington, DC, New York City, and surrounding suburban sprawl adversely affect fish habitats in the Delaware, Susquehanna, Ohio, Hudson,and Potomac River basins, as well as many smaller streams. A concentration of human population and impervious surfaces extends from northeastern New Jersey to southeastern Virginia and to the coastal areas of the Mid-Atlantic. For example, the 2015 assessment determined high degradation risk in streams along the I-95, I-81, and I-79 corridors. Urban development continues to spread, as rural land in the states of this region declined by 5.9 million acres from 1982 to 2012. Pennsylvania lost the most acreage (1.7 million acres) while New Jersey developed 21 percent of its rural land.

Runoff from urban and suburban areas in this region typically contains many pollutants such as excessive nutrients, sediments, motor oil, heavy metals, and pesticides. 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, Potomac River, Delaware River, and Hudson River. These inputs are both from current and legacy pollution issues along these watersheds that still plague the region. Historically, these systems were heavily polluted and huge metropolitan areas such as much of northeast New Jersey and New York City did not even have functioning primary sewage treatment systems until the 1960s and 1970s. The negative direction of this fish habitat impairment was improved by the passage of the Federal Clean Water Act in 1972 (CWA). This one act has improved fish habitat nationally but particularly in urban areas. Many of the nation’s best fisheries were created by rehabilitating key fish habitat and the CWA was the causative agent.

Patapsco/ Gunpowder River estuary in Baltimore was found to have the worst cumulative disturbance index score in the 2015 National Assessment and is seriously affected by urban runoff and associated sedimentation and pollution. The Lynnhaven River estuary in Virginia Beach has the highest scores for the pollution sub-index of disturbance in the 2015 National Assessment; urban development and vessel discharges have contributed to these pollution issues. Work was being done to improve habitats in both of these estuaries by 2015. Barnegat Bay, New Jersey, one of the highest risk estuaries in the region and already struggling with eutrophication from rapid urbanization, was seriously affected by Super Storm Sandy in 2012, which swept massive amounts of urban debris and sewage into coastal habitats. New Jersey authorities updated a restoration plan for Barnegat Bay in 2014. It is critical that the response to controlling flooding be environmentally sound as past implementation of flood control measures after large events created substantial damage to rivers and estuarine areas in this region.

Habitat Trouble for American Shad in Mid-Atlantic States

Historically, **American Shad** (*Alosa sapidissima*) spawned in virtually every river and tributary along the Atlantic coast and was relied on by Native Americans and early Europeans as a food source. Early declines in abundance of American Shad have been attributed to dam construction, overfishing and degradation of riverine habitats. Water pollution contributed to the decline and resulted in the almost complete disappearance of shad in many watersheds along the Atlantic Coast. The American Shad used to spawn as much as 300 miles upstream in some of the larger tributary watersheds such as the Susquehanna River; however many dams now block fish passage to their historic spawning grounds. Between 1998 and 2007, only two east coast rivers showed an increase in population.

American shad *(Alosasapidissima)*

Habitat Trouble for Blackbanded Sunfish in Mid-Atlantic States

The **Blackbanded Sunfish** (*Enneacanthus chaetodon*) inhabits acidic swamps, backwaters, and ponds. Although once a widespread species, it is disappearing from much of its former range. Forest clearing, loss of beavers, liming of farm fields, and stream channelization have reduced the amount of habitat available for this rare species.

Blackbanded sunfish *(Enneacanthuschaetodon)*

Habitat Trouble for Chesapeake Logperch in Mid-Atlantic States

The **Chesapeake Logperch** is native to Maryland and Pennsylvania; populations in Virginia have been extirpated. It requires rocky habitat in larger rivers and is listed as imperiled. This species has suffered from water quality and habitat degradation in the larger rivers in Mid-Atlantic States with mining, agriculture, and wastewater discharges, which causes elevated metal concentrations, suspended solids, nutrient loading, pH, and high oxygen demand in river waters.

Chesapeake logperch *(Percinabimaculata)*

Fish Habitat Partnership Activities for the Mid-Atlantic States

Partnerships - Atlantic Coastal Fish Habitat Partnership, Eastern Brook Trout Joint Venture, Reservoir Fish Habitat Partnership, Southeast Aquatic Resources Partnership, and Great Lakes Basin Fish Habitat Partnership

1. Partners installed 269 woody and rock structural habitats in two reservoirs in Pennsylvania.
2. Assisted with the removal 17 fish passageway barriers that allowed access to over 47 miles of streams used for spawning by freshwater and diadromous fish species.
3. Improved over nine miles of streams and six acres of wetlands that benefitted Eastern Brook Trout and other species.
4. Restored 0.25 miles of in-stream habitat in Walnut Creek, a tributary of Lake Erie, to promote formation of gravel beds for steelhead and other fish.

For more about specific waters and projects that the Mid-Atlantic Fish Habitat Partnerships are working on, please see the following locations:

•James River, Virginia Atlantic Sturgeon Habitat Restoration – see featured article
•Bobs Creek, Pennsylvania
•South Fork Little Conemaugh River, Pennsylvania
•Williams Run, Pennsylvania
•Mill Creek, West Virginia
•Whitethorn Creek, West Virginia
•Smith Creek, Virginia
•Aaron Run, Maryland – see featured article
•Whitewater to Bluewater Project

Aaron Run, Maryland - Brook Trout Restoration

Partnership - Eastern Brook Trout Joint Venture

Aaron Run, in western Maryland, was once a home to Brook Trout and many other aquatic animals, but aquatic life has been seriously reduced ever since historic coal mining activities polluted the stream. A portion of the watershed sits over abandoned deep coal mines and there are several hundred acres of reclaimed surface mines in the watershed. Additionally, coal waste piles were dumped along the stream banks. Like many waters in the northeastern and Mid-Atlantic United States, acid mine drainage has severely impaired water quality of the creek causing very low pH levels, which in turn precipitated iron into the streambed, causing the creek bed to turn reddish-yellow in color. In addition, mining practices and agricultural impacts have damaged the stream banks in other parts of the watershed which led to excessive sedimentation.

The Maryland Department of the Environment (Bureau of Mines), The Eastern Brook Trout Joint Venture, the Western Maryland Resource Conservation and Development Council, the Maryland Department of Natural Resources, and many other partners worked together to remediate the sources of habitat degradation in Aaron Run and to bring back the Brook Trout in this stream. Restoration was completed in 2011 and included installing a limestone doser (which adds limestone granules to the water to raise the pH), one leach bed and two alkalinity -producing system cells in the headwaters, and one oxidizing pond. Water quality conditions were restored in four miles of stream and in 2014, Aaron Run was removed from the Maryland list of pH impaired waters. About 600 feet of streambank was rehabilitated to reestablish the natural stream channel and about 20 acres of native riparian vegetation was planted, creating a stream-side wetland area. With the habitat restored, Brook Trout and other species were reintroduced to the stream in 2012, and fish populations were reestablished in Aaron Run. This project reconnected the tributary population to mainstem populations of Brook Trout in Savage and North Branch Potomac rivers.

James River, Virginia - Atlantic Sturgeon Habitat Restoration

Partnership - Atlantic Coastal Fish Habitat Partnership

Atlantic Sturgeon (Acipenser oxyrinchus oxyrinchus) spend a majority of their lives in the ocean but depend on freshwater tributaries for spawning and estuaries for rearing. Overfishing and habitat loss has resulted in the disappearance of this fish from a majority of its original range by the early 1900s. A remnant population of Atlantic Sturgeon continued to use the James River in Virginia, but in 2012, the Chesapeake Bay population segment of Atlantic sturgeon was listed as "endangered" under the Endangered Species Act by NOAA Fisheries. A lack of clean, hard substrate was determined to be one of the limiting factors in the James River for Atlantic Sturgeon and other anadromous (fish that spawn in freshwater and live in saltwater) species, such as American Shad, River Herring, and Striped Bass. The loss of ideal spawning habitat has been attributed to urban development, dredging, and excessive sedimentation. To improve conditions for Atlantic Sturgeon, sediment entering the James River from excessive soil erosion needs to be reduced and controlled.

Researchers from the Virginia Institute of Marine Science and Virginia Commonwealth University, in cooperation with commercial anglers and other partners, used acoustic tags to track Atlantic Sturgeon and determine preferred habitats in the James River. Using information obtained from tracking studies, along with mapping, underwater video, and bottom sampling data from NOAA, a project site was selected to rehabilitate spawning habitat to increase the spawning activity of Atlantic Sturgeon and other anadromous (fish that spawn in freshwater and live in saltwater) fish in the James River. The project site was located in a tidal freshwater section of the James River where the dominant substrate was a fine, muddy sediment and where the current could adequately prevent excessive siltation. A 70' x 300' x 2' high artificial spawning reef was constructed using approximately 2,500 tons of broken granite donated by Luck Stone Corporation. Two more reefs were constructed by 2013. Following construction, the site was extensively monitored for spawning activity and outreach was conducted via educational signs, brochures, and sturgeon-watching trips. As of 2014, the granite reefs were inhabited by many fish species but Atlantic Sturgeon had not been observed using the site for spawning. However, to identify successful spawning, scientists use small spawning mats placed on granite reefs, which would be like "finding a needle in a hay stack." Researchers have located Atlantic Sturgeon on the reefs and remain confident that Atlantic Sturgeon will use the reefs for spawning.

The U.S. Fish and Wildlife Service, through the Atlantic Coastal Fish Habitat Partnership, provided funding for various facets of this project, including reef construction, monitoring, and outreach.

Mountain States Region

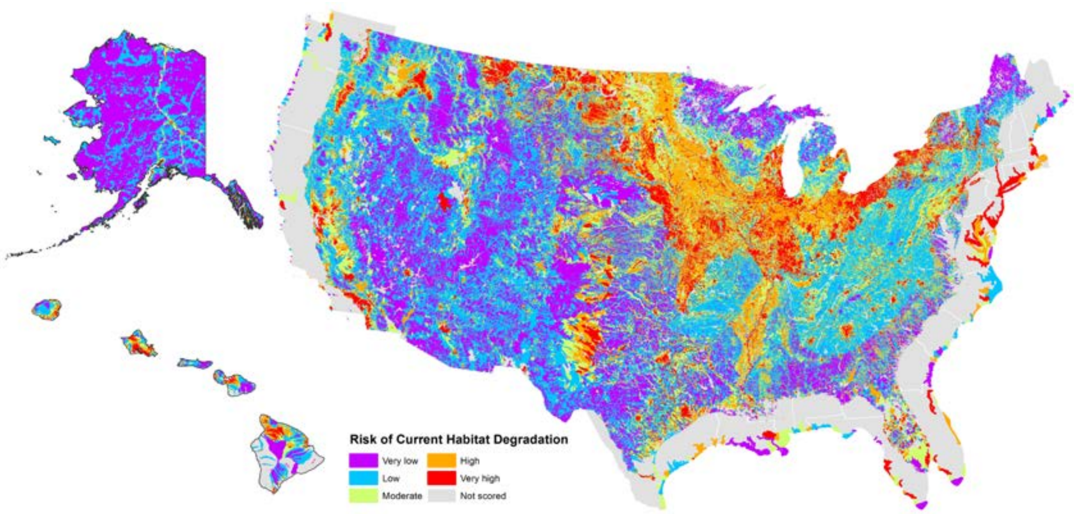
from

Through a Fish's Eye:

The Status of Fish Habitats in the

United States

2015



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[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Mountain States Region

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Regional Summary

While fish habitat was found to be generally to be at very low or low risk of degradation in this mostly arid western region of the United States, water availability (hydrology – a key fish habitat process and driver of fish habitat) could only be partly examined using the available datasets in this Assessment. The lack of information on the status of water flow in many basins has led them being overestimated in fish habitat quality, even if streams in these basins are actually dry most of year. Additionally, data availability for grazing intensity, another key landscape use, is also unavailable, and has also created situations where the Assessment overestimates habitat quality. Despite such absences, impairment to fish habitats was determined from conservative analyses detecting associations between stream fishes and nationally consistent and comprehensive disturbance data sets, highlighting condition of and limits to fish habitats in a nationally-comparable manner. These data gaps must be kept in mind while examining the results.

Overall, fish habitat in the higher elevations of the mountain states are higher quality, particularly in protected wilderness areas and national parks, but are degraded in urban areas, heavily grazed or farmed floodplains, and mining districts. Using the *available*data, about 77 percent of the streams in the mountain states are estimated to be at low or very low risk of current habitat degradation and only 11 percent are at high risk.

Although this assessment predicted that the Mountain Region has a high proportion of streams in good condition, there are still significant areas that are threatened. Areas with a very high risk of current habitat degradation in the mountain states correspond to areas of intensive agriculture or grazing, urban development, highway corridors, and rivers that have been altered for hydropower, water supply and navigation. Many systems are still recovering from the massive landscape-scale effects of historic mining and logging conducted without any consideration for the effects of those operations on our waters and as a result of this historic impairment, some watersheds remain degraded. The effects of these legacy land uses could not be completely measured by this assessment and future assessments will work to include these effects on fish habitat. Additionally, many of the region's rivers and streams have been altered extensively for water uses, including irrigation for agriculture, domestic water supplies, and flood control, clearly impairing a number of waters in this region. 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.

Chicago Creek, Colorado

Fun Facts

•A total of 15 large dams have been constructed along the 1,040-mile (1,674-kilometer) Snake River from its headwaters in the Rocky Mountains to its mouth on Lake Wallula, a reservoir formed behind McNary Dam on the Columbia River.

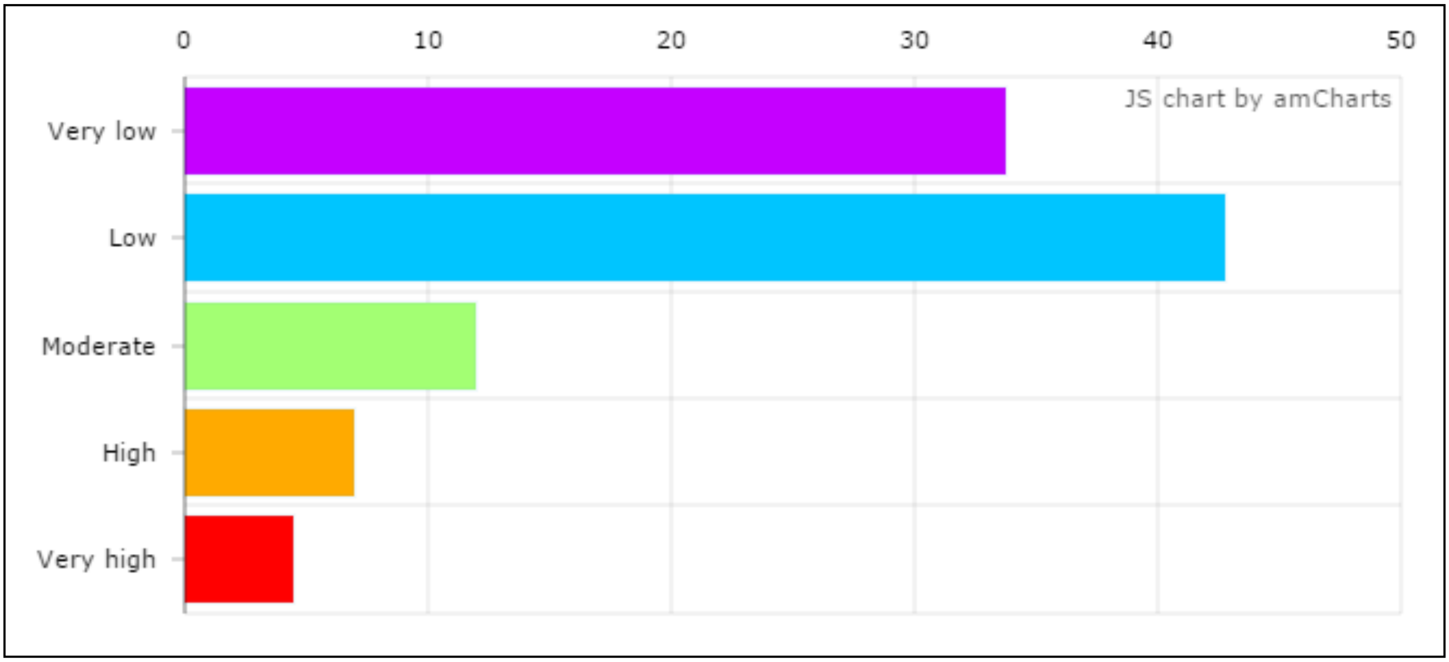
•Compared to the lower Snake River, the rest of the Columbia River watershed, and most of the Rocky Mountain West, the Upper Snake ecoregion has a high level of unique organisms (endemism), especially among freshwater mollusks, such as snails and clams. There are at least 21 snail and clam species of special concern, including 15 that appear to exist only in single clusters. There are 14 fish species found in the Upper Snake region that are not present elsewhere in the Columbia River watershed, but are present in the Bonneville freshwater ecoregion of western Utah, which is part of the Great Basin and the modern remnant of the prehistoric Lake Bonneville. Some of these fish species are only found in single watersheds or segments. Examples include the Wood River Sculpin (*Cottus leiopomus*) that is found in the Wood River, Idaho; and the Shoshone Sculpin (*Cottus greenei*) that is only found in a small portion of the Snake River between Shoshone Falls and the Wood River.

•The Green River is 730 miles (1,175 kilometers) long; approximately 450 miles (724 kilometers) of it are in Utah. The Green River drains the northeast corner of Utah, or about one-quarter of the entire area of the State.

•The Missouri River is formed near the town of Three Forks by the confluence of the Jefferson, Madison, and Gallatin Rivers. The “Mighty Mo” is the longest river in America (2,341 miles or 3,767 kilometers). It flows 783 miles (1,260 kilometers) in Montana before crossing into North Dakota.

Habitat Degradation in Inland Streams

(a)



(b)

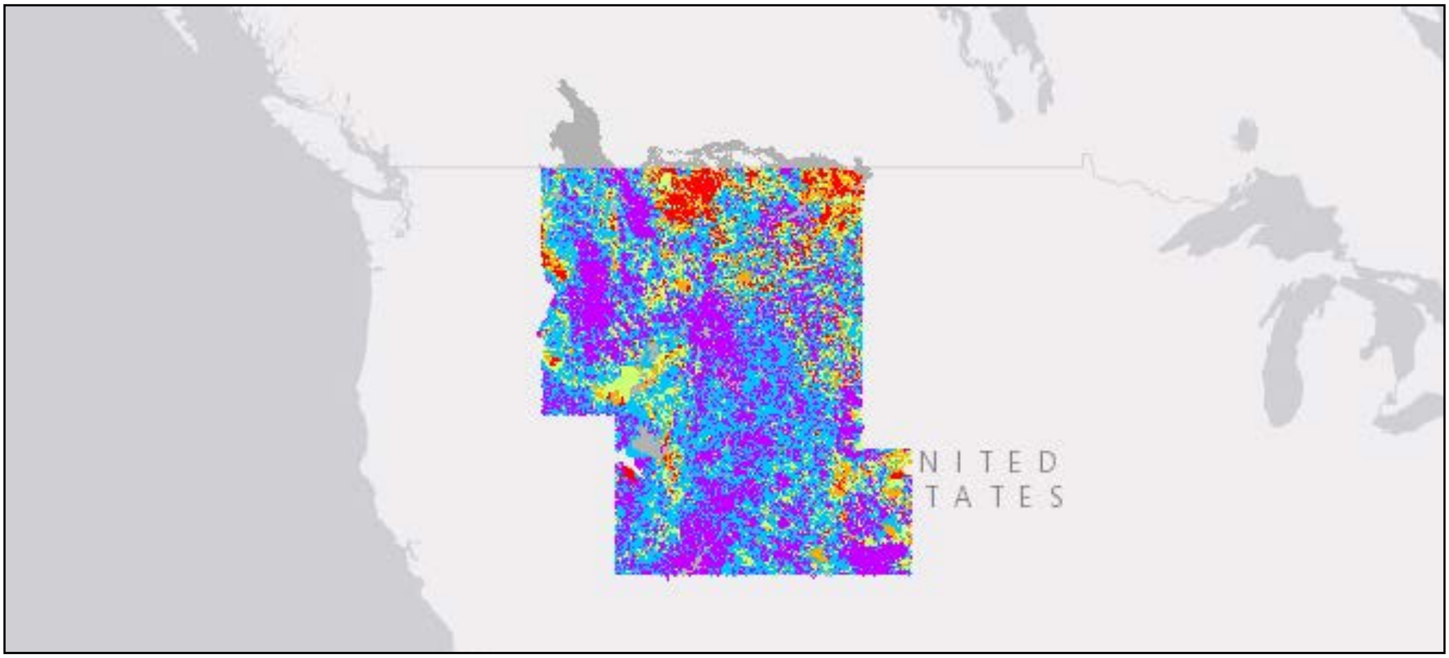


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Most Pervasive and Severe Disturbances for the Mountain States

A.Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Impervious surface

•Road crossing density

•Road length density

•Downstream dam density

•Crop land use

Top five most pervasive disturbances**, specific to** spatial scale:

•Road crossing density in network catchments

•Road length density in network catchments

•Impervious surface cover in network catchments

•Downstream dam density in network catchments

•Impervious surface cover in network buffers

In the Mountain state group, 76.6% of streams are classified as low or very low risk of habitat degradation in this assessment, which could not evaluate some key stress variables in this region. Infrastructure factors (impervious surface, roads and dams) and potential fragmentation of stream watersheds (road crossings and dams) are important landscape factors in this state group. **(NOTE: There is no destination of creeks and rivers for this state group, because the Northern Plain Ecoregion, which covers parts of these states, could not be assessed in stream size classes.)**

B.Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat degradation (red and orange color groups).

Top five overall most severe disturbances to all stream reaches, regardless of stream size and across all spatial scales (ranked highest first):

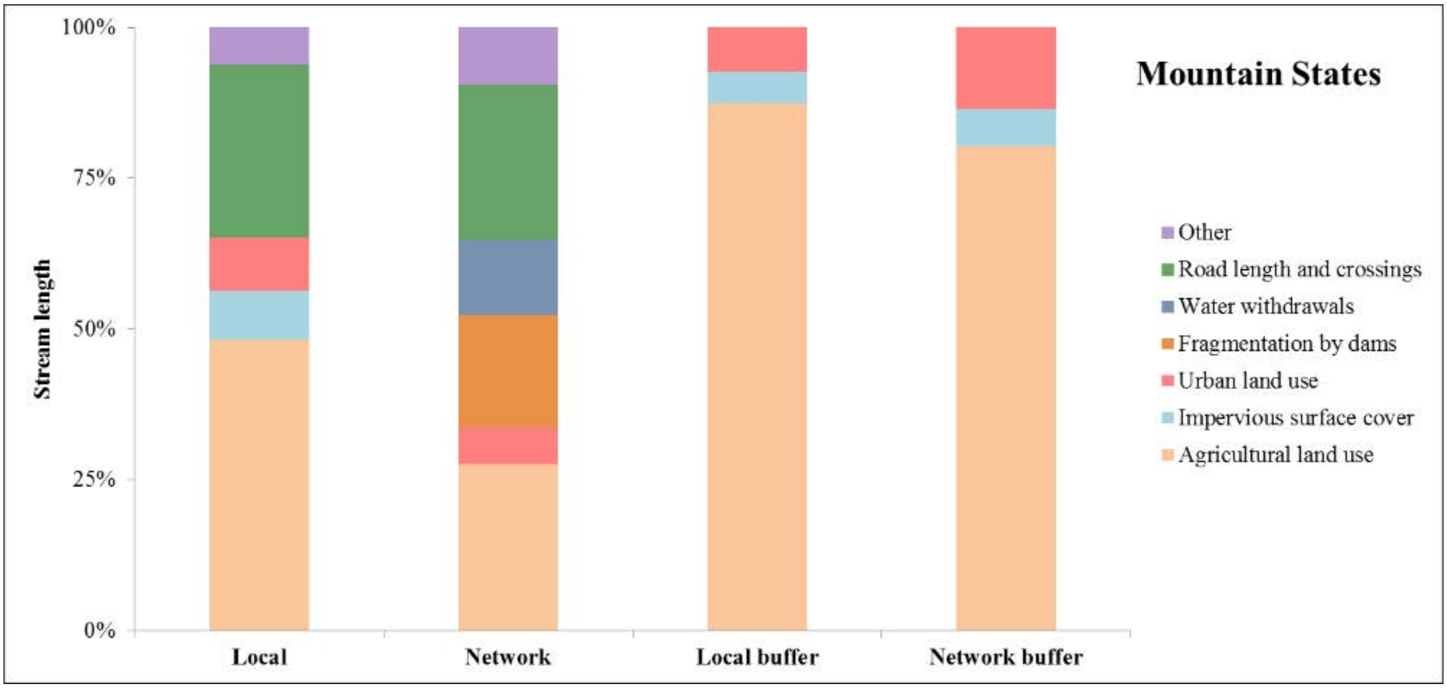
•Crop land use

•Road crossing density

•Pasture and hay land use

•Total water withdrawals

•Upstream dam density



Most severe disturbances in the Mountain States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into large groups (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial extents (local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial extent; buffers have only urban land use, agricultural land use, and impervious surface cover.See Detailed Inland Stream Methodology for more details.

Agriculture

The agricultural areas of the Mountain States have created a substantial drain on the water resources of this region. Northern Montana stands out as an area of very high risk for fish habitat degradation on the few streams and rivers in the area. This threatened area is principally comprised of row crops, such as wheat, barley, and alfalfa production, and cattle farms. Other areas of high risk of habitat degradation, such as southern Idaho and northeastern Colorado, correspond to areas with a high density of row crops, typically corn and wheat, cattle farms, alfalfa and potato (particularly in Idaho) production, and rangeland. Farms and ranches dependent on irrigation require large amounts of water diverted from streams and rivers or pumped from aquifers, 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. Researchers have found that grazing livestock in the arid regions of the United States caused 80 percent of the damage to streams and this factor could not be directly addressed in the Assessment with the existing datasets.

Dams and Other Barriers

There are more than 9,800 regulated dams in the Mountain States and 69 percent are in Colorado and Montana. This does not include a large number of dams that are not regulated under dam safety codes, in particular the large number of water withdrawal structures. 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. The reduced flows from water diversions result in less water in the streams for fish, and these altered flows change river habitat by changing sediment and woody debris recruitment and transport, a key factors that control fish habitat that could only be partly examined using existing datasets in this assessment. Dams also make it difficult, if not impossible, for fish to migrate to and from spawning grounds. The decrease in many species of Pacific Salmon in the Mountain States' tributaries to the Columbia River is a direct result of barriers to upstream and downstream migration of fish compounded by other factors that degrade fish habitat. For example, dams on the Snake River in Idaho have restricted Pacific Salmon migration and spawning areas, reduced productivity of tributary stream systems by cutting off ocean generated nutrients, increased pollution from agriculture, and increased and concentrated predators that prey on out-migrating salmon and steelhead smolt. Similar effects have been documented for Bull Trout, many of the native Cutthroat Trout sub-species, Pacific Lamprey, and White Sturgeon, as well as sucker and minnow species. Some progress is being made to address dams that no longer serve a social need, as at least six dams were removed from Mountain States' waterways during 2010-14.

Pueblo Dam on the Arkansas River in Colorado.

Urban Land Use

Urban areas significantly and negatively affect aquatic habitat quality in the Mountain States. This was particularly apparent in the rapidly growing Denver/Ft. Collins, Boise, Salt Lake City, Great Falls, and Billings areas. Highway corridors along Interstates 25 and 90 in Wyoming and 76 in Colorado were implicated to be causing high to very high risk factors. In 2015, the highly urbanized I-25 corridor between Cheyenne, WY and Pueblo, CO had a population of 4.49 million people. In these cities and their surrounding suburbs, large areas of impervious surfaces (i.e. buildings, parking lots, and roads) replace natural streamside habitat, increase pollution and sedimentation, alter hydrology, and increase the demand for scarce water. Denver, for example, annually withdraws 234,000 acre-feet of water from regional rivers over a 4,000 square mile area, particularly from the South Platte River drainage. When compounded with recent trends of decreased snow fall, increased drought, and warmer temperatures, significant reductions in flow, depth, and water quality may occur in regional waterways. These conditions will seriously affect fish populations near the cities as well as downstream.

This photograph depicts an example of many ways urban land use may influence streams in the mountain state region at the junction of Clear Creek and Georgetown Lake in Georgetown, CO.

NATIONAL FISH HABITAT PARTNERSHIP

Habitat Trouble for Arctic Grayling in Mountain States

Arctic Grayling (*Thymallus arcticus*) now inhabits less than 5 percent of its historic river range in the Mountain States. This species requires high-quality coldwater habitat with long, un-fragmented reaches. Historically, glacial relict river populations were found in the Upper Missouri River Basin with another now extinct population in the Midwest (Michigan). The Arctic Grayling has been affected by water withdrawals, barriers to movement, and habitat degradation. One of the last strongholds, the Big Hole River in Montana, was reduced to a trickle in the summers of the 1990s as a result of irrigation withdrawals. Recent cooperative efforts, which include better water management, have improved populations of Arctic Grayling in the Big Hole River.

Arctic grayling *(Thymallusarcticus)*

Habitat Trouble for Plains Minnow in Mountain States

The **Plains Minnow** (*Hybognathus placitus*) is well adapted to prairie watersheds. It is found in open, shallow river channels of highly turbid rivers and creeks with sandy bottoms, high levels of dissolved solids, and slight to moderate erratic flows, typical of these watersheds. One of many issues affecting the Plains Minnow is that the construction of dams has significantly altered flow regimes in its range. Eliminating flood events has removed the historical cues for spawning and reduced spawning habitat.

Plains minnow *(Hybognathusplacitus)*

Habitat Trouble for Westslope Cutthroat Trout in Mountain States

The **Westslope Cutthroat Trout** (*Oncorhynchus clarkii lewisi*) is a subspecies of Cutthroat Trout that requires high quality coldwater fish habitat along with connected river segments. It has been in decline because of habitat degradation from logging, road building, overgrazing, mining, urban development, agriculture and dams, and competition and hybridization from introduced non-native trout species. Intensive habitat restoration efforts are underway to improve populations of this important species. In addition, restrictive harvest regulation strategies have been passed as this species is very vulnerable to angling.

Cutthroat trout *(Oncorhynchusclarkii)*

Fish Habitat Partnership Activities for the Mountain States

Partnerships - Western Native Trout Initiative, Reservoir Fisheries Habitat Partnership, Desert Fish Habitat Partnership, and Great Plains Fish Habitat Partnership

1. Partners removed 11 barriers and reconnected over 112 miles of native trout streams and river habitat and improved instream flow in 45 miles of streams.
2. Installed four barriers to protect native trout from competition, predation, and interbreeding with introduced species.
3. Funded 26 population assessments that provided valuable information for the management of native trout in the Mountain States.
4. Cooperated on a critical project for Greenback Cutthroat Trout to place in-stream structures to restore pool habitat, stabilize eroding stream banks, remove existing sediment, and establish riparian vegetation for 3.4 miles *of the only remaining habitat* for genetically pure Greenback Cutthroat Trout.
5. Provided funding for installation of 33 rock piles to concentrate sportfish in Willard Bay, a freshwater reservoir in the Great Salt Lake, Utah.

For more about specific waters and projects the Mountain States Fish Habitat Partnerships are working on, please see the following locations:

•Chadbourne Dam Fish Passage Project, Yellowstone River Basin, Montana – see featured article
•Weber River, Utah – see featured article
•Interior Redband Trout Range-wide Assessment – see featured article
•Bear Creek, Colorado
•Green River Basin, Colorado-Wyoming-Utah
•Badger Creek, Idaho
•Georgetown Creek, Idaho
•St. Charles Creek, Idaho
•O'dell Spring Creek, Montana
•Duchesne River, Utah
•South Fork Chalk Creek, Utah
•LaBarge Creek, Wyoming

Weber River, Utah - Weber River Restoration Project

Partnerships - Desert Fishes Habitat Partnership and Western Native Trout Initiative

Bluehead Sucker (Catostomus discobolus) and Bonneville Cutthroat Trout (Oncorhynchus clarki utah) have experienced extensive population declines and range reduction, often from habitat fragmentation. In the Weber River, Utah, Bluehead Sucker occurs in three fragmented reaches and the strongest population in the Weber River is confined below the Lower Weber River Diversion structure. Allowing passage around this diversion would provide Bluehead Sucker access to needed canyon habitat. Large fluvial Bonneville Cutthroat Trout have been virtually eliminated from river mainstems throughout this species' range, but still persists within isolated mainstem segments of the Weber River, unable to migrate back to ideal spawning grounds in tributary streams. Opening the barriers to Cutthroat Trout passage would reconnect canyon habitat and initiate major reconnection with tributary streams. Each fragmented reach in the Weber River supporting these species not only impeded movement but potentially increased sedimentation of gravel beds, reduced woody debris movement that reduced habitat for these species, threatened population resiliency, genetic diversity and long-term persistence of both species.

A restoration project was developed to protect native fish and improve the water withdrawal efficiency for the water companies in the Weber River drainage, Utah. To facilitate the upstream movement of fish from the lower Weber River drainage upstream into the Strawberry Creek and Gordon Creek drainages, project funds were used to design, engineer and build/re-build: the Strawberry Creek culvert to provide for fish passage; a step-pool complex and riffle reconstruction in Gordon Creek to facilitate fish passage; and a pool/weir fish passage at the mainstem Weber River Diversion Dam. Initial upstream fish passage constructed at the diversion site was found to allow water velocities that were too high for upstream fish movement when the river was at bankfull discharge. A fish ladder that is only active at high flows was successfully retrofitted within the fishway and provided passage upstream during high-water events. This project advanced a larger scale effort to remove additional barriers located upstream and 17.5 miles of river were reconnected.

For additional information on efforts to conserve the Weber River, please visit the following:
http://www.desertfhp.org/#!weber-river/c13cj
http://www.westernnativetrout.org/media/waters-to-watch/2012-waters-to-watch_weber-river-utah.pdf

Chadbourne Diversion Dam Fish Passage Project

Partnership - Western Native Trout Initiative

Seldom are dams beneficial to fish populations but the Chadbourne Dam is an exception. The Shields River watershed has substantial conservation value for Yellowstone Cutthroat Trout (Oncorhynchus clarkii bouvieri) because the watershed is the largest basin-level stronghold for Yellowstone Cutthroat Trout populations in Montana. Within the Shield River watershed, sixty-six percent of streams of historically occupied habitat still support Yellowstone Cutthroat Trout. This watershed is at the northern extent of the species' native range, which also provides an opportunity to conserve Yellowstone Cutthroat Trout where they can be resilient to climate change.

The Chadbourne Diversion is a dam spanning the Shields River about 16 miles from its confluence with the Yellowstone River, northeast of Livingston, Montana. Built in 1908, the Chadbourne Diversion had the unintended consequence of being largely impassable to fish, which has prevented the invasion of Rainbow Trout into the Shields River watershed. Rainbow Trout are a primary cause of the declines in distribution and abundance of Yellowstone Cutthroat Trout; so preventing them from accessing the bulk of the Shields River watershed is a high conservation priority. By excluding Rainbow Trout, the diversion protects 375 miles of stream occupied by core populations of Yellowstone Cutthroat Trout. This project had been a conservation priority for Yellowstone Cutthroat Trout since 2004, with awareness of the century old dam structure's design flaws that: could potentially allow Rainbow Trout passage; left the dam in a state of disrepair; and provide for the potential of total failure. In fact, a 10-ft section of wall collapsed during a large flood in 2011. A catastrophic failure would allow Rainbow Trout open access to a watershed where they were rare and would likely result in the eventual loss of pure Yellowstone Cutthroat Trout through competition and genetic contamination.

Plans were developed to replace the vertical dam with a curved-shaped dam and steep splash pad to improve hydraulics. These new features would make it almost impossible for a fish to leap over the dam – something that was observed with the original design. Construction was completed December 2012. This project provided an opportunity to combine the interests of agriculture and native fish conservation. The Chadbourne Diversion is now reinforced, stable, and has several new features that make it impassable to fish, which protects Yellowstone Cutthroat Trout populations upstream.

To monitor results, biologists tagged all Rainbow Trout captured upstream of the dam and released them below the dam. Fish sampling above the dam in 2013 resulted in only one small, tagged Rainbow Trout, which was believed to be either transported by an angler or escaped during tagging. The reconstruction is believed to have been successful in virtually eliminating upstream movements of Rainbow Trout above Chadbourne Diversion Dam. Monitoring is planned for 10 years.

For additional information on efforts to conserve native trout, please visit the following:

http://www.westernnativetrout.org/media/2012-funded-projects/chadbourne-dam-repair-and-fish-barrier-final-report.pdf
http://fwp.mt.gov/news/publicNotices/environmentalAssessments/restorationAndRehab/pn_0109.html

Interior Redband Trout Range-wide Assessment

Partnership *- Western Native Trout Initiative*

The Redband Trout, a group of Rainbow Trout, are remarkable fish. Some live as freshwater fish and some as anadromous fish that occupy both fresh and saltwater habitats during different stages of their lives. The interior Redband Trout is listed as a "Species of Conservation Concern" in most of its range. Its historic range covers eastern Washington and Oregon, northeastern California, central and southwestern Idaho, northwestern Montana, and parts of northern Nevada. Within this broad area, Redband Trout habitat can vary from higher elevation cold-water mountain streams to lower elevation warmer desert-type streams that have periods of low stream flows and high water temperatures. Habitat for the interior Redband Trout has declined 42 percent from its historical range as a result of habitat degradation including water diversion and agricultural runoff, habitat fragmentation from artificial barriers to fish movement, and introductions of non-native species and other forms of Rainbow Trout – down from 60,295 kilometers of stream and 152 lakes to just 26,000 kilometers of stream and 124 lakes.

In 2009, to catalyze conservation of this group of Rainbow Trout, the Western Native Trout Initiative funded a 3-day workshop between biologists from the states of Idaho, Washington, Oregon, California, Nevada, and Montana to share information on the status of Redband Trout populations across their range. This workshop became the precursor to a range-wide assessment of Interior Redband Trout in 2011, which received Western Native Trout Initiative funding. The range-wide assessment required 13 workshops to complete a comprehensive status review in partnership with the state fish and wildlife agencies of California, Idaho, Montana, Nevada, Oregon, Washington, U.S. Fish and Wildlife Service, U.S. Forest Service, Bureau of Land Management, 11 Tribal nations, and representatives from private companies. The assessment, completed in 2012, focused on collecting and compiling existing and historic information on the interior (non-anadromous) range of the species, with the intent of identifying and prioritizing key Redband Trout habitats to be enhanced and protected. When the assessment was complete, the final results involved the expertise of 95 biologists and ArcGIS technical experts, and 15 data entry personnel.

Subsequent development of a Redband Trout Conservation Agreement among partners was then undertaken and in June 2014, six state agencies, four federal agencies, five Tribal governments, and Trout Unlimited developed and signed the Redband Trout Conservation Agreement to facilitate greater partnerships and prioritization goals for the species. The Conservation Agreement identified six goals and 28 actions to promote Redband Trout conservation efforts range-wide. In December 2014, a Redband Trout Species Conservation Team formed to begin developing a conservation portfolio that will lead to a range-wide conservation strategy. The successful cooperation and commitment leading up to the development of the 2014 Redband Trout Conservation Agreement is an example of the power of a years-long partnership among state and federal fish and wildlife agencies, tribal nations, researchers, land managers, and private citizens.

http://www.westernnativetrout.org/media/2011-funded-projects/final-report-rangewide-redband-trout-status-report-.pdf

Interior Redband Trout Range-wide Conservation Agreement

Northeastern States Region

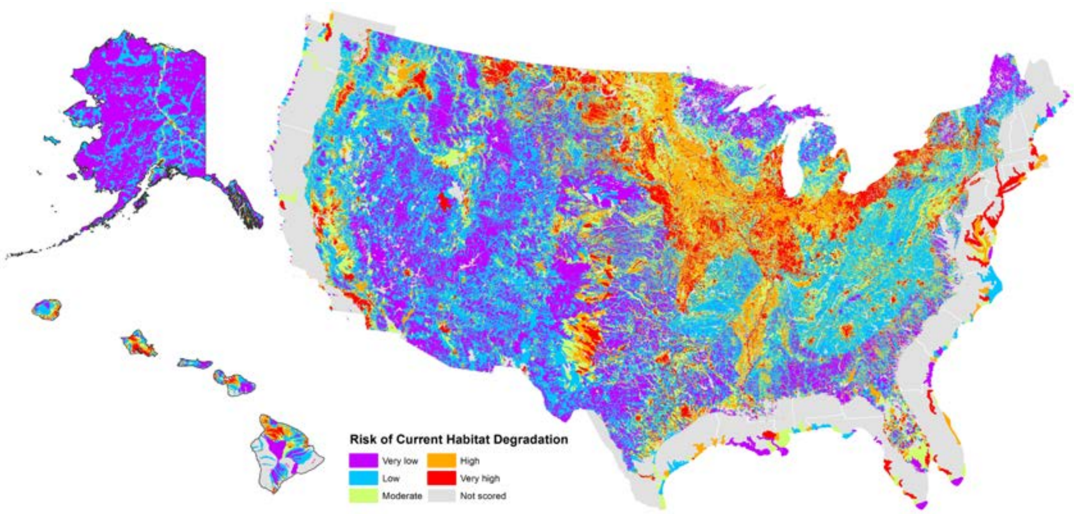
from

Through a Fish's Eye:

The Status of Fish Habitats in the

United States

2015



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[1] Retired Florida Fish and Wildlife Conservation Commission

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[3] Michigan State University, Department of Fisheries and Wildlife

[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Northeastern States Region

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NATIONAL FISH HABITAT PARTNERSHIP

Regional Summary

In general, the northern portion of this region, such as Maine, upper Vermont and New Hampshire, and the Adirondack and Catskill Mountains in New York, are at lower risk of current degradation than the southern areas, where population pressures are more intense. Overall, 53 percent of the stream miles in the Northeastern States have a low or very low risk of habitat degradation. However, the Northeastern States have experienced extensive alteration and loss of aquatic habitats in many areas. As a result, 32 percent of the stream miles have high or very high risk of aquatic habitat degradation and the region is one of the most threatened in the conterminous United States. The most common disturbances in the region are urban and suburban development, roads, and pasture land. The disturbances that most affected scores for high risk streams were roads, suburban sprawl, pasture and agricultural land use, urban development, and mine density.

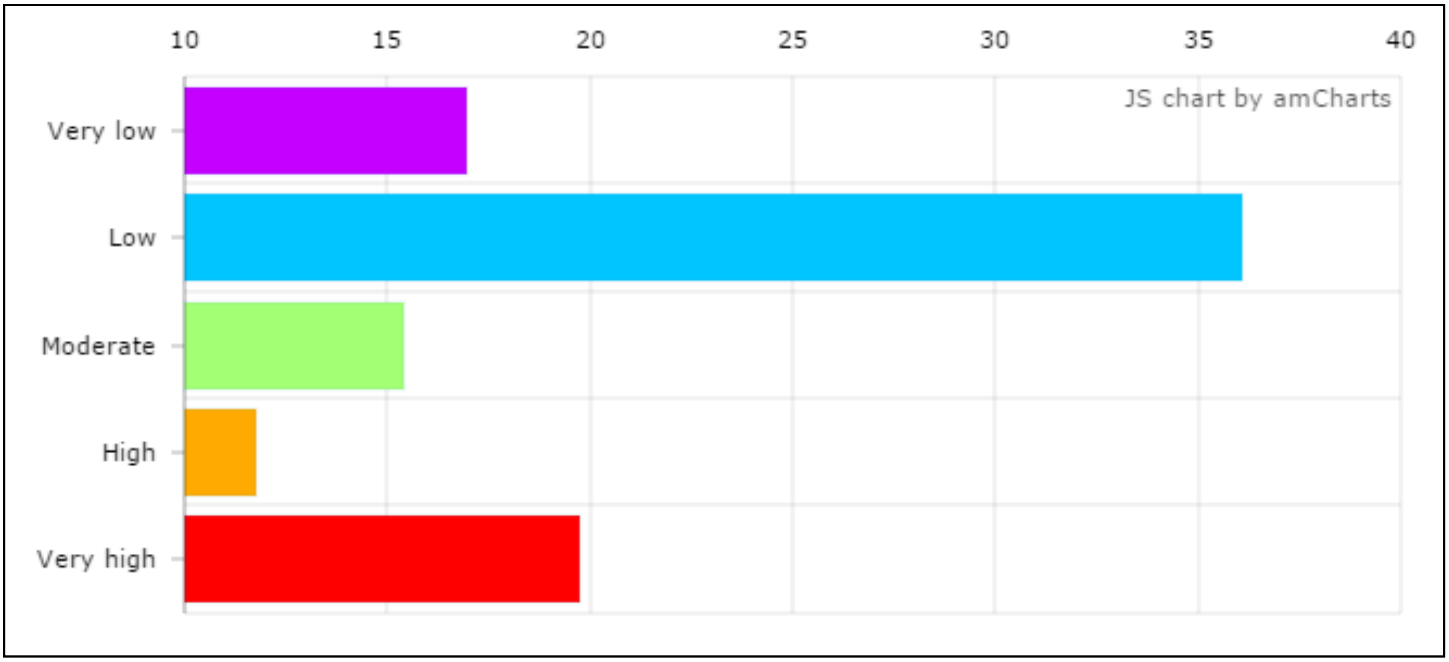
In contrast, 79 percent of the estuarine area is at high or very high risk of current habitat degradation and overall the region's coastal habitats are at greater risk than most of the country. Long Island Sound, Massachusetts Bay, Narragansett Bay in Rhode Island, Boston Harbor, Hudson River, and Connecticut River are at very high risk. Pollution and urban development were factors that were typically the worst disturbances in these estuaries. However, even lesser known estuaries were at very high risk, such as Plumb Island Sound in northeast Massachusetts, which was also affected by eutrophication. Other anthropogenic threats to Northeastern States regional estuaries are water quality and withdrawal, dams and other barriers, urban land use, and dredging and coastal maintenance. The coastal waters with the lowest risk were all located in Maine.

Fun Facts

- The Connecticut River is the largest river in New England. It flows 410 miles (660 kilometers) from its source to the Long Island Sound. New Hampshire and Vermont share about two-thirds of the river's length, or 275 miles (443 kilometers).
- The Connecticut River:
- is named after the Pequot word “quinetucket,” meaning “long tidal river.” The European corruption of that begat “Connecticut.”
- provides 70 percent of all the freshwater entering Long Island Sound.
- The Connecticut River has more than 1,000 dams on its tributaries and 16 dams on its main stem, 12 of which are hydropower projects. Many of these dams are more than 100 years old.
- The first dinosaur tracks in North America were discovered in Triassic rocks of the Connecticut River basin near Greenfield, Massachusetts.
- The Connecticut River is one of the few large, developed rivers in the United States without a port city at its mouth because shifting shoals at the Long Island Sound make safe navigation by larger ships impossible.
- The Connecticut River was designated one of just 14 American Heritage Rivers by President Clinton in 1998 due to its historic and cultural significance to the Nation.
- The Connecticut River is home to 12 species of freshwater mussels. The Dwarf Wedgemussel is a Federally endangered species. Eight of the other species are listed as either threatened, endangered, or of special concern in one or more States.
- The U.S. Fish and Wildlife Service and State agency partners are working to rehabilitate the Connecticut River’s native migratory fish including the Atlantic salmon, which for more than 200 years had been extinct from the river due to dam construction. Several fish ladders and fish elevators have been built to allow fish to move around barrier dams and resume their natural migration upriver each spring.
- The American Eel has become a highly sought-after fish since the 2011 tsunami in Japan wiped out eel stocks and Europe banned eel exports a year later. Glass eels are the juvenile life stage of the American Eel, and during the past few years they have brought a fortune to Maine fishermen who have sold the tiny eels to Asian dealers for as much as $2,600 per pound. Maine is one of two States that allow glass eel harvesting, and at its high point in 2012, Maine’s glass eel catch represented a $38-million industry.

Habitat Degradation in Inland Streams

(a)



(b)

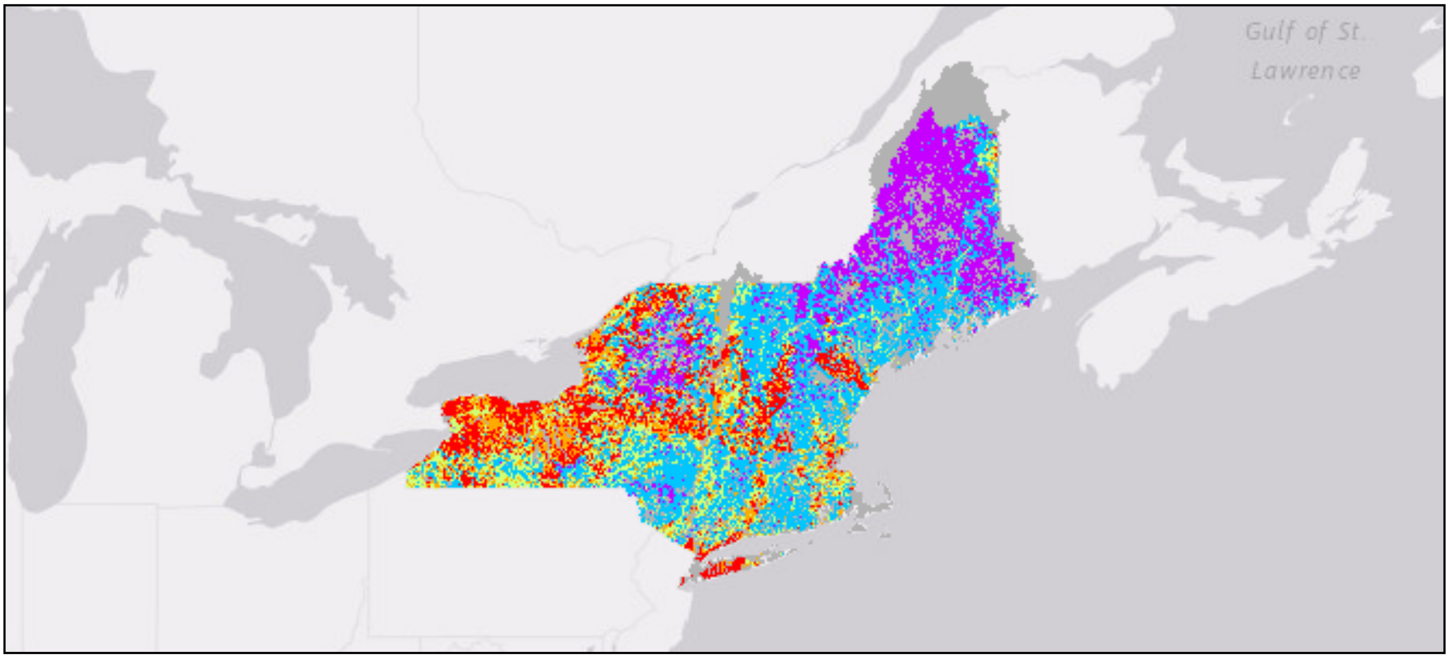
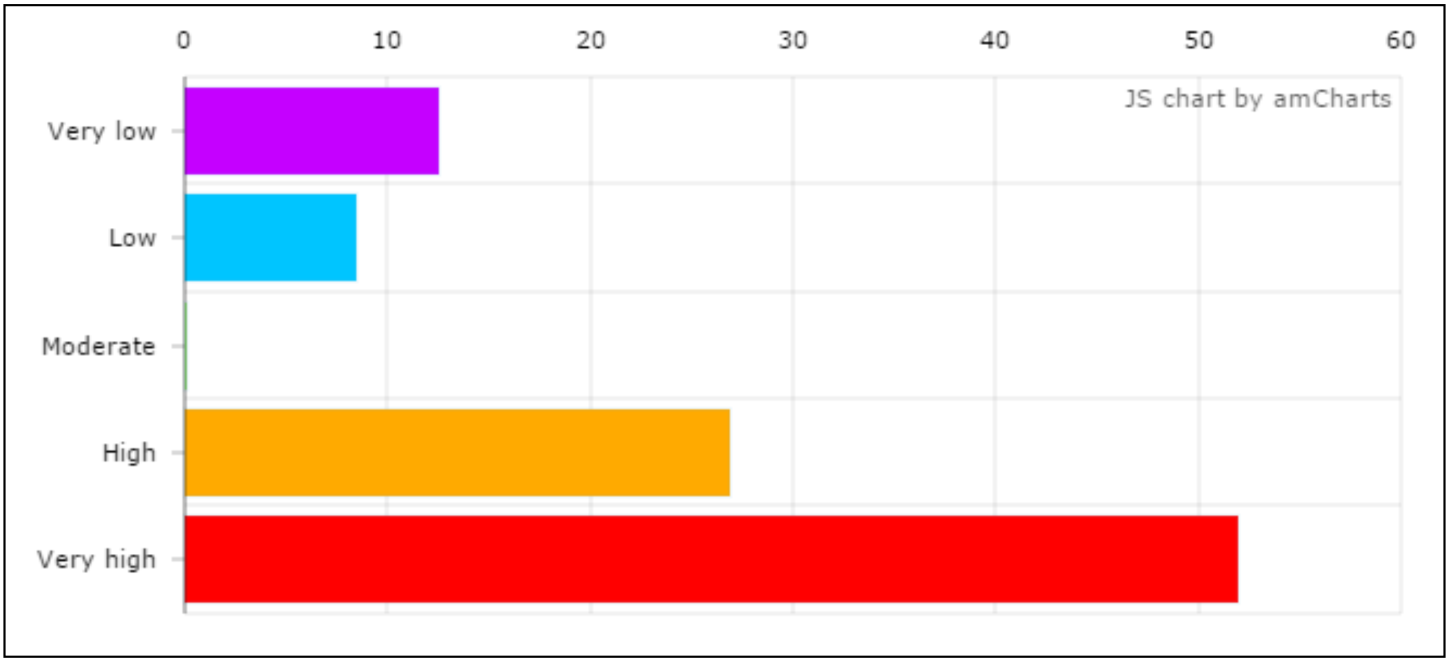


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Habitat Degradation in Estuaries

(a)



(b)

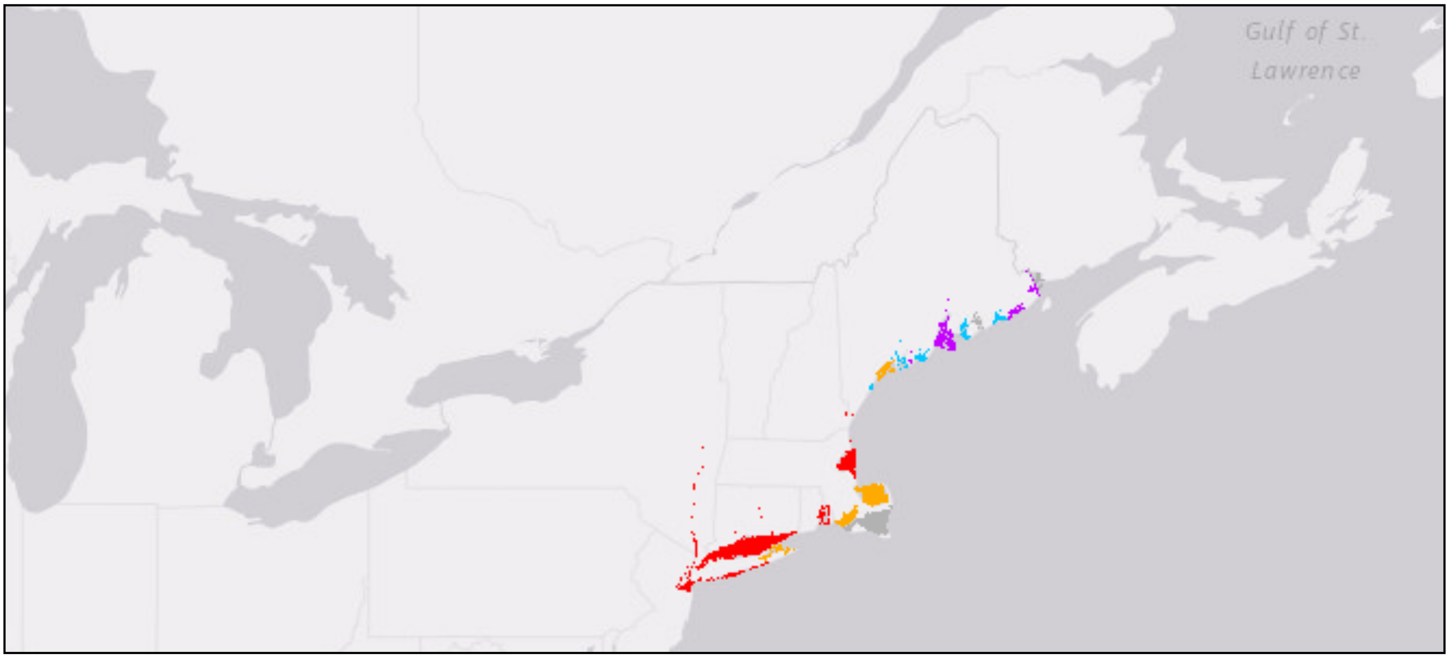


Figure1: This interactive figure summarizes the risk of fish habitat degradation. The currently selected tab shows data from the national estuary assessment. (a) Relative condition of fish habitat in estuaries. Estuary summaries represent percentage of total estuary area in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all estuary condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the national estuary assessment.

NATIONAL FISH HABITAT PARTNERSHIP

Most Pervasive and Severe Disturbances for the Northeastern States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Population density

•Impervious surface cover

•Road length density

•Pasture and hay land use

•Low intensity urban land use

Top three most pervasive disturbances to **creeks** (watersheds <100 km^2 in area) **across all** spatial scales:

•Population density

•Impervious surface cover

•Road length density

Top three most pervasive disturbances to **rivers** (watersheds >100 km^2 in area) **across all** spatial scales **:**

•Pasture and hay land use

•Crop land use

•Impervious surface

Top five most pervasive disturbances to **creeks, specific to** spatial scale:

•Road length density in network catchments

•Population density in local catchments

•Impervious surface cover in local catchments

•Low intensity urban land use in network buffers

•Impervious surface cover in network buffers

Top five most pervasive disturbances to **rivers, specific to** spatial scale:

•Pasture and hay land use in network buffers

•Low intensity land use in network buffers

•Pasture and hay land use in network catchments

•Downstream dam density in network catchments

•Crop land use in network catchments.

In the Northeastern state group, 53.1% of streams are classified as low or very low risk of habitat degradation, and these streams should be where protection efforts are focused.

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat

degradation (red and orange color groups).

Top five overall **most severe disturbances** to all stream reaches, regardless of stream size and across all spatial scales (ranked highest first):

•Road length density

•Low intensity urban land use

•Pasture and hay land use

•Population density

•Coal mine density

Top three most **severe disturbances** to **creeks** (<100 km^2 watersheds) across all spatial scales:

•Road length density

•Low intensity urban land use

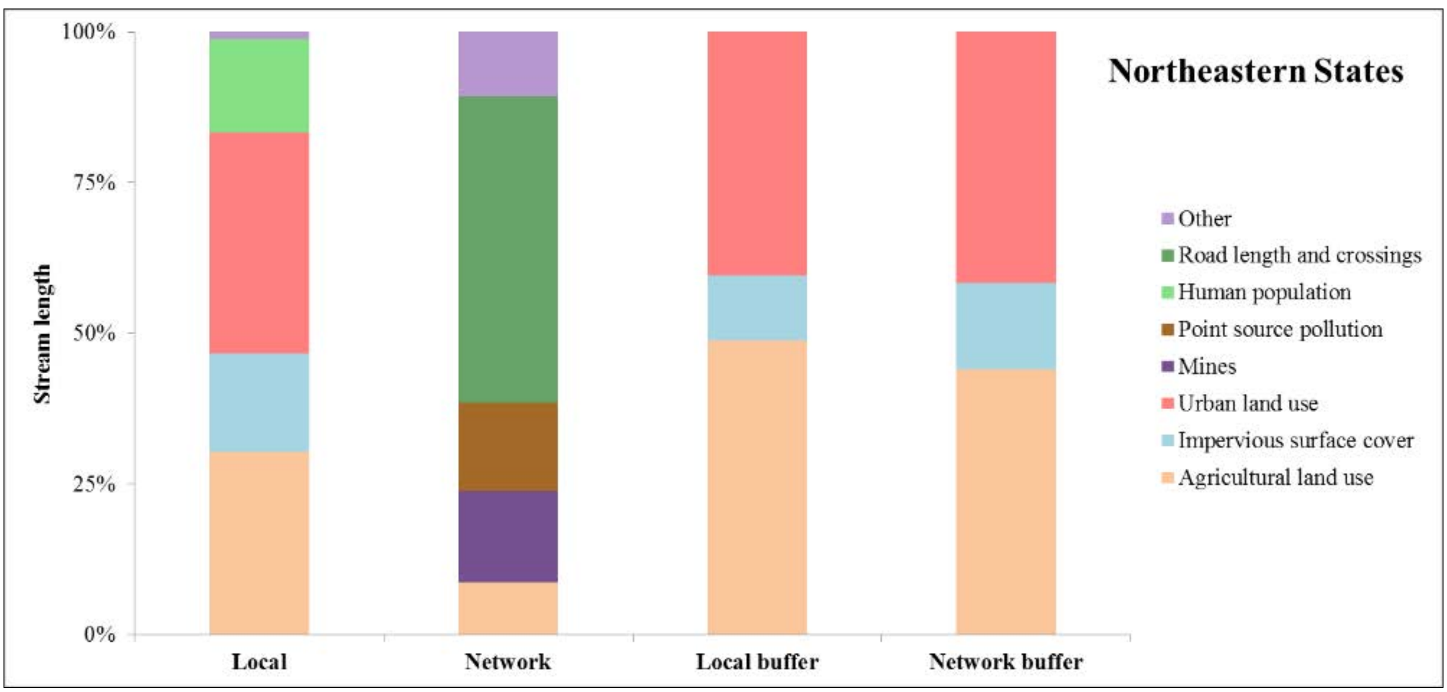
•Pasture and hay land use

Top three **most severe disturbances** to **rivers** (>100 km^2 watersheds) across all spatial scales:

•Pasture and hay land use

•Impervious surface cover

•Industrial water withdrawals



Most severe disturbances in the Northeastern States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into super categories (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales (local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale; buffers have only urban land use, agricultural land use, and impervious surface cover. See Detailed Inland Stream Methodologyfor more details.

NATIONAL
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PARTNERSHIP

Mining

Mining efforts in the Northeastern States contributed to the high risk scores of network catchments in the 2015 inland assessment. The very high risk region of southern Maine and central New Hampshire has a concentration of active and legacy mines. Sand, gravel and rock are dominant mining products in that area, along with heavy metals such as lead, zinc, and tungsten which also actively mined. The high risk area along both sides of the Connecticut River between Vermont and New Hampshire contains a large number of mines, which predominately excavate sulfur, copper, zinc, iron, molybdenum, and beryllium. Limestone is heavily mined along the western border of Vermont as well as along the I-90 corridor in New York, which both have current high to very high risk assessment. Sulfur and lead, zinc, and iron mines are common in Northwest New York along the St. Lawrence River. Many mines in the Northeastern States region are near streams and rivers and can seriously damage aquatic biota through the release of nutrients, heavy metals, mining by-products, and sedimentation if proper mine drainage and retention practices are not followed. For example, three Vermont copper mines in the Connecticut River drainage basin are Superfund cleanup sites due to release of toxic chemicals.

Point Source Pollution

The massive urban development of the northeast has resulted in discharged contaminants such as heavy metals, PCBs, and pesticides throughout the region's waters. The number of industrial sites is much lower today, but their legacy continues as pollution leaks from abandoned industrial sites, landfills and disposal areas. 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 heavy metals (e.g., arsenic, chromium, mercury, nickel, silver, and zinc), PCBs, and pesticides occur. There are numerous impaired aquatic habitats in counties bordering Lake Ontario and Lake Champlain as well as in the Hudson River drainage basin.

Many surface waters near urban areas throughout the Northeast are impaired by excessive phosphorus, siltation, pathogens, and low oxygen levels that are caused by excessive algal growth. Contaminants often find their way into the food chain, affecting fish directly by killing them or indirectly by affecting growth, behavior, and reproduction, and sometimes making them unsuitable for human consumption. Fish obtained from forty percent of sites sampled by the Environmental Protection Agency (EPA) on the Northeast coast had moderate to high levels of contamination – the highest percentage nationwide. Almost one-third of fish collected for tissue samples by the EPA in northeast coastal areas contained contaminant concentrations above levels recommended for human consumption, reducing our nation's potential seafood supply. Increased nutrients and pollution in Great Bay Estuary, New Hampshire have caused a 90% decline in oysters. Recent restoration efforts re-established two acres of oyster beds, which also benefitted Winter Flounder, Striped Bass and other species.

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 water flow (hydrology) of streams and increase sedimentation, nutrient loading, and pollution in rivers, lakes, and bays. Urbanization also results in the direct loss of fish habitat as wetlands are filled, streams diverted, and channels dredged. The effects of urbanization are apparent in the greater New York City area, Boston, Westchester-Springfield, Providence, and Buffalo-Rochester. However, increasing suburban sprawl also has a significant negative affect on aquatic habitats. From 1982 to 2012, developed land increased by almost three million acres in the Northeastern States. The most development occurred in New York (one million acres) while the greatest percentage increase in development was 81 percent in New Hampshire. On a positive note, forest land actually increased in New York by 889,000 acres, likely a result of the conversion of small abandoned farms to forests.

Dams and Other Barriers

The Northeastern States contain over 17,000 dams with most built before 1910 for agricultural and industrial water power uses. A few have been built more recently for flood control, recreation, water supply, and energy generation. In many cases, the dams have outlived their expected life expectancy and use, but continue to block the passage of migratory fish species, such as American Shad, river herring, American Eel, Rainbow Smelt, and Atlantic Salmon, to and from their historic upstream spawning grounds. Additionally, the fragmentation of stream systems by dams have reduced Brook Trout populations in some locations. Progress is being made on this impairment as over 67 dams were removed during 2010 to 2014 in the Northeast Region. The removal of several dams on the Penobscot River in Maine provided migratory fish access to 1,000 miles of habitat. Other dam removals in the region improved habitat for several trout species, particularly Brook Trout. For those dams or culverts that cannot be removed, as was the case in Patten Stream, Maine, fish passageways can be and are being constructed to allow fish greater access.

In addition to dams, poorly constructed culverts, other types of road crossings, and misplaced flood control projects also have negative effects on fish migration, tidal exchange, and stream flow, which directly affect fish growth and reproduction. Repair of transportation infrastructure after catastrophic weather events, such as hurricanes, have also caused significant damage in many locations in this region. It is absolutely critical that transportation system rehabilitation efforts consider fish habitat and are rebuilt to be more resilient to such large scale weather events. Interstate corridors, such as I-95, I-91, and I-90, as well as many other roads, produced very high threat to fish habitats throughout the region.

Habitat Trouble for American Eel in Northeastern States

Available data for the **American Eel** (*Anguilla rostrata*) indicate that, overall, there have been declines in recruitment, population, and escapement during three generations (36 years). A recent report indicated that barriers to migration (dams and weirs), passage through turbines at hydropower dams, habitat degradation or loss, and overharvest were likely the greatest threats by humans across the species' range. Although eels are able to ascend many smaller barriers, recent studies have documented a tenfold reduction in eel density above each potentially passable barrier. For example, the number of juvenile eels migrating to Lake Ontario passing over hydropower dams fell from 935,000 in 1985 to approximately 8,000 in 1993 and, finally, to levels approaching zero in 2001. Throughout the United States, it is reported that as much as 84 percent of historic stream length is now inaccessible to eels.

Habitat Trouble for Atlantic Salmon in the Northeastern States

Atlantic Salmon *(Salmo salar*) is an internationally famous anadromous trout species that can reach weights of 80 lbs. and has been listed as endangered since 2000. In the United States, Atlantic Salmon historically existed as far south as Long Island Sound, although today they are now mostly limited to the Gulf of Maine. These salmon spend their early years in Maine rivers, before migrating into international seas. After one to three years off the coasts of Newfoundland, Labrador, and Greenland, they return to their natal rivers to spawn. The primary threats to Atlantic salmon are reduced migratory passage and increased mortality due to dams and other barriers, inadequate harvest regulations in international waters, and low marine survival. A host of secondary threats affect the species, including impairments to their spawning and rearing habitat quality, water quality degradation and access to key habitat. New threats have been identified which include but are not limited to road crossings at streams preventing passage of all sizes of this species and the effects of climate change. In 2015, NOAA launched an initiative called *Species in the Spotlight*to increase focus on improving key endangered species including the Gulf of Maine population of Atlantic Salmon. Priority actions include reconnecting Gulf of Maine headwater streams with the ocean and increasing the number of fish successfully entering the marine environment, reducing mortality due to international fishing, and increasing our understanding and ability to improve survival in the marine environment.

Atlantic Salmon *(Salmo salar*)

Habitat Trouble for Bridle Shiner in Northeastern States

Aquatic vegetation is the key to **Bridle Shiner** (*Notropis bifrenatus*) survival. The loss of aquatic vegetation makes this species vulnerable to predation, often by piscivorous fishes. Land use practices that increase turbidity also affect this visual predator.

Habitat Trouble for Shortnose Sturgeon in Northeastern States

The **Shortnose Sturgeon** (*Acipenser brevirostrum*), the smallest of the three sturgeon species that occur in the eastern United States, requires clean rock or rubble above the head of tide for spawning. It has suffered from the construction of dams in the region. This species migrates upriver from lower reaches of river systems or from upper estuary areas to spawn, but has been blocked from reaching spawning areas by dams. Other spawning habitat has been impaired by water flow changes from water withdrawals and dam operations, particularly peaking power operations. Sturgeon species, in general, are very sensitive to changes from the natural water flow conditions.

Shortnose sturgeon *(Acipenserbrevirostrum)*

Partnership Activities for the Northeastern States

Partnerships - Eastern Brook Trout Joint Venture, Great Lakes Basin Fish Habitat Partnership and Atlantic Coastal Fish Habitat Partnership

1. Almost 32 miles of streams and 260 acres of riparian habitat were rehabilitated to improve Eastern Brook Trout habitat.
2. Nearly 800 feet of riverine bottom in Maine was restored to improve spawning habitat for diadromous fish.
3. Two acres of oysters were installed in the Great Bay Estuary (310,000 spat) to stabilize sediments, improve water quality, and provide habitat for species such as river herring, Atlantic Tomcod, Winter Founder, and Striped Bass.
4. Partners removed or improved 46 barriers, which allowed inland and diadromous fish to access an additional 108 miles of riverine habitat and 1324 acres of spawning area.
5. Mooring chains were replaced with bungee conservation moorings in Buzzards Bay, Massachusetts, which allowed restoration of seagrass beds. This work has inspired similar actions in other areas of New England.

For more about specific waters and projects the Northeastern States Fish Habitat Partnerships are working on, please see the following locations:

•Patten Stream, Maine – see featured article

•South Bog Stream, Maine

•West Branch Machias River, Maine

•Nash Stream, New Hampshire – see featured article

•White River Vermont

•Batten Kill River, New York

•Scoy and Staudinger’s Pond, New York

Nash Stream, New Hampshire - Restoration Project

Partnership - Eastern Brook Trout Joint Venture

Historically, Nash Stream, New Hampshire was known as a high quality wild Brook Trout stream that provided exceptional angling opportunities. Unfortunately in 1969, the dam used to release water from Nash Bog Pond for log drives failed sending a torrent of water akin to the 500-year flood event down Nash Stream. Immediately thereafter and in response to the dam failure, stretches of Nash Stream were straightened and its banks made higher by bulldozers. Consequently, much of the instream and riparian habitat was altered to the detriment of wild Brook Trout and other fish species. Additionally, undersized culverts were placed in many essential Brook Trout spawning tributaries and fish passage was impeded, not allowing fish to complete their life cycle.

Restoration of Nash Stream began in 2005 and was still ongoing through 2015. This project was a joint effort of the New Hampshire Fish and Game Department (NHFGD), New Hampshire Division of Forest and Lands (NHDFL), and Trout Unlimited (TU). The objective of this conservation effort was to restore habitat for native fish species in the watershed using well-established restoration principles. More than 90% of the watershed is owned by the NHDFL and much of Nash Stream is easily accessible to the public. All of the work directly implemented one or more of the Eastern Brook Trout Joint Venture (EBTJV) habitat objectives. The work also helped to implement the New Hampshire Wildlife Action Plan, NHFGD Inland Fisheries Operational Plans, and TU's Strategic Plan.

Over 6 miles of instream habitat on the mainstem of Nash Stream between its confluence with Emerson and Long Mountain Brooks were restored. The restoration activities included: replacing or removing dysfunctional culverts; removing a 2000 square-foot berm; removing a stream crossing; instream boulder placements; pool construction; large wood additions; floodplain reconnection; and riparian revegetation. All work was done to simulate natural stream morphology and processes. Furthermore, the Nash Stream Restoration Project reconnected over twelve miles of spawning habitat for wild Brook Trout that provided access to habitat that had been inaccessible for 43 years. Fish sampling demonstrated that many species moved upstream when passageways were improved and that biomass and density of wild Brook Trout increased after restoration (unpublished data, New Hampshire Fish and Game Department). Ongoing research at Nash Stream, funded by the U.S. Fish and Wild Service (USFWS) Science Excellence Initiative Program and Management Assistance Grant, is providing valuable data on fish movements and usage of new habitats created in Nash Stream. This information will be used to evaluate this restoration project and provide guidance for similar work elsewhere. The resulting socioeconomic benefit resulting from these conservation outcomes was estimated to be $8.2 million.

Link to full project description - http://bit.ly/1e47yXn
Link to Nash Stream article published in Northern Woodlands - http://bit.ly/1opTRvR


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New Hampshire Fish and Game Department

Patten Stream, Maine - Connectivity Project

Partnerships - Atlantic Coastal Fish Habitat Partnership and Eastern Brook Trout Joint Venture

The Upper Patten Stream Watershed near Surry, Maine historically supported a thriving commercial Alewife fishery and was used by many other anadromous fish species including Blueback Herring, American Eel, sea-run Brook Trout, and Atlantic Salmon. The Route 172 road crossing caused a four-foot drop without a jumping pool, creating a significant fish movement barrier. The road was the only barrier between Patten Bay and the upper drainage, located just upstream of the estuary. Patten Stream's Alewives were nearly eliminated, surviving mainly due to volunteers who carried fish over the barrier in nets so they may reach spawning habitat.

This project restored access to more than 20 stream miles, including over nine miles designated as "High Ranking" wild Eastern Brook Trout watershed, and 1,200 acres of Alewife spawning habitat in Patten Stream. A temporary fish ladder was initially installed at the drop while development and construction of the weirs was accomplished. The installation of a series of five granite rock weirs will allow for more natural fish passage. The design of the rock weirs was developed to adequately dissipate energy associated with high flows. Primary and secondary notches were provided to facilitate passage under a range of flows, and the modular design of the weirs facilitated cost-effective adjustments in notch elevation if necessary. The project was completed in late 2015.

The U.S. Fish and Wildlife Service provided the Atlantic Coastal Fish Habitat Partnership and the Eastern Brook Trout Joint Venture with conservation dollars to fund numerous components of the project, including supplies for construction materials, labor, and onsite engineering. Community events, school trips, and a volunteer alewife monitoring program are all planned during the course of this project as well.

Northern Plains States Region

from

Through a Fish's Eye:

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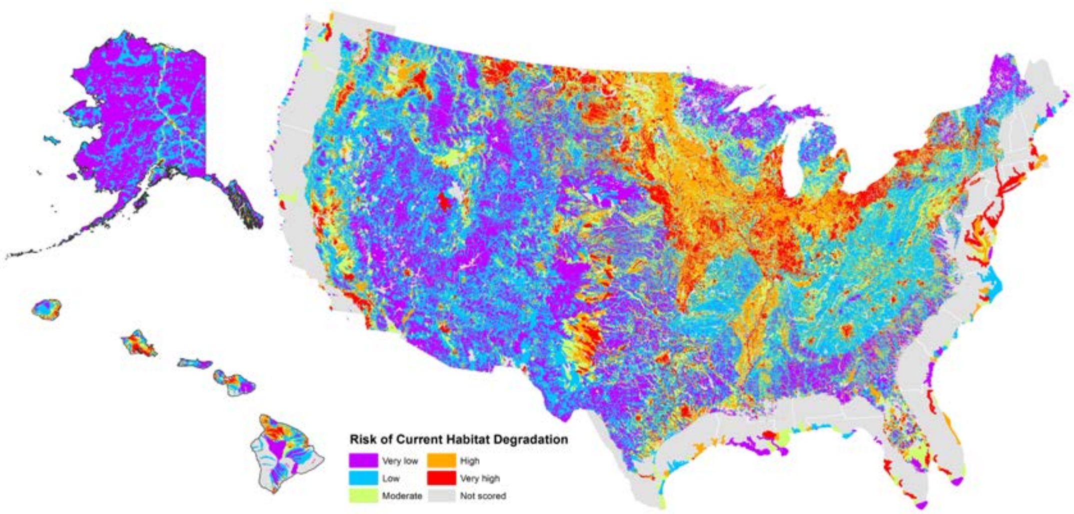

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[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

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Regional Summary

While the overall assessment indicated that fish habitat in this region is some of the most threatened in the United States, some of the key fish habitat forming processes, such as water flow (hydrology) and grazing intensity, could not be fully included in this assessment as there are no national coverages for all of the supporting data needed to properly examine these processes. As a result, habitat condition (quality) has likely been overestimated for some systems in this region and the risk of degradation is likely higher than estimated. It is expected that future national assessments will include information on more of the key habitat processes as resources and data are available.

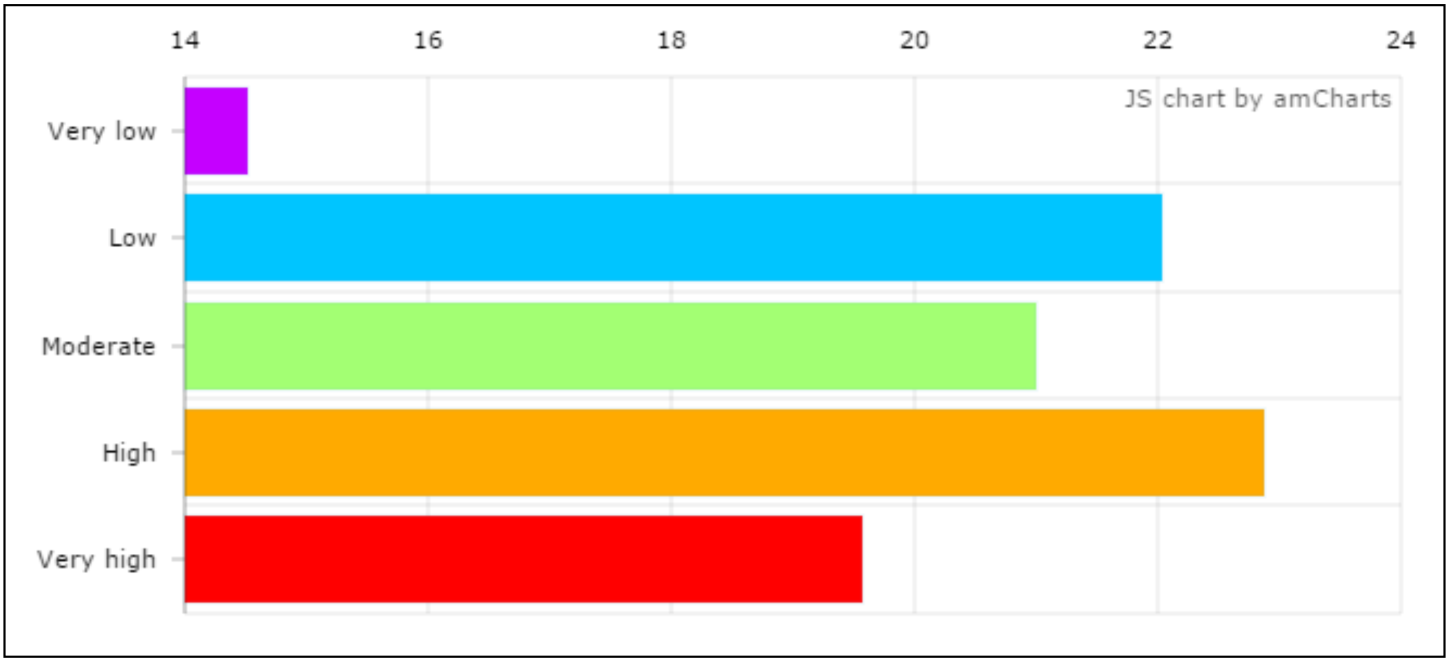
The results from this assessment indicate the aquatic resources of the Northern Plains States are some of the most threatened in the nation, mostly from agricultural effects on stream systems. Only 37 percent of the streams are at low risk of habitat degradation, while more than 42 percent of the streams in these states are at high or very high risk. Agriculture and livestock are the predominant land uses contributing to runoff of nutrients and sediment into streams – particularly in North Dakota and the eastern side of South Dakota and Nebraska. Although 93 percent of Nebraska is farms or ranches, the areas of high or very high risk are concentrated on the eastern side and are due to row crops and the density of road crossings. Central and east 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 western North Dakota. Road crossings and dams also contribute to habitat degradation in all of these areas. Fish habitat in the northern plains states is relatively undisturbed by urban development with Omaha, Nebraska being the largest city.

Fun Facts

- The Missouri River is the longest river (2,341 miles or 3,767 kilometers) in North America and, in this region, forms the boundary of South Dakota and Nebraska and, after being joined by the James River from the north, forms the Iowa/Nebraska boundary. The longest tributary of the Missouri is the Platte River (310 main-stem miles (499 kilometers) and 1,050 miles (1,690 kilometers) including the longest main tributary), which joins from the west.
- Nebraska has the largest aquifer (underground lake/water supply) in the United States, the Ogalala aquifer, and has more subsurface groundwater reserves than any other State in the continental United States.
- Nebraska's name originates from an Oto Indian word meaning "flat water," referring to the Platte River, which means "flat river" in French.
- The Platte River was significant in the westward expansion of the United States, providing the route for several major westward trails including the Oregon Trail, California Trail, Mormon Trail, Pony Express, the Union Pacific transcontinental railroad, the first transcontinental paved highway (U.S. Highway 30), and Interstate 80.
- The James River drops approximately 5 inches (130 mm) per mile (1.6 km), and this low gradient sometimes leads to its flow reversing direction. Reverse flow occurs when high inflow from tributaries leads to James River water flowing upstream for several miles above the joining water. This happens most frequently north of Huron, South Dakota.

Habitat Degradation in Inland Streams

(a)



(b)

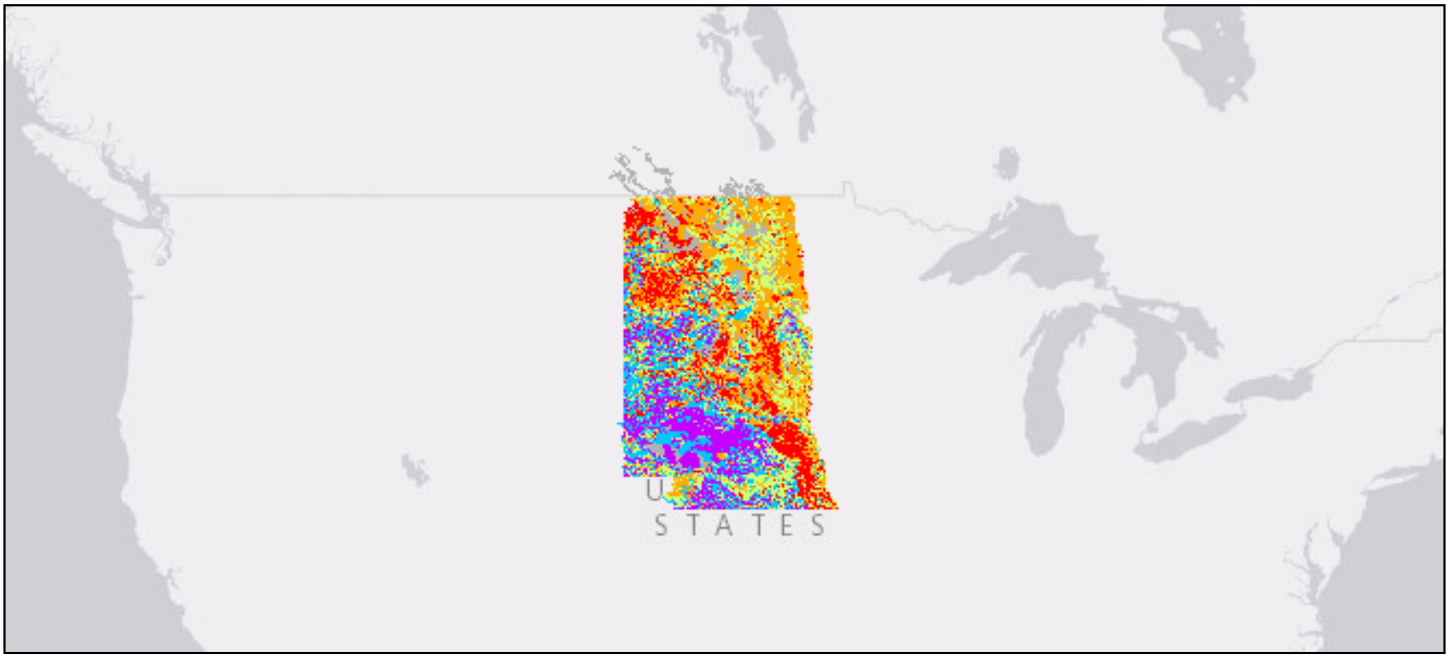


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

NATIONAL FISH HABITAT PARTNERSHIP

Most Pervasive and Severe Disturbances for the Northern Plains States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Crop land use

•Low intensity urban land use

•Impervious surface cover

•Road crossing density

•Agricultural water withdrawal

Top five most pervasive disturbances to **, specific to** spatial scale:

•Crop land use in network catchments

•Crop land use in network buffers

•Low intensity urban land use in network catchments

•Crop land use in local buffers

•Impervious surface cover in network catchments

In the Northern Plains state group, 36.6% of streams are classified as low or very low risk of habitat degradation.

Crop land use makes up the majority of the landscape disturbance leading to the risk of habitat degradation in all four spatial scales (local catchment, network catchment, local 90m buffer and network 90m buffer) and both stream sizes (creeks and rivers).

(NOTE: There is no destination of creeks and rivers for this state group, because the Northern Plain Ecoregion, which covers parts of these states, could not be assessed in stream size classes.)

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat degradation (red and orange color groups).

Top five overall most severe disturbances to all stream reaches, regardless of stream size and across all spatial scales (ranked highest first):

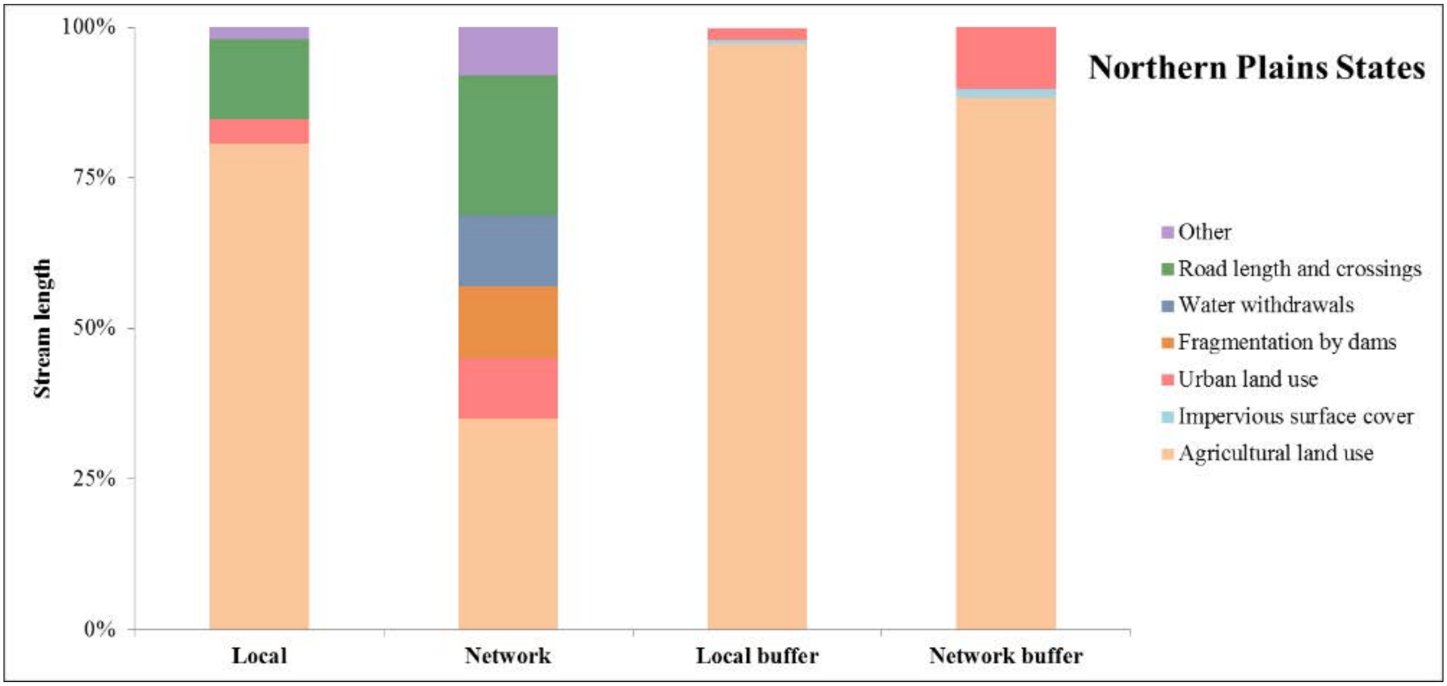
•Crop land use

•Road crossing density

•Pasture and hay land use

•Agricultural water withdrawal

•Low intensity urban land use



Most severe disturbances in the Northern Plains States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into large groups (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales (local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale ; buffers have only urban land use, agricultural land use, and impervious surface cover. See Detailed Inland Stream Methodology for more details.

Agriculture

Wheat, corn, and soybeans are some of the primary crops grown in the Northern Plains States. About 8.5 million acres, one-fourth of the state's land area, are used to grow wheat in North Dakota. In areas of intense cultivation, streams are often channelized for irrigation, reducing their habitat value for fish as temperature, in-channel cover, and stream flow are significantly changed. In addition, watersheds dominated by row-crop agriculture discharge excess sediment and nutrients to downstream waters. Agricultural water withdrawal was also one of the most limiting disturbances identified in this assessment. A large number of groundwater wells in the Nemaha River basin in southeast Nebraska, an area dominated by agriculture, are reported to be depleted by the Nebraska Department of Natural Resources. These withdrawals of surface and ground water, especially when compounded by severe drought conditions, as experienced during 2011 to 2014, produce significant fish habitat losses as stream flows decline to zero and entire stream reaches become dry.

Pasture

Lands within the watersheds of the Great Plains streams that are not used for crops are often used for cattle grazing and hay production. Northern Plains States are one of the nation's top producers of cattle, which outnumber people almost three to one in North Dakota. Cattle can have direct habitat impacts by trampling stream banks, which destroys beneficial vegetation and increases sedimentation and nutrient loads. Hofmann and Ries (1991) found that livestock increased sediment runoff in North Dakota streams. Schepers and Francis (1982) reported that runoff from a Nebraska cattle farm increased total phosphorus levels in runoff by 37%. In addition, cattle watering ponds, often constructed by diverting streams, disrupt the connectivity of the streams, potentially interfering with the natural movements of fish.

Habitat Trouble for Pallid Sturgeon in Northern Plains States

The **Pallid Sturgeon** (*Scaphirhynchus albus*) once ranged throughout the Missouri and Mississippi Rivers and requires moderate to swift rivers with both sand and rock substrates. This long-lived species, often living more than 50 years and growing to 90 pounds, requires un-fragmented river reaches to complete its life history. River channelization, bank stabilization, impoundments, and altered flow regimes have all negatively affected this species, which is listed under the Federal Endangered Species Act. The presence of multiple large dams on the Missouri River has truncated the distance the larvae can be free-floating and may cause them to settle out in the reservoirs and perish. Adult Pallid Sturgeon are not able to reproduce in these reservoirs. Current adult population estimates of this species indicate that there are only 30 adults upstream of Fort Peck Dam in Montana and fewer than 125 adults upstream of Garrison Dam, North Dakota. These two populations could be lost by 2018 if rehabilitation efforts are not successful.

Pallid sturgeon *(Scaphirhynchusalbus)*

Habitat Trouble for Sicklefin Chub in Northern Plains States

The **Sicklefin Chub** (*Macrhybopsis meeki*) requires main channel gravel and sand runs in turbid flowing waters; however, decreased and controlled flows from dam operations have resulted in excessive siltation of these key gravel beds. Dams also reduce turbidity and alter water temperatures, making the habitat unsuitable for this species.

Habitat Trouble for Topeka Shiner in Northern Plains States

The **Topeka Shiner (** *Notropis topeka* **)** requires prairie streams or oxbows that have good water quality and cool to moderate temperatures. Land practices that increase siltation, such as agricultural use, clear-cut logging, urban development, and intensive grazing, have negatively affected this fish species which is now listed as endangered under the Federal Endangered Species Act. Excessive sedimentation from poorly planned and controlled human development covers fish eggs, reduces instream cover, and fills in gravel areas needed for feeding.

Fish Habitat Partnership Activities for the Northern Plains States

Northern Plains States Fish Habitat Partnerships' 2010 - 2015 Actions to Make a Difference

Partnerships - Reservoir Fisheries Habitat Partnership, Great Lakes Basin Fish Habitat Partnership, Midwest Glacial Lakes Partnership, and Fishers and Farmers Partnership

1. Provided funding for restoration of 2,825 feet of shoreline habitat, 932 feet of wetlands, and 2.5 acres of cove habitat in Custer County, Nebraska.
2. Partners installed 25 rock piles, 26 tree reefs, and 26 shoals.
3. Removed 58,810 cubic yards of bottom sediments from Arnold Lake, Nebraska.

For more about specific waters and projects the Northern Plains States Fish Habitat Partnerships are working on, please see the following locations:

•New Life for Aging Waters: Nebraska's Aquatic Habitat Program – see featured article

•Alteration of Christine and Hickson Dams, Red River, North Dakota – see featured article

Red River, North Dakota - Alteration of Christine and Hickson Dams

Partnership - *Great Plains Fish Habitat Partnership*

Lake Sturgeon were an important protein and cultural resource for Native Americans and a key food resource for early settlers in the Red River basin in the 1800's and earlier. By the mid-1900's, this unique species was extirpated from this river system as the result of barrier and dam construction, overharvest, and pollution. In the late 1980's, a broad coalition started the process of reestablishing this key species back into its native range in the Red River system with a focus on rehabilitating habitat, removing barriers/dams, and re-populating the river using hatchery fish. The Christine and Hickson dams were 2 of 3 remaining mainstem dams that prevented fish from freely migrating upstream to access spawning, rearing, and overwintering habitats in the upper Red River. The Christine and Hickson Dams were 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 blocked passage of Lake Sturgeon, Walleye, Channel Catfish, and many other native river species. Through a partnership between several state, federal, local, and nonprofit agencies in Minnesota and North Dakota, the two dams were replaced with rock arch rapids that will allow fish access to 68 upstream miles mainstem and to two major upper tributaries. This project resulted in almost 358 miles of uninterrupted river down to Drayton Dam, the last dam downstream before Canada. The project was completed in 2012 and cost $1.4 million dollars. In addition, Lake Sturgeon were stocked in the Red River basin and are making a comeback due to the elimination or alteration of these and other dams.

This project is the culmination of a 10-year effort to replace all of the lowhead dams with rock arch rapids, in keeping with the goals and objectives of the Great Plains Fish Habitat Partnership. This effort has restored fish passage, increased fish and native mussel production, and increased recreational fishing opportunities and boating safety on the Red River.

For more information: http://midwestfishhabitats.org/project/red-river-fish-passage-hickson-dam-minnesota-and-north-dakota

Fish and Wildlife Service

New Life for Aging Waters: Nebraska's Aquatic Habitat Program

Partnership - *Reservoir Fisheries Habitat Partnership*

Following the reservoir construction boom of the 1960's and 1970's, fisheries biologists recognized an emerging problem with these waters. As aquatic habitats declined within aging reservoirs and impoundments, so did the quality of the fisheries and subsequently fishing participation. Motivation to take action was substantial as reservoirs and impoundments support the majority of recreational public fishing opportunities within the State of Nebraska. Biologists raised awareness of the importance of healthy aquatic habitats and Nebraska anglers strongly supported a legislative initiative to require the purchase of an "Aquatic Habitat Stamp" with their fishing license. Their support was predicated on the increased revenue being used solely to rehabilitate and enhance aquatic habitats with the aim to improve recreational fishing.

Since 1997, the Nebraska Aquatic Habitat Program has completed 90 projects, developing a number of new techniques to mimic natural functions in altered systems. Commonly employed strategies include: the removal of accumulated sediments and construction of retention cells; installing hard structures (e.g., breakwaters, wave attenuation, groynes) to modify water-body dynamics; bio-engineering (e.g., vegetation plantings, buffer strips, constructed wetlands, application of alum) to improve water quality conditions; and basin sculpting, substrate modifications, fish renovations and the installation of fish attractors compliment the other tactics and significantly improve recreational fishing. The total costs to date are $59,394,404. The Aquatic Habitat Stamp provided $15,579,422 or 26% of the total project costs, with 63 different funding partners picking up the balance. Sport Fish Restoration is a major partner contributing $15,131,319 to 73 projects, as is Nebraska's Environmental Trust ($10,934,402 to 38 projects) and the Nebraska Department of Environmental Quality ($7,434,327 to 14 projects).

Nebraska's Aquatic Habitat Program has been successful in building partnerships and leveraging limited fishing license dollars to improve aquatic habitat conditions and recreational fishing in Nebraska. Over the last two decades the program has grown and now encompasses stream restoration, angler access and technical assistance for all managed water systems across the state. And it all began with a little stamp!

For additional information on Nebraska Game and Parks Commission's Aquatic Habitat Program, please visit the following:

http://outdoornebraska.ne.gov/fishing/programs/aqhabitat/aqhabitat.asp


AQUATIC HABITAT STAMP
$5
1997
NEBRASKA GAME AND PARKS COMMISSION

Pacific Coast States Region

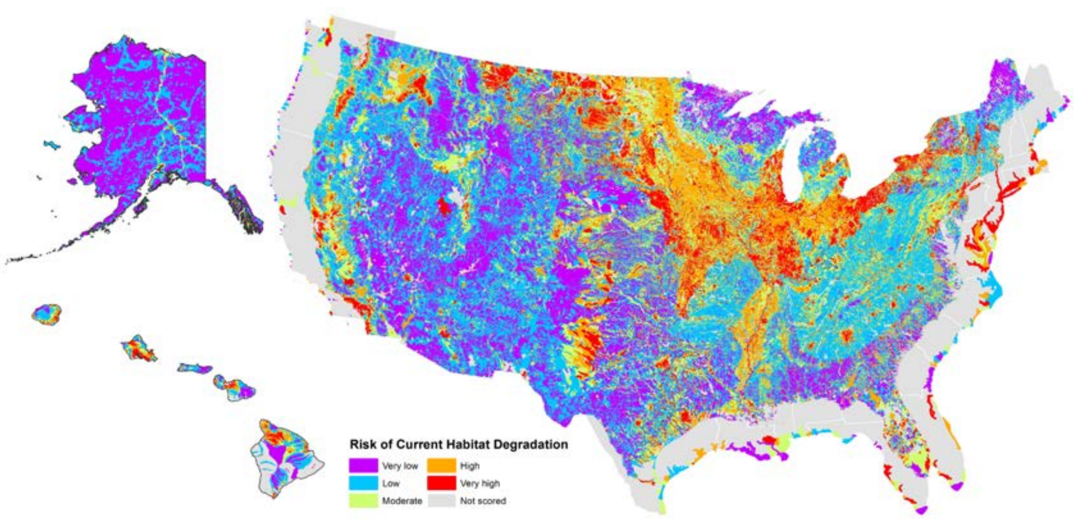
from

Through a Fish's Eye:

The Status of Fish Habitats in the

United States

2015



Steve Crawford[1], Gary Whelan[2], Dana M. Infante[3], Kristan Blackhart[4], Wesley M. Daniel[3], Pam L. Fuller[5], Tim Birdsong[6], Daniel J. Wieferich[5], Ricardo McClees-Funinan[5], Susan M. Stedman[7], Kyle Herreman[3], and Peter Ruhl[5]

[1] Retired Florida Fish and Wildlife Conservation Commission

[2] Michigan Department of Natural Resources

[3] Michigan State University, Department of Fisheries and Wildlife

[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Pacific Coast States Region

Table of Contents

Regional Summary

While this assessment has found that many of the inland streams were at a low or very low risk of degradation, some fish habitat disturbances, including water diversions, timber harvest practices, and intensity of livestock grazing in watersheds, could not be directly included in this assessment because national datasets of these disturbances and their component variables are unavailable. These disturbances are known to have major, negative effects on fish habitats in this region. Their absence from this assessment, along with absences of other disturbances, has likely produced an overestimation of habitat condition (quality) for some water bodies. *These gaps need to be kept in mind while examining the results.*Despite such absences, impairment to fish habitats was determined from conservative analyses detecting associations between stream fishes and nationally consistent and comprehensive disturbance datasets, highlighting condition of and limits to fish habitats in a nationally-comparable manner.

A majority of inland streams (67%) assessed from the Pacific Coastal States were classified to be at low or very low risk of degradation. These streams were typically located in the Cascades, the high desert region of Oregon, and in the desert and National forests region of eastern California. However, large portions of California's Central Valley, the Willamette Valley area in west Oregon, and southeast Washington between the cities of Spokane and Walla Walla have high risk of current habitat degradation due to row crops, fruit orchards, and pasture that require substantial irrigation. Urban areas such as Los Angeles/San Diego, San Francisco, and the corridor from Eugene through Portland to Seattle are also at a high risk of aquatic habitat degradation due to intensive urban land use and road crossings that restrict fish passage, reduce water flow or quantity, and pollutants.

In conjunction with both agriculture and urban water demand increasing, extreme drought conditions over the past few years seriously affected water supplies in the region with direct implications for fish habitat. During 2014 through 2015, Oregon and Washington experienced drought conditions that reached up to 100% of each state being classified as being in severe drought or worse by the fall of 2015 (http://droughtmonitor.unl.edu/MapsAndData/DataTables.aspx). Drought began in 2012 in California and during 2014 through 2015 nearly one-half of that state was declared to have exceptional drought conditions, the worst level of the U.S. Drought Monitor Categories. These conditions caused great reductions in water levels and flow of aquatic resources, elevated water temperatures to lethal levels for cold water fish, such as salmonids, and affected estuaries as well. To allow fish communities to continue to persist in these and future extreme conditions, it is critical that fish habitat measures that provide for resilience and drought tolerance be implemented.

Thirty-five percent of the Pacific coastal estuarine area is estimated to be at high or very high risk of fish habitat degradation. Notable estuaries, such as Puget Sound in Washington, South San Francisco Bay, Anaheim Bay and Santiago Creek in the greater Los Angeles area, and San Diego Bay are at very high risk. Also, experiencing very high risk are smaller and less familiar estuaries such as Sixes River Estuary near Cape Blanco, Oregon and Sequim Bay on the northern end of the Olympic Peninsula of Washington. These elevated risks are due to long term settlement of these areas, intensive urban development, drainage from agricultural land, elevated nitrogen loading caused by both of those factors, and altered water flows caused by dams, water diversions, and water withdrawals. These variables have resulted in altered food webs, changes in habitat including the loss of sea grasses and large woody debris in estuarine and inshore areas, and the loss of tidal connectivity to floodplains.

Overall, the majority of the Pacific Coast estuaries assessed were at low or very low risk but these were mostly small systems comprising only 22 percent of the total Pacific coastal states estuarine area; a score below the national average. Estuarine results in this Region were dominated by several very large estuaries at higher risk. Additionally, a significant area of the Pacific Coast was not scored due to data limitations.

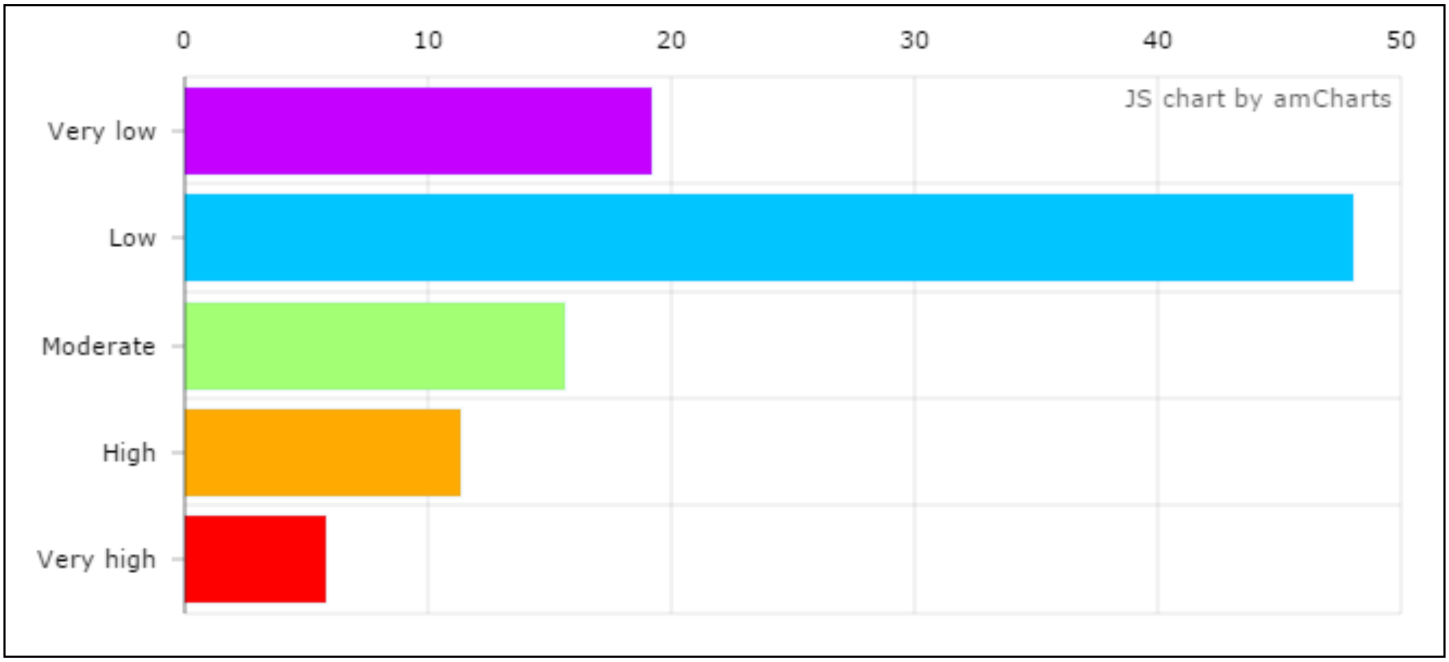
Snorkelers survey adult fish and their habitat on the Skokomish River in Washington state.

Fun Facts

- The Columbia River is the fourth largest river by volume in North America, draining an area the size of France (670,000 square kilometers).
- There are 14 dams on the main stem of the Columbia River and more than 450 dams throughout the entire Columbia Basin. The dams on the Columbia River and its tributaries produce half of the electricity used in the Pacific Northwest. These dams have completely altered river habitat and significantly changed the river's flow, water quality, and Pacific salmon spawning runs along with the survival of out-migrating smolts.
- By discharge, the Sacramento River is the second largest river on the west coast of the contiguous United States, after only the Columbia River, which has almost seven times the flow of the Sacramento.
- The Sacramento River watershed is often said to receive 66 to 75 percent of northern California's precipitation though it has only 25 to 33 percent of the land. In contrast, the San Joaquin River watershed occupies 66 to 75 percent of northern [central] California's land but only collects 25 to 33 percent of the precipitation.
- Some of the earliest transplants of fish species in the United States were mass introductions of eastern species to the lower Sacramento River in the early 1870s. These stockings included American Shad, Striped Bass, and American Eel. Chinook Salmon and Rainbow Trout were introduced to eastern streams from the U.S. Fish Commission Baird Hatchery on the McCloud River, a tributary to the Sacramento River above Shasta Dam.
- There are four species of introduced gobies in the lower Sacramento drainage and one in the lower Columbia drainage. All are from Asia and are a result of ballast water introductions.

Habitat Degradation in Inland Streams

(a)



(b)

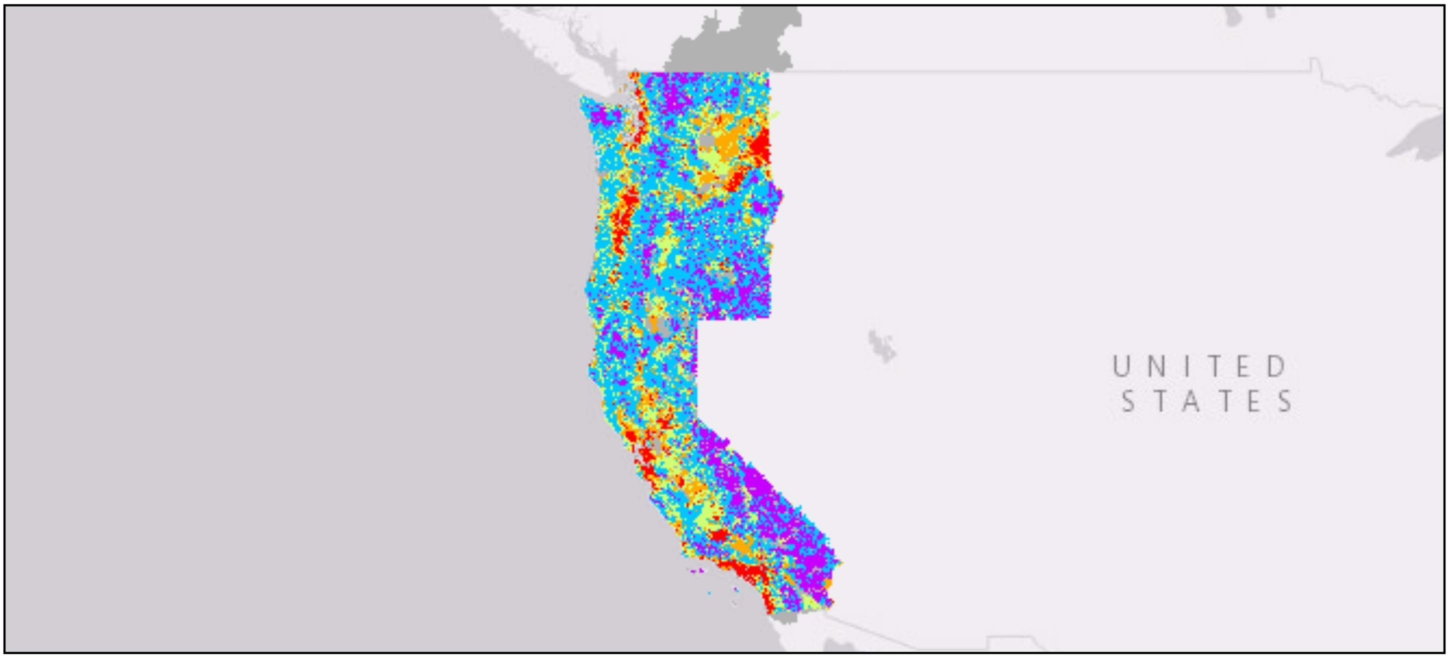
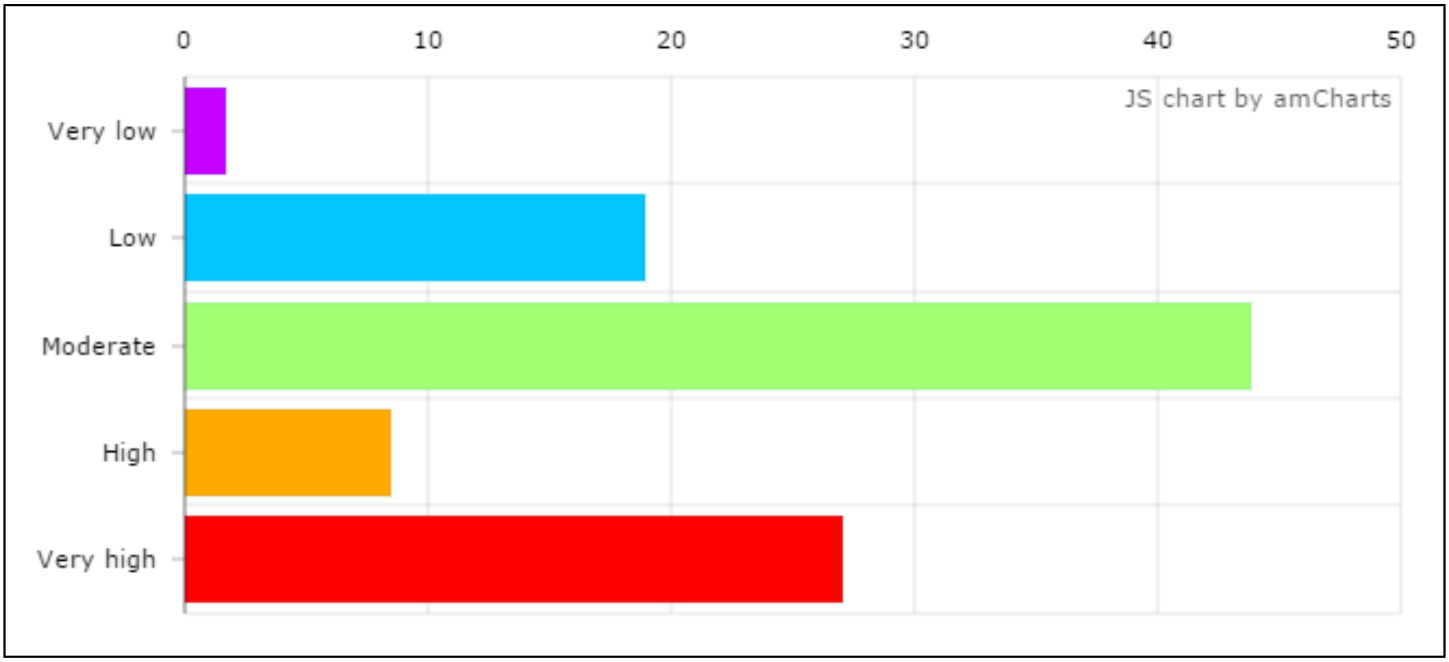


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Habitat Degradation in Estuaries

(a)



(b)

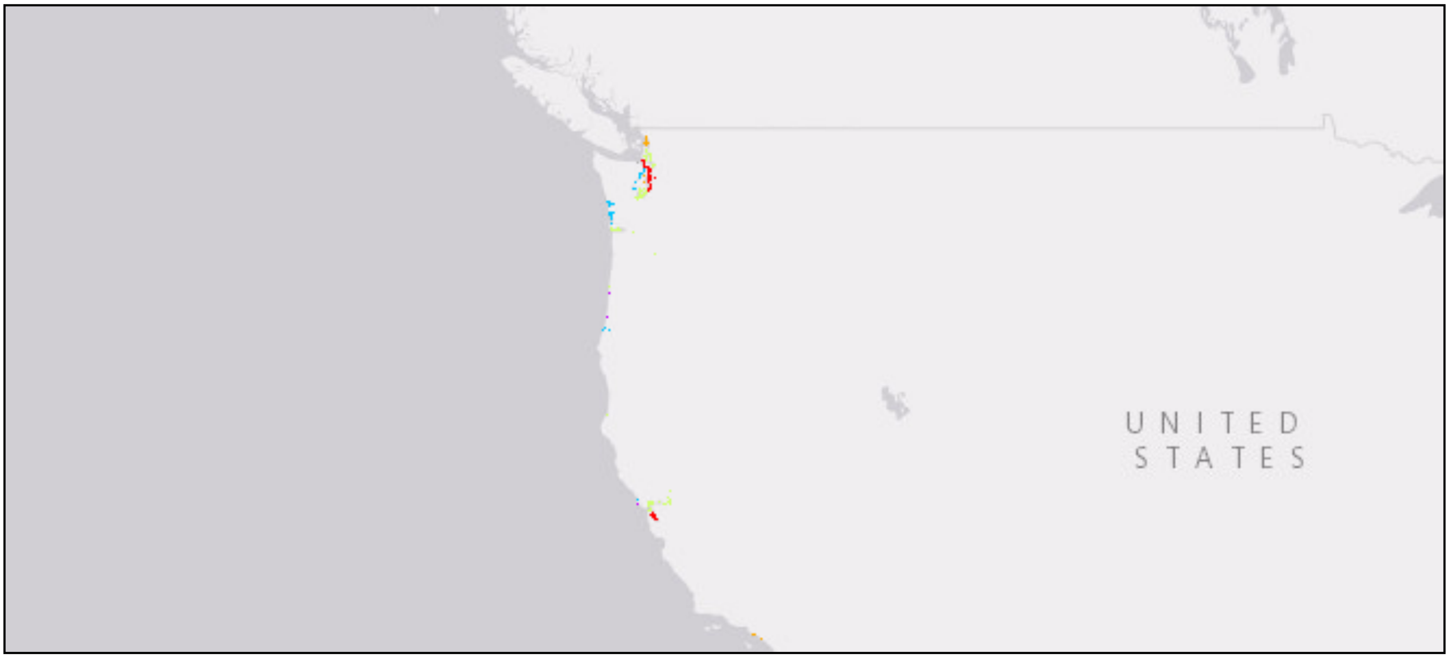


Figure1: This interactive figure summarizes the risk of fish habitat degradation. The currently selected tab shows data from the national estuary assessment. (a) Relative condition of fish habitat in estuaries. Estuary summaries represent percentage of total estuary area in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all estuary condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the national estuary assessment.

Most Pervasive and Severe Disturbances for the Pacific Coast States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Impervious surface cover

•Total anthropogenic sediment yield

•Upstream dam density

•Industrial water withdrawal

•High intensity urban land use

Top three most pervasive disturbances to **creeks** (watersheds <100 km^2 in area) **across all** spatial scales:

•Total anthropogenic (human caused) sediment yield

•Impervious surface cover

•Industrial water withdrawal

Top three most pervasive disturbances to **rivers** (watersheds >100 km^2 in area) **across all** spatial scales **:**

•Road crossing density

•Road length density

•Impervious surface cover

Top five most pervasive disturbances to **creeks, specific to** spatial scale:

•Road crossing density in network catchments

•Road length density in network catchments

•Impervious surface cover in local catchments

•Impervious surface cover in network catchments

•Total anthropogenic sediment yield in network catchments

Top five most pervasive disturbances to **rivers, specific to** spatial scale:

•Road crossing density in network catchments

•Impervious surface cover in network buffers

•Road length density in network catchments

•Low intensity urban land use in network buffers

•Low intensity urban land use in network catchments

In the Pacific Coast state group, 67.3% of streams are classified as low or very low risk of habitat degradation.

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat

degradation (red and orange color groups).

Top five overall most severe disturbances to all stream reaches, regardless of stream size and across all spatial scales (ranked highest first):

•Crop land use

•Pasture and hay land use

•Impervious surface cover

•Medium intensity urban land use

•Total anthropogenic sediment yield

Top three most severe disturbances to **creeks** (<100 km ^{2}watersheds) **across all** spatial scales:

•Crop land use

•Impervious surface cover

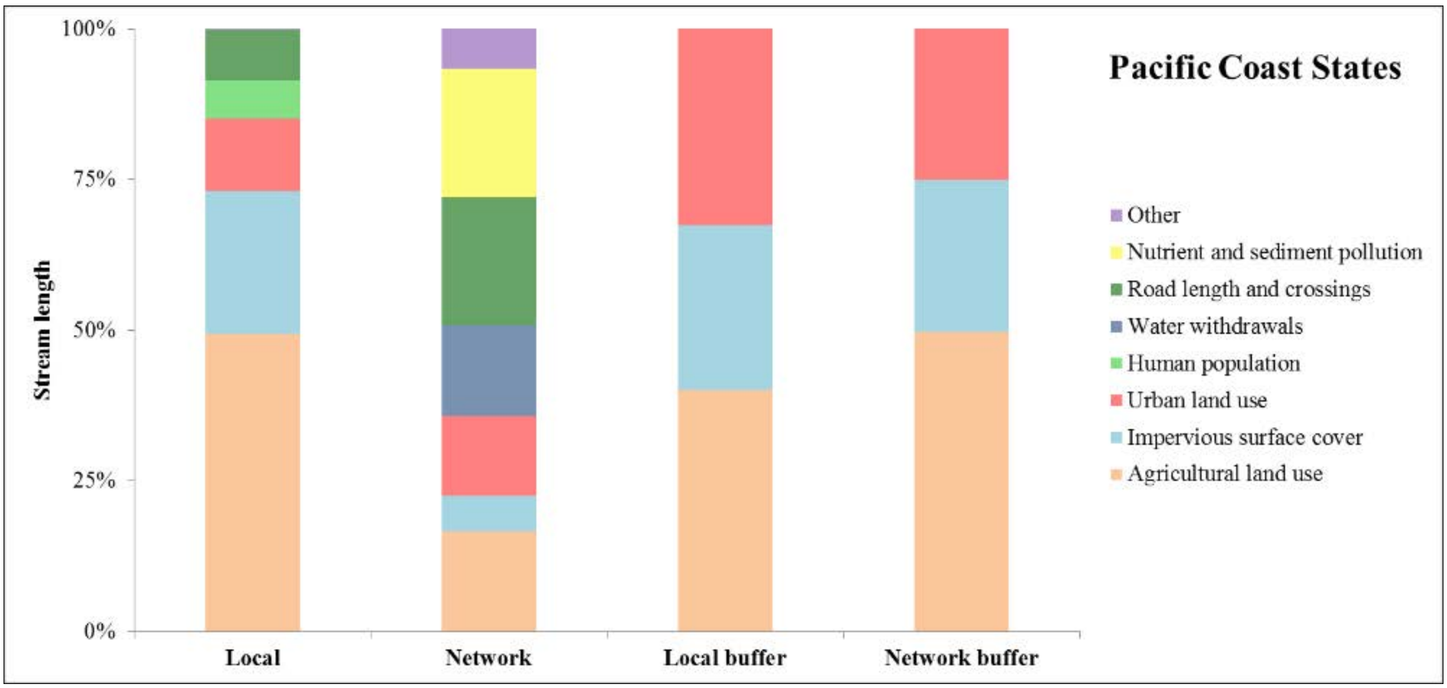
•Pasture and hay land use

Top three most severe disturbances to **rivers** (>100 km ^{2}watersheds) **across all** spatial scales:

•Total water withdrawals

•Pasture and crop land use

•Impervious surface.



Most severe disturbances in the Pacific Coast States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into large groups (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales (local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale ; buffers have only urban land use, agricultural land use, and impervious surface cover. See Detailed Inland Stream Methodology for more details.

Agriculture

Agriculture was highly influential on the fish habitat assessment of the Pacific Coastal States. One of the broadest areas implicated is the California Central Valley that extends 450 miles from Redding to Bakersfield. This region grows a wide variety of row crops and fruit trees and supports abundant cattle and dairy farms. Another region of very high risk is Willamette Valley in Oregon, where crops such as berries, vegetables, sod, and vineyards are grown. Silviculture, particularly large-scale timber clearcuts, is another significant agricultural practice in this area. Also at high risk are aquatic habitats in eastern Washington between Spokane and Walla Walla, where wheat, hay, potatoes and apples are the dominant crops. Without proper conservation measures, such as recycling water and reducing runoff, these agricultural areas negatively affect aquatic resources by surface and groundwater withdrawals and by increasing nutrient, pesticide, and sediment loading in rivers and downstream to estuaries. These factors directly affect salmon and many other aquatic species that use rivers, streams, and estuaries. The recent drought conditions have heightened the effects of all these variables and have also caused additional serious negative fish habitat impacts. For example, excessive groundwater pumping may deplete the aquifer and cause land to sink, which can lead to permanent loss of groundwater storage in the aquifer system. This has occurred in the San Joaquin Valley of Central California (http://ca.water.usgs.gov/data/drought/drought-impact.html).

Dams and Diversions

The rivers of the Pacific Coast states are heavily altered by dams and diversions *(*over 1,400 dams in California, 1,039 in Oregon, 1,174 in Washington *)*. 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 by interrupting or halting their migration from the Pacific to upstream habitats and killing large numbers of young salmon (smolts) 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 available for fisheries, and have reduced connectivity between the main river channel and these habitats. Communities have begun to realize that dams can be problematic. Americanrivers.org reported that during 2010 through 2014 seventeen dams were removed from rivers in California, 20 in Oregon, and four in Washington.

Removal of the Glines Canyon Dam, Elwha River, Washington state.

Urban Land Use

There are three designated megaregions in the Pacific Coast States: Southern California, with a population of 22.4 million; Northern California, with a population of 14.6 million; and Cascadia (from Vancouver, British Columbia to Eugene, Oregon), with a population of 8.4 million. These areas have enormous effects on both the inland and coastal aquatic habitats. Continual development increases areas of impervious surfaces (completely altering natural water flows and hydrology) and the amount of sewage discharge, sediments, and other pollutants associated with urbanization. Ever increasing urban water needs can be far reaching and affect systems and fish habitat far away from the urban areas. Los Angeles, which is located in a semi-arid plain, affects habitat in the Colorado and San Joaquin Rivers through its water withdrawals that supply the city via aqueducts.

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. For example, the Port of Los Angeles was originally an area of shallow mudflats but is now an active commercial deepwater port. Such habitat alterations occur not only in large urban areas but even in small communities like Newport, Oregon where 70 percent of Yaquina Bay salt marsh habitat has been lost to filling and diking; or in Megler Creek in Washington, where most of the shoreline has been riprapped and poorly placed culverts have disconnected the creek from the Columbia River mainstem. Plans are in place to restore both of these areas.

Habitat Trouble for Bull Trout in Pacific Coast States

The **Bull Trout** (*Salvelinus confluentus*) is widely distributed within the region and occupies a variety of large lakes, small headwater streams and larger river systems. Of all the native salmonids in the Pacific Northwest, the Bull Trout generally has the most specific habitat requirements, which are often referred to as "the four Cs": cold, clean, complex, and connected habitat. In November 1999, the U.S. Fish and Wildlife Service listed all Bull Trout populations within the lower 48 States of the United States as threatened pursuant to the Endangered Species Act. The U.S. Fish and Wildlife Service's 2015 Bull Trout Recovery Plan lists historical habitat loss and fragmentation; interactions with nonnative species such as Brook, Brown and Lake Trout, and fish passage issues as the primary threats affecting Bull Trout. Climate change also poses a dramatic risk for Bull Trout, especially warming of migratory and larger river habitats to temperatures beyond the tolerance for this species. Since the listing of Bull Trout as threatened, numerous conservation measures have been and continue to be implemented across its range. In many cases, these Bull Trout conservation measures incorporate or are closely interrelated with ongoing work for the recovery of salmon and steelhead, which are limited by many of the same threats.

Habitat Trouble for Delta Smelt in Pacific Coast States

The **Delta Smelt** (*Crystallaria asprella*) is only found in the Sacramento - San Joaquin River Delta in California and requires estuaries for juvenile and adult habitat along with the ability to migrate into tributary rivers to spawn in the spring. Declines of Delta Smelt can largely be attributed to the changes and fluctuations in flow of the estuarine ecosystem. Reduced flows resulting from water projects have resulted in saltwater intrusion into the Delta, which has reduced the amount of preferred habitat for spawning and nursery areas. When increased amounts of water are released by the water projects, larvae and adults become entrained and die, and both the fish themselves and the food they depend on are washed out of the system. Critical habitat for this Federally listed species is threatened by sand and gravel excavation in river channels, diking of wetlands, levee maintenance, and bridge and marine construction. Effects of water pollution from agriculture and urbanization are unclear at this time.

Delta smelt *(Hypomesustranspacificus)*

Habitat Trouble for Green and White Sturgeon in Pacific Coast States

Both **Green** (*Acipenser medirostris*) and **White Sturgeon** (*Acipenser transmontanus*) are long-lived species with delayed and intermittent spawning that require large amounts of connected habitat to complete their life cycle. Both species use inshore marine and estuarine habitat along with rivers for juvenile and adult habitat and require clean substrates in rivers to successfully spawn. Hydropower dams are barriers to movements of these species in Pacific rivers and have negatively affected spawning success by creating unstable daily water flow patterns through peaking power operations as has been documented in other sturgeon species. For example, the fragmentation of the Columbia River by dams has created 17 land-locked sub-populations of White Sturgeon upstream of the Bonneville Dam with population sizes much below historic numbers. It is often mentioned that “it is hard to kill an individual White Sturgeon, but easy to threaten their continued population as a whole.”

Habitat Trouble for Pacific Chinook Salmon and Coho Salmon in Pacific Coast States

The Sacramento River represents by far the largest population of returning **Chinook Salmon** (*Oncorhynchus tshawytscha*). There are four distinct spawning runs of Chinook Salmon; fall, late fall, winter, and spring. Historically, maximum spawning runs in the Central Valley approached 2 million salmon including: 100,000 late-fall fish; 200,000 winter fish; 700,000 spring fish; and 900,000 early fall fish. Current spawning sizes are a fragment of historic numbers and some of the spawning runs are listed stocks under the Federal Endangered Species Act. In 2009, total Chinook Salmon spawning populations were fewer than 69,000 salmon including: 50,000 fall fish; 10,000 late-fall fish; 3,800 spring fish; and 4,700 winter fish. In 2015, Sacramento River winter-run Chinook Salmon were named as a Species in the Spotlight, a NOAA program that seeks to draw focus to key endangered species. Winter-run Chinook salmon spawn during the warmer summer months but are blocked from their historic coldwater spawning grounds by the Shasta and Keswick dams. Managed releases of cold water from the Shasta reservoir, among other conservation measures including habitat restoration, are critical to the survival of the species.

The Chinook Salmon population abundance in the Puget Sound is also decreasing according to the Puget Sound Partnership's 2015 State of the Sound report, which determined that the mean total abundance of naturally spawning Chinook salmon was lower in the recent 3-year period of 2011-2013 than in the baseline 5-year period of 2006-2010. Although 10 indicators that measure the health of the Puget Sound are improving, many of which are measures of the habitat restoration work in which a significant investment has been made, a positive biological response has not been seen from Chinook Salmon. One reason for this could be that it takes a while to detect salmon response to habitat work because their life cycles cause them to return to spawn between the ages of 2-6 years and trends over a number of years are needed to detect changes in populations. In addition, ocean conditions impact returning adults; gains seen in the juveniles' survival resulting from habitat gains may, in some cases, be lost to unfavorable ocean conditions.

Central California Coast (CCC) coho salmon are an evolutionarily significant unit of salmon and was first listed as threatened under the Endangered Species Act in 1996. It was relisted as endangered in 2005, where it has remained since, showing an overall downward trend. CCC coho salmon spend the first portion of their lives feeding on plankton and insects in freshwater, before migrating into estuarine and marine environments to feed on small fish. After two-three years in the Pacific Ocean, these salmon return to the stream in which they hatched (or in other cases the stream in which they were released) to spawn, thus ending their life cycle. There are numerous factors threatening CCC coho salmon including but not limited to surface water extraction, climate change, drought, estuary impairment, loss of wetlands, and legacy effects of timber harvest. Bright spots do exist however, where populations are showing signs of improvements due to conservation hatchery work and habitat improvement projects. Included as a NOAA Species in the Spotlight, the priority recovery actions for CCC coho salmon include expanding hatchery programs to prevent extinction, expanding restoration and funding partnerships in target locations, and improving freshwater survival.

Chinook Salmon *(Oncorhynchustshawytscha)*

Coho Salmon*(Oncorhynchus kisutch)*

Habitat Trouble for Salmon and Steelhead in Pacific Coast States

The Columbia River historically supported one of the greatest salmon and steelhead runs on Earth. Prior to the 1840s, up to 16 million salmon and steelhead returned to the Columbia River to spawn each year. Unfortunately, by the end of the 20th century that number declined to less than 1 million fish annually. In response to the severe population declines of Columbia River salmon by the 1990s, as the result of habitat degradation in the basin, the National Marine Fisheries Service (NMFS) designated 13 stocks of anadromous salmonids as Federally threatened or endangered with extinction under the Endangered Species Act (ESA). There are currently 28 listed stocks of salmon and steelhead, plus an additional three more classified as "Species of Concern."

Fish Habitat Partnership Activities for the Pacific Coast States

Partnerships - California Fish Passage Forum, Pacific Marine and Estuarine Fish Habitat Partnership, Western Native Trout Initiative, and Desert Fish Habitat Partnership

1. Partnerships supported the removal of 59 barriers that reconnected 114 miles of native trout habitat and 14.5 miles of coastal streams to be used by threatened and endangered anadromous species.
2. Funded estuarine restoration of 500 acres in Washington and 519 acres in Oregon.
3. Sponsored the installation of one barrier to protect native trout from introduced species.
4. Partnerships funded 24 population assessments of inland stream native trout species and three assessments of fish assemblages in habitats of Coos estuary, Oregon. Assessments provide valuable information that allows habitat managers to utilize best practices to improve aquatic resources and the fish populations that rely on them.
5. Evaluated the effects of habitat changes from the 2011 Lion Fire in the Sequoia National Forest on Little Kern Golden Trout population structure and genetics.
6. Provided funding to restore consistent seasonal fish passage between the Sixes River, Oregon and the 200 acres of enhanced wetland located upstream of the Cape Blanco access road.
7. Supported protection of 1,200 feet of saltmarsh/forest shoreline of critical juvenile rearing habitat of priority salmonids. Restored a high priority shoreline by removing a residential site built over wetlands, decommissioning a well/septic system, removing invasive plants, and re-vegetating the site.
8. Produced a white paper, "Optimizing fish passage barrier removal in California while considering climate change effects," which summarizes climate change effects while prioritizing fish passage barrier removal as a restoration action in California.
9. Developed FISH*Pass* software that optimizes fish passage barrier remediation; integrates information on barrier passability, potential habitat, and mitigation cost; identifies cost-efficient mitigation actions to maximize the amount of accessible fish habitat above barriers; and uniquely accounts for spatial structure of barrier networks and interactive effects of mitigation decisions on longitudinal connectivity.
10. Conducted a West Coast-wide tier 1 and tier 2 data survey in 2015 to obtain information about existing datasets on juvenile fish use of estuaries and estuarine habitats. Collected and processed all datasets.
11. Initiated West Coast tidal mapping to refine mapping of estuary extents on the West Coast using a variety of interpolation methods, including VDatum and 50% exceedance. In 2015, data was acquired, iterative steps have been completed, key experts were convened to review the results, and, in concert with NOAA, the data layers are being created and will be available in 2016.

12. Completed the "Nursery Functions of U.S. West Coast Estuaries: The State of Knowledge for Juveniles of Focal Invertebrate and Fish Species" in 2015. The report compiles existing information on juvenile presence for a set of 15 species that were selected to encompass the unique life-histories, functional groups, habitats, and ecological roles of important species found in West Coast estuaries.
13. Completed the inventory and classification of Oregon, Washington, and California estuaries in 2014.
14. Completed a range-wide assessment for interior Redband Trout in 2012. A subsequent Redband Trout Conservation Agreement was signed in June 2014 by six state agencies, four federal agencies, five Tribal governments, and Trout Unlimited to facilitate greater partnerships and prioritization goals for the species.

For more about specific waters and projects the **Pacific Coast States** Fish Habitat Partnerships are working on, please see the following locations:

•Shoshone Springs, California – see featured article
•Interior Redband Trout Range-wide Assessment – see featured article
•Bear River Estuary, Washington
•Milltown Island Estuary – see featured article
•Kilchis Estuary, Oregon
•Sun Creek, Oregon
•Conner Creek, California
•Eel River Delta, California
•Grape Creek, California
•Pinole Creek, California

Milltown Island Estuary Restoration Project

Partnership - *Pacific Marine and Estuarine Fish Habitat Partnership*

Milltown Island historically was an estuarine wetland and is located in the Skagit River tidal delta in Washington. However, beginning in the late 1800s the island was diked and disconnected from the Skagit River and Bay. There was, and still is a great deal of local interest in this and many other projects on the Skagit River watershed because of the desire to restore estuaries and wetlands and improve habitat for native fish. Current fish assemblage includes 14 native species: Chinook Salmon, Coho Salmon, Chum Salmon, Pink Salmon, Cutthroat Trout, Steelhead Trout, Mountain Whitefish, Three Spined Stickleback, Peamouth Chub, Prickly Sculpin, Pacific Staghorn Sculpin, Starry Flounder, Large Scale Sucker, and Surf Smelt. Potential fish assemblage may include several additional native fish species (Pacific Lamprey, Shiner Perch) and non-native fish species (Largemouth Bass, Pumpkinseed Sunfish).

Restoration of this island was identified by local groups and designed to restore natural hydrologic and biologic processes. The primary purpose of restoration at Milltown Island was to increase rearing habitat capacity for wild juvenile Chinook Salmon, though many other species would benefit. Juvenile habitat carrying capacity in the Skagit estuary was limiting the Chinook Salmon population's ability to recover. Plans were federally adopted in the Skagit Chinook Recovery Plan.
Restoration began at the 212-acre Milltown Island in 2007 through the use of explosives to breach the dike surrounding the perimeter of the island. Restoration, which continued through 2014, also included building channels to allow water flow through wetlands, the burning of non-native plants, and planting native vegetation. The processes restored included:

•Natural formation of tidal channels in estuaries

•Unrestricted movements of saltwater through tidal channels in estuaries

•Unrestricted movement and migration of fish and wildlife

Conditions improved as a result of the restoration:

•Restored tidal freshwater wetlands, which are highly productive habitats that support high biodiversity values and provide connectivity between the land and sea

•Restored a key area on large river delta that provides valuable nursery habitat for threatened species of juvenile salmon, such as Chinook Salmon, increasing their survival and supporting population recovery in Puget Sound

•Improved quality of water flowing through the estuary

Partners: *Staff collaborate with NOAA fisheries for ecology research and monitoring. Restoration feasibility and design is vetted through multi-discipline technical groups within the watershed through Puget Sound's Chinook Salmon Recovery process. These local groups are known as TAGs (Technical Advisory Groups). Once approved locally, and submitted for funding through the State's Salmon Recovery Funding Board (SRFB), the SRFB technical review panel evaluates each project. Milltown Island Restoration has been through this process for each phase.*
http://www.pugetsoundnearshore.org/factsheets/Milltown_TSP.pdf

http://skagitcoop.org/programs/restoration/milltown-island/
http://fishhabitat.org/partnership/pacific-marine-and-estuarine-fish-hab...

Shoshone Pupfish Project

Partnership - *Desert Fish Habitat Partnership*

Shoshone Pupfish are one of the most imperiled species in the Death Valley region due to their natural rarity, historic disruption of their habitats, lack of replication of the one remaining population, and genetic effects of small population size. Shoshone Spring and wetlands have been owned by one family for over 50 years. Endemic Shoshone Pupfish were considered extinct by 1969, but rediscovered in a ditch near the springs in 1986.

A single pond was built and stocked with 75 of these fish, believed to be the last of their kind. The purpose of the project was to construct two new additional habitats, one secluded in a mesquite bosque, and one in a landscaped tourist area. The project secured the existence of Shoshone Pupfish in their native range far into the future and has educated the public about their importance. The project quadrupled the habitat area occupied by endemic Shoshone Pupfish benefiting the entire known population in the one spring, spring brook, and a spring supported riparian system where they naturally occur. The long term extinction risk of Shoshone Pupfish has been greatly reduced by spreading the risk among three populations, instead of one. Genetic diversity will improve by the increasing population size, which is now estimated to be over 1,000. Creation of a pond suitable for public viewing and interpretation in an existing ecotourism area has the added benefit of promoting public and business support for conservation of pupfish, wildlife, and the environment. The pond also benefits riparian birds, waterfowl, and neotropical migrant birds. There is now a series of ponds along the original stream leading to the Amargosa River where the first pupfish were found. It also includes a pond in a public area that is landscaped with native vegetation. Walking trails have been created to guide the public to view points, and interpretive signs will soon be placed around the pond to educate residents and visitors about the pupfish, its native habitat, the importance of sustaining all endangered species, and about biodiversity. In addition to being drawn by birding and ecotourism, visitors to Shoshone Village have begun to ask "where can I see the pupfish?"

For additional information on efforts to conserve Shoshone Pupfish, please visit the following: http://www.fishhabitat.org/content/shoshone-springs-california

Interior Redband Trout Range-wide Assessment

Partnership - *Western Native Trout Initiative*

The Redband Trout, a group of Rainbow Trout, are remarkable fish. Some live as freshwater fish and some as anadromous fish that occupy both fresh and saltwater habitats during different stages of their lives. The interior Redband Trout is listed as a "Species of Conservation Concern" in most of its range. Its historic range covers eastern Washington and Oregon, northeastern California, central and southwestern Idaho, northwestern Montana, and parts of northern Nevada. Within this broad area, Redband Trout habitat can vary from higher elevation cold-water mountain streams to lower elevation warmer desert-type streams that have periods of low stream flows and high water temperatures. Habitat for the interior Redband Trout has declined 42 percent from its historical range as a result of habitat degradation including water diversion and agricultural runoff, habitat fragmentation from artificial barriers to fish movement, and introductions of non-native species and other forms of Rainbow Trout – down from 60,295 kilometers of stream and 152 lakes to just 26,000 kilometers of stream and 124 lakes.

In 2009, to catalyze conservation of this group of Rainbow Trout, the Western Native Trout Initiative funded a 3-day workshop between biologists from the states of Idaho, Washington, Oregon, California, Nevada, and Montana to share information on the status of Redband Trout populations across their range. This workshop became the precursor to a range-wide assessment of Interior Redband Trout in 2011, which received Western Native Trout Initiative funding. The range-wide assessment required 13 workshops to complete a comprehensive status review in partnership with the state fish and wildlife agencies of California, Idaho, Montana, Nevada, Oregon, Washington, U.S. Fish and Wildlife Service, U.S. Forest Service, Bureau of Land Management, 11 Tribal nations, and representatives from private companies. The assessment, completed in 2012, focused on collecting and compiling existing and historic information on the interior (non-anadromous) range of the species, with the intent of identifying and prioritizing key Redband Trout habitats to be enhanced and protected. When the assessment was complete, the final results involved the expertise of 95 biologists and ArcGIS technical experts, and 15 data entry personnel.

Subsequent development of a Redband Trout Conservation Agreement among partners was then undertaken and in June 2014, six state agencies, four federal agencies, five Tribal governments, and Trout Unlimited developed and signed the Redband Trout Conservation Agreement to facilitate greater partnerships and prioritization goals for the species. The Conservation Agreement identified six goals and 28 actions to promote Redband Trout conservation efforts range-wide. In December 2014, a Redband Trout Species Conservation Team formed to begin developing a conservation portfolio that will lead to a range-wide conservation strategy. The successful cooperation and commitment leading up to the development of the 2014 Redband Trout Conservation Agreement is an example of the power of a years-long partnership among state and federal fish and wildlife agencies, tribal nations, researchers, land managers, and private citizens.

http://www.westernnativetrout.org/media/2011-funded-projects/final-report-rangewide-redband-trout-status-report-.pdf

Interior Redband Trout Range-wide Conservation Agreement

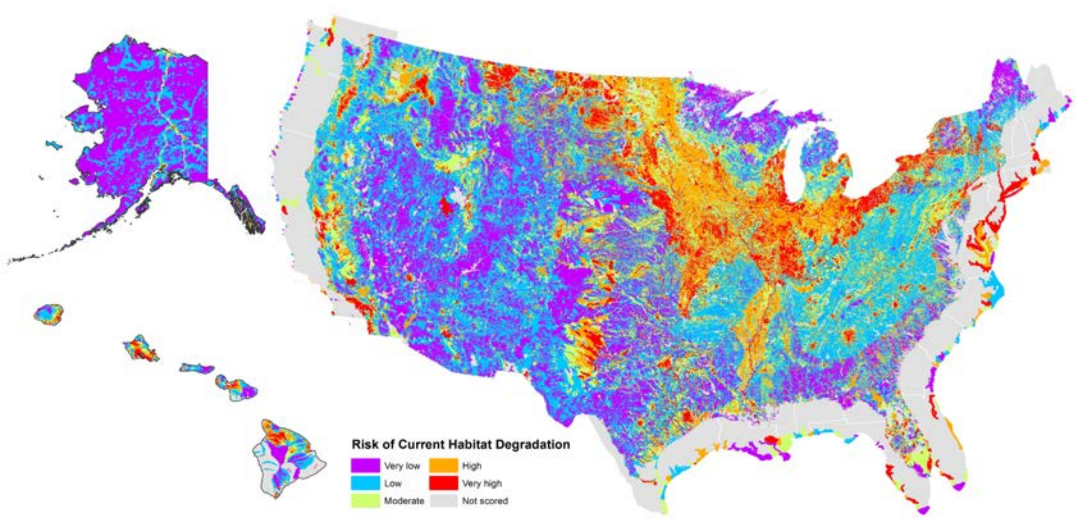
Southeastern Atlantic States Region

from

Through a Fish's Eye:

The Status of Fish Habitats in the United States

2015



Steve Crawford[1], Gary Whelan[2], Dana M. Infante[3], Kristan Blackhart[4], Wesley M. Daniel[3], Pam L. Fuller[5], Tim Birdsong[6], Daniel J. Wieferich[5], Ricardo McClees-Funinan[5], Susan M. Stedman[7], Kyle Herreman[3], and Peter Ruhl[5]

[1] Retired Florida Fish and Wildlife Conservation Commission

[2] Michigan Department of Natural Resources

[3] Michigan State University, Department of Fisheries and Wildlife

[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Southeastern Atlantic States Region

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Regional Summary

The habitats of the Southeast Atlantic states range from the mountains and uplands in the Blue Ridge and Piedmont areas in the western portion of this region to the Southeastern and Coastal Plains. Fish habitats in the higher elevation regions are typically fast-moving, clear, coldwater streams originating from seeps and springs, while warmwater rivers of the plains carry more organic material and sediment. This diversity of habitats along a very long period of stable geologic activity produces one of the most diverse assemblages of aquatic species in the nation. The Altamaha, Chattahoochee, Flint, Savannah, Catawba, Pee Dee, Broad, and Neuse are major rivers of the region. There are a large number of dams on waterways of the Southeast Atlantic states.

The mountains of North Carolina and most of the coastal plain of all three states have a low risk of habitat degradation, although development is intensifying on some of the barrier islands of the coast. Based on the factors evaluated in this assessment, 67% of the inland stream area in the region was estimated to be at low to very low risk of current habitat degradation. On the other hand, 18 percent was predicted to be at high or very high risk of current habitat degradation. The threats to the regional aquatic habitats were generally from urban expansion, dams and water control structures, and agriculture. The key disturbances of streams classified with high or very high risk in the assessment of this region were: urban land use, dams, crop land use, and impervious surface cover.

Eighty-five percent of the estuarine area of the Southeast states was assessed as low or very low risk of current habitat degradation. Although many of the smaller estuaries in the Southeast Atlantic states have low or very low risk of current habitat degradation, the greatest overall risk tended to occur in North Carolina from agricultural and urban land use runoff containing excess nutrients and pollutants. Some estuaries with overall moderate risk of current habitat degradation have a very high risk of degradation from pollution, such as Charleston Harbor, which had the highest pollution sub-index of disturbance score for the region.

Banded sunfish *(Enneacanthusobesus)*

NATIONAL FISH HABITAT PARTNERSHIP

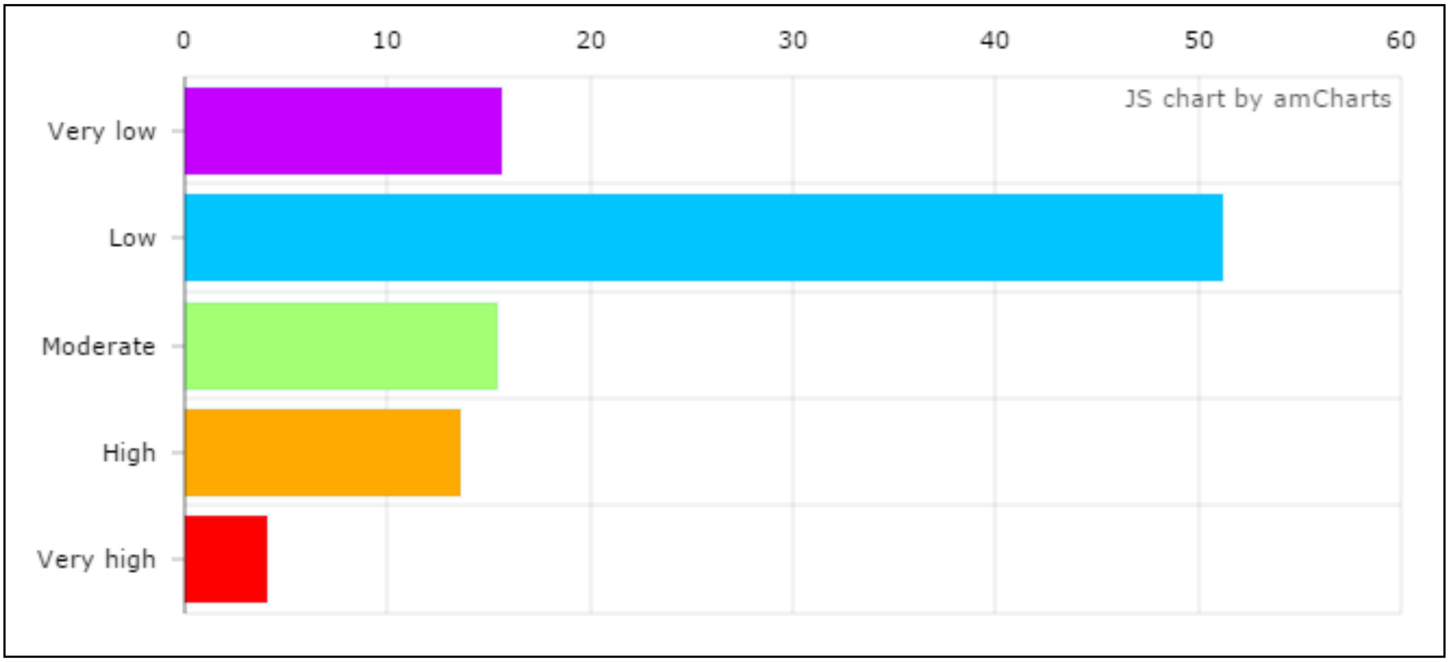
Fun Facts

- Invasive predatory Flathead Catfish are causing population declines of native Redbreast Sunfish and species of Bullhead and Madtom catfishes in Georgia, North Carolina, and South Carolina, along with issues for other migratory species, such as Alewife, Blueback Herring, and American Shad. The Georgia Department of Natural Resources maintains a program to control the population in the Satilla River, and North and South Carolina State fishery agencies have similar efforts and concerns.
- The Savannah River Basin is home to more than 75 species of rare plants and animals and 110 fish species. There are 18 Federally listed fish species in the Savannah River Basin—five are Federally listed as threatened and 13 are Federally listed as endangered. In addition, there are 55 fish species that are either State-listed or of special concern.
- The Georgia State-endangered Robust Redhorse, once thought to be extinct, was found in the Savannah River shoals in 1997. Prior to 1997, the Oconee River Basin had the only known native population of this endangered fish. Robust Redhorse reintroduction stocking efforts are currently directed at the Broad River, a major tributary of the Savannah River. In addition, these fish can now be found in the Oconee, Ocmulgee, Broad, and Ogeechee Rivers in Georgia; the Pee Dee River in North and South Carolina; and the Wateree River in South Carolina.
- Only about 3,000 Federally listed endangered Shortnose Sturgeon are known to exist in the Savannah River.
- As an indication of the intense nature of water use in this region, the Georgia Environmental Protection Division issued 464 agricultural water withdrawal permits in the Savannah River Basin alone during 2013.
- The Augusta Canal Diversion Dam and Lock was constructed in 1845 to supply water power and drinking water to Augusta and continues to do so today.
- The New Savannah Bluff Lock and Dam below Augusta was constructed by the U.S. Army Corps of Engineers in 1937 and, over time, fell into disrepair. Consequently, this facility has been a major fish barrier on this waterway and a fish passageway has been approved for construction around the lock and dam.
- Downstream from the city of Savannah, the river exhibits one of the highest tidal ranges on the U.S. southeast coast, with a tidal range of more than 7 feet (2 meters).
- Cape Romain National Wildlife Refuge in South Carolina consists of more than 66,000 acres (26,709 hectares) of estuarine, beach, and maritime forest and protects a 29,000-acre (11,736 hectares) Class I Wilderness Area.
- The U.S. Army Corps of Engineers plans to deepen Charleston Harbor from 47 to 52 feet (14.2 to 15.8 meters) to allow for larger ships. The original natural depth of the harbor was 12 feet (3.7 meters).
- At more than 400 feet (122 meters) high, Whitewater Falls in Transylvania County, North Carolina, is the highest waterfall on the East Coast.

- Albemarle Sound, North Carolina, is the largest freshwater sound in the world.
- At 480 feet (146 meters) high, Fontana Dam on the Little Tennessee River, North Carolina, is the tallest dam in the Eastern United States.
- The water quality in the Roanoke River Basin in North Carolina and Virginia is generally good. Although only 9 percent of the streams are impaired, 27 percent of the streams are threatened, primarily from polluted runoff. Sediment is the major concern.

Habitat Degradation in Inland Streams

(a)



(b)

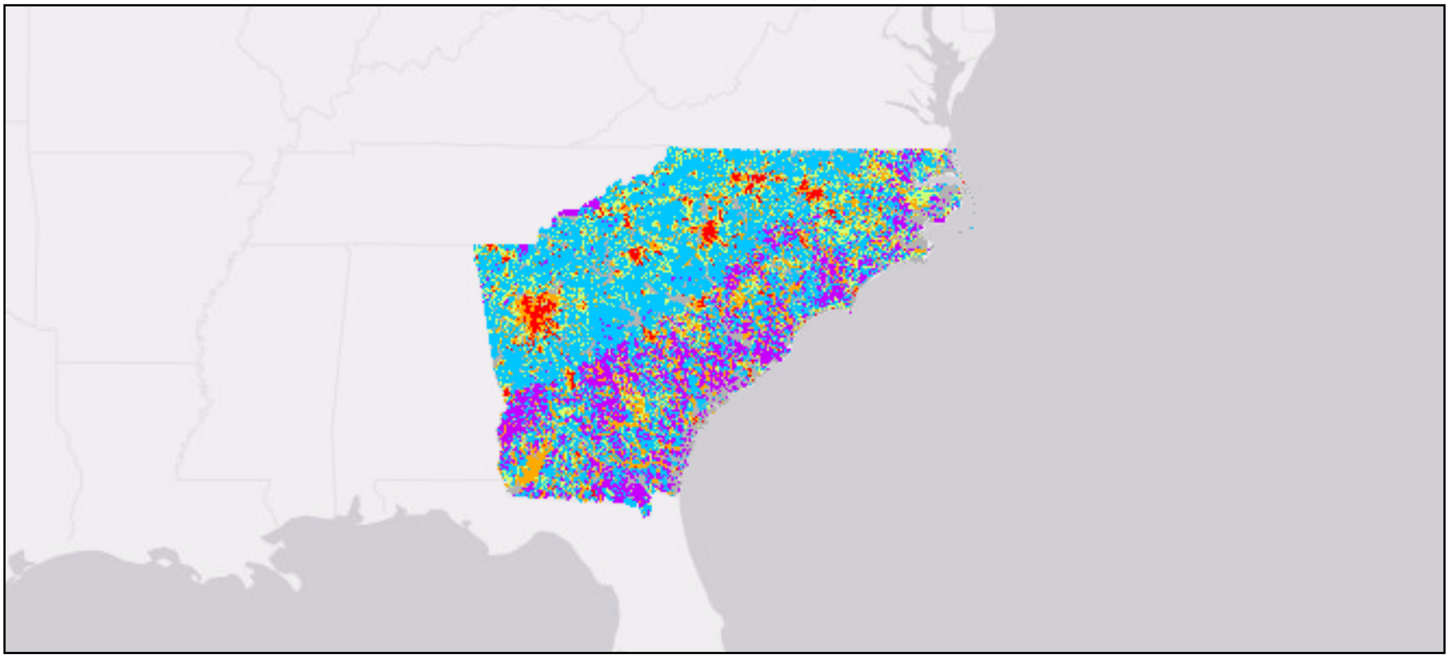
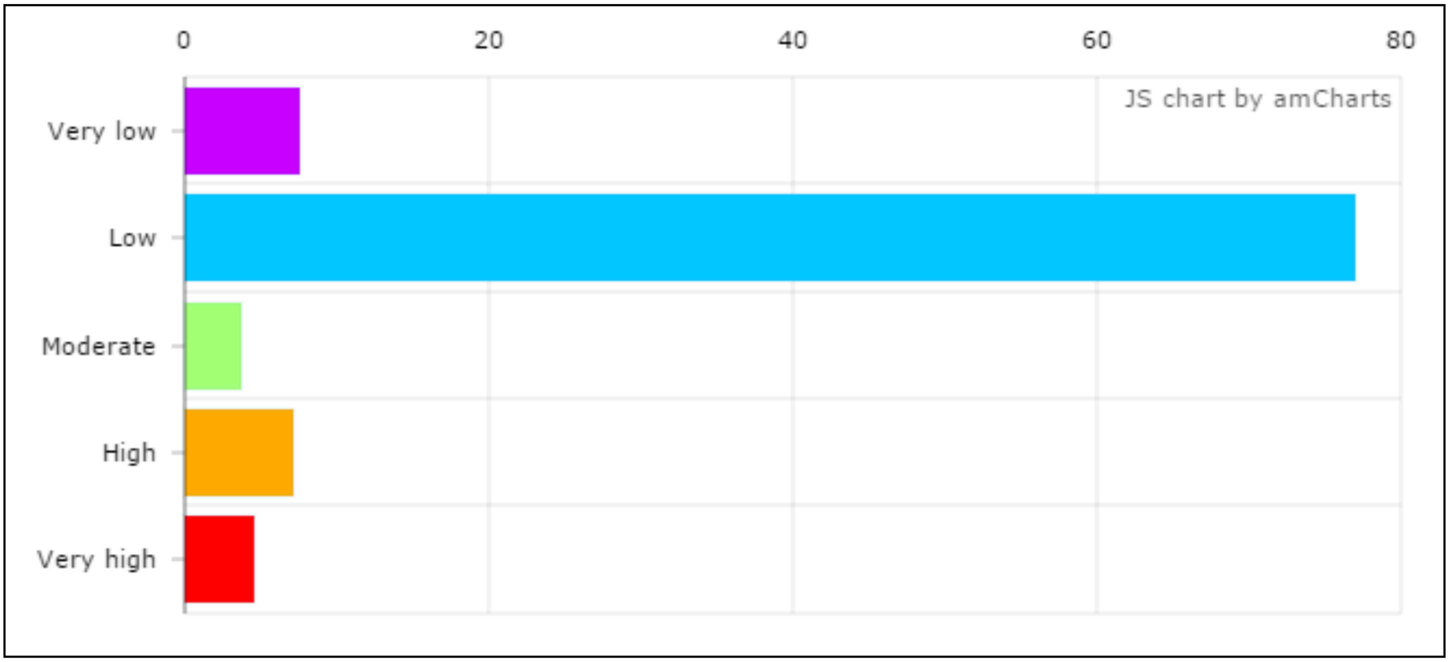


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Habitat Degradation in Estuaries

(a)



(b)

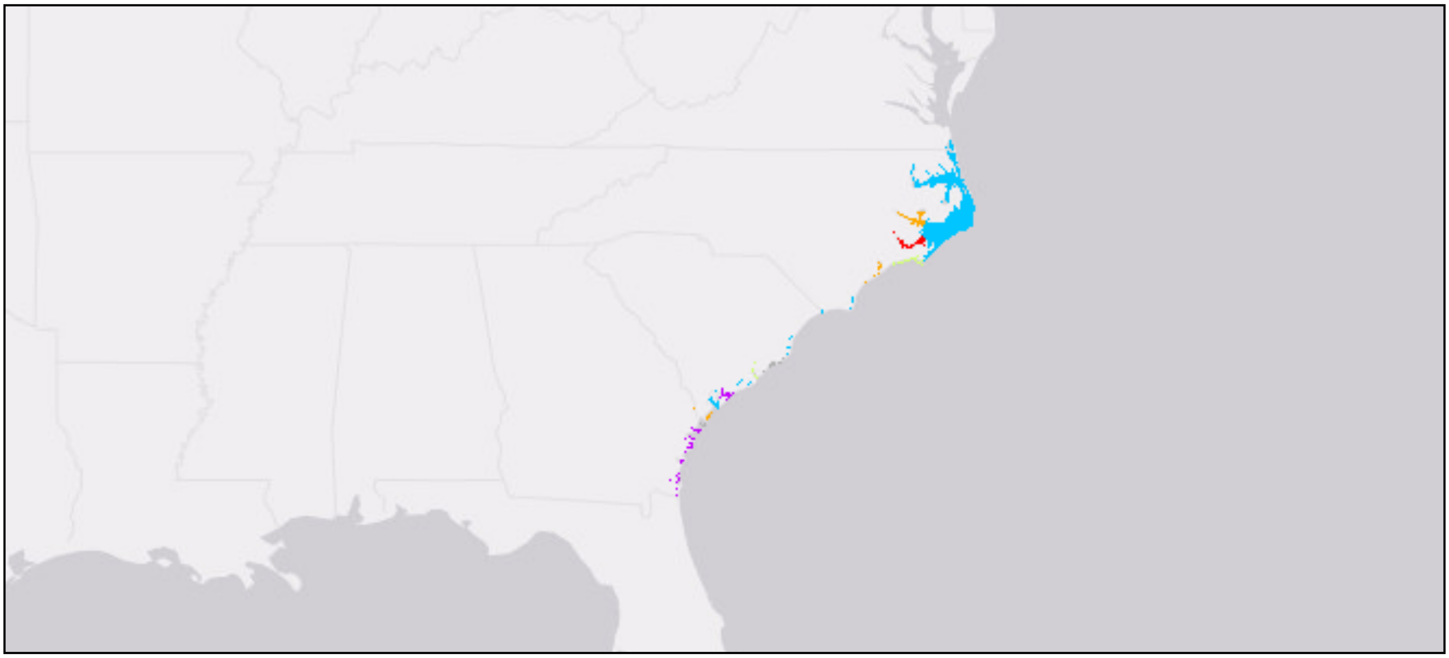


Figure1: This interactive figure summarizes the risk of fish habitat degradation. The currently selected tab shows data from the national estuary assessment. (a) Relative condition of fish habitat in estuaries. Estuary summaries represent percentage of total estuary area in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all estuary condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the national estuary assessment.

Most Pervasive and Severe Disturbances for the Southeast Atlantic States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Impervious surface cover

•Population density

•Low intensity urban land use

•Road length density

•Downstream dam density

Top three most pervasive disturbances to **creeks** (watersheds <100 km^2 in area) **across all** spatial scales:

•Impervious surface cover

•Low intensity urban land use

•Population density

Top three most pervasive disturbances to **rivers** (watersheds >100 km^2 in area) **across all** spatial scales:

•Upstream dam density

•Pasture and hay land use

•Population density

Top five most pervasive disturbances to **creeks, specific to** spatial scale:

•Road length density in network catchments

•Impervious surface cover in network catchments

•Low intensity urban land use in local catchments

•Downstream dam density in network catchments

•Road crossing density in network catchments

Top five most pervasive disturbances to **rivers, specific to** spatial scale:

•Upstream dam density in network catchments

•Pasture and hay land use in network buffers

•Pasture and hay land use in network catchments

•Population density in network catchments

•Impervious surface cover in network catchments

In the Southeast Atlantic state group, 67.0% of streams are classified as low or very low risk of habitat degradation.

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat

degradation (red and orange color groups).

Top five overall most severe disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Low intensity urban land use

•Upstream dam density

•Crop land use

•Pasture and hay land use

•Impervious surface cover

Top three most severe disturbances to **creeks** (<100 km ^{2}watersheds) **across all** spatial scales:

•Low intensity urban land use

•Crop land use and pasture

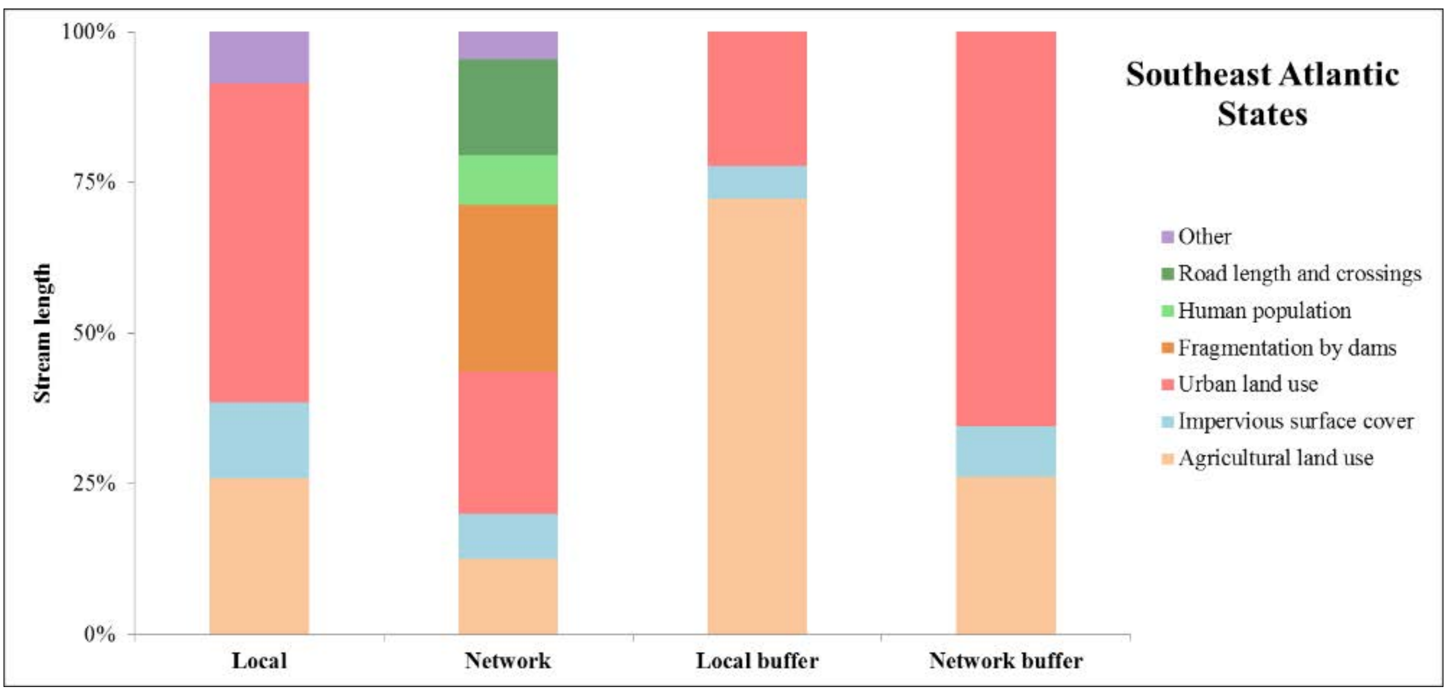
•Hay land use

Top three most severe disturbances to **rivers** (>100 km ^{2}watersheds) **across all** spatial scales:

•Upstream dam density

•High intensity urban land use

•Population density.



Most severe disturbances in the Southeast States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into large groups (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales (local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale ; buffers have only urban land use, agricultural land use, and impervious surface cover. See Detailed Inland Stream Methodologyfor more details.

Agriculture

Since European settlement, the wide coastal plain of the Southeast Atlantic states has been used for large agricultural operations producing soybeans, corn, cotton, peanuts, tobacco, and many other agricultural products. Recently, farmers have intensively planted more acreage with soybeans and corn, which is in part due to the biofuel demand. Increasing use of irrigation for these row crops has changed water flow (hydrology) in many of the region's streams. Intensive hog and chicken farming have expanded as well. Improperly managed runoff from farms contributes excess sediments and nutrients to streams, which interferes with fish spawning, can lead to potentially harmful algal blooms, and can cause fish kills from dissolved oxygen depletion issues from excessive algal and aquatic vegetation growth. 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. Hog farm retention ponds have failed in North Carolina, particularly on the Neuse River, releasing large volumes of animal waste that killed fish and contaminated coastal bays. As a result, the Neuse River was the only estuary in the Southeast region that was classified in this assessment as having a very high threat to fish habitat. Industrial forestry is another major agricultural practice, particularly in Georgia and South Carolina. Although not evaluated in the assessment, clear-cut forests can increase erosion and sedimentation into local streams, while paper mills along the coast can release excess nutrients and harmful organochlorine compounds into coastal rivers and estuaries.

Urban land use, dams and barriers, and agriculture all can have a negative influence on all aquatic organisms and the plight of freshwater mussels in the southeast is a sentinel of declining habitat. E.P. Keferl reported in 1993 that mussel populations were in serious decline in Georgia, North Carolina, and South Carolina. For example, he cited that mussel species had declined in Mecklenburg County (where Charlotte is located) from 13 species in the mid-1800s to 3 species in 1987 and that similar declines were observed throughout these three states. Gangloff and Feminella (2007) evaluated the relationship between mussel abundance/richness with physical habitat in the southern Appalachians and concluded that mussels were sensitive to any changes in channel geomorphology and hydraulic conditions. These factors bolster the fact that not only do threatened aquatic systems need restoration, but "low risk" aquatic habitats need protection to maintain diverse populations of sensitive organisms.

Dams and Other Barriers

Over 10,000 dams impound rivers and streams in the three Southeast Atlantic states. North Carolina has over 5,600 dams and barriers on 17,000 stream miles, many of which are old and obsolete structures. There is an average of one barrier structure every three miles. The state also ranks second in the number of high-hazard dams, which can negatively affect the safety of the citizens of North Carolina and aquatic species. These dams impede movements of many native river resident species, such as Brook Trout and Shoal Bass, but also restrict migrations of marine fish that rely on rivers for various life stages, including Striped Bass, Atlantic Sturgeon, American Shad, American Eels, and river herring. In many cases, these blockages restrict access to historical spawning habitats and limit adequate spawning flows necessary for egg and fry survival. In spite of the high number of dams in this region, only four are reported to have been removed during 2010 to 2014. One of these, the Altapass Dam on Roses Creek in North Carolina, improved access to key habitats for Brook Trout.

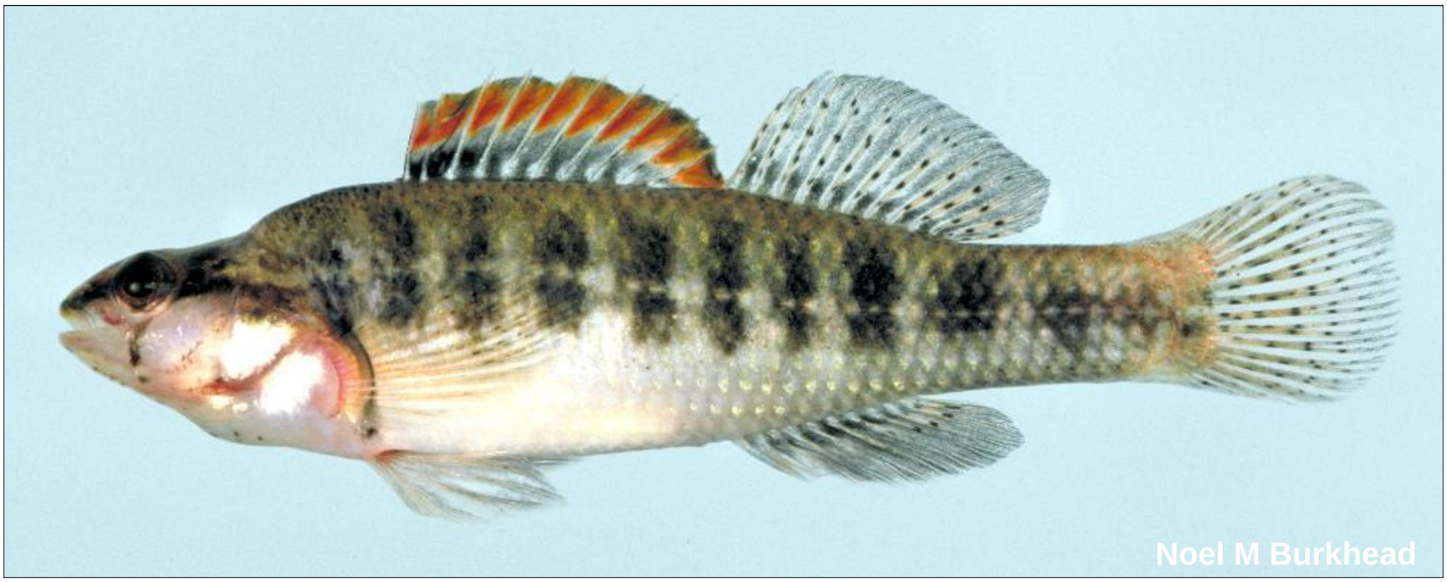
Urban Land Use

The southeastern states contain the rapidly growing urban centers of Atlanta, Greenville, Columbia, Charlotte, and Winston-Salem/Raleigh with suburban corridors between them. In these cities and the surrounding suburbs, large areas of impervious surfaces replace natural streamside habitat, increase pollution and sedimentation, and alter water flow (hydrology). In this 2015 assessment, land cover type was estimated to be a major risk factor for about one-third of the estuaries of the Southeastern states. The United States Department of Agriculture reports that from 1982 to 2012 over 2.6 million acres of rural land in Georgia was developed. Development in North Carolina was almost as high, while South Carolina lost over 1.3 million acres of rural land. These increases in urban development result in excessive sedimentation, especially with the clay-based soils of the Southeast, and increased pollution. This results in declining fish and invertebrate populations near cities and downstream of the urban areas. A recent study showed a correlation with the increase in Atlanta-area development and the decrease of three groups of aquatic insects. Another effect of urbanization is an increasing demand for water. From 2011 through 2013, Georgia experienced drought, which peaked when up to 80 percent of the state was estimated to be in extreme drought conditions. These conditions seriously reduced the flow of the Flint and Chattahoochee Rivers that Atlanta uses for water supplies, and greatly affected the oyster fishery in Apalachicola Bay, Florida, which led to interstate disputes over water allocation.

This photograph depicts an example of urban land use influence on streams in the Southeastern Atlantic States. The photograph is of a Maple Creek tributary in Greer, SC.

Habitat Trouble for Pinewoods Darter in Southeast Atlantic States

The **Pinewoods Darter** (*Etheostoma mariae*) is native to the Little Peedee River system in the Carolina Sandhills area where it is found in smaller, swift-flowing creeks with gravel bottoms and vegetation. This area is becoming increasingly altered by residential development, agriculture, lumbering, and damming of headwater streams, typically for golf course development. Additionally, the reintroduction and rapid expansion of beavers in this drainage is converting some of the critical flowing streams to small impoundments.



Pinewoods darter *(Etheostomamariae)*

Habitat Trouble for Shoal Bass in Southeast Atlantic States

The **Shoal Bass** (*Micropterus cataractae*) is one of a number of unique, lesser-known native bass species that have very restricted distributions. Juveniles and adults of this species require riffle and pool habitat with clean gravel substrate for spawning. Although the exact mechanism of population declines for this species has not been proven, the Apalachicola-Chattahoochee-Flint basin where Shoal Bass occur is the second-most impounded basin east of the Mississippi River, with more than 1,400 impoundments. The dams have fragmented and destroyed habitats through inundation, altered water flows, changed temperature regimes, and allowed the establishment of similar competing non-native basses, such as the Spotted Bass.

Habitat Trouble for Waccamaw Silverside in Southeast Atlantic States

The **Waccamaw Silverside** (*Menidia extensa*) has a very limited distribution confined to Lake Waccamaw in North Carolina, a lake with neutral pH levels from underlying limestone formations in an area of acidic natural waters. This species is found in large schools and often over dark-colored substrates. Its limited habitat is threatened by nutrient loading caused by the runoff of organic matter and agricultural chemicals.

Fish Habitat Partnership Activities for the Southeast Atlantic States

Partnerships - Atlantic Coastal Fish Habitat Partnership, Eastern Brook Trout Joint Venture, Reservoir Fisheries Habitat Partnership, and Southeast Aquatic Resources Partnership

1. Removed four barriers that opened access to six mile of streams and restored 21 miles of streams to improve habitat for Eastern Brook Trout and other fish species.
2. A shoreline restoration demonstration area was constructed near the U.S. Army Corps of Engineers Visitors Center in North Carolina. Native vegetation was used to stabilize 175' of shoreline to be used as a showcase for other lakeshore property owners.
3. Planted 0.2 acres of tidal marsh and installed 0.1 acres of oyster reefs in Stump Sound, North Carolina. Also planted 0.15 acres of salt marsh along the Intercoastal Waterway, South Carolina. Protection helped stabilize the shoreline, reduced erosion, and improved water quality and fish habitat. Thee oyster reefs provided habitat for Red Drum, Spotted Sea Trout, Weakfish, Spot, Atlantic Croaker, Black Sea Bass, and many other species.
4. Restored 0.5 acres of North Carolina riverine spawning habitat for diadromous species, such as Atlantic Sturgeon.
5. Installed two eel ladders to allow American Eels to pass Goose Creek Dam near Charleston, South Carolina and access 40 miles of streams and wetlands.

For more about specific waters and projects the **Southeast** Fish Habitat Partnerships are working on, please see the following locations:

•Native Black Bass Initiative: Implementing Watershed-Scale Conservation of Native Fish Populations in Southern US Rivers and Streams – see featured article
•Southeast Aquatic Connectivity Program: Regional Assessments and Decision Support Tools to Guide Fish Passage in the Southeastern United States – see featured article
•Cape Fear, North Carolina
•Jockey's Ridge State Park, North Carolina
•Ashepoo-Combahee-Edisto River Basin, South Carolina
•Lake Oconee, Georgia
•Lower Flint River, Georgia
•Whitewater to Bluewater

Fish Habitat Partnerships Making A Difference with Regional Assessments and Decision Support Tools to Guide Fish Passage in the Southeastern United States

Partnership - Southeast Aquatic Resources Partnership

Dams and man-made barriers pose to impeding the movement of fish and blocking fish from their spawning grounds and habitat connectivity is listed as a top priority of the Southeast Aquatic Habitat Plan, the strategic plan of the Southeast Aquatic Resources Partnership (SARP). To help address this issue, SARP, together with the Nature Conservancy (TNC) has completed a large scale assessment of dams in the Southeastern United States. The Southeast Aquatic Connectivity Assessment Project (SEACAP), funded by the South Atlantic Landscape Conservation Cooperative (SALCC), supports planners and managers in their efforts to target fish passage and other aquatic connectivity projects where they will have the most benefit. SEACAP features a web based tool and inventory, providing opportunities to improve aquatic connectivity by prioritizing dams based on their potential ecological benefits if removed or bypassed. In addition to SEACAP, other smaller scale assessments have been completed in North Carolina and the Tennessee Cumberland river basins.

With the completion of these assessments, SARP together with American Rivers and other partners have formed a Connectivity Program with the goals of: 1) Creating a regional GIS based fish barrier inventory and assessments; 2) Providing technical support and training for assessment tools to facilitate on the ground restoration from assessment results; and 3) Initiate Connectivity Teams in the 14 SARP states and bring these teams together to initiate and develop working relationships to address barrier issues. Since its development, the Program, together with partners, has facilitated the initiation of several fish passage projects in TN, NC, SC, and GA using the assessment tool results.

For additional information, please visit the following:
http://maps.tnc.org/seacap/
http://southeastaquatics.net/sarps-programs/southeast-aquatic-connectivity-assessment-program-seacap

Native Black Bass Initiative

Partnership - Southeast Aquatic Resources Partnership

Eleven of the fourteen species, subspecies, and other unique forms of black bass are found in the southeastern U.S. and nowhere else in the world. Several undescribed species and subspecies of black bass are also found in the region and almost all are in need of conservation measures to prevent them from becoming imperiled.

In an effort to focus and coordinate actions to secure healthy, fishable populations of the diversity of black basses, the Southeastern Aquatic Restoration Partnership (SARP) led the development of the Native Black Bass Initiative (NBBI). The NBBI is guided by a 10-year, $30 million plan that was assembled in partnership with the National Fish and Wildlife Foundation and numerous local, state and federal agencies, nongovernmental organizations, and industry partners. Since 2010, the NBBI has contributed significant funding and other resources to conserve native black bass populations in rivers of the Texas Hill Country; tributaries of the Apalachicola River Basin in Alabama, Florida and Georgia; and tributaries in the Savannah River Basin in South Carolina.

Between 2010 and 2014, the NBBI implemented more than 8,239 acres of habitat restoration projects and provided technical guidance, planning assistance and financial incentives to improve land management practices on more than 100,000 acres of priority watersheds. These actions directly benefited habitat conditions for native black basses and other species in more than 150 miles of focal rivers. Additionally, the NBBI has provided coordination, funding and other resources to fill critical data and information gaps on the status of native black bass populations, resulting in a data-driven, science-based approach to conservation. Much of this science is represented in a book sponsored by the NBBI titled Black Bass Diversity: Multidisciplinary Science for Conservation, published by the American Fisheries Society in 2015.

For additional information, please visit the following:
http://southeastaquatics.net/
http://southeastaquatics.net/sarps-programs/native-black-bass-initiative
https://fisheries.org/shop/54082c

Southern Plains States Region

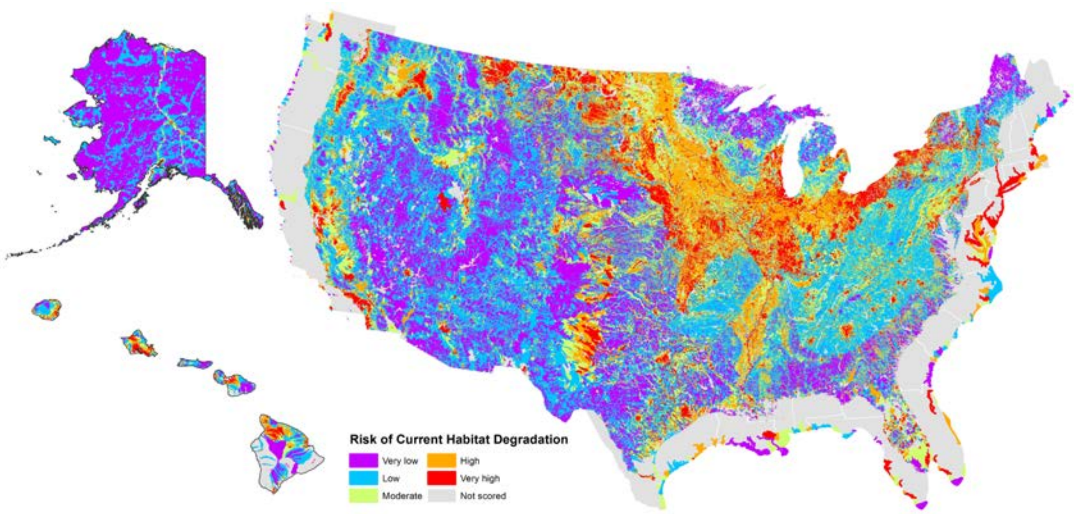
from

Through a Fish's Eye:

The Status of Fish Habitats in the

United States

2015



Steve Crawford[1], Gary Whelan[2], Dana M. Infante[3], Kristan Blackhart[4], Wesley M. Daniel[3], Pam L. Fuller[5], Tim Birdsong[6], Daniel J. Wieferich[5], Ricardo McClees-Funinan[5], Susan M. Stedman[7], Kyle Herreman[3], and Peter Ruhl[5]

[1] Retired Florida Fish and Wildlife Conservation Commission

[2] Michigan Department of Natural Resources

[3] Michigan State University, Department of Fisheries and Wildlife

[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Southern Plains States Region

Table of Contents

Regional Summary

While this assessment has found that much of the stream habitat in this region is at low or very low risk of degradation, some key fish habitat disturbances, including water withdrawals or diversions and intensity of livestock grazing in watersheds, could not be directly included in this assessment because national datasets of these disturbances and their supporting variables are unavailable. These disturbances are known to have major, negative effects on fish habitats in this region. Their absence from this assessment, along with absences of other disturbances, has likely produced an overestimation of habitat condition (quality) for some water bodies. Despite such absences, impairment to fish habitats was determined from conservative analyses detecting associations between stream fishes and nationally consistent and comprehensive disturbance data sets, and highlight condition of and limits to fish habitats in a nationally-comparable manner. These gaps need to be kept in mind while examining the results.

The Southern Plains States contain a mixture of coastal, desert, and plains habitats. Considering the assessment limitations listed above, about 68 percent of the streams in the Southern Plains States are classified as being at low or very low risk of current habitat degradation, and about 17 percent are classified as being at high or very high risk of current habitat degradation. Large areas of the western side of all three states, the eastern side of Oklahoma and, in particular, eastern Kansas are projected to be at very high risk of habitat degradation from the factors assessed. Urban land use had a significant negative effect on fish habitat in Dallas/Fort Worth, Houston, Oklahoma City, Tulsa, Kansas City, and Wichita areas. Smaller areas at very high risk of habitat degradation occur in central Oklahoma and northeast Kansas.

Regional habitat losses and degradation patterns see in the Southern Plains States are attributed principally to the conversion of native prairie to agriculture and the diversion of water for irrigation. Irrigation diversions on the Rio Grande, Red, Arkansas, and Kansas Rivers have changed the water flow patterns (hydrology) in these rivers to the point where there are large reaches without water seasonally. Accelerated water withdrawals in combination with drought has greatly reduced or stopped spring flow in many locations of Texas. Many of the documented issues in streams and rivers in this region also directly result in affects on fish habitat in reservoirs including: sedimentation and rapid shallowing of reservoir depths; loss of structural habitat from the lack of woody inputs or the covering of hard rocky substrate from excessive sedimentation; excessive nutrient inputs resulting in excessive plant and algae growth; and altered water flow (hydrology) resulting in changed patterns in reservoir water levels and losses in shoreline habitat.

Based on the results of the national estuary assessment update, 34% of the estuarine area in Texas has a high or very high risk of habitat degradation due to the factors assessed. Austin-Oyster Estuary was assessed to be at very high risk, while the rest of Galveston Bay, Port Arthur, and Pelican Bay near Port Lavaca were assessed as having a high risk of degradation. Excessive nutrient inputs, from agriculture and urbanization, and reduced river flow were the principal factors that contributed to the elevated risks to these estuaries. Coastal areas in Texas are becoming increasingly urbanized, causing additionally losses of habitat and impaired water quality.

Additional information on the status of estuaries along the Gulf Coast are available in a separate section detailing the results of the new state-of-the-art regional estuary assessment for the northern Gulf of Mexico. This separate assessment uses a different methodology and the results are therefore not directly comparable to those presented here.

Onion Creek, TX

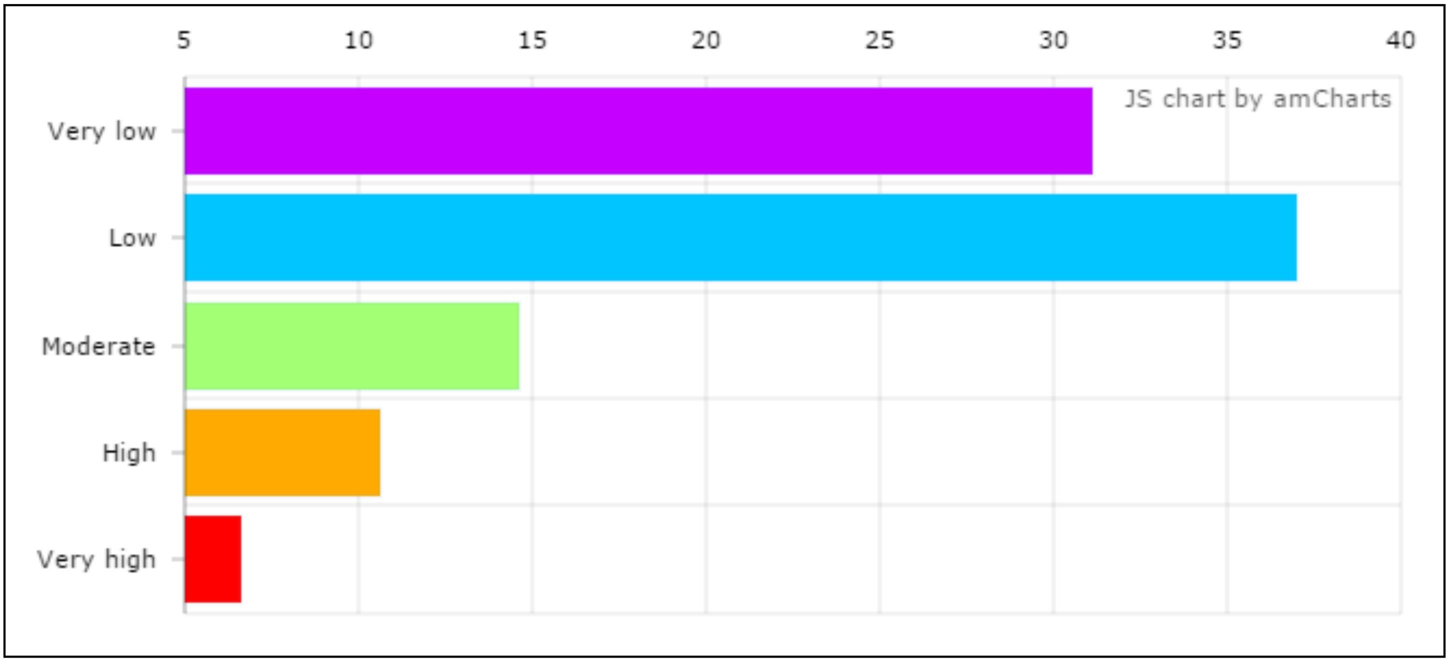
Llano River near Kingsland, TX

Fun Facts

- Texas has flown flags for six different nations, which complicates fisheries management in this region.
- Spain 1519-1685
- France 1685-1690
- Spain 1690-1821
- Mexico 1821-1836
- Republic of Texas 1836-1845
- United States 1845-1861
- Confederate States 1861-1865
- United States 1865 to present
- More land is farmed in Texas than in any other State.
- Texas has 624 miles (1,024 kilometers) of coastline along the Gulf of Mexico.
- The Trinity River is 710 miles (1,140 kilometers) long and is the longest river that flows entirely within the State of Texas. Original Federal plans called for building 36 locks and dams from Trinity Bay near Houston to Dallas but only 7 were built.
- The Brazos River is translated as "The River of the Arms of God."
- New Mexico and Texas disputed water rights to the Pecos River until the U.S. Government settled the dispute in 1949 with the Pecos River Compact. The Pecos River Settlement Agreement was signed between New Mexico and Texas in 2003.
- Since the mid-20th century, excessive water consumption of farms and cities along with many large diversion dams on the Rio Grande River has left only 20 percent of its natural discharge flowing to the Gulf of Mexico.
- Every type of prairie habitat can be found in Kansas.
- The Washita River, which is primarily in Oklahoma, has a bed made up of unstable mud and sand. The banks of the river are steeply incised and erosive and are made up of red earth. The river is one of the most naturally silt-laden streams in North America.
- The Red River, which forms the border between Texas and Oklahoma, is the second-largest river basin in the Southern Great Plains.

Habitat Degradation in Inland Streams

(a)



(b)

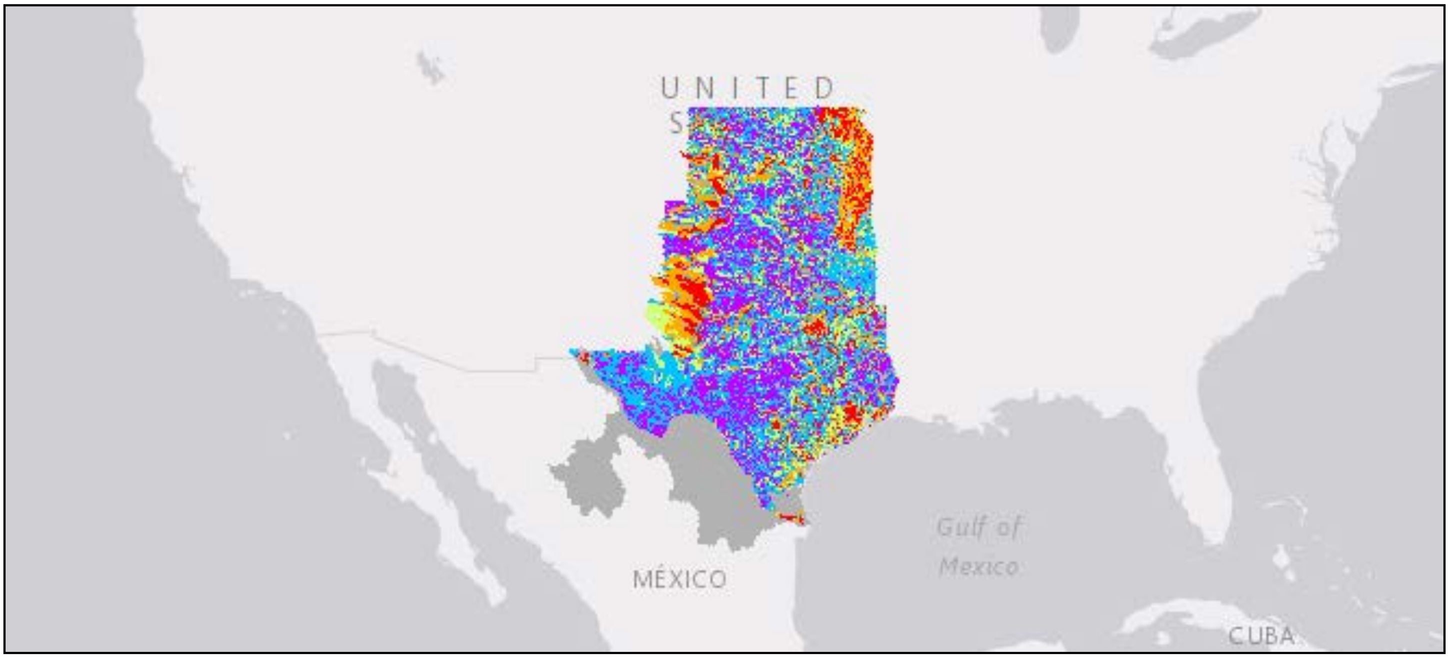
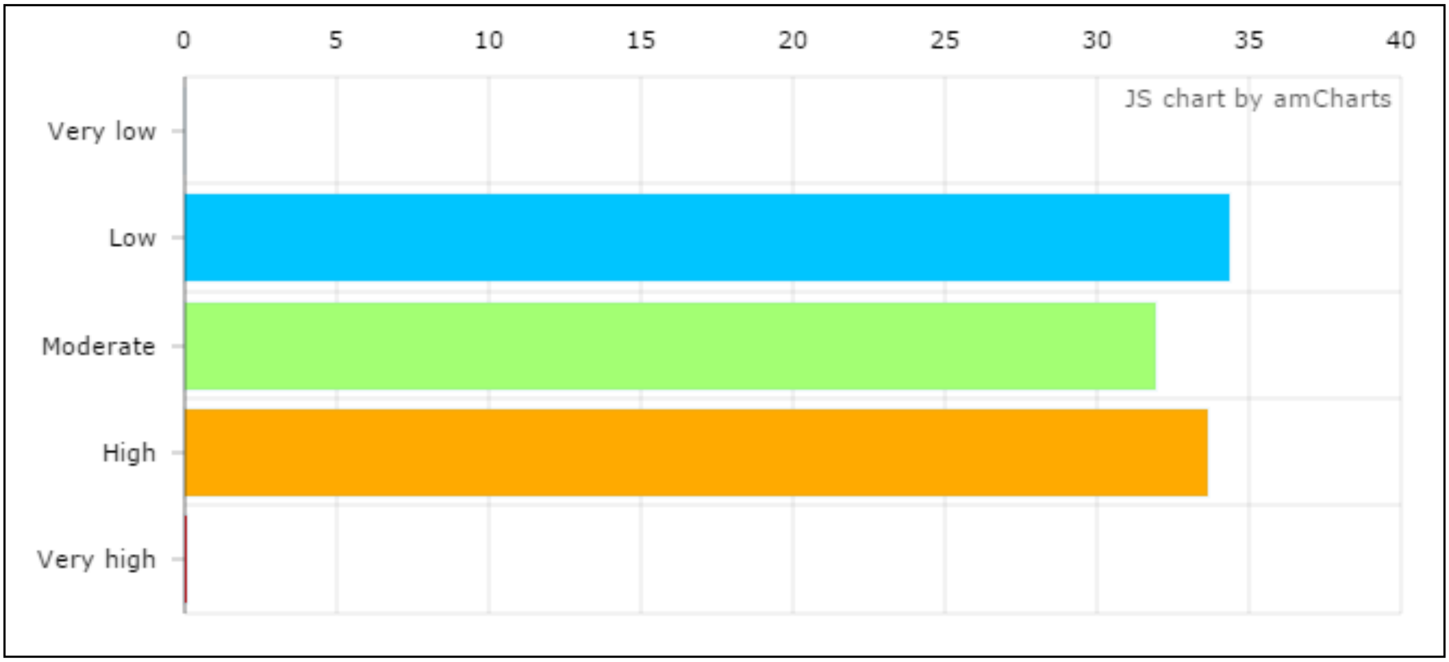


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Habitat Degradation in Estuaries

(a)



(b)

Figure1: This interactive figure summarizes the risk of fish habitat degradation. The currently selected tab shows data from the national estuary assessment. (a) Relative condition of fish habitat in estuaries. Estuary summaries represent percentage of total estuary area in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all estuary condition classes. User may change map display by selecting a bar in (a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the national estuary assessment.

Most Pervasive and Severe Disturbances for the Southern Plains States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Low intensity urban land use

•Impervious surface

•Pasture and hay land use

•Population density

•Crop land use

Top five most pervasive disturbances, **specific to** spatial scales **:**

•Low intensity urban land use in network catchments

•Low intensity urban land use in local catchments

•Impervious surface cover in network catchments

•Low intensity urban land use in local buffers

•Pasture and hay land use in network catchments

Low intensity urban land use makes up the majority of the landscape disturbance leading to the risk of habitat degradation in three of four spatial scales (local catchment, network catchment and local 90m buffer).

In the Southern Plains state group, the assessment estimated that 67.9% of streams had low or low risk of habitat degradation. Local variables, such as drought or intensive grazing, could create higher risk to specific locations.

(NOTE: There is no designation of creeks and rivers for this state group, because the Northern Plain Ecoregion, which covers parts of these states, could not be assessed in stream size classes.)

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat degradation (red and orange color groups).

Top five overall most severe disturbances to **all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Pasture and hay land use

•Crop land use

•Low intensity urban land use

•Road length density

•Upstream dam density

Top three most severe disturbances to **creeks** (<100 km^2 watersheds) **across all** spatial scales:

•Pasture and hay land use

•Crop land use

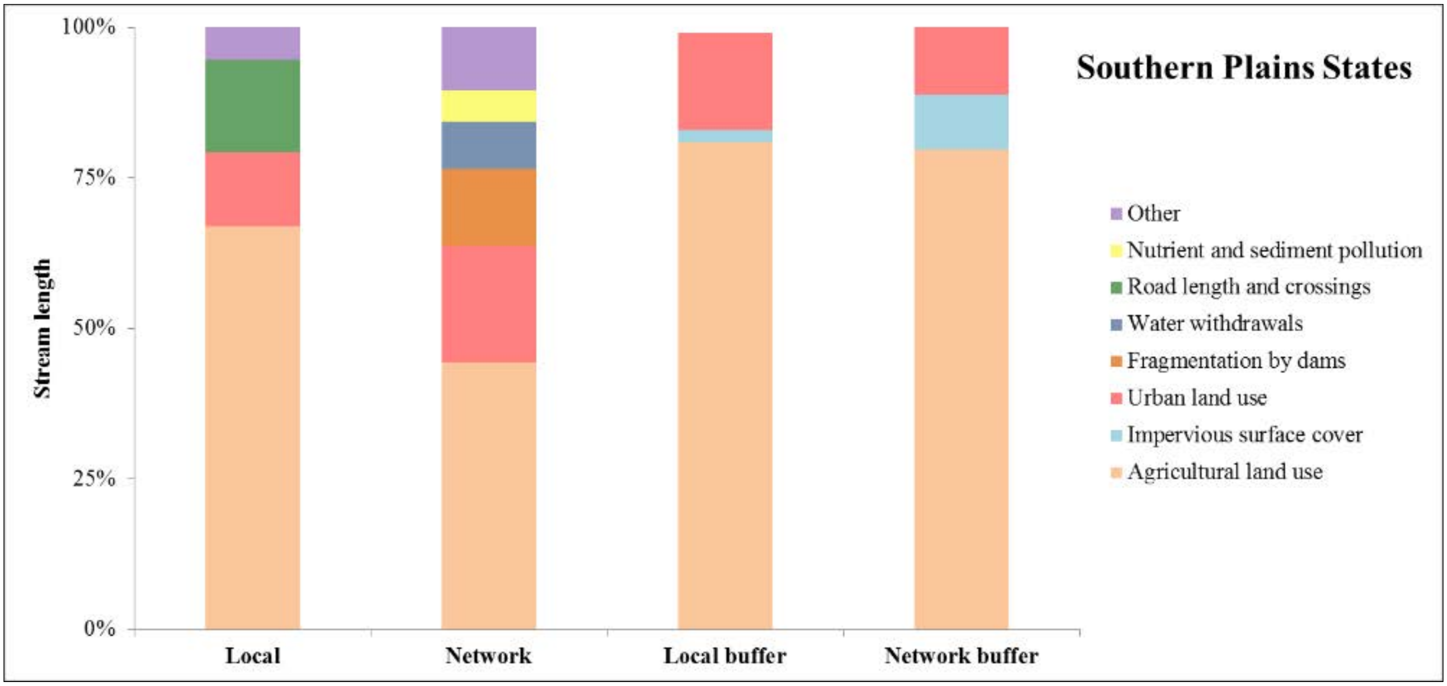
•Low intensity urban land use

Top three most severe disturbances to **rivers** (>100 km^2 watersheds) **across all** spatial scales:

•Pasture and hay land use

•Crop land use

•Upstream dam density



Most severe disturbances in the Southern Plains States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into large groups (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales(local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale ; buffers have only urban land use, agricultural land use, and impervious surface cover. See Detailed Inland Stream Methodologyfor more details.

Agriculture

Wheat and corn are the two most commonly grown crops in Kansas and Oklahoma and zones with a high risk of habitat degradation in eastern Kansas and Oklahoma correspond to areas of these and other row crops. Texas grew 6.2 million acres of cotton in 2014-15 predominately in the panhandle region, which was projected to be at high risk of fish habitat deterioration. Nutrient runoff from crop fields from all southern plains states not only affects local streams but eventually ends up in estuaries and the Gulf of Mexico. This high-nutrient runoff contributes to a low oxygen dead zone which annually averages over 5,000 square miles in size in the northern Gulf of Mexico and causes fish kills.

Pasture

Cattle and sheep ranching are common in Southern Plains States. Areas of very high risk of habitat degradation in eastern portions of this region correspond to areas characterized as pasture. Rain and snow melt carry nutrient-rich animal waste to streams and rivers and when livestock drink from local streams they trample the stream banks and cause excessive sedimentation in the streams. Sedimentation, caused by many forms of human activity, has affected many rivers and reservoirs of the Southern Plains and work is underway in some areas to rehabilitate reservoirs affected by sedimentation. For example, a large scale project to remove seven million cubic yards of sediment from Lake Wichita, Texas is underway. Rehabilitating shallow reservoirs only treats the symptoms that result from impaired habitat processes that really needed to be addressed in the watersheds that flow into these waters to provide long-term solutions that maintain high quality fish habitat.

Pasture land effecting a tributary to Richland Creek in Texas.

Urban Land Use

The Southern Plains States contain one of the fastest-growing urban centers areas in the country—the Texas Triangle of Houston, Dallas/Fort Worth, and San Antonio, where more than 17 million people are spread over 58,000 square miles. Texas is also part of the Gulf Coast megaregion. In these cities and the surrounding suburbs, large areas of impervious surfaces have replaced natural streamside habitat, increased pollution and sedimentation, and completely altered water flows (hydrology). Declining fish populations are the result, near the cities as well as in downstream river reaches. Water coming from both of these megaregions also seriously affects fish habitat in receiving coastal bays and estuaries. Another effect of urban land use is an ever increasing demand for water. Urban areas in the Texas Urban Triangle initially relied mostly on limited regional groundwater supplies to meet their water needs, but as aquifer levels have declined, more and more cities have switched to surface water from streams and reservoirs. Major rivers such as the Colorado, San Jacinto, and Trinity Rivers are already heavily used for urban and agricultural water supply. This became extremely problematic from 2011 to 2015 when the United States Drought Monitor estimated that up to 97 percent of Texas had extreme drought conditions. Portions of the Colorado River and tributaries, such as Brady Creek, dried up. Lakes Buchanan and Travis near Austin, Texas lost nearly 1.7 million acre-feet of water at the peak of the drought due to climatic conditions combined with water withdrawals to meet urban water demands.

Habitat Trouble for Arkansas Darter in Southern Plains States

The **Arkansas Darter** (*Etheostoma cragini*) is native to the Arkansas River drainage and is known to move extensively in this system in response to varying stream flows. It requires shallow water gravel habitat or woody debris for spawning. Stream dewatering and decreased flows caused by groundwater pumping have affected populations of this darter. Water quality degradation has also been an issue and is often the result of intensive livestock grazing and trampling of stream banks, application of animal wastes as fertilizer to cropland, salt-water intrusion into groundwater, and spills from concentrated animal feed operations.

Arkansas darter *(Etheostomacragini)*

Habitat Trouble for Fountain Darters in Southern Plains States

Reductions of flows resulting from drought and water withdrawals threaten the **Fountain Darter** (*Etheostoma fonticola*) in the headwater springs that feed the San Marcos and Comal Rivers, Texas. These are the only two places in the world this species is found. It uses dense aquatic plants and algae as habitat. It is severely threatened by the loss of vegetation caused by an exotic snail and afflicted by a parasitic non-native trematode whose life cycle uses the exotic snail as a host.

Habitat Trouble for Guadalupe Bass in Southern Plains States

The **Guadalupe Bass** (*Micropterus treculii*) is endemic to the spring-fed central Texas rivers and streams. This species is threatened by a number of factors that have contributed to its overall decline including decreased stream flows, habitat loss and degradation, and hybridization with non-native Smallmouth Bass.

Guadalupe bass *(Micropterustreculii)*

Guadalupe bass *(Micropterus treculii)*

Habitat Trouble for Prairie Chub in Southern Plains States

The **Prairie Chub** (*Macrhybopsis australis*) requires streams with gravel and rock bottoms and can live with high levels of dissolved salts that occur in intermittent streams in the upper Red River Basin, Texas. This Texas-listed species of special concern is potentially threatened by large-scale chloride removal planned for the upper Red River Basin that could drastically change the stream chemistry required by this unique fish species.

Fish Habitat Partnership Activities for the Southern Plains States

Southern Plains States Fish Habitat Partnerships' 2010 - 2015 Actions to Make a Difference
Partnerships - Reservoir Fisheries Habitat Partnership, Southeast Aquatic Resources Partnership, Great Plains Fish Habitat Partnership, Desert Fishes Habitat Partnership, and Western Native Trout Initiative

1. Funded a project to stabilized 3,050 feet of shoreline on Olpe City Lake, Kansas.
2. Assisted partners in installation of a fish barrier on Lovewell Reservoir, Kansas to prevent fish loss during irrigation releases. Evaluation is ongoing but preliminary results show a large increase in the forage base.
3. Provided funding for 400 plastic fish attractors that were installed in six Texas reservoirs: Sam Rayburn, Toledo Bend, Lake Fork, Lake Conroe, Lake Nacogdoches, and Lake Naconiche.
4. Planted native vegetation along 1.3 miles of shoreline of Lake Palestine, Texas.
5. Established 1500 acres of native vegetation in Lake Conroe, Texas.

For more about specific waters and projects the **Southern Plains States** Fish Habitat Partnerships are working on, please see the following locations:

•Repatriation of Guadalupe Bass in the Blanco River Watershed – see featured article
•Habitat Restoration in the Nueces River, Texas – see featured article
•The Death and Holistic Revitalization of a Reservoir: The Case of Lake Wichita, Texas
•Rillito Springs Project, Texas
•Balmorhea Springs, Texas
•Lake Conroe, Texas
•Lake Houston, Texas
•Lake Livingston, Texas
•Llano River, Texas
•Rio Grande Tributaries in the Big Bend, Texas

Nueces River, Texas - Habitat Restoration

Partnership – Southeast Aquatic Resources Partnership

The Nueces River basin has some of the most pristine streams, creeks, and rivers in Texas. The Nueces River basin supplies approximately two-thirds of the recharge to the Edwards Aquifer, which serves as a drinking water supply for millions of Texans. Since 2007, a riparian invasive plant, Arundo donax(giant reed), has been spreading at a rapid rate. Giant reed forms dense colonies that can grow to more than 20 feet in height and channelize streams, significantly altering instream habitat conditions for native aquatic species.

In the early spring of 2010, landowners along the Nueces River began to notice the explosive expansion of Giant reed and large diurnal (daily) fluctuations in river flows. Giant reed was consuming an estimated 7,000 acre feet of annual base flow from the Nueces River headwaters. A multi-pronged management plan was created through cooperation with landowners and local, state and federal agencies. The Giant reed control efforts began in the fall of 2010 with state and federal funds going to twelve landowners on the upper Nueces River for a demonstration management project that treated 70 acres by aerial herbicide application. In 2011, the comprehensive Arundo control program, known as Pull-Kill-Plant, was implemented on 58 miles of the upper Nueces River and 8 miles of the upper Sabinal River, a major tributary of the Nueces. The project was then expanded to include the Dry Frio and later the Frio River within the Nueces River basin. By the summer of 2015, the Giant reed control program had facilitated treatment of 288 acres of Giant reed and physical removal of 2.67 million plant nodes. Landowners have continued to stay engaged in management efforts that are now on-going throughout the basin to control this invasive plant that can clearly degrade fish habitat.

For additional information, please visit the following:
http://www.invasivespeciesinfo.gov/aquatics/giantreed.shtml
http://www.texasinvasives.org/plant_database/detail.php?symbol=ARDO4
https://nueces-ra.org/PKP/

Repatriation of Guadalupe Bass in the Blanco River Watershed

***Partnership –** Southeast Aquatic Resources Partnership*

The Guadalupe Bass (Micropterus treculii) is the Texas state fish, endemic to central Texas, and an economically important stream sport fish. It is also listed as threatened due to habitat degradation, stream flow alteration, and hybridization with non-native Smallmouth Bass stocked in the 1970's and 80's.

The headwaters of the Blanco River bubble up from springs near the city of Blanco in the Texas Hill Country. Historically this river was home to a good population of Guadalupe Bass, but recent surveys found only Guadalupe/Smallmouth Bass hybrids. It was thought efforts to remove Smallmouth Bass were impractical. However, in 2011 during the height of a historic drought the upper portion of the river above a natural fish passage barrier was reduced to a series of enduring pools. Smallmouth Bass and hybrids were removed from these pools by project partners and in 2012 and 2013, when the river began flowing again, pure Guadalupe Bass were stocked. Genetic results from 2014 indicate the repatriation effort was successful, as only pure Guadalupe Bass from the stockings and their offspring were collected. Additional stockings in the far upper reaches of the watershed, fish community sampling, and Guadalupe Bass genetics monitoring are ongoing at this time. In 2015, through a grant from the Southeast Aquatic Resources Partnership, project partners also initiated large-scale habitat improvements with private landowners throughout the upper portions of the watershed to insure a self-sustaining population of this iconic native black bass species is maintained into the future.

For additional information on efforts to restore Guadalupe Bass to the Blanco River, please visit the following:
https://tpwd.texas.gov/publications/pwdpubs/media/pwd_br_t3200_003_3_15.pdf
https://tpwd.texas.gov/publications/pwdpubs/media/pwd_br_t3200_003_8_12.pdf
http://southeastaquatics.net/resources/sarp-outreach-materials-1/nbbi/guadalupe-bass-fact-sheet-2/view?searchterm=guadalupe

Southwestern States Region

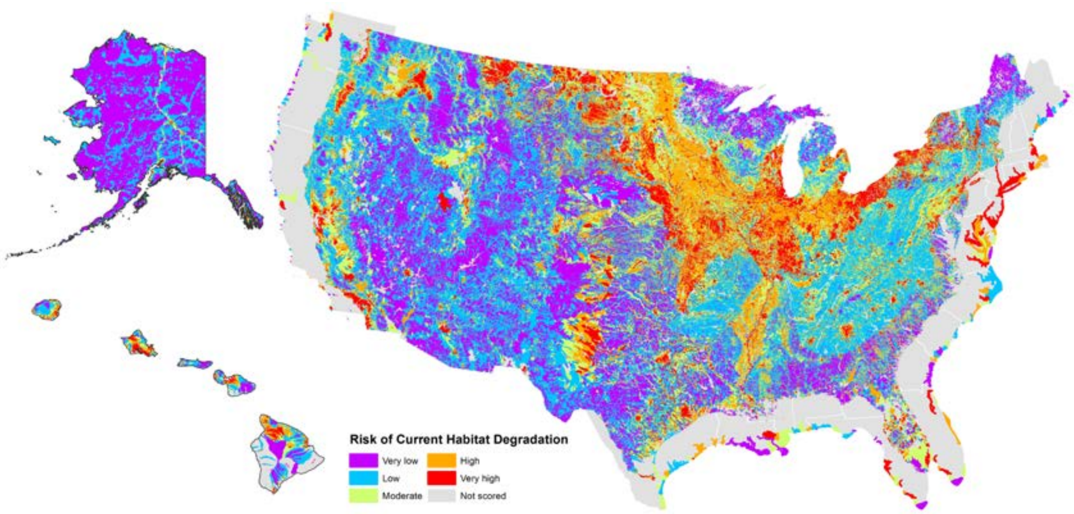
from

Through a Fish's Eye:

The Status of Fish Habitats in the

United States

2015



Steve Crawford[1], Gary Whelan[2], Dana M. Infante[3], Kristan Blackhart[4], Wesley M. Daniel[3], Pam L. Fuller[5], Tim Birdsong[6], Daniel J. Wieferich[5], Ricardo McClees-Funinan[5], Susan M. Stedman[7], Kyle Herreman[3], and Peter Ruhl[5]

[1] Retired Florida Fish and Wildlife Conservation Commission

[2] Michigan Department of Natural Resources

[3] Michigan State University, Department of Fisheries and Wildlife

[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Southwestern States Region

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Regional Summary

In the mostly arid Southwestern United States, water availability (hydrology – a key fish habitat process), wildfires, and grazing intensity are important disturbances that are known to have major, negative effects on fish habitats. While this assessment indicated that many of the streams in this region are in good condition, a number of key habitat variables (i.e. water availability, wildlife frequency and intensity, and grazing intensity) could not be directly included in this assessment because national datasets of these disturbances and their measured variable are unavailable. Their absence from this assessment, along with absences of other disturbances, has likely produced an overestimation of habitat condition (quality) for some water bodies. Despite such absences, impairment to fish habitats was determined from conservative analyses detecting associations between stream fishes and nationally consistent and comprehensive disturbance data sets, highlighting condition of and limits to fish habitats in a nationally-comparable manner. *These gaps in data need to be kept in mind while examining the results.*

Aquatic habitats in the Desert Southwest range from high-elevation mountain streams to channelized and often dry streambeds as found in Salt River Valley in Arizona. Springs, seeps, and wetlands are very small oases in the deserts that provide unique and fragile habitats but are of such a small scale that this assessment could not fully evaluate them, another acknowledged gap in this work. Although the assessment indicated that 93% of the streams in this region could have low or very low risk of degradation, it is widely accepted that localized risk of fish habitat degradation in this region may be much higher due to factors not measured, and the fragile nature of the available arid fish habitats.

However, infrastructure factors (development, roads, and dams) and potential fragmentation of stream watersheds (road crossings and dams) were important fish habitat risk factors in the assessment of this region. These factors, coupled with wildfires, water diversions, introduction of nonnative species, and pollution have led to the disappearance of desert aquatic habitats and desert fish species throughout the Southwestern United States. For example, the combination of extensive logging, livestock grazing, and particularly landscape scale wildfires has degraded or eliminated populations of the highly threatened Gila Trout of New Mexico and Arizona. At least two-thirds of Arizona's fish species are listed as threatened or endangered.

Concentrated urban areas in the southwestern states, though sparse compared to Eastern U.S. or the West coast, tended to cause high to very high threats to fish habitats. Phoenix, Reno, and Las Vegas had the greatest effects in the region, where in some cases, such as the Phoenix metro area, nearly all natural fish habitat has been lost. Tucson, Prescott, Flagstaff, and Albuquerque metro areas also had high effect but on a smaller scale. The impacts of urban runoff on small arid streams can be extreme and completely alter and overwhelm natural streamflow patterns.

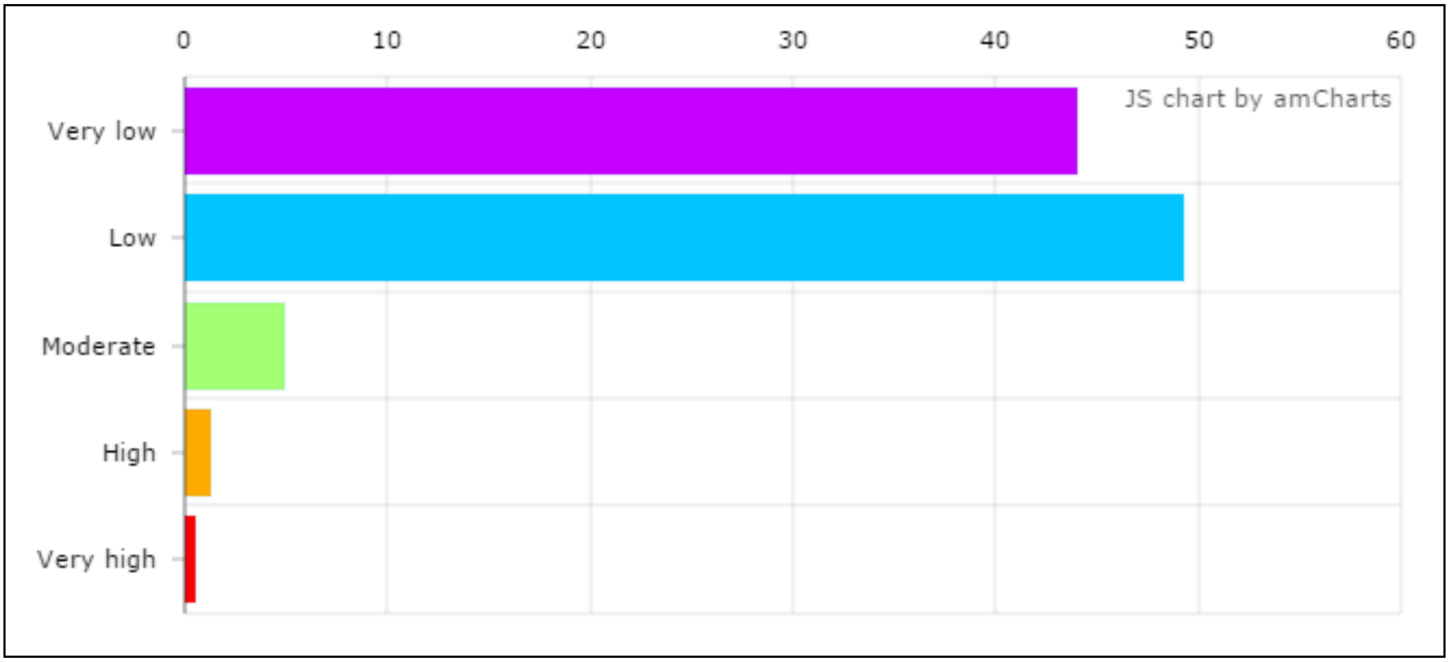
Fish sampling in a small Arizona stream.

Fun Facts

- The Sonoran Desert is the only place in the world where Saguaro cacti grow. It can take up to 100 years for a Saguaro cactus to grow an arm in areas of low precipitation.
- The Sonoran Desert receives more rainfall than any other desert, which is approximately 10 inches (25 centimeters) a year on average.
- In the 1800s, many people used the Gila River as a trail across Arizona. This trail became known as the Gila Trail.
- Arizona is large enough to fit all of New England plus the State of Pennsylvania inside of it.
- Arizona is the only State besides Hawai'i that does not observe Daylight Savings time.
- Santa Fe, New Mexico, is the highest capital city in the United States at almost 7,200 feet (2,286 meters) above sea level.
- Lakes and rivers make up only 0.002 percent of New Mexico’s total surface area, which is the lowest water-to-land ratio of all 50 States. Most of New Mexico's lakes are manmade reservoirs. A dam on the Rio Grande formed the Elephant Butte Reservoir, which is the State's largest lake.
- The Rio Grande is New Mexico's longest river and runs the entire length of New Mexico.
- Manmade Lake Mead and Lake Mohave are the only lakes in Nevada with an outlet to the sea.
- The Lake Mead National Recreation Area is the first and largest recreation area in the United States and the fifth most visited national park in the United States. Its sport fisheries generate more than 150,000 angler use days per year.
- Three of the four North American Desert ecosystems (Great Basin, Mojave, and Sonoran) converge at Lake Mead National Recreation Area.
- Lake Mead National Recreation Area has 25 threatened or endangered species.
- The Lahontan Cutthroat Trout of Pyramid and Walker Lakes (Nevada) was of considerable importance to the Paiute tribe. This trout, as well as Cui-ui, a sucker found only in Pyramid Lake, were key protein resources for the tribe and were used by other tribes in the area. The Pilot Peak Lahontan Cutthroat Trout in Pyramid Lake (Nevada) grows to 20-24 pounds (9-11 kilograms).

Habitat Degradation in Inland Streams

(a)



(b)

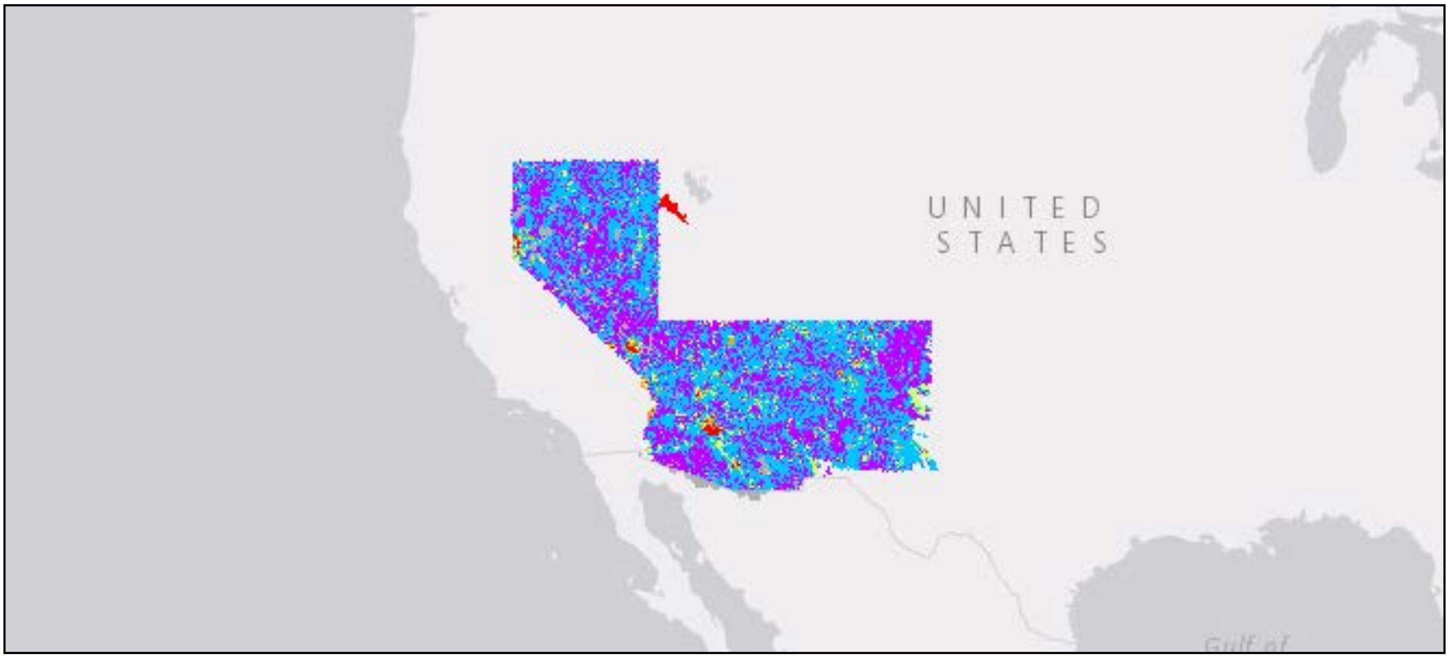


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Most Pervasive and Severe Disturbances for the Southwestern States

Assessment Results for Rivers and Streams of the Southwestern States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Road crossing density

•Road length density

•Impervious surface

•Downstream dam density

•Population density

Top three most pervasive disturbances to **creeks** (watersheds <100 km^2 in area) **across all** spatial scales:

•Road crossing density

•Road length density

•Impervious surface

Top three most pervasive disturbances to **rivers** (watersheds >100 km^2 in area) **across all** spatial scales **:**

•Road crossing density

•Road length density

•Impervious surface

Top five most pervasive disturbances to **creeks, specific to** spatial scale:

•Road crossing density in network catchments

•Road length density in network catchments

•Downstream dam density in network catchments

•Impervious surface cover in network catchments

•Impervious surface cover in network buffers

Top five most pervasive disturbances to **rivers, specific to** spatial scale:

•Road crossing density in network catchments

•Road length density in network catchments

•Impervious surface cover in network buffers

•Impervious surface cover in network catchments

•Low intensity urban land use in network catchments

In the Southwestern States group, 93.1% of streams are classified as low or very low risk of habitat degradation. Local variables, such as water diversion and withdrawal, drought or intensive grazing, will increase risk of degradation to specific locations.

Infrastructure factors (impervious surface, roads and dams) and potential fragmentation of stream watersheds (road crossings and dams) are important landscape factors in this state group.

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat degradation (red and orange color groups).

Top five overall most severe disturbances to **all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

•Impervious surface cover

•Road crossing density

•Pasture and hay land use

•Medium intensity urban land use

•Road length density

Top three most severe disturbances to **creeks** (<100 km ^{2}watersheds) **across all** spatial scales:

•Impervious surface cover

•Road crossing density

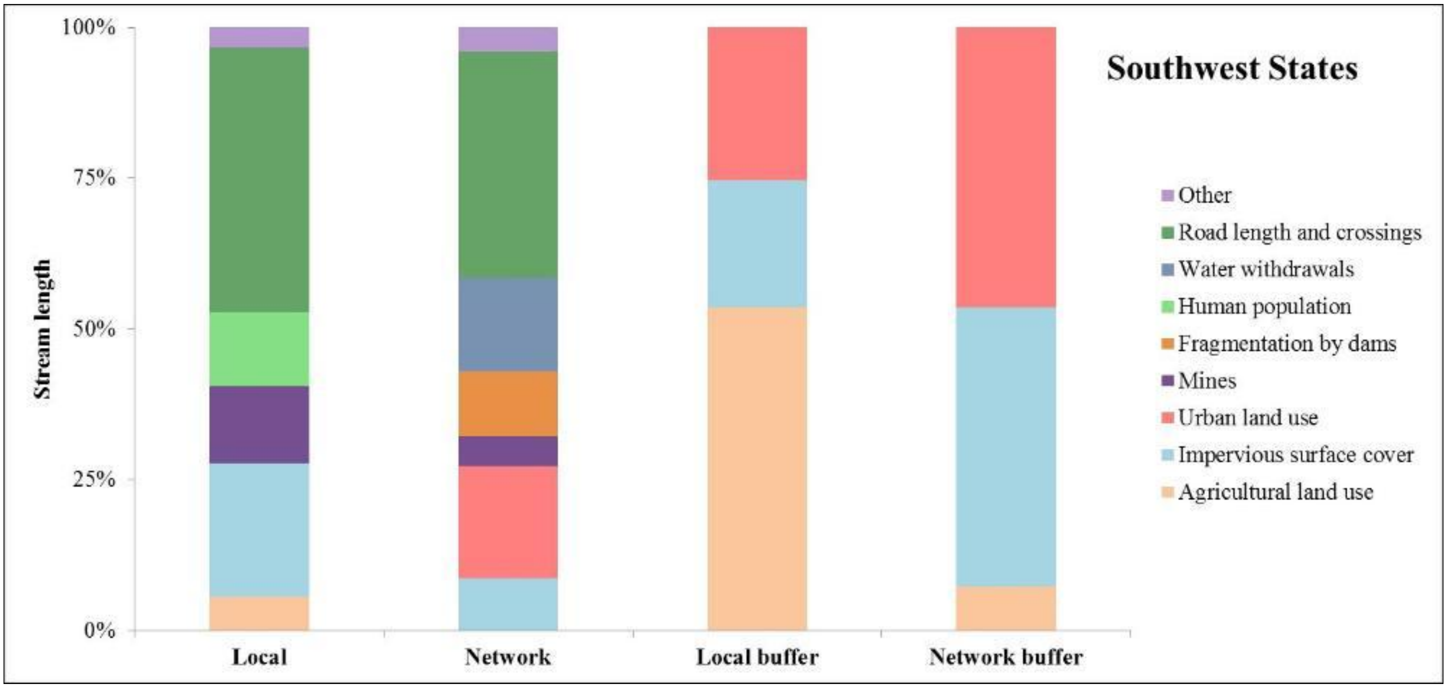
•Medium intensity urban land use

Top three most severe disturbances to **rivers** (>100 km ^{2}watersheds) **across all** spatial scales:

•Impervious surface cover

•Pasture and hay land use

•Road crossing density



Most severe disturbances in the Southwestern States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into large groups (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales(local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale ; buffers have only urban land use, agricultural land use, and impervious surface cover. See Detailed Inland Stream Methodology for more details.

Agriculture and Water Use

Agriculture is limited in the desert states but numerous hay fields, cotton and vegetable farms along the Colorado River near Parker, Arizona, and alfalfa and row crops in southwest of Reno, Nevada are located in areas estimated to pose high risk of fish habitat degradation. The agricultural areas of the desert states continue to demand more water from an over-allocated regional water supply. Farms dependent on irrigation and ever growing urban populations use increasing amounts of water diverted from streams and rivers, leaving less water for fish and other aquatic life and impairing connectivity of their habitats. Fragile and unique 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. Livestock grazing, although not measured in this assessment, has huge effect on these rare desert aquatic habitats and the fragile fauna that relies on them.

Dams and Other Barriers

Water projects that include large dams and water withdrawal systems alter seasonal and daily water flows (hydrology) and water temperatures, adversely affecting desert species that are adapted to the natural cycles in this region. Combined with water diversions for domestic and agricultural use, drought conditions from 2010 to 2015 in the Southwest adversely affected all desert aquatic habitats. Large rivers in the Southwest states, such as the Colorado River and the Rio Grande, 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 and economically important sport fisheries based on mostly introduced species, such as Striped Bass and Largemouth Bass, which often outcompete and prey upon native desert fish. There are 675 state regulated dams in Nevada and 373 registered in Arizona (data not available for New Mexico). In spite of the great effect of dams in the Southwestern Region, no dams have been removed in this region during 2010 to 2014.

Habitat Trouble for Apache Trout and Gila Trout in Southwestern States

Two rare trout subspecies, the **Apache Trout** (*Oncorhynchus apache*) and **Gila Trout (** *Oncorhynchus gilae***)**, are endemic to high elevation areas of Arizona and New Mexico. They are particularly threatened by hybridization with non-native trout and devastating wildfires. Severe wildfires caused by land use changes and exotic plants result in sedimentation and ash deposition in the clear waters where they live.

Habitat Trouble for Desert Pupfish in Southwestern States

The **Desert Pupfish** (*Cyprinodon macularius*) is a Federally listed endangered species found in shallow waters of rare desert springs, small streams, and marshes. The typical habitat includes clear water with aquatic plants or algae. These are difficult habitats for fish as they have high salinity water, high water temperatures, and low oxygen concentrations. Decline of the Desert Pupfish has been associated with dam construction, water diversions, groundwater pumping, pesticide drift, and encroachment of non-native vegetation such as *Tamarix*, also known as Salt Cedar. Salt Cedar can alter riparian habitats and the subsequent shading and roots can alter aquatic habitats.

Desert pupfish *(Cyprinodonmacularius)*

Habitat Trouble for Gila Chub in Southwestern States

The endangered **Gila Chub** (*Gila intermedia*) is found in springs and small streams of the upper Gila River basin mostly in southern Arizona but also in portions of Mexico. It prefers quiet, deep pools near cover, such as vegetation or boulders. The Gila Chub has been eliminated from 85 percent of its former range as a consequence of predation from introduced species and habitat loss resulting from water diversions, road crossings, livestock grazing, declining water quality, and groundwater pumping.

Habitat Trouble for Lahontan Cutthroat Trout in Southwestern States

The **Lahontan Cutthroat Trout** (*Oncorhynchus clarki henshawi*) is native to the Lahontan basin of northern Nevada, northeastern California, and southeastern Oregon. Like other native trout species, the Lahontan Cutthroat Trout is found in a wide variety of cold-water habitats including large terminal alkaline lakes, alpine lakes, slow meandering rivers, montane rivers, and small headwater tributary streams. They currently occupy only about 10 percent of their historic range primarily due to habitat fragmentation from dams and water diversions, changes in water flow patterns, loss of riparian and aquatic habitat quality, severe drought conditions, and the introduction of non-native trout species. One population in Walker Lake, Nevada, has been recently lost due to increased salinity from water diversions for agriculture and drought.

Lahontan cutthroat trout *(Oncorhynchusclarkiihenshawi)*

Habitat Trouble for Pahrump Poolfish in Southwestern States

The **Pahrump Poolfish** (*Empetrichthys latos*) is an endangered endemic springfish and is the only remaining species in its genus, *Empetrichthys*. Originally occurring only in a large spring in southern Nevada, its entire historic habitat was lost in the 1960s due to excessive groundwater pumping, which desiccated the spring system. This species now exists in several refuge habitats in southern and central Nevada, as efforts to restore its original habitat have thus far been unsuccessful.

Habitat Trouble for Woundfin in Southwestern States

The **Woundfin** (*Plagopterus argentissimus*) once ranged from southwest Utah to southern Arizona in the Colorado and Gila River basins, but now only occur in 12 percent of its historical range, and is classified as critically endangered. It prefers quiet water adjacent to riffles of swift, warm, turbid small to medium rivers, but spawns in swifter flowing water over gravel. Populations have been affected by habitat loss, fragmentation, and degradation caused by dams and water diversions. Woundfin populations have also shown declines in areas where the non-native Red Shiner has proliferated due to changes in water flow patterns caused by dams and diversions. The Red Shiner is both a predator of and a competitor with Woundfin, but the Red Shiner also was likely the means of introduction of the Asian fish tapeworm that parasitizes Woundfin.

Whitewater-Baldy Fire Gila Trout Habitat Assessment and Rehabilitation

Partnerships - Western Native Trout Initiative, Reservoir Fisheries Habitat Partnership, Desert Fish Habitat Partnership

1. Funding was provided to construct three barriers to protect Rio Grande Cutthroat Trout populations in the Carson National Forest, New Mexico; one barrier to protect Gila Trout in Willow Creek, New Mexico; and one barrier to protect 54 miles of important Lahontan Cutthroat Trout habitat in Lower McDermitt Creek, Nevada, the largest meta population of Lahontan Cutthroat Trout in the Northwest population segment.
2. Assessed 89 miles of streams for 15 fish populations and aquatic macroinvertebrate surveys, predominantly, to determine the effect of wildfires on Gila Trout and associated aquatic species communities. This information was used to determine steps required to rehabilitate streams to allow fish populations to recover.
3. Funded restoration of habitats for the threatened Big Spring Spinedace in eastern Nevada.
4. Provided funding for an economic evaluation survey to evaluate the economic value of a long-term structure addition project on Lake Havasu, Arizona.
5. Helped implement 30 watershed best management practices that aided aquatic resource improvement in New Mexico. These included measures such as: sewer pump-outs; farming practice improvements; pet waste policies; and removal of impervious surfaces among other things.
6. Funded restoration of four acres of wetland habitat and 2000 feet of shoreline habitat in New Mexico.

For more about specific waters and projects the Southwest States Fish Habitat Partnerships are working on, please see the following locations:

•Whitewater-Baldy Fire Gila Trout Habitat Assessment and Rehabilitation – see featured article

•Muddy River, Nevada – see featured article

•Interior Redband Trout Range-wide Assessment – see featured article

•Bear Wallow Creek, Arizona

•Stinky Creek, Arizona

•Fairbanks and Soda Springs, Nevada

•Maggie Creek, Nevada

Muddy River, Nevada - Muddy River Restoration

Partnership - *Desert Fish Habitat Partnership*

The Muddy River is a major river in southern Nevada about 30 miles NE of Las Vegas. Many tourist destinations exist along and near the Muddy River, including: Moapa Valley National Wildlife Refuge and Warm Springs Natural Area at its headwaters; the towns of Moapa, Logandale, and Overton downstream; many scenic destinations such as Lake Mead National Recreation Area, Valley of Fire State Park; and several established and proposed wilderness areas.

The Moapa Dace (Moapa coriacea) is an endemic minnow occurring only in the upper Muddy River system. Requiring temperatures of at least 86° F for reproduction, the species is highly dependent on access to warm springs in the Muddy River headwaters for survival. Originally, the Moapa Dace inhabited 25 springs and about 10 miles of the Muddy River. However, a series of events have eliminated the dace and three other endemic fish from much of the Muddy River system including: the creation of Lake Mead in 1935; the introduction of non-native fish including Shortfin Molly (Poecilia mexicana) and Mosquitofish (Gambusia affinis); the conversion of many of the springs into swimming pools; the diversion of water for agriculture and industry; a large wildfire in 1994; and the introduction of Blue Tilapia (Oreochromis aureus) in the mid-1990s. The dace is only currently found in five thermal headwater spring systems and a portion of the main stem of the upper Muddy River. As a result, the Moapa Dace is highly endangered with the highest Federal recovery priority possible (Recovery Priority 1c).

Other rare native species that will benefit from restoration of the Muddy River system include three species all of which are Nevada Species of Conservation Priority: Virgin River Chub (Gila seminuda); Moapa Speckled Dace (Rhinichthys osculus moapae); and Moapa White River Springfish (Crenichthys baileyi moapae). Also, benefitting are three mollusks (Pyrgulopsis avernalis, P. carinifera, Tryonia clathrata) that were petitioned for listing under the Federal Endangered Species Act and found to warrant further consideration for listing. The Muddy River also supports the Federally-listed endangered Southwestern Willow Flycatcher (Empidonax traillii extimus) and many other wildlife species.

In response to the fish habitat issues on this river system, the Muddy River Ecosystem Recovery Project was designed to enhance and restore endemic Moapa Dace (Moapacoriacea) populations and other native species dependent upon the Muddy River system. It is an ongoing basin-wide recovery effort that began in 2006 and focuses primarily on upstream portions of the river, in particular springheads and spring brooks, but also extends downstream to Lake Mead.

Two projects funded in part by the Desert Fish Habitat Partnership were the Apcar Springs Culvert Replacement and the Muddy River Stream Bank Habitat Rehabilitation. The Apcar Springs project was completed in 2013 and replaced a dilapidated culvert with a fish-friendly passage that changed *an 11 percent grade drop in water flow to a gentler 4 percent grade. This project created connectivity for Moapa Dace between vital upstream breeding areas and downstream rearing habitats.*

The second project is the Muddy River Stream Bank Habitat Rehabilitation, which was developed by the Moapa Band of Paiutes. A large portion of the lower reaches of the Muddy River and the associated riparian area are degraded due to historical river dredging, overgrazing and streambed trampling by cattle. In addition, invasive plants, Salt Cedar (Tamarix spp.) and common reed (Phragmites), have replaced native cottonwood and willow vegetation. The implemented stream bank stabilization project and habitat improvement plan along the Muddy River has resulted in improved fisheries habitat for the Virgin River Chub and Moapa Speckled Dace. The project involved the removal of invasive plant species and stream bank restoration using natural stream bank stabilization techniques (bioengineering techniques) and was completed in 2015. Outreach for this project began in March 2015. The Moapa Band of Paiutes provide site tours and prepared brochures and training material for Tribal members and the public on the importance of the Muddy River and its critical fisheries habitat.

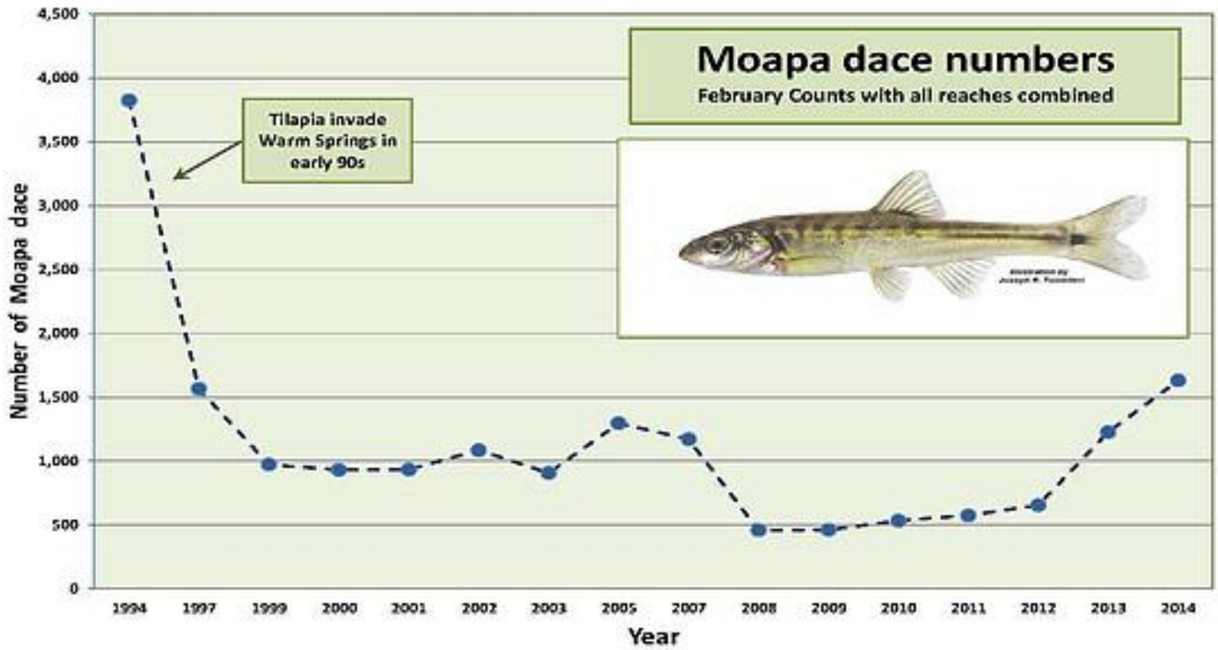
Another long-term effort by partners that began in the 1990s has been the removal of non-native fish. The Muddy River recovery effort received a boost from major national funding (>$800K) in early 2014 for additional chemical eradication of exotic fish and additional habitat restoration. The fish toxicant, rotenone, has been used to remove Blue Tilapia from the upper Muddy River tributaries and mainstem, and efforts are ongoing further downstream. Three fish barriers have been installed to protect the restored habitats and endemic fish populations.

All of these efforts have resulted in significant recovery of the Moapa Dace populations and the project is considered to be highly successful thus far. Further work should foster substantial recovery through 2017 (the implementation period) and beyond. Hence, the Muddy River will definitely be a "Water to Watch".

Beyond the recovery goals detailed above, this project also built trust among its many partners which will help facilitate other recovery efforts in southern Nevada and the southwest generally. As importantly, this project demonstrated the power of cooperation in achieving effective conservation progress at local and watershed scales.

***Partners:** This partnership involves national, state, and local jurisdictions, plus many other entities that cooperate to recover the Muddy River ecosystem. Partners include several programs in the U.S. Fish and Wildlife Service (Moapa Valley National Wildlife Refuge, Ecological Services, Fisheries), Desert Fish Habitat Partnership, Nevada Department of Wildlife, U.S. Bureau of Land Management, Southern Nevada Water Authority, Moapa Valley Water District, Nevada Energy, Moapa Band of Paiutes, Clark County, The Nature Conservancy, Coyote Springs Investments LLC (a development firm), U.S. Geological Survey, U.S. Environmental Protection Agency, Natural Resource Conservation Service, university academics, and private landowners.*

http://fishhabitat.org/partnership/desert-fish-habitat-partnership


Moapa dace numbers
February Counts with all reaches combined
Tilapia invade Warm Springs in early 90s
Number of Moapa dace
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1994 1997 1999 2000 2001 2002 2003 2005 2007 2008 2009 2010 2011 2012 2013 2014
Year

Interior Redband Trout Range-wide Assessment

Partnership *- Western Native Trout Initiative*

The Redband Trout, a group of Rainbow Trout, are remarkable fish. Some live as freshwater fish and some as anadromous fish that occupy both fresh and saltwater habitats during different stages of their lives. The interior Redband Trout is listed as a "Species of Conservation Concern" in most of its range. Its historic range covers eastern Washington and Oregon, northeastern California, central and southwestern Idaho, northwestern Montana, and parts of northern Nevada. Within this broad area, Redband Trout habitat can vary from higher elevation cold-water mountain streams to lower elevation warmer desert-type streams that have periods of low stream flows and high water temperatures. Habitat for the interior Redband Trout has declined 42 percent from its historical range as a result of habitat degradation including water diversion and agricultural runoff, habitat fragmentation from artificial barriers to fish movement, and introductions of non-native species and other forms of Rainbow Trout – down from 60,295 kilometers of stream and 152 lakes to just 26,000 kilometers of stream and 124 lakes.

In 2009, to catalyze conservation of this group of Rainbow Trout, the Western Native Trout Initiative funded a 3-day workshop between biologists from the states of Idaho, Washington, Oregon, California, Nevada, and Montana to share information on the status of Redband Trout populations across their range. This workshop became the precursor to a range-wide assessment of Interior Redband Trout in 2011, which received Western Native Trout Initiative funding. The range-wide assessment required 13 workshops to complete a comprehensive status review in partnership with the state fish and wildlife agencies of California, Idaho, Montana, Nevada, Oregon, Washington, U.S. Fish and Wildlife Service, U.S. Forest Service, Bureau of Land Management, 11 Tribal nations, and representatives from private companies. The assessment, completed in 2012, focused on collecting and compiling existing and historic information on the interior (non-anadromous) range of the species, with the intent of identifying and prioritizing key Redband Trout habitats to be enhanced and protected. When the assessment was complete, the final results involved the expertise of 95 biologists and ArcGIS technical experts, and 15 data entry personnel.

Subsequent development of a Redband Trout Conservation Agreement among partners was then undertaken and in June 2014, six state agencies, four federal agencies, five Tribal governments, and Trout Unlimited developed and signed the Redband Trout Conservation Agreement to facilitate greater partnerships and prioritization goals for the species. The Conservation Agreement identified six goals and 28 actions to promote Redband Trout conservation efforts range-wide. In December 2014, a Redband Trout Species Conservation Team formed to begin developing a conservation portfolio that will lead to a range-wide conservation strategy. The successful cooperation and commitment leading up to the development of the 2014 Redband Trout Conservation Agreement is an example of the power of a years-long partnership among state and federal fish and wildlife agencies, tribal nations, researchers, land managers, and private citizens.

http://www.westernnativetrout.org/media/2011-funded-projects/final-report-rangewide-redband-trout-status-report-.pdf

Interior Redband Trout Range-wide Conservation Agreement

Fish Habitat Partnerships Making a Difference: Whitewater-Baldy Fire Gila Trout Habitat Assessment and Species Rehabilitation

Partnership - Western Native Trout Initiative

The Gila Trout (Oncorhynchus gilae) is one of the rarest native trout species in the United States. Gila trout were listed as federally endangered in 1967, and re-classified as threatened in 2006 after efforts to restore populations were successful.

Over the past 25 years, 14 wildfires have burned in watersheds occupied by Gila Trout, requiring fish evacuation on multiple occasions, and ten Gila Trout populations have been eliminated, setting back recovery efforts. While previous fires only affected one or two populations of fish, recent fires have become exceedingly large. The 2012 Whitewater-Baldy fire burned over 290,000 acres, encompassing much of the current range of Gila Trout and affecting 9 of 16 recovery populations. In 2013 and 2014, the Western Native Trout Initiative helped fund habitat assessments to survey Gila Trout recovery streams affected by the Whitewater-Baldy Fire to determine fish survival, abundance and distribution within impacted streams. Additionally, partners surveyed habitat characteristics such as suitable trout habitat availability, cover, substrate, burn severity, discharge, water quality, and temperature. Permanent photo points were established to monitor habitat recovery. Survey information was used to develop baseline data on Gila Trout streams to monitor future recovery of these streams. Post-fire ash flows from Whitewater-Baldy ultimately eliminated 8 of the 16 populations. Establishment of new populations was initiated immediately following the fire, with the transplant of fish from un-affected to affected, fishless streams. A protective barrier is planned to be built in Willow Creek, New Mexico to protect Gila Trout from non-native trout species. The interagency Gila Trout Recovery Team and fish and wildlife management agencies continue to adapt strategies to address the conservation of Gila Trout in fire affected streams and to determine activities necessary to retain and restore these populations.

For additional information, please visit the following:

http://www.westernnativetrout.org/media/2013-funded-projects/2013-gila-trout-streams-post-fire-assessment-white-water-baldy-final-report.pdf

http://www.westernnativetrout.org/media/2014-funded-projects/2014-gila-trout-streams-post-fire-assessment-whitewater-baldy-final-report.pdf

http://www.westernnativetrout.org/media/trout/gila-trout-assessment.pdf

NATIONAL
FISH
HABITAT
PARTNERSHIP

Upper Midwest States Region

from

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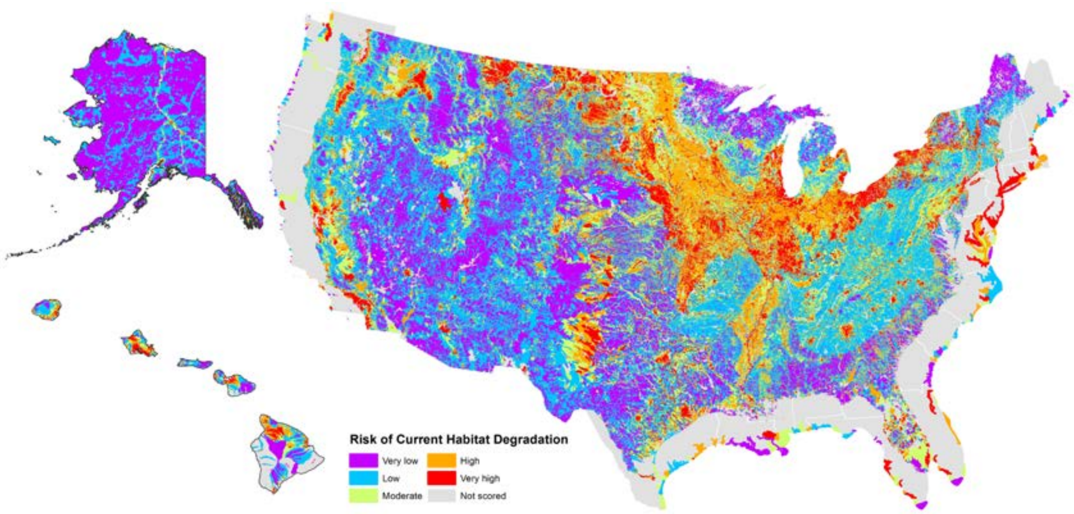
2015



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[1] Retired Florida Fish and Wildlife Conservation Commission

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[4] ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

[5] U.S. Geological Survey

[6] Texas Parks and Wildlife Department

[7] National Oceanic and Atmospheric Administration

Upper Midwest States Region

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Regional Summary

Michigan, Wisconsin, and Minnesota border four of the five Great Lakes (lakes Michigan, Superior, Huron, and Erie) and have over 150,000 miles of rivers and streams and 50,000 inland lakes within their boundaries. The upper Mississippi River flows through the Upper Midwest states, from its headwaters in Minnesota along the boundary between Minnesota and Wisconsin. Much of the region has deep glacial deposits which has a tremendous influence over the habitat types and water flow (hydrology), providing for some of the most stable river flows in the United States. An exception to the glaciated region is a unique region of deeply carved unglaciated river valleys known as “The Driftless Area” which located in southwestern Wisconsin and southeastern Minnesota that also provide large amounts of groundwater to streams in that area.

Nearly intact watersheds and high quality conditions occur in the northern portion of the region, which has mostly recovered from historical effects of logging, which removed nearly all of old-growth forest by 1910, and widespread surface and underground mining that occurred in the late 1800s and early 1900s. This strongly influenced an assessment estimate of 48 percent of the streams in the Upper Midwest region as having low or very low risk of degradation.

On the other hand, 29 percent of the fish habitat in streams of the Upper Midwest is estimated to have a high or very high risk of degradation. The assessment found that agriculture and intensive urban land use largely contributed to these results. The areas with the highest risk of degradation occur in: western Minnesota, where row crops dominate the landscape; south and southeastern Wisconsin from a combination of row crops, dairy farms, and urban land use; and eastern Michigan in urban areas around Detroit and the row crop region of the Saginaw River Basin and Thumb Region.

The waters of 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, massive pollution, construction of thousands of dams (many abandoned and having no specific social purpose), and the introduction (both accidental and intended) of non-native species have degraded habitat, collapsed food webs, and threatened fish populations and human health. Wisconsin Department of Natural Resources reports that there are over 150 fish and 53 mussel species in the warm water streams of that state and almost one-third of the mussels are threatened or endangered.

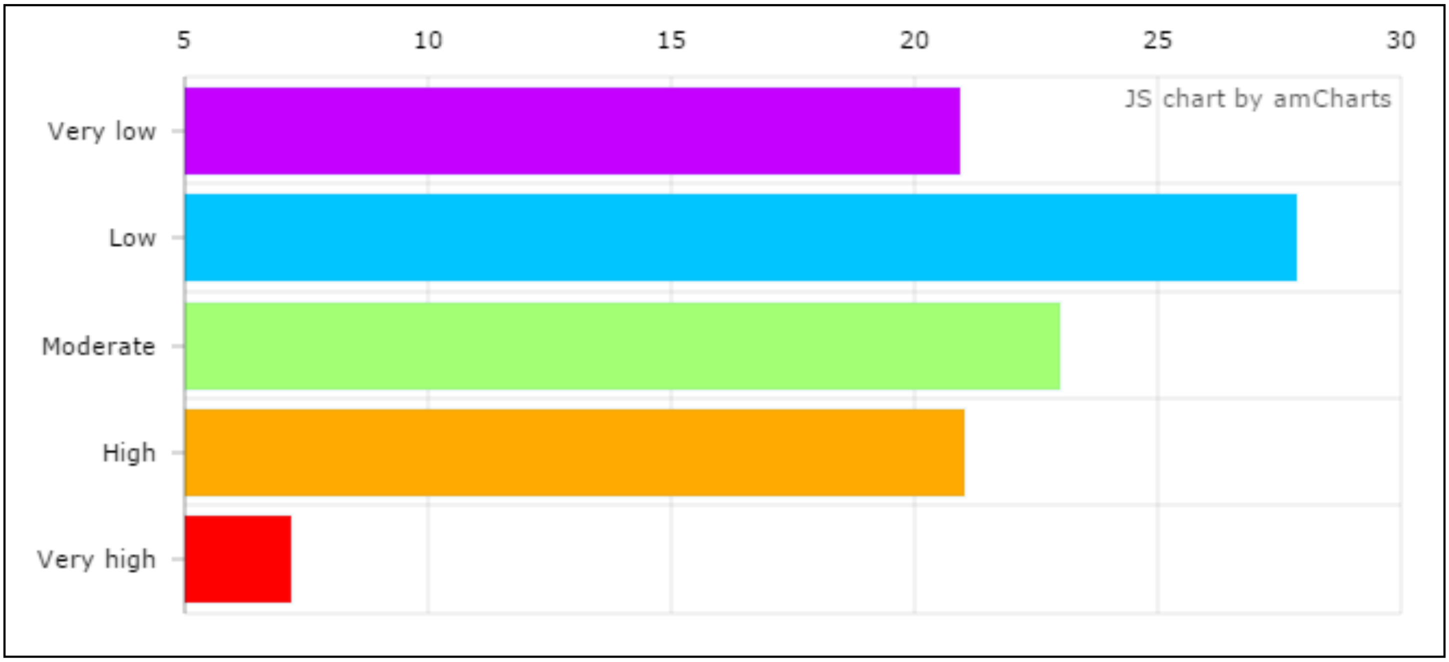
Fortunately, bi-national efforts have resulted in improvements in water quality in all of the Great Lakes, thanks to the enactment of the Federal Clean Water Act in 1972 and similar efforts by the Canadian Government and the Province of Ontario. Much remains to be done as urban land use, legacy industrial wastes, and agriculture continue to affect the Great Lakes, streams and rivers such as the upper Mississippi River, and the many thousands of smaller lakes of the region.

Fun Facts

- Minnesota is known as “The Land of 10,000 Lakes” and officially there are 11,842 lakes more than 10 acres (40,000 mÂ²) in size. The prevalence of lakes has generated many repeat names. For example, there are more than 200 Mud Lakes, 150 Long Lakes, and 120 Rice Lakes.
- Minnesota's waters flow outward in three directions: 1) north to Hudson Bay in Canada; 2) east to the Atlantic Ocean; and 3) south to the Gulf of Mexico. Wisconsin and Michigan both have waters that flow east to the Atlantic Ocean and south to the Gulf of Mexico.
- Wetlands acreage present in 1850: 18.6 million acres (7.5 million hectares).
- Wetlands acreage present in 2008: 10.6 million acres (4.3 million hectares).
- Massive ice sheets at least 1 kilometer thick completely altered the landscape of the region and sculpted its current terrain. The last glacial period, the Wisconsin glaciation, ended 12,000 years ago. These glaciers covered all of Minnesota, Wisconsin, and Michigan except the far southeast part of Minnesota and southwest part of Wisconsin, an area characterized by steep hills and streams that cut into the bedrock. This area is known as the “Driftless Zone” for its absence of glacial drift.
- The Mississippi River begins its journey from its headwaters at Lake Itasca, Minnesota.
- More than 36 percent of Minnesotans fish, second only to Alaska.
- Wisconsin has more than 15,000 inland lakes up to the 134,000-acre (54,227-hectare) Lake Winnebago and 84,000 miles (135,185 kilometers) of rivers and streams.
- The name Michigan is the French form of the Ojibwa word “mishigamaa,” meaning "large water" or "large lake."
- Michigan is the only State to consist of two peninsulas. The Lower Peninsula, to which the name Michigan was originally applied, is often noted to be shaped like a mitten and the Upper Peninsula, which is often referred to as "the U.P."
- Michigan also has more than 10,000 inland lakes and ponds; more than 70,000 miles (112,654 kilometers) of rivers, stream, and ditches; and a person in the State is never more than 6 miles (9.7 kilometers) from a natural water source or more than 85 miles (137 kilometers) from a Great Lakes shoreline.

Habitat Degradation in Inland Streams

(a)



(b)

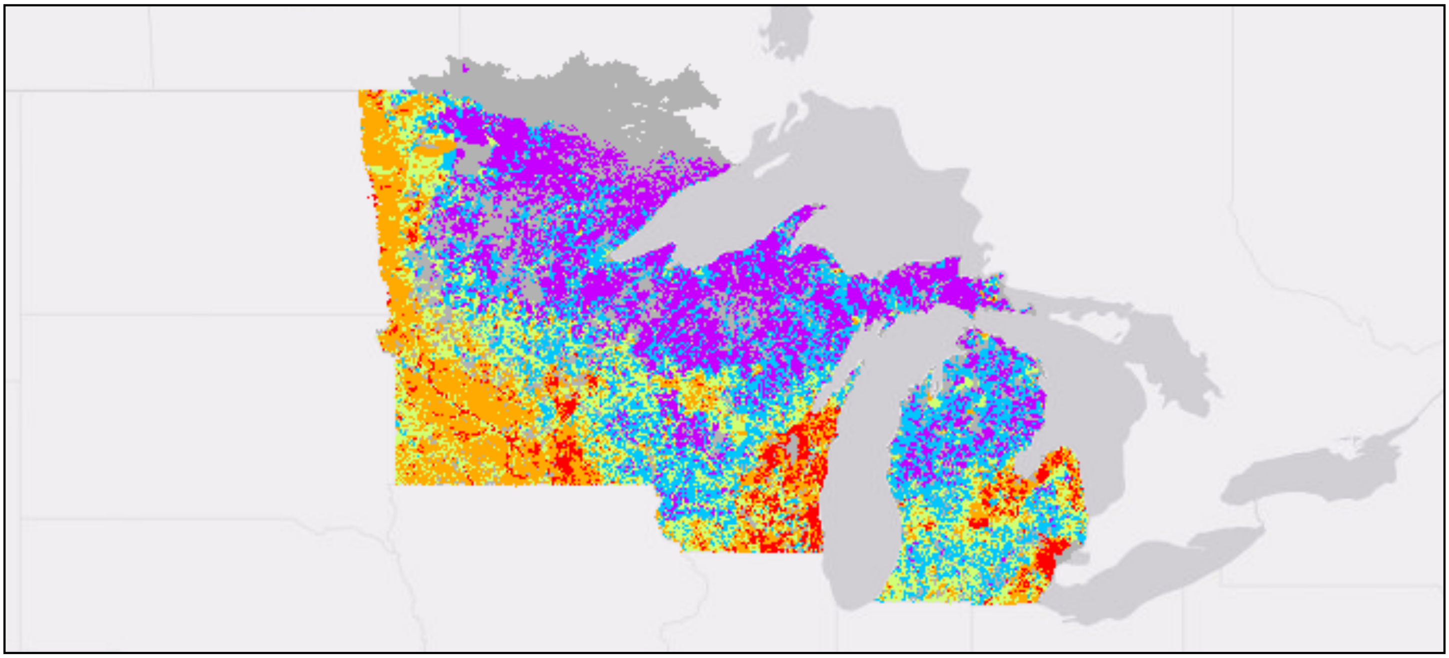


Figure1: This interactive figure summarizes the risk of fish habitat degradation for both perennial and intermittent waters as defined by the National Hydrography Dataset Plus Version 1. Future assessment enhancements will include a map of scores for only perennial streams in the U.S. The currently selected tab shows data from the inland assessment of streams for the contiguous United States. (a) Relative condition of fish habitat in streams. Stream summaries represent percentage of total stream length in each condition class. (b) Map showing risk of fish habitat degradation. The default view shows all stream condition classes. User may change map display by selecting a bar in

(a), resulting in a display of the selected condition class in (b). Please see How to Read this Report for important information about strengths and limitations of these findings. Click here to download scores from the inland assessment of streams for the United States.

Most Pervasive and Severe Disturbances for the Upper Midwest States

A. Pervasive disturbances: The most common disturbances based on total stream length in a given region.

Top five overall most pervasive disturbances **to all stream reaches**, regardless of stream size and across all spatial scales ranked highest first):

•Crop land use

•Population density

•Pasture and hay land use

•Road crossing density

•Low intensity land use

Top three most pervasive disturbances to **creeks** (watersheds <100 km^2 in area) **across all** spatial scales:

•Crop land use

•Population density

•Low intensity urban land use

Top three most pervasive disturbances to **rivers** (watersheds >100 km^2 in area) **across all** spatial scales **:**

•Pasture and hay land use

•Population density

•Crop land use

Top five most pervasive disturbances to **creeks, specific to** spatial scale:

•Population density in network catchments

•Crop land use in local catchments

•Crop land use in network catchments

•Downstream dam density in network catchments

•Crop land use in local buffers

Top five most pervasive disturbances to **rivers, specific to** spatial scale:

•Pasture and hay land use in network catchments

•Population density in local catchments

•Crop land use in network catchments

•Crop land use in local catchments

•Crop land use in network buffers

In the Upper Midwest state group, 48.2% of streams are classified as low or very low risk of habitat degradation, and these streams should be where protection efforts are focused.

Agricultural land use (crop and pasture) makes up the majority of the landscape disturbance leading to the risk of habitat degradation in all four spatial scales (local catchment, network catchment, local 90m buffer and network 90m buffer) and both stream sizes (creeks and rivers).

B. Most severe disturbances (a subset of pervasive disturbances): Disturbances associated with stream reaches in a given region that were scored as having high or very high risk of habitat degradation (red and orange color groups).

Top five overall most severe disturbances to **all stream reaches**, regardless of stream size and across all spatial scales (ranked highest first):

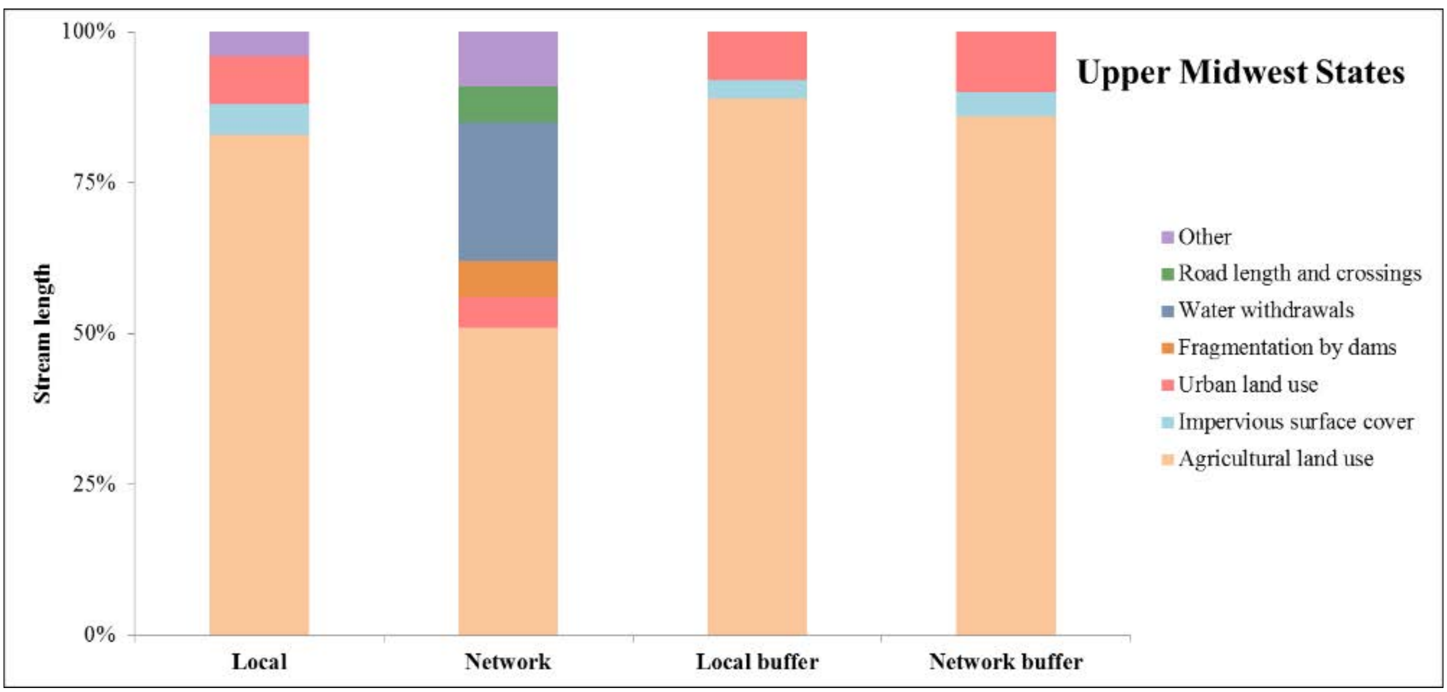
- Crop land use
- Agricultural water withdrawal
- Low intensity urban land use
- Pasture and hay land use
- Downstream dam density

Top three most severe disturbances to **creeks** (<100 km ^{2} watersheds) **across all** spatial scales:

- Crop land use
- Agricultural water withdrawal
- Pasture and hay land use

Top three most severe disturbances to **rivers** (>100 km ^{2} watersheds) **across all** spatial scales:

- Crop land use
- Agricultural water withdrawal
- Pasture and hay land use



Most severe disturbances in the Upper Midwest States associated with stream reaches being scored as having high or very high risk of habitat degradation. Disturbances are grouped into large groups (fragmentation by dams; nutrient and sediment pollution; human population; road length and crossings; water withdrawals; urban land use; agricultural land use; mines and impervious surface cover) within the four spatial scales (local catchment, network catchment, local buffer, and network buffer). Only disturbance groups that have greater than 5% of stream length in a given category are represented in this figure. Note that not all disturbance categories are available for each spatial scale ; buffers have only urban land use, agricultural land use, and impervious surface cover. See Detailed Inland Stream Methodology for more details.

Agriculture

Corn, soybeans, other row crops, and dairy farms dominate the landscape across southern Minnesota, Wisconsin and Michigan. Most of the agricultural activity in this region came at the expense of the large wetland complexes and woodlots that were found across the landscape in this region.Tile drains have been used extensively throughout the region and have turned streams and wetlands into drainage ditches, devoid of fish habitat. These drainage systems have completely altered stream flow patterns (hydrology), increasing watershed-wide peak discharge events that have destabilized downstream river reaches and decreased baseflows, in these areas. These changes in water flow patterns have created higher bank erosion rates, unnaturally widened stream and river channels, and have increased sedimentation and nutrient loading in receiving streams. Recently, crop prices have increased considerably, particularly during the period from 2010 to 2015, which has led to the rapid reconversion of what was protected conservation reserve land being back to farming. This will lead to additional degradation of fish habitat in areas that are already under stress.

Dams and Other Barriers

Dams and other barriers are having a significant effect on fish habitat in the Upper Midwest. More than 3,700 dams have been constructed on Wisconsin's warm water streams. Similarly, there are 2,500 listed dams in Michigan and likely a similar number that are not in the dam safety database for that state. In the Lake Michigan watershed alone, dams, culverts, and road crossings that impede fish migration have reduced nearly 19,000 miles of accessible stream habitat to only 3,300 miles. With many Great Lakes fish species using tributaries as spawning and nursery habitats, these barriers are a significant factor impairing the full recovery of fish populations in the Great Lakes. Similar fragmentation occurs on other inland waters with similar barriers. Barriers in this region have significantly increased fisheries management costs, requiring the use of hatcheries to replace wild fish production from these tributary systems. The public has begun to recognize the damaging effects of dams and during 2010 to 2014 at least 25 dams were removed from the Upper Midwest states' streams and rivers.

Point Source Pollution

A major hub for manufacturing and transportation, the Great Lakes and their tributaries were once an easy dump site for their waste products that included organic toxins, mercury, PCBs, and dioxins. As a result of the Federal Clean Water Act (1972) most of the direct pollution discharges from known point sources have stopped, but the legacy pollutants remain because many are trapped in lake and stream sediments. Other dissolved pollutants have long residence times because less than one 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 urban areas. The inland fish habitats of the Upper Midwest are negatively affected by agricultural runoff carrying fertilizer and pesticides, and urban runoff contaminated by oil, grease, salt, sewage, and trash. These not only affect fish habitat but also fish and human health. Almost one-third of nutrient load of Lake Michigan is contributed primarily by the Fox River drainage into Green Bay, with much of this loading coming from agriculture and paper mills.

Urban Land Use

Major cities, such as Detroit, Milwaukee, Minneapolis/St. Paul, and numerous smaller lakefront cities support a population of over 21 million people in the Upper Midwest area. Converting land to urban areas has reduced fish habitat through the filling of wetlands, altered rivers and streams to convey artificially-caused high-flow events through these areas, decreased the streams ability to meander, and has converted natural lake shorelines to bulkheads and seawalls. Many parcels of private land in the forested portions of this region: are being sold for development of subdivided vacation communities; have impoundments developed on free flowing streams to create “new” lakefront properties; and are seeing a rapid increase in the number of vacation homes developed. This wave of “urbanization” in what were forest lands with low density housing have and are threatening river, stream, lake and reservoir habitat through direct habitat loss, alteration of natural processes, and by the input of excessive nutrients and sediments.

Detroit river and city skyline.

Habitat Trouble for Brook Trout in Upper Midwest States

The **Brook Trout** (*Salvelinus fontinalis*) requires cold, clean rivers and streams. This species will move long distances to find cold water refugia and spawning habitat with upwelling groundwater, however, the species suffers from habitat degradation and watershed fragmentation. Land use changes have resulted in excessive erosion and increased water temperatures and the large number of dams and culverts in the region heavily fragment available habitat.

Brook trout *(Salvelinus fontinalis)*

Brook trout *(Salvelinus fontinalis)*

Habitat Trouble for Ironcolor Shiner in Upper Midwest States

The **Ironcolor Shiner** (*Notropis chalybaeus*) is found in deep pool areas of creeks and small rivers and is often associated with aquatic vegetation. This species needs clear sandy areas for spawning. Populations of Ironcolor Shiner are in decline due to increased turbidity, siltation, and pollution.

Ironcolor shiner*(Notropischalybaeus)*

Habitat Trouble for Lake Sturgeon in Upper Midwest States

Lake Sturgeon (*Acipenser fulvescens*) is the largest species (maximum weight between 300-400 lbs.), longest lived (50-year-olds are common but can reach over 100 years in age), and among the slowest maturing species (first reproduction is between 15-25 years old) found in the Great Lakes region. Historically, this species had populations that numbered in the millions basin-wide but had been reduced to remnant populations by 1920 from overharvest; habitat destruction from river channel alteration, landscape scale logging, and pollution from industrialization; and barrier construction. The Lake Sturgeon requires clean rock substrates for spawning and often undertakes long migrations to complete its life history. Although dams that block Lake Sturgeon migrations may be the greatest habitat threat, the species also suffers from altered water flow from peaking hydropower projects, water pollution, elimination of backwater habitats in rivers, alteration of inshore Great Lakes habitat, and destruction of spawning habitat.

Lake sturgeon *(Acipenserfulvescens)*

Habitat Trouble for Redside Dace in Upper Midwest States

The **Redside Dace** (*Clinostomus elongatus*) prefers small to medium, cool, clear, rubble- and gravel-bottomed streams. This type of habitat in streams is disappearing in parts of the region because of excessive sedimentation, altered water flows, and nutrient inputs from farming, mining, and urban development.

Redside dace *(Clinostomuselongatus)*

Fish Habitat Partnership Activities for the Upper Midwest States

Partnerships - Driftless Area Restoration Effort, Great Lakes Basin Fish Habitat Partnership, Great Plains Fish Habitat Partnership, Midwest Glacial Lakes Partnership, Fishes and Farmers Partnership , and Reservoir Fisheries Habitat Partnership

1. Partners removed: one barrier in Minnesota that increased fish passage to over 3 miles of streams; 12 barriers in Wisconsin that increased fish passage by 12 miles and reconnected 15 acres of wetlands to streams; and 13 barriers in Michigan that reconnected over 147 miles of streams.
2. In Wisconsin, enhanced 13.0 stream miles for Brook Trout including tributary spawning habitat, 20.5 miles of mixed Brook/Brown Trout water, and 13.2 miles of stream for Brown Trout.
3. Improved 3.7 stream miles for Brook Trout and 27.2 miles for Brown Trout in the Minnesota Driftless Area.
4. Funding was also provided to restore another three miles of instream habitat in Wisconsin and over five miles in Michigan.

For more about specific waters and projects the Upper Midwest States Fish Habitat Partnerships are working on, please see the following locations:

•Great Lakes Aquatic Habitat Framework – see featured article

•Boardman River, Michigan – see featured article

•Lake Vermilion, Minnesota

•Leech Lake, Minnesota

•Trout Run, Minnesota

•Au Sable River, Michigan

•Manistee River, Michigan

•Bear Creek, Wisconsin

•Big Spring Branch, Wisconsin

•Pine Creek, Wisconsin

Boardman River, Michigan - Dam Removal and Monitoring

Partnership – *Great Lakes Basin Fish Habitat Partnership*

The nearly 300 square mile Boardman River watershed is located in Grand Traverse and Kalkaska Counties in northwest Michigan. With the exception of the extreme lower river and three impoundments, the Boardman River is an oligotrophic river system with excellent water quality characterized by cold temperatures, high dissolved oxygen concentrations, and nutrients provided by distant inputs. Of the approximately 179 miles of river and tributary streams in the Boardman system, 36 miles are designated as a "Blue Ribbon" trout stream, providing premier fish habitat. Anglers from near and far come to enjoy the predominantly resident Brook and Brown Trout fishery, providing important economic benefits to the region. The entire watershed is also used for activities such as canoeing, tubing, kayaking, hiking, hunting, and bird watching. These uses make it a destination for an estimated 2 million Recreational User Days annually.

However, a series of four decommissioned hydroelectric dams limit fishery movement, and therefore fishery potential, throughout the Boardman River system. To address this concern, the Conservation Resource Alliance has led a wide ranging team of partners to restore the Boardman River to a more natural, free flowing state by removing the upper three dams in the system (the Sabin, Boardman and Brown Bridge dams). The lower dam (Union Street dam) will be maintained but modified to prevent expansion of spawning and rearing habitat for invasive Sea Lamprey. The removal of the three dams will restore free fishery movement throughout approximately 180 miles of mainstream and tributaries. Other valuable benefits of the project include: the restoration of natural large woody debris transport; mitigation of temperature regimes lethal to salmonids; restoration of natural stream flow function and channel form; restoration of 250 acres of wetlands and 60 acres of upland habitat; improvements to the local economy and business growth through interest in water-related activities; and involvement of a diverse group of individuals and organizations throughout the process, and into the future, which will ensure the long-term health of the Boardman River.

The Brown Bridge Dam was removed in 2012-2013 and re-established 2.5 miles of river channels, 12.2 acres of floodplains, and reconnected over 50 miles of river habitat. Woody debris was placed on the stream banks to reduce erosion and also placed instream to provide habitat. Nearly 260,000 cubic yards of sediment that had accumulated in the impoundment was graded away from the river to build appropriate river benches. Subsequent work on the Brown Bridge area included: removal of a culvert on Bancroft Creek, a tributary of the Boardman River; control of invasive plants; planting more than 9,500 native trees and shrubs in the old impoundment area; monitoring; and plans to build river access sites. Work was scheduled to commence on the Boardman Dam beginning in 2016.

Monitoring is planned over a period that encompasses a minimum of 3 large flood events (bank-full or larger), which represents the events and time needed to re-establish the channel processes. Monitoring will include fish passage evaluation (Michigan DNR Fisheries Division Status and Trends

Program), river cross sections, fish and wildlife habitat conditions, invasive species passage prevention, gradient changes, substrate composition, biological community responses, amphibian and reptile habitat monitoring, macroinvertebrate monitoring, and invasive plant monitoring.

Partners:

•Grand Traverse Band of Ottawa and Chippewa Indians
•City of Traverse City
•Grand Traverse County
•Michigan Department of Natural Resources
•Michigan Department of Environmental Quality
•Great Lakes Basin Fish Habitat Partnership
•Michigan Hydro Relicensing Coalition
•Traverse City Light and Power
•U.S. Fish and Wildlife Service
•Great Lakes Fishery Trust
•Conservation Resource Alliance
•Grand Traverse County Road Commission
•Rotary Camps and Services
•Watershed Center Grand Traverse Bay
•Charter Township of Garfield

http://fishhabitat.org/partnership/great-lakes-basin-fish-habitat-partne...
http://www.rivercare.org/local/upload/file/MDNRBoardmanRiverAssessment2014DRAFT.pdf

Great Lakes Aquatic Habitat Framework (GLAHF)

Partnership - Great Lakes Basin Fish Habitat Partnership

The Great Lakes Aquatic Habitat Framework (GLAHF) is an international, basin-wide, comprehensive database and spatial framework for the Great Lakes Basin. It is supported by the Great Lakes Basin Fish Habitat Partnership and links available fisheries and habitat inventory, assessment, and monitoring data with restoration and management plans and policies across multiple spatial and temporal scales. GLAHF consists of three components: 1) a spatial framework of geo-referenced grid cells that allow aggregation into larger units; 2) a suite of geologic, hydrologic, connectivity, and physiographic variables (>300) important to aquatic communities attributed (attached) to each classified unit; and 3) a dynamic habitat classification system that allows the constant updating and integration of new information to support decision making. The unique top–down (hierarchical) structure of GLAHF provides a framework for developing habitat units for Great Lakes coastal and near shore fish.

A collaborative team of Great Lakes scientists from the U.S. and Canada are currently developing models to predict habitat quality for a set of Great Lakes fish species using available fish data and natural variables as input to validated predictive models across the Great Lakes. The team is also developing a stressor index that incorporates key habitat quality indicators from Great Lakes tributary stream systems and those found in each lake. The next steps are to complete developing models that will predict stress response relationships for coastal Great Lakes habitats. The final product of this coastal condition assessment for the Great Lakes will be: 1) maps that identify high quality fish habitat for coastal and nearshore areas that should be considered for protection; 2) maps that identify areas where stressors have degraded habitat that require rehabilitation; and 3) identification of key stressors that affect coastal habitats that will help inform how to rehabilitate degraded areas. These final products, along with the currently available GLAHF framework and spatial layers, will be provided publically through an on-line interactive viewer, and are expected to be completed by 2020.

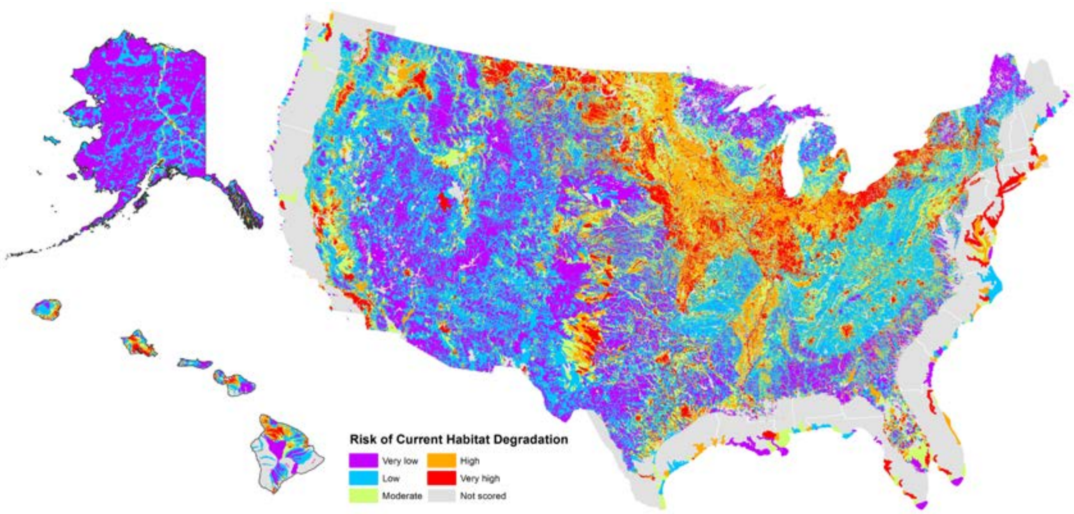
All Assessments - Detailed Methods

from

Through a Fish's Eye:

The Status of Fish Habitats in the United States

2015



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[6] Texas Parks and Wildlife Department

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All Assessments - Detailed Methods

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Detailed Methodology for Inland Stream Assessment for the Conterminous United States

Key elements of the 2015 national assessment of stream fish habitats follow the 2010 assessment, including: 1) the idea that fishes reflect the quality of habitat in which they live; and 2) human landscape factors pose a risk to the condition of stream habitat, and indirectly, to fishes. The assessment followed five broad steps (Figure 1), and each are described in detail below.

NATIONAL FISH HABITAT PARTNERSHIP

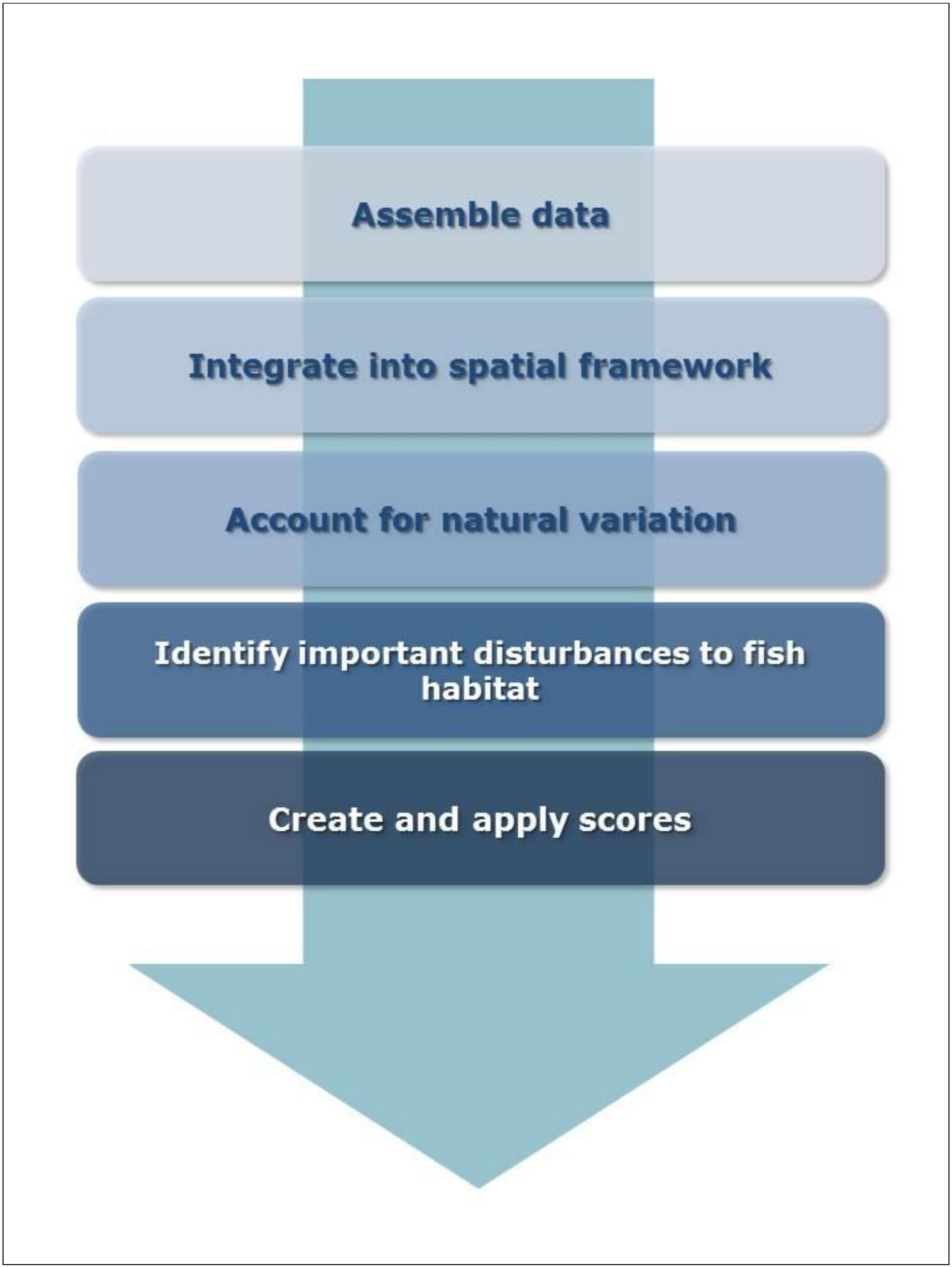


Figure1: Steps for 2015 national assessment of stream fish habitats.

Detailed Methodology for Inland Stream Assessment for the Conterminous United States (Step1)

Assembling data

Data on stream fishes were provided for use in the 2015 assessment from many federal and state agencies and organizations from around the country. For a list of data providers, see Table 2. Due to the cooperation and support of multiple data providers, the 2015 assessment used stream fish assemblage data from 39,405 stream reaches as compared to 26,468 stream reaches in 2010 assessment. Data now reflects abundances of different fish species found in streams throughout the conterminous United States.

Besides fish data, many different human (anthropogenic) landscape factors were assembled and used to characterize habitat condition. These factors include: urban and agricultural land use; intensity of different types of mining activities; impervious surfaces; estimates of nutrient loading to streams; estimates of water withdrawals; major point sources of water pollution; and measures describing fragmentation of rivers by dams (Table 1). To increase accuracy, the 2015 stream assessment incorporated 12 additional human disturbance variables into the fish analysis compared to the 2010 assessment. Associations between all human disturbance variables, summarized in both catchments as well as stream buffers, were tested against stream fish metrics to develop assessment scores. Additional variables incorporated into the 2015 assessment and their summary within catchments and buffers allowed for more explicit characterization of the diverse set of disturbances to stream fish habitats occurring across the Nation than what occurred in 2010, and this was made possible due in part to advances in available GIS layers.

Some important threats to fish and fish habitat that could not be incorporated into the assessment due to data limitations include: historical land use, hydrologic changes, legacy mining, oil and gas extraction, fragmentation by culverts and small dams, sedimentation and woody debris recruitment and transport, water temperature and dissolved oxygen, other water quality impairments such as contaminants and nutrients, animal feed lots, channel and bottom morphology, forestry practices, grazing intensity, and regional habitat stressors. All of these missing variables will be addressed in future assessments as resources and data become available. *Based on missing factors and variables, 2015 habitat condition scores may underestimate the true amount of disturbance in some systems and reaches. This limitation should be kept in mind as the reader interprets the information in this report.*

Table1: Table showing human and natural landscape factors used for the 2015 national assessment of stream fish habitat.

Super Category	Variable	Units	Scale	Date	Source
Human landscape factors					
Mines	All mines (mineral, coal, uranium mine density)*	#/km^2	NA	2003, 2012	USTRAT[1], MRP[2]
	Coal mine density*	#/km^2	NA	2012	USTRAT[1]
	Mineral mine density*	#/km^2	NA	2003	MRPS[2]
	Uranium mine density*	#/km^2	NA	2003	OAR[3]
Fragmentation by dams	Downstream main-stem dam density*	#/100km	NA	2012	NABD[4], Cooper et al. In Review
	Upstream main-stem dam density*	#/100km	NA	2012	NABD[4], Cooper et al. In Review
Water withdrawal	Domestic water withdrawal*	MGY	HUC12	2005	EPA, USGS[5]
	Industrial water withdrawal*	MGY	HUC12	2005	EPA, USGS[5]
	Thermo-electric water withdrawal*	MGY	HUC12	2005	EPA, USGS[5]
	Agriculture water withdrawal*	MGY	HUC12	2005	EPA, USGS[5]
	Total water withdrawal*	MGY	HUC12	2005	EPA, USGS[5]
Human population	Population density[Δ]	#/km^2	1:100,000	2000	TIGER US Census[6]
Road length and crossings	Road length density[Δ]	km/km^2	1:100,000	2006	TIGER US Census[6]
	Road crossing density[Δ]	#/km^2	1:100,000	2006	TIGER US Census[6]
Urban land use	Low intensity urban and open space[Δ]	%	30m	2006	MRLC[7]
	Medium intensity urban[Δ]	%	30m	2006	MRLC[7]
	High intensity urban[Δ]	%	30m	2006	MRLC[7]
Agriculture land use	Pasture/Hay[Δ]	%	30m	2006	MRLC[7]
	Cultivated crops[Δ]	%	30m	2006	MRLC[7]
Impervious surface cover	Percent impervious surface[Δ]	%	30m	2006	MRLC[7]
Nutrient and sediment pollution	Total anthropogenic nitrogen yield*	kg/km/yr	1:500,000	1992	SPARROW[8]
	Total anthropogenic phosphorus yield*	kg/km/yr	1:500,000	1992	SPARROW[8]
	Total anthropogenic sediment yield*	kg/km/yr	1:500,000	1992	SPARROW[8]
Point source pollution	Toxic release inventory site density	#/km^2	NA	2007	EPA[9]
	Comprehensive Environmental Response, Compensation, and Liability Information System site density	#/km^2	NA	2007	EPA[9]
	Permit Compliance System site density	#/km^2	NA	2007	EPA[9]
Natural landscape factors					
	Mean elevation in catchment	m	30m	2005	NED[10]
	Mean slope in catchment	degrees	30	2005	NED[10]
	Ground water contribution to base flow	%	1km	2003	USGS[11]
	Mean annual precipitation	mm	1:250,000	1990-2010	PRISM[12]
	Mean annual air temperature	°C	1:250,000	1990-2010	PRISM[12]

*New variable used in 2015 assessment (compared to 2010 assessment).
Updated variable used in 2015 assessment (compared to 2010 assessment).

1.USTRAT (US Stratigraphy, www.energy.usgs.gov/Tools/NationalCoalResourcesDataSystem.aspx)
2. USGS MRP (US Geological Survey Mineral Resources Program, http://minerals.usgs.gov/)
3. EPA OAR (US Environmental Protection Agency Office of Radiation and Indoor Air, www.epa.gov/aboutepa/about-office-air-and-radiation-oar)
4. NABD (National Anthropogenic Barrier Dataset)
5. USGS (U.S. Geological Survey, http://water.usgs.gov/watuse/data/2005/index.html)
6. TIGER U.S. Census (Topologically Integrated Geographic Encoding and Referencing, www.census.gov/geo/maps-data/data/tiger-line.html)
7. MRLC (Multi-Resolution Land Characteristics Consortium, www.mrlc.gov)
8. SPARROW (SPAtially Referenced Regressions On Watershed attributes, http://water.usgs.gov/nawqa/sparrow/)
9. EPA (http://www.epa.gov/enviro/geospatial-data-download-service)
10. NED (National Elevation Dataset, http://nationalmap.gov/elevation.html)
11. USGS (http://water.usgs.gov/GIS/metadata/usgswrd/XML/bfi48grd.xml)
12. PRISM (Parameter-elevation Relationships on Independent Slopes Model, www.prism.oregonstate.edu/)

Stream Fish Data Providers for 2015 National Assessment of Stream Fish Habitats

Stream fish data providers for 2015 national assessment of stream fish habitats.

Alabama Department of Conservation and Natural Resources	Alabama Department of Environmental Management	Alaska Department of Fish and Game
Arizona Game and Fish Department	Arkansas Department of Environmental Quality	Clemson University, Campbell Museum of Natural History
Colorado Division of Parks and Wildlife	Connecticut Department of Energy & Environmental Protection	Delaware Department of Natural Resources and Environmental Control, Division of
Florida Fish and Wildlife Conservation Commission	Geological Survey of Alabama	Georgia Department of Natural Resources, Wildlife Resources Division
Idaho Department of Environmental Quality	Illinois Department of Natural Resources	Kentucky Department of Fish and Wildlife Resources
Kentucky Division of Water	Lake Superior State University	Louisiana Department of Environmental Quality
Louisiana Department of Wildlife and Fisheries	Louisiana State University, School of Renewable Natural Resources	Maine Department of Environmental Protection
Maryland Department of Natural Resources	Massachusetts Division of Fisheries & Wildlife	Michigan Department of Natural Resources
Michigan State University, Department of Fisheries and Wildlife	Minnesota Pollution Control Agency	Mississippi Natural Heritage Museum
Missouri Department of Conservation	Missouri Resource Assessment Partnership	Multistate Aquatic Resources Information System
Museum of Southwestern Biology	Natural History Museum of Los Angeles County	Nebraska Department of Environmental Quality
Kansas Department of Natural Resources	Nebraska Regional Environmental Monitoring and Assessment Program	Nevada Department of Wildlife
New Hampshire Fish and Game Department	New Jersey Division of Fish and Wildlife	New Mexico Department of Game and Fish
New York State Department of Environmental Conservation	North Carolina Division of Water Quality	Ohio Environmental Protection Agency
Oklahoma Conservation Commission	Pennsylvania Fish and Boat Commission	Rushing Rivers Institute
South Atlantic Landscape Conservation Cooperative	South Carolina Department of Natural Resources	South Dakota Game, Fish and Parks
Southeast Aquatic Resources Partnership	State of Hawaii, Division of Aquatic Resources	Tarleton State University, Department of Biological Sciences
Tennessee Water Resources Authority	Tennessee Wildlife Resources Agency	Texas Commission on Environmental Quality

Texas Parks and Wildlife Department	Texas Water Development Board	Troy University
U.S. Forest Service	University of Central Arkansas, Department of Biology	University of Southern Mississippi, Department of Biological Sciences
University of Wyoming, Department of Zoology and Physiology	US Environmental Protection Agency, Environmental Monitoring and Assessment Prog	US Environmental Protection Agency, National Rivers and Streams Assessment
Arkansas Water Science Center	US Geological Survey, BioData	USGS National Water Quality Assessment Program
Vermont Fish and Wildlife Department	Virginia Department of Environmental Quality	Washington State Department of Ecology
West Virginia Department of Environmental Protection	Wisconsin Department of Natural Resources	Idaho Department of Fish and Game

Detailed Methodology for Inland Stream Assessment for the Conterminous United States (Step 2)

Integrating data into a spatial framework

After acquiring data, variables were attributed to a national stream coverage for use in assessment following Wang et al. (2011). The National Hydrography Dataset Version 1 (NHDV1) is a 1:100,000 scale representation of streams from throughout the conterminous United States. The NHDV1 identifies stream reaches as sections of streams occurring between confluences (Figure 2). We attributed all data to stream reaches (i.e., fish data, fragmentation metrics by dams) or to local catchments and 90m buffers draining to stream reaches (i.e., human land uses, mining activities, impervious surfaces, etc.). Local catchments (watersheds) and buffers are the land areas draining directly to a stream reach. Using a process described in Tsang et al. (2014), we aggregated landscape information throughout network catchments and buffers, resulting in data available in four spatial scales for use in assessment. See Figure 2 for a visual representation of local and network catchments and buffers. These data, as well as our assessment scores, are available for public download by clicking here .

Data summarized in four spatial scales allowed us to test relationships between stream fish information and a single landscape factor in different extents because different types of fishes may be more sensitive to disturbances at local vs. larger spatial scales. This is partially due to the fact that habitat factors important to fishes may also be differentially affected by buffer vs. catchment influences. Hydrology, for example, may be influenced most strongly by catchment-scale factors, while sedimentation of streams may be more strongly influenced by stream buffer characteristics (e.g., Allan 2004).

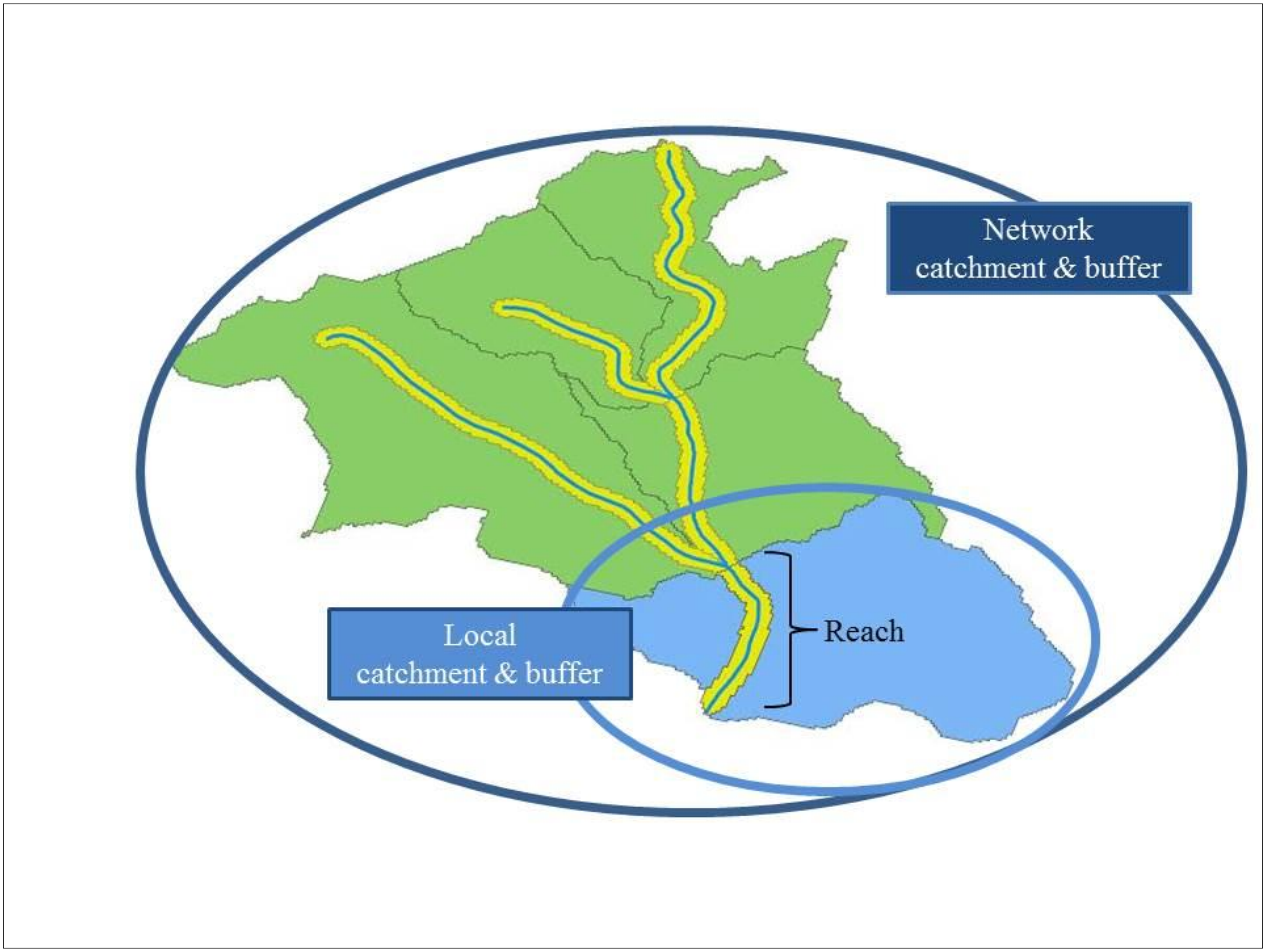


Figure 2: Stream reaches and local and network catchments and buffers (modified from Wang et al. 2011).

Detailed Methodology for Inland Stream Assessment for the Conterminous United States (Step 3)

Accounting for natural variation

Besides influences of human landscape factors on fishes, many "natural" landscape factors also affect species composition and their abundances found in different stream habitats. We incorporated multiple analytical steps that accounted for factors like stream catchment area, elevation, and slope; estimates of groundwater contribution to stream baseflow; and mean annual precipitation and air temperature in stream catchments. Also, because of broad differences in distributions of stream fish species in different-sized streams and across the United States, we developed assessment scores specifically for small and large streams and within nine large ecoregions of the country (WSA ecoregions), United States EPA 2006, Figure 3).

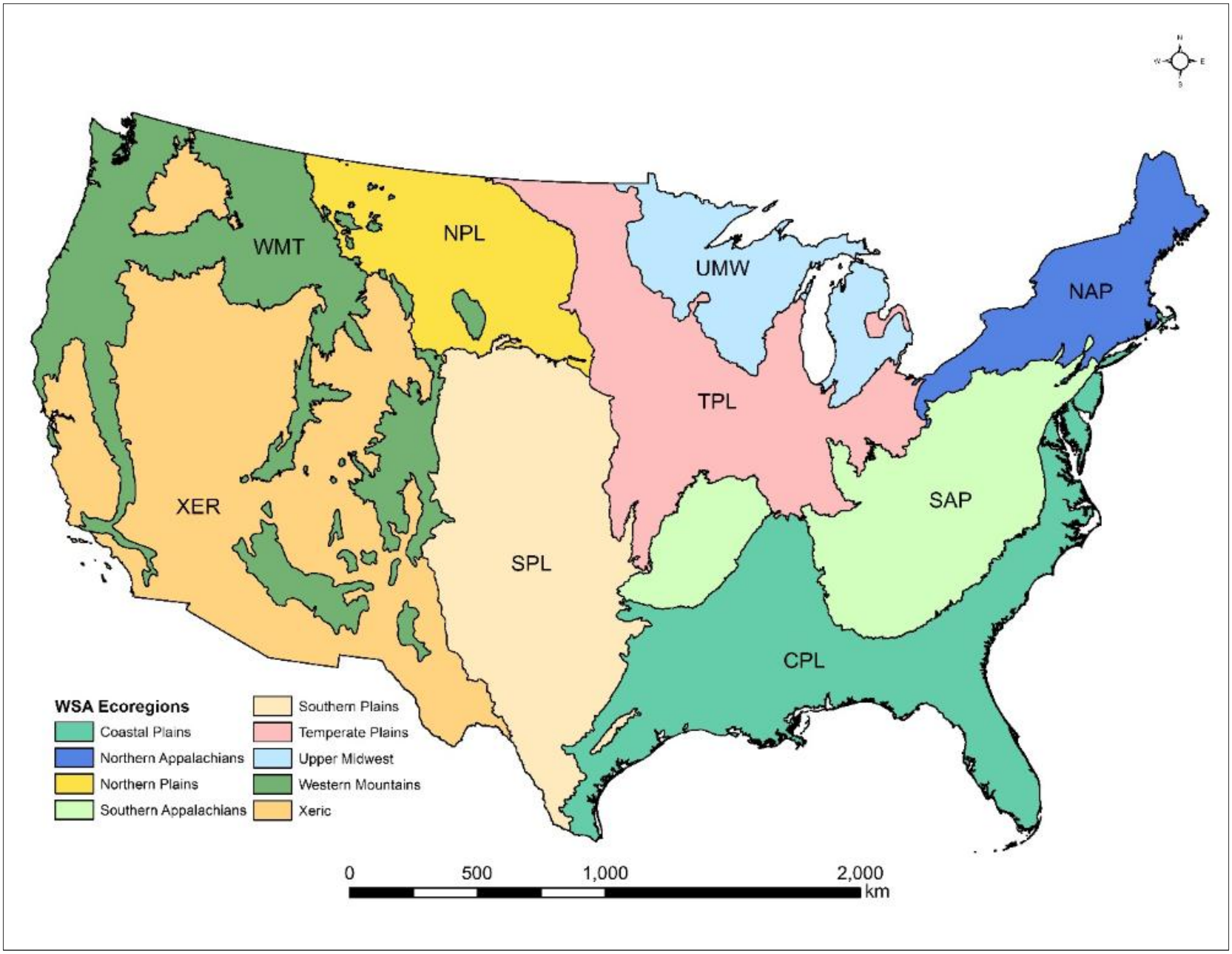


Figure 3: Nine large ecoregions of the conterminous United States used to select fish metrics and conduct the 2015 condition assessment of stream habitats.

Detailed Methodology for Inland Stream Assessment for the Conterminous United States (Step 4)

Identifying disturbances to fish habitat

The first step in identifying disturbances to fish habitat involved summarizing stream fish species data into a set of metrics that could be potential indicators of stream habitat condition. Examples of metrics include summaries of fish species by their feeding preferences, reproductive strategies, or tolerance to stressors. While many potential indicators were generated, an analytical process was used to identify a subset of metrics that were the most effective indicators of habitat condition in each of nine large ecoregions (Stoddard et al. 2008). Next, each of the key fish metrics was tested against each of the human landscape factors summarized in watersheds and stream buffers described above. When a key fish metric showed a significant, negative association with a specific human landscape factor (detailed methods described in Daniel et al. 2015), the human landscape factor was identified as a regional risk to stream habitat. Figure 4 shows a hypothetical relationship between a stream fish metric (y-axis) and increasing levels of a human landscape disturbance (x-axis). Step 5 explains the process of creating habitat condition scores for stream reaches based on associations between multiple fish metrics and multiple human landscape factors.

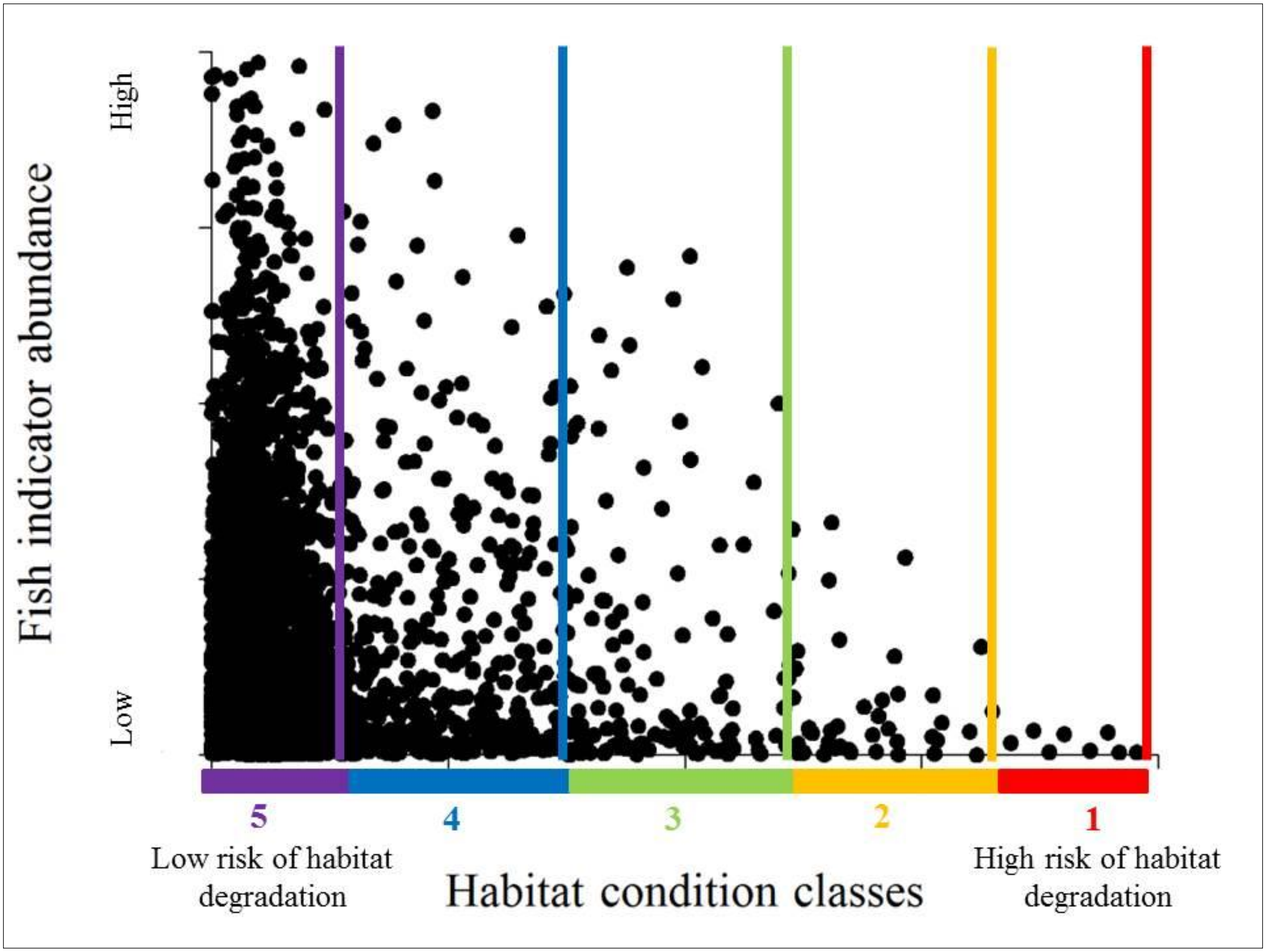


Figure 4: Association between fish indicator (y-axis) and human landscape factor (x-axis). Note that the threshold point occurs at the boundary of condition classes 5 and 4, and the plateau point occurs at the boundary of condition classes 1 and 2.

Detailed Methodology for Inland Stream Assessment for the Conterminous United States (Step 5)

Creating cumulative habitat condition scores

To create the cumulative habitat condition index (CHCI) for streams of the conterminous United States, associations between multiple fish metrics and multiple human landscape factors were synthesized into a single number using the following scoring process.

5a. For each significant association between a fish metric and a human landscape factor, we evaluated the shape of the relationship to identify two key points. The " threshold point" is the level of a landscape factor associated with a decrease in abundance of a particular fish metric (change in condition class between 5 and 4 in Figure 4), and the "plateau point" is the level of a landscape factor beyond which increasing levels of the landscape factor no longer yield a negative response in a fish metric (change in condition class between 2 and 1 in Figure 4).

5b. Next, we divided the range of the landscape disturbance factor occurring between the threshold and plateau points by three and assigned a score to each of the resulting five classes, reflecting relative condition of habitat (Figure 4). For example, class 5 indicates levels of a landscape factor likely to yield the lowest risk of degradation from a particular factor, while class 1 indicates levels of a landscape factor likely to yield the greatest risk of degradation. Note that at this stage in the cumulative habitat scoring process, results are specific to a single fish metric and a single landscape disturbance.

5c. We next used the breakpoints in classes identified in step 5b to extrapolate scores (generated just from stream reaches with fish data) to all ecological stream reaches (described by Wieferich et al. 2015) for a stream size group and throughout an ecoregion and based on levels of human landscape factors in catchments or buffers for a given reach.

5d. We then determined the minimum condition score (i.e. highest risk) identified for all human landscape factors in catchments and buffers that was found to be significantly associated with each fish metric in an ecoregion (Figure 5a). This builds on the idea that biological condition may only be as good as its response to its most limiting influences (following Esselman et al. 2013). The lowest condition score was considered to be the maximum observable biological potential of an ecological stream reach, based on a single fish metric.

5e. Finally, we created a habitat condition index (HCI) for all stream reaches in an ecoregion by averaging all of fish metrics' minimum scores. At this point in the scoring process, each stream reach had an HCI score specific to disturbances in local and network catchments and buffers based on multiple fish metric associations to human landscape disturbances. The cumulative habitat condition index (CHCI) was created from the minimum of the HCI scores across the four spatial scales within each ecoregion. See Figure 5a and 5b for a representation of this process. To identify the habitat condition classes based on the CHCI scores and to provide national comparability, we used Jenks natural breaks to define categories ranging from very low to very high. The Jenks method assigned reaches into five groups based on an optimization process that minimizes variation within and maximizes variation between groups of reaches.

(a)

	Habitat condition index				
	Reach 1	Reach 2	Reach 3	Reach 4	Reach 5
Local catchment	1.5	5.0	4.8	4.9	3.6
Local buffer	3.8	5.0	3.9	4.9	2.2
Network catchment	1.5	5.0	4.8	4.5	1.0
Network buffer	3.8	5.0	3.9	3.7	3.5
Cumulative Habitat Condition Index	1.5	5.0	3.9	3.7	1.0

(b)

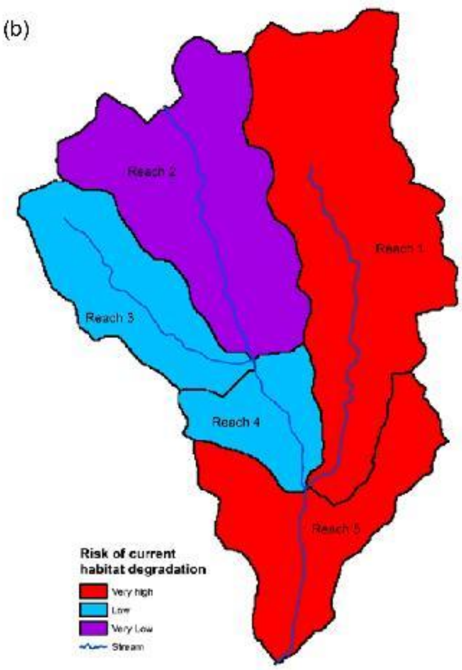


Figure 5: (a) A demonstration of methodology used to generate cumulative habitat condition index (CHCI) scores from habitat condition indices (HCI) for stream reaches. The minimum HCI score generated for a given stream reach is assumed to reflect that stream reachs maximum biological potential, and therefore serves as the CHCI for that stream reach. (b) Risk of current habitat degradation scores for stream reaches mapped to local catchments based off data in (a).

Detailed Methodology for Inland Stream Assessment for Alaska

Key elements of the 2015 national assessment of stream fish habitats follow the 2010 assessment, including: 1) the idea that distributions and numbers fishes reflect the quality of habitat in which they live; and 2) human landscape factors pose a risk to the condition of stream habitat, and indirectly, to fishes. The 2015 inland stream assessments for the contiguous United States, Alaska, and Hawaii all followed five broad steps (Figure 1) that are described in detail below for the inland stream assessment for Alaska. Note that analytical details for the Alaska assessment differed in southeast Alaska as compared to the remainder of the state (referred to as greater Alaska) due to differences in the resolution of the spatial framework characterizing stream catchments (Figure 10).

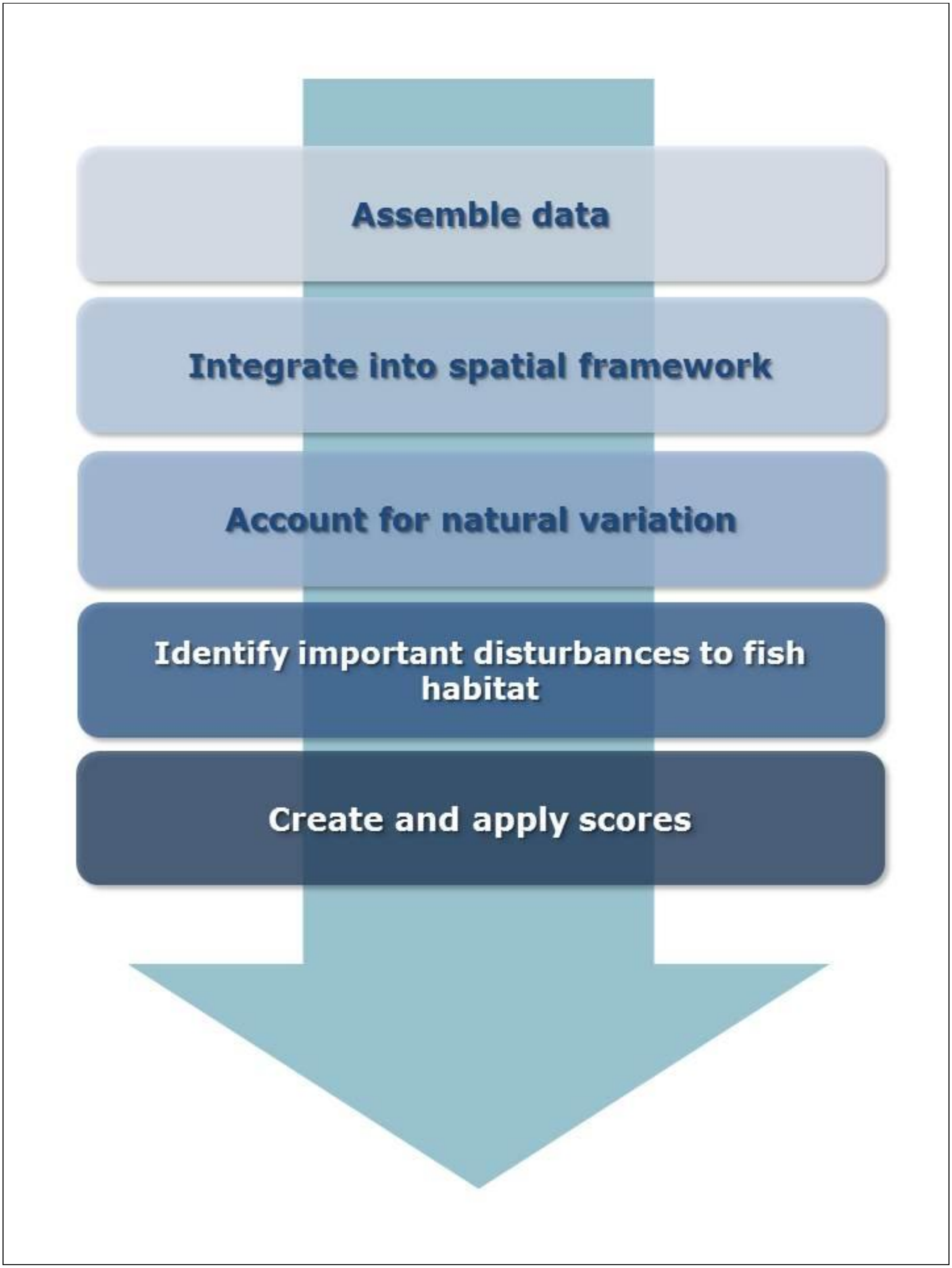


Figure1: Steps for 2015 national assessment of stream fish habitats.

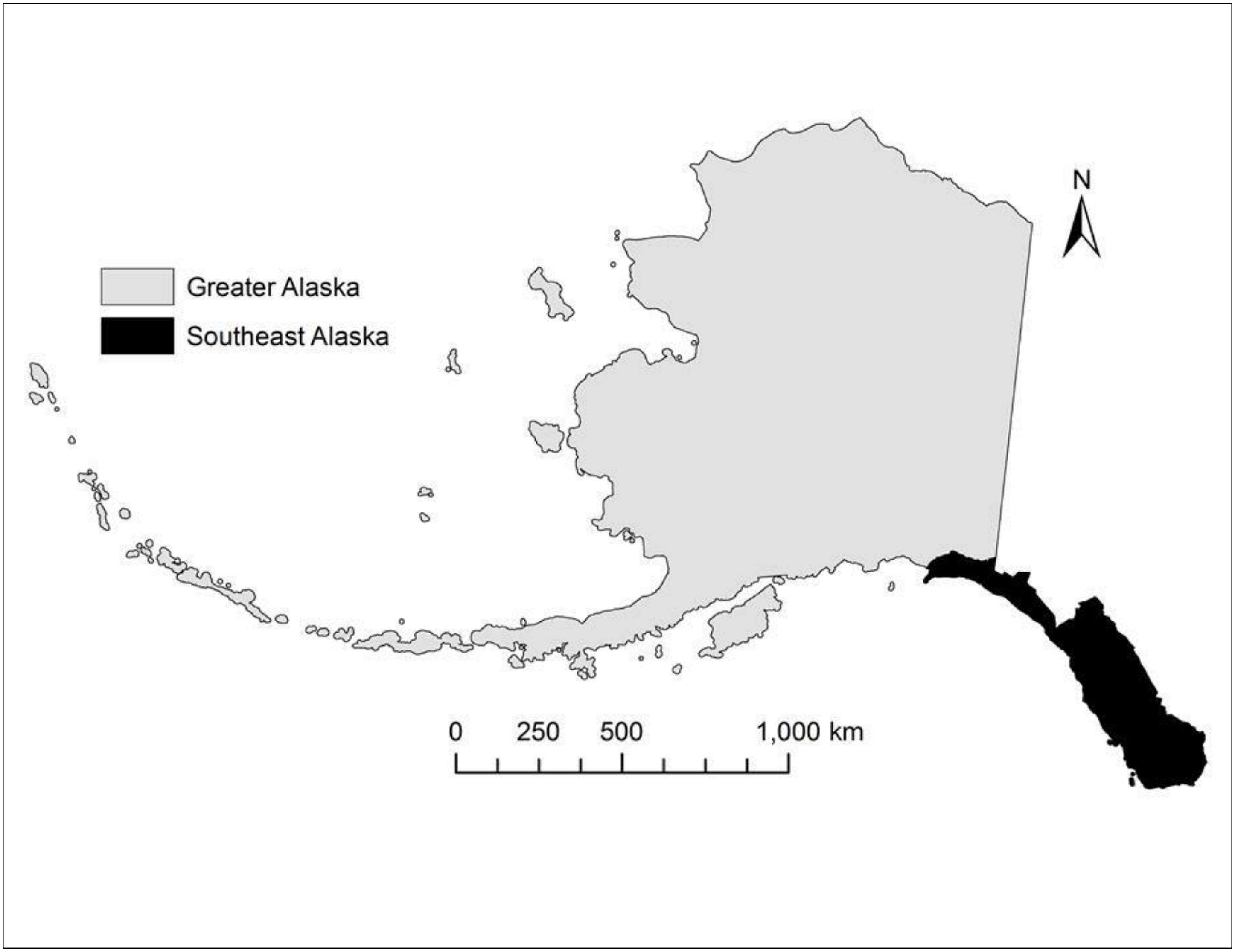


Figure10: Different assessment regions of Alaska.

Detailed Methodology for Inland Stream Assessment for Alaska (Step 1)

Assembling data

Many different human landscape factors were assembled and used to characterize condition of Alaska stream fish habitat (Table 3). Factors include: urban and agricultural land uses; density of point sources of pollution in catchments; measures of stream network fragmentation, including densities of dams and culverts; density of infrastructure (road length, pipelines, etc.) and locations of mines. The availability of some landscape factors varied between southeast Alaska and greater Alaska (see Table 3). Some important threats to fish and fish habitats could not be incorporated into the assessment due to data availability limitations (one example includes forest harvest information across the entire state), and subsequently were not available for this assessment. Based on these and other missing factors, 2015 habitat condition scores may underestimate the true amount of disturbance to stream habitats in some areas.

Table3: Human landscape factors used for the 2015 Alaska assessment of stream fish habitat.

Table 1. Human landscape factors used for the 2015 Alaska assessment of stream fish habitat.

Sub-index Category	Variable	Units	Date	Source	Greater Alaska	Southeast Alaska
Urban land use	Population density	#/km^2	2010	US Census	x	x
	Developed open space	%	2011	MRLC[1]	x	x
	Developed low intensity	%	2011	MRLC[1]	x	x
	Developed medium intensity	%	2011	MRLC[1]	x	x
	Developed high intensity	%	2011	MRLC[1]	x	x
Agriculture land use	Pasture/hay	%	2011	MRLC[1]	x	x
	Cultivated crops	%	2011	MRLC[1]	x	x
	Conventional forest harvest	%	2012	USFS[2] and Sealaska		x
Fragmentation	Culvert density	#/km^2	2014	Tongass USFS[2]		x
	Culvert density	#/km2	2014	ADFG[3]	x	x
	Dam density	#/km^2	2012	NABD[4]	x	x
Point source pollution	Toxic release inventory site density	#/km^2	2013	EPA[5]	x	x
	Comprehensive environmental response, compensation, and liability information system site density site density	#/km^2	2013	EPA[5]	x	x
	Permit compliance system site density	#/km^2	2013	EPA[5]	x	x
	Contaminated site database	#/km^2	2015	AK DEC[6]	x	x
	303D impaired waters	% impaired stream km		EPA[5]	x	x
Infrastructure	Road length density	km/km^2	2014	TIGER[7]	x	
	Road length density	km/km^2	2012	Southeast Alaska GIS Library		x
	Railroad length density	km/km^2	2006	ASGDC[8]	x	x
	Pipeline length density	km/km^2	2006	ASGDC[8]	x	x
	Airport/landing strips	#/km^2	2006	ASGDC[8]	x	x
Mines	Active and prospect mines	#/km^2	2008	ASGDC[8]	x	x

[1]Multi-Resolution Land Characteristic Consortium; [2]United States Forest Service; [3]Alaska Department of Fish & Game; [4]National Anthropogenic Barrier Database; [5] Environmental Protection Agency; [6]Alaska Department of Environmental Conservation; [7]Topologically Integrated Geographic Encoding and Referencing; [8]Alaska State Geospatial Data Clearinghouse

[1]Multi-Resolution Land Characteristic Consortium; [2]United States Forest Service; [3]Alaska Department of Fish &Game; [4]National Anthropogenic Barrier Database; [5]Environmental Protection

Agency; [6]Alaska Department of Environmental Conservation; [7]Topologically Integrated Geographic Encoding and Referencing; [8]Alaska State Geospatial Data Clearinghouse

Detailed Methodology for Inland Stream Assessment for Alaska (Step 2)

Integrating data into a spatial framework

Greater Alaska

For most of Alaska excluding the southeast portion of the state, watershed boundaries for individual stream reaches were unavailable, and the highest resolution spatial units available for assessment were 12-digit USGS hydrological units (HUC-12s). Greater Alaska includes 12,824 HUC-12s that partially follow watershed boundaries; however, boundaries are also intended to capture roughly similarly-sized regions vs. entire upstream landscape areas draining to streams (Figure 11). After acquiring data, variables were attributed to HUC-12s for the greater Alaska assessment.

Southeast Alaska

For the southeast portion of Alaska, watersheds were delineated from a 60 m digital elevation model and 1:63,360 National Hydrography Dataset (NHD) stream coverage. Stream reaches were defined as sections of streams occurring between confluences, headwaters and confluences, and confluences and pour points. Stream reaches were used as the basic spatial units for the southeast Alaska assessment and were similar to the spatial units used in the contiguous US stream assessment. Each of 219,802 stream reaches in southeast Alaska has an associated local catchment (watershed) and upstream network catchment, and these spatial units provide a finer-scale view of human disturbance to streams then HUC-12s (Figure 11). Landscape data were attributed to the local and network catchments for use in assessment following Wang et al. (2011). Using a process described in Tsang et al. (2014), we aggregated landscape information throughout network catchments. Summarization of data into two spatial extents allowed us to estimate threats to stream habitats that may result from differential effects of disturbances operating over different spatial scales (e.g., Allan 2004).

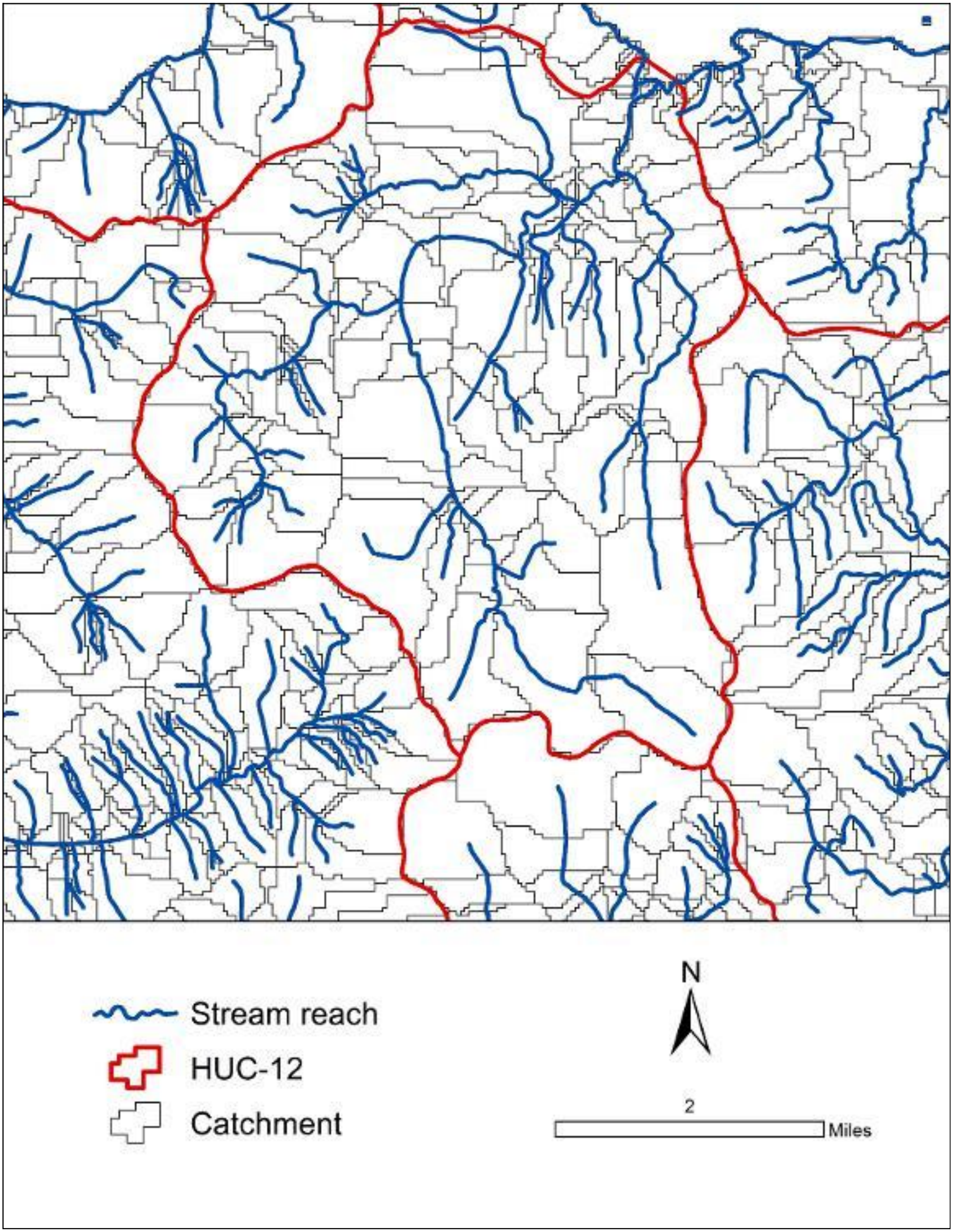


Figure11: Spatial units (HUC-12s and local catchments) to which data were attributed for the Alaska stream assessment. A HUC-12 contains multiple local catchments.

Detailed Methodology for Inland Stream Assessment for Alaska (Step 3)

Accounting for natural variation

With the exception of differences in spatial units, assessments for greater Alaska and southeast Alaska were conducted similarly across regions. Because stream fish assemblage data were not available for the state, no steps were taken to account for natural variation in stream habitats for either southeast or greater Alaska. This represents an important need for future work.

Detailed Methodology for Inland Stream Assessment for Alaska (Step 4)

Identifying disturbances to fish habitat

The approach for identifying disturbances to fish habitat was based on the assumption that greater intensities and types of human landscape disturbances would most likely lead to more disturbed stream fish habitat (e.g., Danz et al. 2007, Esselman et al. 2011). Twenty-two human landscape variables were identified for the Alaska assessment, with 21 variables used in the southeast and 19 in greater Alaska. We grouped variables into six sub-indices representing specific types of disturbances including: urban land use, agricultural land use, stream fragmentation, point source pollution, infrastructure, and active mines. Each sub-index of disturbance was represented by 2 to 5 landscape variables (Table 3).

Greater Alaska

Six sub-indices of disturbance were determined for each HUC-12 of greater Alaska. Sub-indices of disturbance values were generated by summing all standardized variable values in each sub-index together and then rescaling resulting values from zero to one. This normalization provides a relative gradient of disturbance for each disturbance sub-index within each HUC-12 relative to all other HUC-12s in greater Alaska. All six sub-indices of disturbances were integrated to create the cumulative habitat condition index (Step 5).

Southeast Alaska

Six sub-indices of disturbance were determined for each spatial extent (local and network catchments) for streams in southeast Alaska. Sub-indices of disturbance values were generated by summing all standardized variable values in each sub-index together and then rescaling resulting values from zero to one. This normalization provides a relative gradient of disturbance for each disturbance sub-index within each spatial extent (local and network catchments). All six sub-indices of disturbances were integrated to create the cumulative habitat condition index (Step 5).

Detailed Methodology for Inland Stream Assessment for Alaska (Step 5)

Creating cumulative habitat condition scores

Greater Alaska

All six sub-indices of disturbance scores in each HUC-12 were summed together to yield a cumulative habitat condition index (CHCI) score for each HUC-12. The maximum value for the CHCI was 6, indicating that a HUC-12 was in the worst condition class for each sub-index of disturbance, while the minimum value of the CHCI was 0, indicating that a HUC-12 was in the best condition class for each sub-index of disturbance. We followed methods applied for the conterminous US and created condition classes using Jenk’s natural breaks. With the exception of the HUC-12s that received a CHCI score of <0.001, which were given a priory assignment of “very low” risk of fish habitat degradation. The Jenks method assigned HUC-12s into four groups with CHCI scores between 0.001 and 6 based on an optimization process that minimizes variation within and maximizes variation between groups of HUC-12s. Because the methods used to calculate these score differ from those used in the conterminous US and in Hawaii, the greater Alaska results cannot be directly compared to results from these regional assessments

Southeast Alaska

For the southeast Alaska assessment, the six sub-indices of disturbance scores in each spatial extent (local and network catchments) were summed independently to create two habitat condition indices (HCI) for each stream reach. Both spatial extents had a theoretical maximum value for the HCI of 6, and were combined to create the cumulative habitat condition index (CHCI) score. To make the continuous map of Alaska at HUC-12s, the catchment CHCI scores were upscale to HUC-12s using area-weighted averages. We followed methods applied for the conterminous US and created condition classes using Jenk’s natural breaks. With the exception of the HUC-12s that received a CHCI score of <0.001, which were given a priory assignment of “very low” risk of fish habitat degradation condition class. The Jenks method assigned HUC-12s into four groups with CHCI scores between 0.001 and 6 based on an optimization process that minimizes variation within and maximizes variation between groups of HUC-12s. Because the methods used to calculate these score differ from those used in thee conterminous US and in Hawaii, the southeast Alaska results cannot be directly compared to results from these regional assessments.

Detailed Methodology for Hawaii

Key elements of the 2015 national assessment of stream fish habitats follow the 2010 assessment, including: 1) the idea that fishes reflect the quality of habitat in which they live; and 2) human landscape factors pose a risk to the condition of stream habitat, and indirectly, to fishes. The 2015 inland stream assessments for the contiguous United States, Alaska, and Hawaii all followed five broad steps (Figure 1) that are described in detail below for the inland stream assessment for Hawaii. Note that the stream assessment for Hawaii is conducted within the five main Hawaiian islands: Hawai'i, Maui, Moloka'i, O'ahu, and Kaua'i.

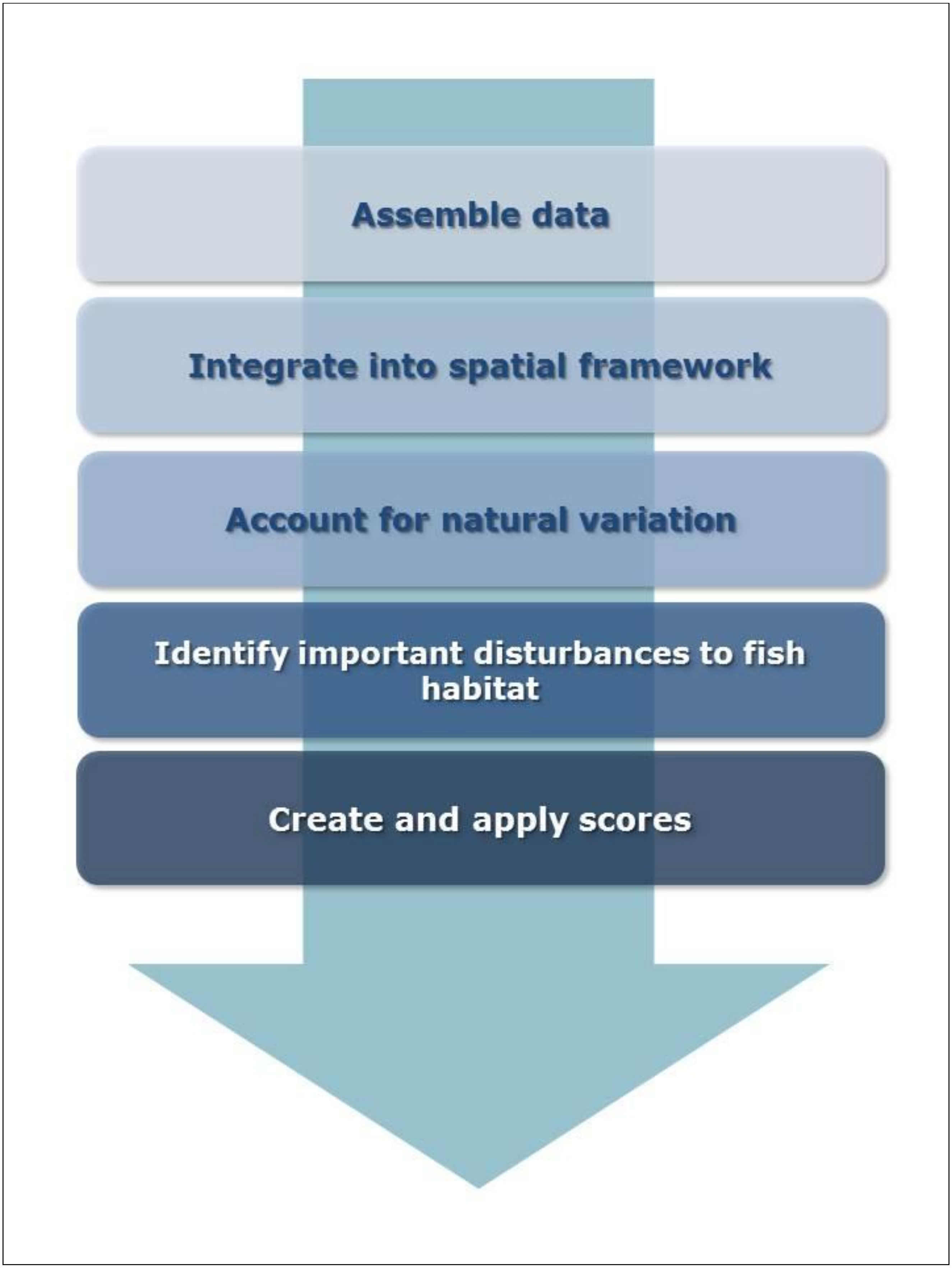


Figure1: Steps for 2015 national assessment of stream fish habitats.

Detailed Methodology for Hawaii (Step 1)

Data on stream fishes were provided for use in the 2015 assessment by the Hawaii Division of Aquatic Resources. Data were collected from 1992 to 2010, and assemblages were sampled using standardized visual surveys (Higashi and Nishimoto 2007). Fish data indicated presence or absence of nine native taxa in stream reaches including five fluvial fish species, two shrimp species, a gastropod, and two species of native flagtails (treated as a single taxonomic group analytically) that periodically enter the stream from the nearshore coastal environment (Table 6). Fish presence-absence data were available for 403 perennial stream reaches throughout the five main Hawaiian Islands.

Many different human landscape factors were assembled and used to characterize condition of habitat (Table 7). Factors include: urban and agricultural land use; density of point sources of pollution in catchments; measures of stream network fragmentation, including fragmentation by dams, roads and ditches; and locations of former plantation lands. Former plantation lands are an acknowledged threat to stream habitat as indicated by the Hawaii Fish Habitat Partnership (HFHP) due to the potential for some of these lands to leach excess nutrients or pesticides into receiving water bodies. Some important threats to fish and fish habitat could not be incorporated into the assessment due to data limitations, including stream-reach specific effects of the magnitude of water withdrawals and diversions, as well as threats from both invasive animal and plant species. Based on these and other missing factors, 2015 habitat condition scores may underestimate the true amount of disturbance to a given stream habitat in some areas.

Table 6: Table displays native stream taxa included in the 2015 assessment.

Taxa	Common name
Aytoida bisulcata	'opae kala'ole
Lentipes concolor	o' opu alamo'o
Sicyopterus stimpsoni	o' opu nopili
Awaous stamineus	o' opu nakea
Neritina granosa	hihiwai
Eleotris sandwicensis	o' opu 'akupa
Stenogobius hawaiiensis	o 'opu nahina
Macrobrachium grandimanus	opae oeha'a
Kuhlia sp.	āholehole

Table 7: Table showing human and natural landscape factors used for the 2015 national assessment of stream fish habitat.

Subindex Category	Variable	Units	Scale	Date	Source
	Human landscape factors				
Agricultural land use					
	Pasture/hay[Δ]	%	30m	2005,2010,2011	CCAP[1]
	Cultivated crops[Δ]	%	30m	2005,2010,2011	CCAP[1]
Urban land use					
	Developed (open)[Δ]	%	30m	2005,2010,2011	CCAP[1]
	Developed (impervious surface)[Δ]	%	30m	2005,2010,2011	CCAP[1]
	Population density[Δ]	#/km^2	1:100,000	2010	TIGER US Census[2]
	Road density[Δ]	km/km^2	1:100,000	2014	TIGER US Census[2]
	Utility pipeline density	m/km^2	1:24,000	1983	Hawaii OP[3]
	Percent of catchment covered by golf courses*	%	N/A	1993	Hawaii OP[3]
Former plantations					
	Percent of catchment that was once used for pineapple production	%	30m	1989	Hawaii OP[3]
	Percent of catchment that was once used for sugarcane production	%	30m	1989	Hawaii OP[3]
Point source pollution					
	Quarry density	#/km^2	N/A	2003	USGS MRP[4]
	Comprehensive Environmental Response, Compensation, and Liability Information System site density[Δ]	#/km^2	N/A	2014	EPA[5]
	Permit Compliance System site density [Δ]	#/km^2	N/A	2014	EPA[5]
	Toxic release inventory site density[Δ]	#/km^2	N/A	2014	EPA[5]
	Underground injection well density	#/km^2	N/A	2010	Hawaii DOH[6]
Density of ditches					
	Ditch density	m/km^2	1:24,000	2004	Hawaii DAR[7]
Stream fragmentation					
	Stream road crossing density[Δ]	#/km^2	1:100000	2014	TIGER US Census[2]
	Dam density	#/km^2	N/A	2010	ACOE[8]
	Ditch intersection density	#/km^2	1:24,000	2004	Hawaii DAR[7]
303d listed streams					
	Percent of upstream river network classified as 303D stream with measured TMDL	%	1:24,000	2012	EPA[9]
	Natural landscape factors				
	Minimum elevation of reach (Local catchment)*	m	10m	2005	NED[10]
	Mean slope of reach (Local catchment)*	%	10m	2005	NED[10]
	Mean slope of downstream reach (Downstream main channel catchment)*	%	10m	2005	NED[10]
	Minimum hydrological soil grouping (Network catchment)*	1-4	1:12,000 -1:63,360	2005	NRCS[11]
	Percent of catchment with wetlands surface cover (Local catchment)*	%	30m	2005,2010,2011	CCAP[1]
	Mean annual rainfall (Network catchment)*	mm/yr	225m	2015	Frazier et al. 2015
	Point locations of waterfalls (Local catchment)*	NA	NA	NA	Tingley et al. in prep

Detailed Methodology for Hawaii (Step 2)

After acquiring data, variables were attributed to a stream coverage for use in assessment following Wang et al. (2011). The Hawaii Fish Habitat Partnership (HFHP) stream layer (Tingley et al. in prep) is a modified version of the 1:24,000 National Hydrography Dataset that consists of 11,436 intermittent and perennial stream reaches across the five largest Hawaiian Islands (Hawai'i, Maui, Moloka'i, O'ahu, Kaua'i). The HFHP stream layer distinguishes stream reaches as sections of streams occurring between confluences, headwaters and confluences, and confluences and pour points, following the definition of stream reaches in the contiguous United States. Each reach has an associated local catchment (watershed), upstream network catchment, and downstream main channel catchment, which is the portion of the stream that connects the reach to the ocean environment (Figure 8). We attributed assembled data to stream reaches, local catchments, upstream network catchments, and/or downstream main channel catchments. These data, as well as our assessment scores, are available for public download by clicking here.

Summarization of data into three spatial scales allowed us to estimate threats to stream habitats that may result from differential effects of disturbances operating over different scales (e.g., Allan 2004).Hydrology, for example, may be more strongly influenced by network catchment factors, while sedimentation of streams may be more strongly influenced by local catchment factors. Similarly, amphidromous native stream organisms of Hawaii require access from streams to marine environments to complete their life cycles. Consequently, the condition of stream habitat downstream of reaches in which adults of these types of organisms are found is vital for successful passage of larvae to the marine environment (Brasher 2003).

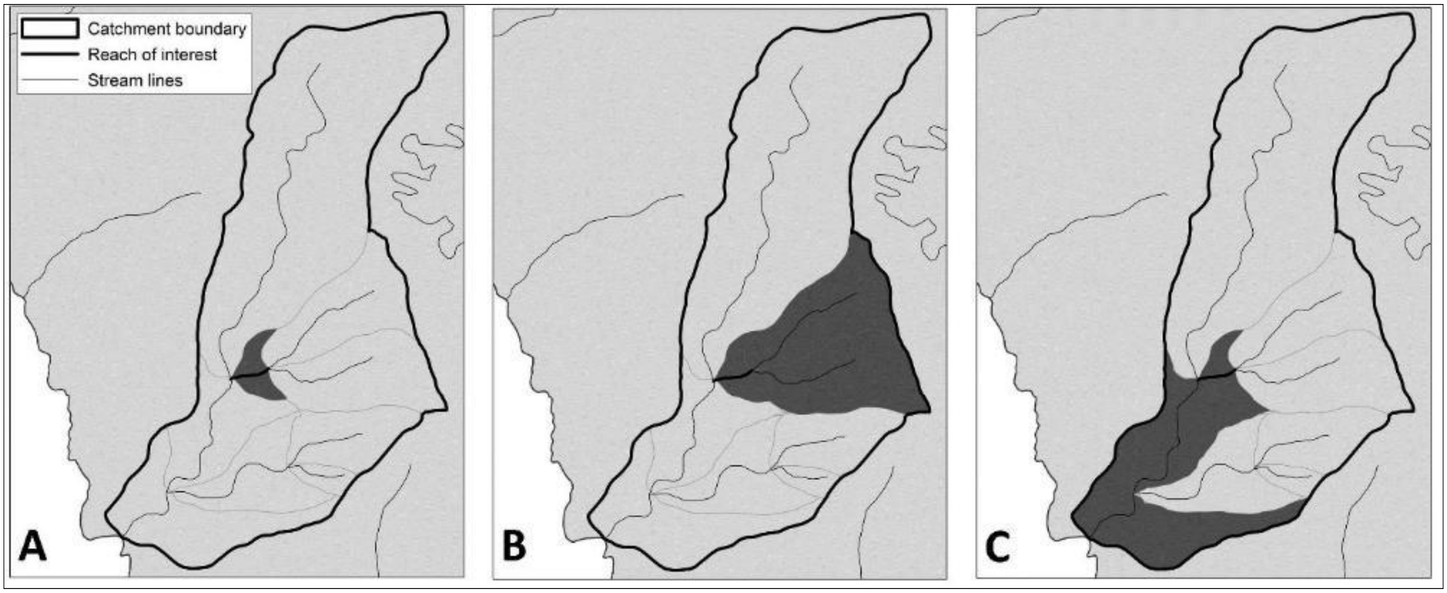


Figure 8: Spatial scales to which data were attributed for Hawaii inland stream assessment. Units include local catchments (A), network catchments (B), and downstream main channel catchments (C).

Detailed Methodology for Hawaii (Step 3)

Classifying Stream Reaches in Hawaii based on Ecological Potential

Besides influences of human landscape factors on stream organisms, many “natural” landscape factors also affect distributions and abundances of species found in different stream habitats. To account for those influences, we used an analytical approach to create groupings of perennial stream reaches with similar natural landscape characteristics that were found to be influential to distributions of nine native stream taxa including fish, shrimp, and snails (Table 2). This approach, referred to as classification, is driven by relationships between natural landscape factors and stream organisms and does not account for influences of anthropogenic factors. As such, results of our classification define the ecological potential of our resulting classes of stream reaches (e.g., Melles et al. 2012).

Four steps were taken to conduct the ecological classification of stream reaches, and our approach and results are described in detail in Tingley et al. (In Prep). First, a large group of natural landscape variables hypothesized to have relationships with distributions of taxa were identified through literature review and with input from affiliates of the Hawaii Fish Habitat Partnership (HFHP). Next, we reduced the large number of variables to a smaller number by eliminating those that were redundant and those that showed weak associations with distributions of stream taxa. After that, we used an analytical classification approach (Hothorn et al. 2006) to create groupings of stream reaches based on those natural landscape factors with strongest relationships to distributions of stream taxa across the five main Hawaiian Islands. This resulted in nine groupings of stream reaches. Our final step was to review these groupings with the HFHP, who proposed creating three additional groupings to account for differences in stream types that were not accounted for in our analytical approach. This resulted in a total of 12 groupings of stream types (in addition to intermittent streams) across the five main Hawaiian islands.

Detailed Methodology for Hawaii (Step 4)

The approach for identifying disturbances to fish habitat was based on the assumption that greater intensities and types of human disturbances would most likely lead to more disturbed stream fish habitat (e.g., Danz et al. 2007, Esselman 2011). Twenty human landscape variables were identified for the Hawaii assessment (Table 2). We grouped variables into seven categories representing specific types of disturbances including: agricultural land use, urban land use, former plantation lands, point source pollution, density of ditches, stream fragmentation, and 303d listed streams.

Disturbance sub-indices were then created for each category of disturbance variables for each spatial scale (i.e., local catchments, network catchments, downstream main channel catchments), with the exception of 303d listed streams which were only summarized within network catchments. To create sub-indices, we first used logistic regression to test for significant ($p<0.05$), negative relationships between presence/absence of native species and each of the 20 human landscape variables in each of three spatial scales. We conducted the logistic regressions within groupings of stream reach types as determined by the ecological classification (described previously) to account for natural variation. We next standardized and summed human landscape variables across all stream reaches for each spatial scale. In cases where a particular disturbance variable at a given spatial scale was found to have a significant, negative relationship with presence/absence of stream organisms, the individual variable was upweighted by a factor of two in the creation of disturbance sub-indices. Six disturbance sub-indices were created for local catchments, six disturbances sub-indices were created for downstream main channel catchments, and seven disturbance indices were created for network catchments. All nineteen sub-indices of disturbances were integrated to create the cumulative habitat condition index (next step).

Detailed Methodology for Hawaii (Step 5)

To create the cumulative habitat condition index (CHCI) for streams of Hawaii, we first standardized and summed disturbance sub-indices described above within each of the three spatial scales to create three habitat condition indices (HCI) for each stream reach. Based on the assumption that urban land use can have excessive negative effects on stream habitat compared to other disturbances and at the request of the HFHP, the urban sub-index was upweighted in each spatial scale by a factor of 2. The CHCI was developed by summing HCI scores across spatial scales for each stream reach and standardizing from 0 (best condition) to 1 (worst condition). We followed methods applied for the contiguous U.S. and created condition classes using Jenk's natural breaks. The Jenks method assigned reaches into five groups based on an optimization process that minimizes variation within and maximizes variation between groups of reaches.

Detailed Methodology for the National Estuary Assessment

The National Estuary Assessment combined landscape and estuary measurements of habitat stressors to produce an estimate of the risk of current habitat degradation for each estuary. The assessment was built on the assumption that both anthropogenic (human caused) activities within estuarine watersheds and local factors affect estuary habitats.

This assessment provides an updated outlook of the estuary condition that was presented in 2010 using the same general approach. However, results from **the 2010 and 2015 National Estuary Assessments should not be viewed as an indication of change** for several reasons. First, the assessment estimates current habitat stress relative to levels found in other estuaries within the framework; to appropriately measure change, the total extent of habitat stress over time would be needed. Second, several new datasets were added to the 2015 analysis, as well as improvements to some of the existing datasets updated from the 2010 analysis. It is vital to take advantage of enhancements in the data inputs where available to improve the overall quality of the assessment, but these changes mean that the results between the two assessment time-periods are not directly comparable.

Our general assessment approach uses four steps: 1) assemble data; 2) integrate data into spatial framework; 3) develop sub-indices of disturbance; and 4) create cumulative disturbance index scores.

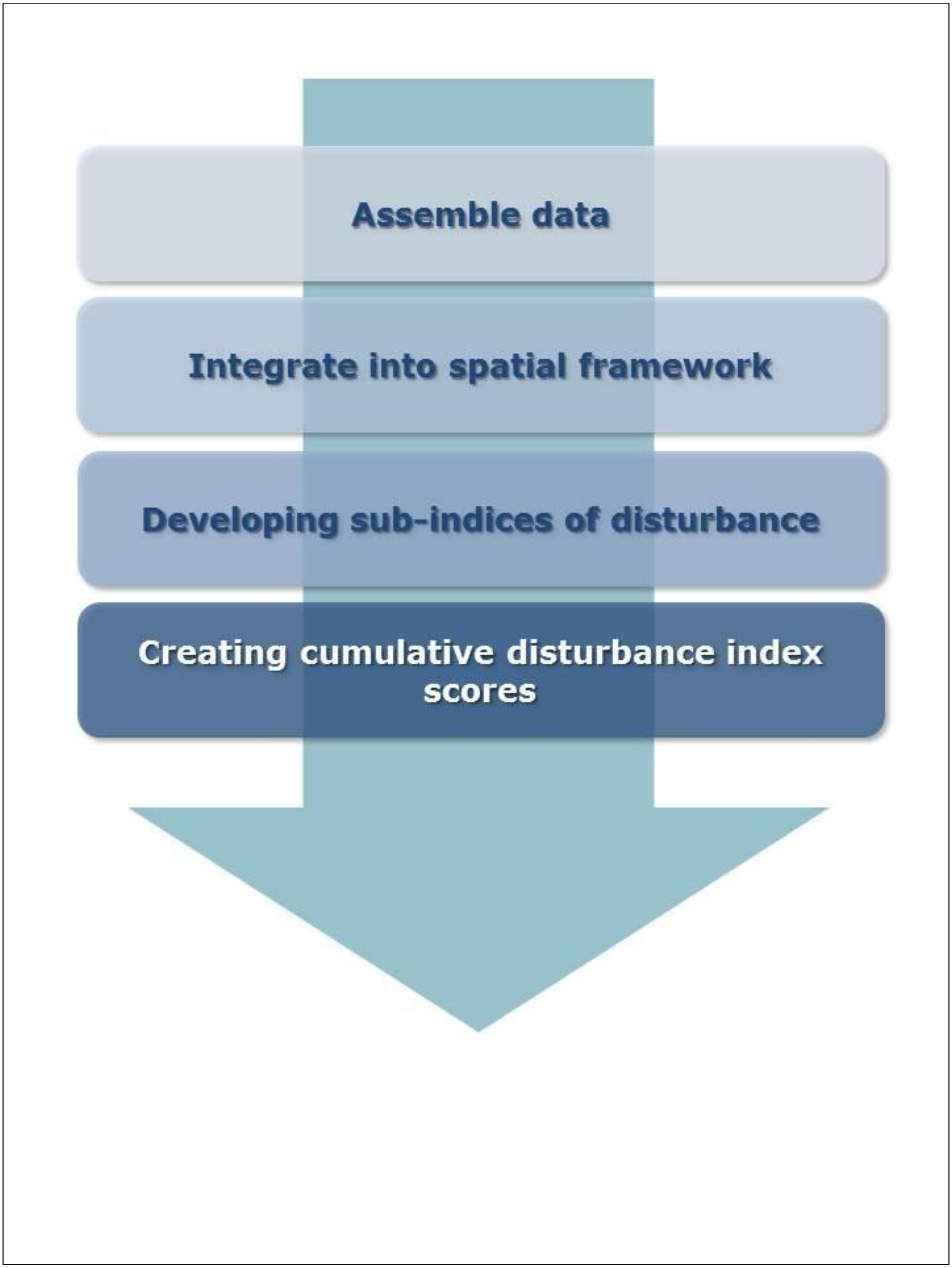


Figure 6: Steps for 2015 national estuary assessment.

Detailed Methodology for the National Estuary Assessment (Step 1)

Assembling Data

We used datasets of habitat stressors available at a national scale and measured within estuaries and their associated watersheds. Included datasets represent anthropogenic stressors likely to affect fish habitat within estuaries based on evidence from the published habitat ecology literature. Although many important factors were included, not all data were available at sufficient spatial resolution or geographic breadth for meaningful analysis. Some important datasets that were investigated but determined to be insufficient for inclusion in the current version of the National Estuary Assessment included: historic habitat extent/habitat loss; storm/wastewater discharges; sediment contaminants; biogenic habitat coverage; navigation projects and channel construction; shoreline hardening; and tidal flow restrictions. Work with partners is ongoing to identify new data resources and improve existing data sets for use in future national assessment efforts.

Individual disturbance variables were assembled within four disturbance categories, and summarized in Table 4.

Table 4: Table displays Individual disturbance variables that were assembled within four disturbance categories, and summarized

Disturbance Category	Variable	Units	Scale	Date	Source
Land Use / Land Cover	Agriculture	%	Shoreline	2010	C-CAP[1]
	Agriculture	%	EDA[2]	2010	C-CAP[1]
	Development	Intensity score	Shoreline	2010	C-CAP[1]
	Development	Intensity score	EDA[2]	2010	C-CAP[1]
	Estuarine	% change	Shoreline	2006-10	C-CAP[1]
	Estuarine	% change	EDA[2]	2006-10	C-CAP[1]
	Palustrine	% change	Shoreline	2006-10	C-CAP[1]
	Palustrine	% change	EDA[2]	2006-10	C-CAP[1]
	Undeveloped	% change	Shoreline	2006-10	C-CAP[1]
	Undeveloped	% change	EDA[2]	2006-10	C-CAP[1]
	Impervious surface[3]	%	Watershed	2011	MRLC[4]
	Population[3]	#/km²	EDA[2]	2010	U.S. Census[5]
Alteration of River Flows	Mean annual discharge	m³/s	Watershed	2015	USGS; IBWC; EC[6]
	7-day minimum discharge	m³/s	Watershed	2015	USGS; IBWC; EC[6]
	7-day maximum discharge	m³/s	Watershed	2015	USGS; IBWC; EC[6]
	Low pulse duration	Days	Watershed	2015	USGS; IBWC; EC[6]
	High pulse duration	Days	Watershed	2015	USGS; IBWC; EC[6]
	Trend in minimum discharge	m³/s/year	Watershed	2015	USGS; IBWC; EC[6]
	Trend in maximum discharge	m³/s/year	Watershed	2015	USGS; IBWC; EC[6]
	Trend in low pulse duration	Days/year	Watershed	2015	USGS; IBWC; EC[6]
	Trend in high pulse duration	Days/year	Watershed	2015	USGS; IBWC; EC[6]
	Dam density[7]	#/km²	Watershed	2010	NID[8]
	Total water withdrawals[3]	mgal/year	EDA[2]	2005	USGS[9]
Sources of Pollution	Mines and mineral plants[7]	#/km²	Watershed	2003	USGS[10]
	EPA pollution sites	#/km²	Watershed	2015	EPA[11]
	Roads[3]	m/km²	Shoreline	2015	U.S. Census[12]
	Roads[3]	m/km²	EDA[2]	2015	U.S. Census[12]
Estuary Eutrophication	Overall eutrophic condition[13]	Categorical score	Estuary	1999; 2007	NEEA[14]

1 C-CAP (Coastal Change and Analysis Program).
2 Estuarine Drainage Area.
3 Variable was not included in the 2010 National Estuary Assessment and is new for the 2015 update.
4 MRLC (Multi-Resolution Land Characteristics Consortium).
5 U.S. Census.
6 USGS (US Geological Survey Surface-Water Data for the Nation); IBWC (International Boundary &Water Commission); EC (Water Survey of Canada).
7 No updated data for this variable has been included relative to the 2010 assessment.
8 NID (National Inventory of Dams).
9 USGS (U.S. Geological Survey).
10 USGS (U.S. Geological Survey).
11 EPA (U.S. Environmental Protection Agency).
12 U.S. Census.

13 No updated data for this variable is available relative to the 2010 assessment.
14 NEEA (National Estuarine Eutrophication Assessment).

Detailed Methodology for the National Estuary Assessment (Step 2)

Integrating Data into the Spatial Framework

This assessment investigated the effects of anthropogenic stressors on 220 estuaries in the conterminous U.S. The nested spatial framework, identical to the one used in 2010, was used to assemble and analyze spatial habitat data. The framework defined four units (see Figure 7) to analyze human effects on estuaries:

- Estuaries: Range from relatively small river mouths (e.g. Carmel River Mouth) to large bays (e.g. San Antonio Bay), and also include some very large and complex estuary systems (e.g. Chesapeake Bay) as well as deep inland seas (e.g. Puget Sound). Estuaries are delineated as distinct units except for very large systems with many tidal tributaries, which are divided based on natural bathymetric breaks.
- Shoreline Buffers: Areas within 30 meters of grid cells identified as water (2006 C-CAP) and within 500 meters of estuary shorelines.
- Estuary Drainage Areas (EDAs): The part of an estuary's watershed that empties directly into the estuary and is affected by tides. Defined as the proximate 8-digit hydrologic unit code (HUC) watersheds that drain directly to an estuary.
- Watershed Basins: Includes the entire drainage area of the estuary. For estuaries with entirely coastal basins, the EDA and watershed basin are the same.

The framework also included a variety of geographic boundaries to facilitate analysis at multiple levels (e.g. regional comparisons). Nearshore and offshore marine areas, as well as estuaries outside of the conterminous U.S. (Alaska, U.S. Caribbean, and U.S. Western Pacific) are not included in the current version of the spatial framework or assessment. It is anticipated that these areas will be systematically added in the future as time and resources allow, and additional data becomes available.

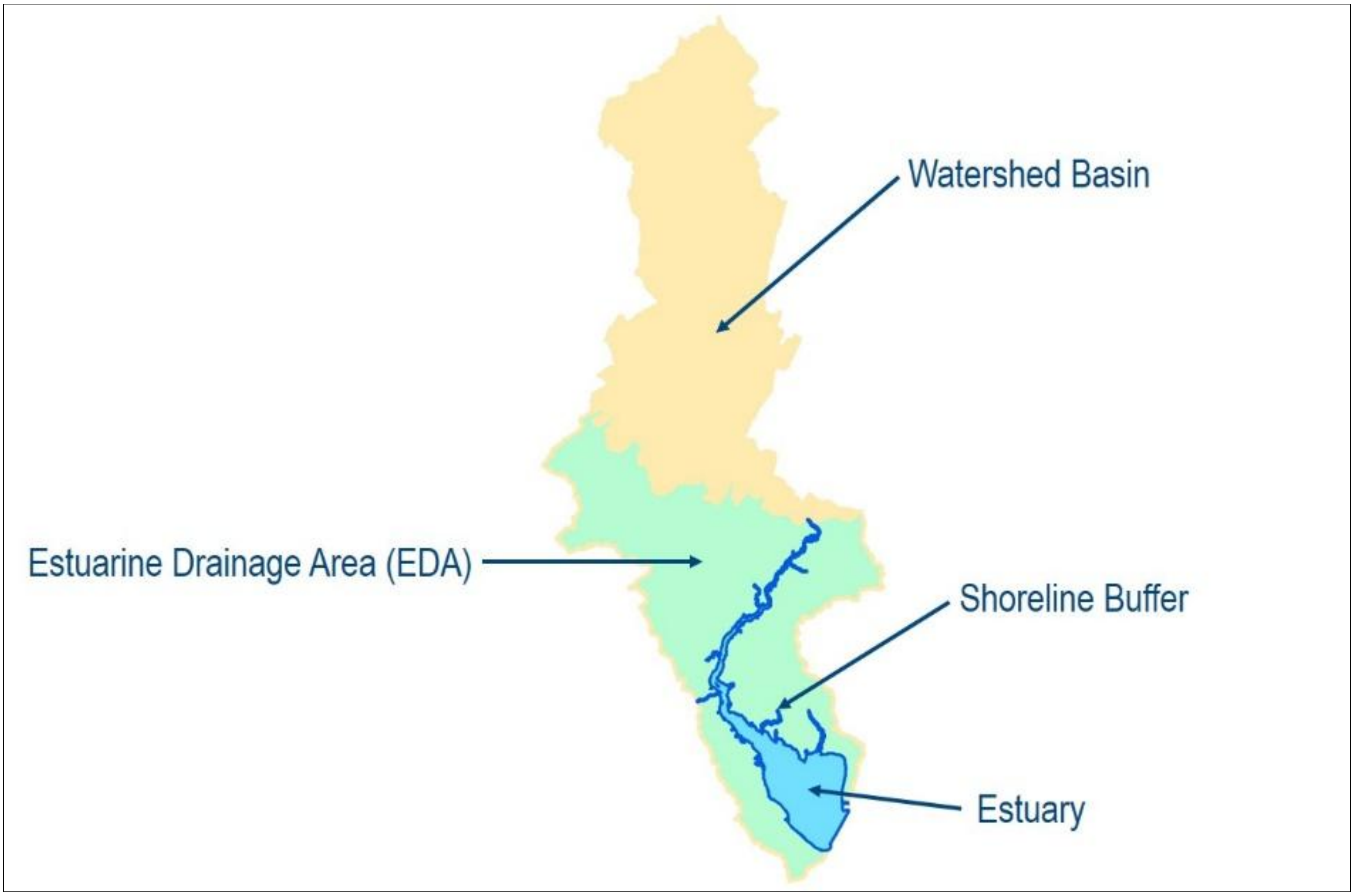


Figure 7: Spatial units used to analyze the effects of variables on estuaries.

Detailed Methodology for the National Estuary Assessment (Step 3)

Developing Sub-Indices of Disturbance

Variables within each of the four disturbance categories (Land Use/Land Cover, Alteration of River Flows, Sources of Pollution, and Estuary Eutrophication) were combined to create a sub-index of disturbance associated with each category. To calculate the sub-indices, a percent rank was calculated for variable scores in each estuary. Percent rank scores were inverted (i.e. 1-percent rank) where necessary to maintain consistency of interpretation, with low scores representing the highest degree of disturbance. Within each disturbance category, the average of each of the variable percent rank values was calculated. Finally, the percent rank of this average was calculated – this represented the sub-index of disturbance for that category. All sub-indices of disturbance are scaled from 0 to 1, with 0 representing the highest risk of current habitat degradation and 1 representing the best relative condition.

Detailed Methodology for the National Estuary Assessment (Step 4)

The cumulative disturbance index for estuaries included information from each of the variables investigated, combining information on land use, river flow, pollution, and eutrophication. *Although these represent many of the major sources of disturbance to estuary habitats, data on some habitat stressors was not available for analysis and will likely cause instances where condition is overestimated. The reader should keep this limitation in mind when examining the information in this assessment.*Similarly, information on localized disturbance or mitigation is not available on a national scale and could not be included. Therefore, the results of this assessment represent conservative estimates of the relative level of habitat stress at the estuary leveland relative to other estuaries included in the assessment. It is important to note that this assessment attempts to develop estimates of the cumulative levels of anthropogenic (man-made) stress known to impact fish habitat within estuaries; however, no data on biological (fish) response is included, so no statements about the correlations between these levels of stress and impacts to fish populations can be made from these results. Work is ongoing to develop estuary assessment products that offer greater insight to the link between anthropogenic stress and fish presence (see the section on Detailed Methodology for the Regional Estuary Assessment for the Northern Gulf of Mexico).

To produce the cumulative disturbance index, we developed a geometric mean of the four sub-indices of disturbance. For this calculation, a disturbance score of zero was reassigned a value of one-half the next lowest score so it could be included. Geometric mean values were then rescaled from 0 to 1 using percent rank, representing the final cumulative disturbance index scores. Due to data limitations, some estuaries did not have scores available for each of the component stressor indices. Scores for the cumulative disturbance index were calculated only for estuaries that had scores for at least three of the four sub-indices of disturbance available. Scores displayed in the report maps were divided into five categories representing risk of current habitat degradation (ranging from very low to very high) using the Jenks natural breaks classification method.

Detailed Methodology for the Regional Estuary Assessment for the Northern Gulf of Mexico

The methodology used for Regional Estuary Assessment for the northern Gulf of Mexico represents the next generation development of estuary assessments and compares the relative condition of different estuary systems using biological indicators. A key challenge to measuring habitat stress within estuaries is separating cumulative anthropogenic (man-made) effects from the high degree of natural variability and statistical “noise” present in available datasets. Identifying indicators of estuary condition and measuring their status relative to some objective or relative benchmark can allow for comparisons between estuary systems. Fish and shellfish species are key biological indicators as they reflect the conditions of their surrounding habitats over their life span in the estuary.

Results from the Regional Estuary Assessment complement the results for estuaries in the Gulf States (TX, LA, MS, AL, FL) from the National Estuary Assessment. However, the methods and data inputs for the two assessments are quite different, meaning that direct comparisons between the two sets of results are not directly appropriate. As resources become available, additional regions will transition to this new assessment approach.

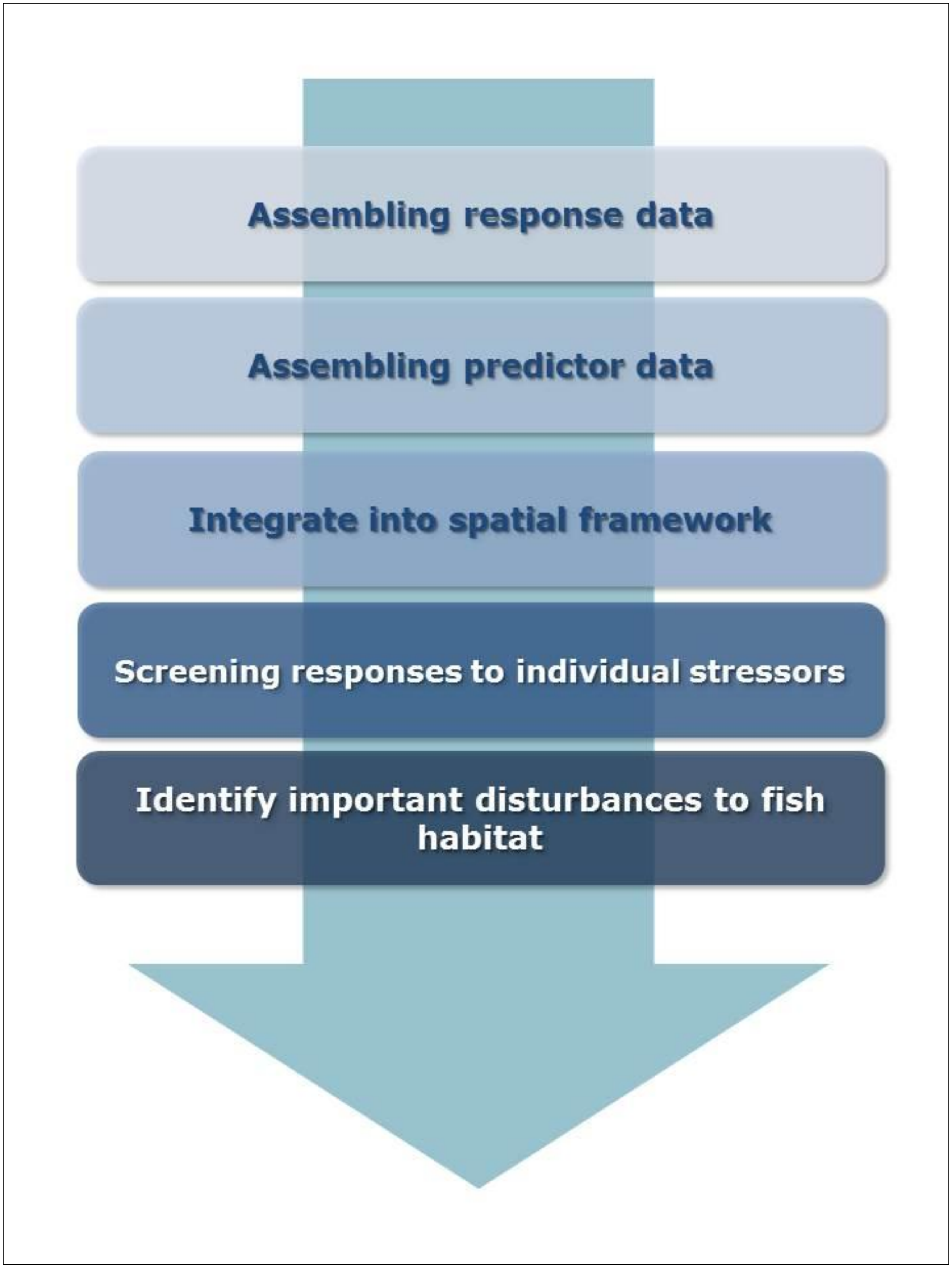


Figure9: Steps used for the 2015 Regional Estuary Assessment for the Northern Gulf of Mexico

Detailed Methodology for the Regional Estuary Assessment for the Northern Gulf of Mexico (Step 1)

Assembling Response Data

The assessment uses available fish and shellfish species presence/absence as indicators of the effects of anthropogenic (human caused) stressors on the estuarine habitats where fish and shellfish live, feed, and reproduce. Fish data were obtained from state and federal trawl survey programs, including each of the five coastal states as well as the U.S. Environmental Protection Agency’s (EPA) Environmental Monitoring and Assessment Program (EMAP) and National Coastal Assessment (NCA). Fish trawl nets are pulled through the water at specified sampling locations for a set period of time to determine the abundance and diversity of fish in the area. Environmental data like water temperature, dissolved oxygen, and salinity are also often concurrently collected.

We used data from over 70,000 trawl events collected from 1990 to 2009. Each individual survey program uses different techniques for their trawl sampling (e.g. different size mesh nets, different tow times). These differences were accounted for in the models to remove sampling biases (e.g. nets with larger mesh do not catch smaller sizes of fish; see modeling approach below for more information).

Species that were found in at least 1% of the total trawl samples and at least six of the seven sampling programs were included in modeling. This included a total of 48 individual species.

Detailed Methodology for the Regional Estuary Assessment for the Northern Gulf of Mexico (Step 2)

Assembling Predictor Data

Predictor data variables include both anthropogenic stressors and natural variables that can affect the susceptibility of estuaries to pollutants and other stressors. Predictors for this assessment were measured at two different scales in space and time: “event-level” and “estuary-level”. Event-level data were recorded at the specific times and locations of individual fish trawls and include variables like water temperature, salinity, and location (i.e. distance to shore). Estuary-level data refers to values averaged at the estuary level. Estuary-level variables include a range of anthropogenic stressors (e.g. nutrient loadings, toxic releases, land use, and population characteristics), as well as physical features (e.g. estuary volume, estuary area, % open to the sea, exchange rates, and freshwater inflows). A total of 87 estuary-level predictor variables were considered in this assessment.

Anthropogenic stressors originating in estuary watersheds were measured at three different spatial scales: watershed basin, estuarine drainage area (EDA), and shoreline buffer.

- Watershed basins include the entire drainage area of the estuary. For estuaries with entirely coastal basins, the EDA and watershed basin are the same.
- Estuarine drainage area (EDA) is the part of an estuary’s watershed that empties directly into the estuary and is affected by tides. Defined as the proximate 8-digit hydrologic unit code (HUC) watersheds that drain directly to an estuary.
- Shoreline buffers are defined as a 500-meter inland buffer from each estuary shoreline.

Gulf-wide watershed loading data were only available for nitrogen. Other available anthropogenic data were used as proxies for additional pollutants. For example, land used for agriculture discharges nitrogen, phosphorous, pesticides and other chemicals downstream to estuaries. In natural systems, most pollutants are mitigated by natural decay reactions, settling, flushing, or a combination of all three. Since most predictor variables represent a mix of potential pollutants, these variables were normalized by considering natural factors such as estuary area, volume, flow, and exchange rates. A full list of the estuary-level predictor values can be found in Table 5.

Land cover categories were grouped to test different combinations that are expected to have similar effects on estuary habitats. For instance, “hard” combines the urban and bare categories defined in land cover datasets; this class of land cover represents a group of relatively impervious surfaces expected to be associated with high runoff episodes.

Table 5: Normalized estuary-level predictor variables used for the Regional Estuary Assessment.

Variable	Unit	Normalization Factor					
		None	Estuary Area	Flow	Volume	Exchange	Land Area
Watershed Factors							
Shoreline Urban	km^2		*				*
Shoreline Hard	km^2		*				*
Shoreline Crop	km^2		*				*
Shoreline Agriculture	km^2		*				*
Shoreline Developed	km^2		*				*
Shoreline Wetlands	km^2		*				*
EDA Urban	km^2		*	*	*	*	*
EDA Hard	km^2		*	*	*	*	*
EDA Crop	km^2		*	*	*	*	*
EDA Agriculture	km^2		*	*	*	*	*
EDA Developed	km^2		*	*	*	*	*
Basin Urban	km^2		*	*	*	*	*
Basin Hard	km^2		*	*	*	*	*
Basin Crop	km^2		*	*	*	*	*
Basin Agriculture	km^2		*	*	*	*	*
Basin Developed	km^2		*	*	*	*	*
EDA Toxic Releases	#		*	*	*	*	
EDA NPDES Sites	#		*	*	*	*	
EDA Population	#		*	*	*	*	
Basin population	#		*	*	*	*	
N Load	kg/d		*	*	*	*	
Estuary Condition							
Estuary Salinity	%	*					
Estuary Openness	%	*					
Hypoxic Condition	I[1]	*					
Toxic Algal Condition	I[1]	*					
Eutrophication Condition	I[1]	*					

[1]"I" indicates a categorical variable on a 1 to 3 scale.

Detailed Methodology for the Regional Estuary Assessment for the Northern Gulf of Mexico (Step 3)

Integrating Data into a Spatial Framework

This part of the assessment examined 33 estuaries across the northern Gulf of Mexico (Florida, Alabama, Mississippi, Louisiana, and Texas). These estuaries were cataloged in a spatial framework used to quantify and analyze the effects of stressors on the estuaries. The framework was composed of a series of estuaries, linked to associated shoreline buffer units, Estuarine Drainage Areas (EDAs), and watershed basins.

The spatial framework was developed based on estuary boundaries used for the National Estuary Assessment. A number of changes were made for the northern Gulf of Mexico region to improve the way estuaries and their coastal catchments were defined in the framework for this assessment. First, the landward extent of estuary units was better defined around both open water areas and estuarine emergent wetlands using remote sensing data available from the Coastal Change Analysis Program (C-CAP; 2006) and the National Wetlands Inventory (NWI). The seaward extent of estuaries was also updated to a 4-meter depth contour, based on an examination of plots of salinity at depth for estuaries in the northern Gulf.

Shoreline buffers extend from estuary shorelines inland 500-meters around each estuary. EDAs are defined as the coastal portion of watershed basins, and consist of the 8-digit USGS hydrologic units (HUCs) that drain directly to an estuary. Watershed basins include the entire upstream drainage network up to the watershed divide. For estuaries with entirely coastal basins, the EDA and watershed basin are the same.

Several estuaries included in the National Estuary Assessment were excluded from analysis in the Regional Estuary Assessment because they have unusual characteristics that may alter how they respond to anthropogenic stressors and were unsuitable for inclusion in the regional models. Estuaries excluded from this analysis were: Atchafalaya Bay, Louisiana (receiving inputs from the unusually large Mississippi River Basin); the Rio Grande, Oyster, and Brazos River estuaries, Texas (more like river mouths than estuaries); and Mermentau Estuary, Louisiana (an inland lake which no longer functions like a traditional estuary). Several smaller estuaries were also excluded due to a lack of sufficient data to support analyses.

Detailed Methodology for the Regional Estuary Assessment for the Northern Gulf of Mexico (Step 4)

Screening Responses to Individual Stressors

We used hierarchical models to develop the northern Gulf of Mexico Regional Estuary Assessment. This approach is a compromise between pooling all data from each estuary together into a single model, and modeling each estuary separately. For hierarchical models, the intercept and/or slope parameters can vary among different groups in the model. The assessment defines groups as estuaries and states (FL, AL, MS, LA, and TX). “Random effects” in hierarchical models account for group-level differences that are not accounted for by the available predictor variables. For example, some variation between estuaries is due to different morphologies and physical features that are not easily quantified.

Event-level predictor variables (natural factors collected concurrently with fish samples) were also included in this assessment. The model parameters for these variables do not vary hierarchically across estuaries, as it is assumed that the underlying mechanistic processes controlling how temperature, salinity, and distance from shore affect fish should be approximately constant across estuaries.

Single stressor screening models were used to rapidly evaluate the significance of each of the 87 estuary-level predictor variables for each fish species and group. All event-level variables (temperature, salinity, and distance from shore) were controlled for in these models to better assess the significance of the estuary-level variables. Each variable was run individually through a hierarchical logistic model for each fish species, testing for statistical significance at the 95% confidence level. Predictors that were significant for more than 30% of the fish species were checked for correlations. Where significant predictors were correlated to each other ($r > 0.80$), only the most significant stressor was retained for consideration in the multi-stressor models. For instance, the percentage of crop land cover in the watershed basin was identified as a significant predictor from single stressor screening models; however, this variable was significantly correlated with the most significant predictor (percentage of developed land cover in the watershed basin), and thus not included in the multi-stressor models, which are described in the next step.

Detailed Methodology for the Regional Estuary Assessment for the Northern Gulf of Mexico (Step 5)

Identifying Disturbances to Fish Habitat

Multi-stressor models were used to identify the most important disturbance factors for Gulf estuaries. For each species, the significant stressors identified in the screening models, along with the event-level variables (temperature, salinity, distance to shore) were combined using a backward selection process to develop a final model for each individual fish species. Backward selection eliminates variables in a stepwise fashion based on statistical significance, until only highly significant (95% confidence level) predictors are left in the model.

Once final model configurations for each species were complete, they were used to measure anthropogenic disturbance levels in Gulf estuaries. Current (actual) condition was measured against the Least Disturbed Condition (LDC), which is the minimum observed value for each significant stressor across the Gulf. Comparing against LDC provides a relative benchmark and allows us to estimate the effect of anthropogenic stress on individual species and on entire estuaries, relative to LDC. This produced a conservative estimate of anthropogenic impacts, without extrapolating beyond the conditions to which the models were fit, and is especially useful for stressor variables which have no baseline data available.

Scores displayed in the maps of risk of fish habitat degradation in estuaries represent the absolute difference in current condition from the Least Disturbed Condition, normalized to the average fish presence for each estuary. Scores were normalized to average fish presence because some estuaries have larger absolute changes from the LDC, but also have higher probabilities of finding fish species; indicating that although habitats may be impaired in some way, they are still able to support a variety of fish species. Scores were broken into categories (Very Low to Very High) based on Jenks natural breaks.

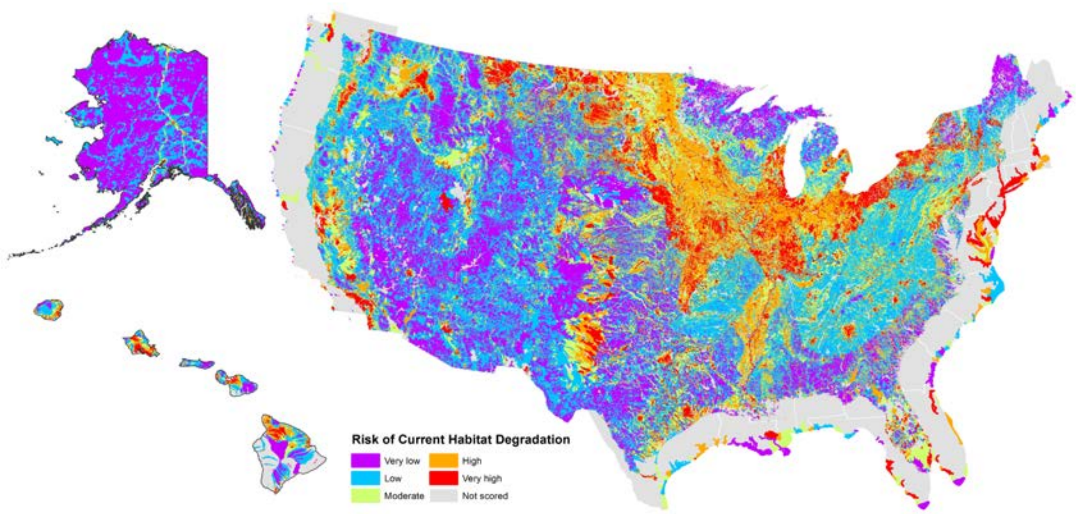
Methods for Selecting Fish with Habitat Troubles

from

Through a Fish's Eye:

The Status of Fish Habitats in the United States

2015



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Methods for Selecting Fish with Habitat Troubles

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NATIONAL FISH HABITAT PARTNERSHIP

Methods for Selecting Fish with Habitat Troubles

The "Fish with Habitat Trouble" section of the National Fish Habitat Assessment is designed in a simple, summarized format to highlight how the impairment of fish habitat can and does directly affect fish in each region of the United States. The following considerations were taken to identify the subset of species used in the report. Initially a list of potential species for each region was developed by querying the American Fisheries Society's Imperiled Fish database for species within each region that have a threat criteria of "1", which indicates that habitat loss is a reason the specie is imperiled. This list was verified and expanded by partner fisheries agencies and Fish Habitat Partnerships to ensure species were appropriate for highlighting how alterations in habitat processes lead to less fish.
The selected species can be characterized as having limited range, which makes them vulnerable to impairment on a local scale; having specialized habitat requirements, which makes them easily affected by human development; being highly migratory, which makes them vulnerable to habitat fragmentation; or having life histories, such as being long-lived and slow maturing, that do not allow easy recovery from human perturbations on the landscape. Many of the species are on State or Federal endangered/threatened/sensitive species lists. The species examples describe the geographic area of concern along with which process or habitat requirement was altered by human action, and also identify if other population issues are at work to prevent easy population rehabilitation.

Information Products From National Assessment

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Through a Fish's Eye:

The Status of Fish Habitats in the United States

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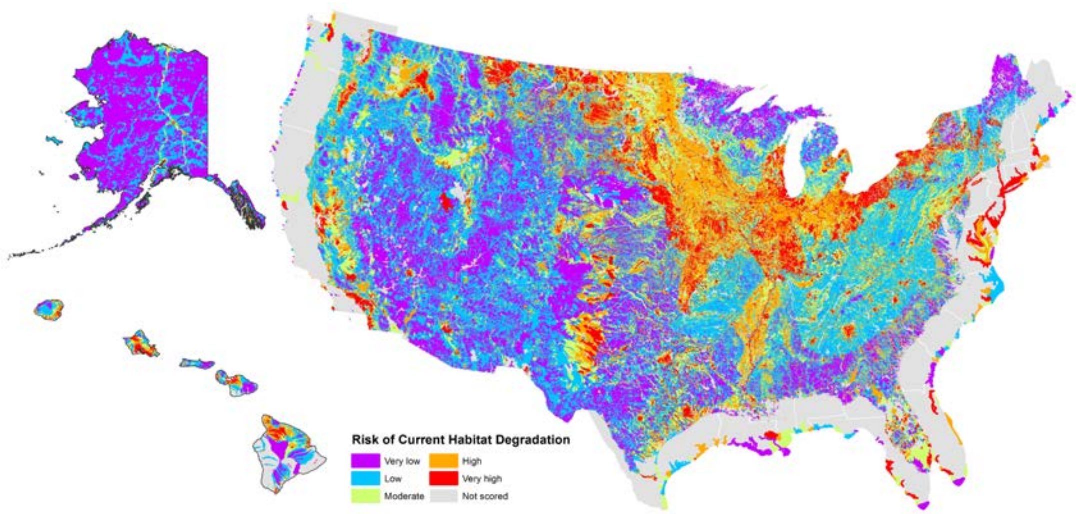

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Information Products From National Assessment

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Information Products From National Assessment

Data

Alaska Inland Assessment of Streams Habitat Condition and Disurbance Indices (HUC12s) - click here to download
Alaska Inland Assessment of Streams Disturbance Data (HUC12s) - click here to download
SE Alaska Inland Assessment of Streams Habitat Condition and Disturbance Indices (Catchments) - click here to download
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Contiguous U.S. Inland Assessment of Streams Habitat Condition Index and Limiting Disturbances – click here to download
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Manuscripts

Cooper, A.R., D.M. Infante, W.M. Daniel, K.E. Wehrly, L.Wang, T.O. Brenden. 2017. Assessment of dam effects on streams and fish assemblages of the conterminous USA. Science of The Total Environment. 586: 879-889. doi: 10.1016/j.scitotenv.2017.02.067.

Daniel, W. M., D. M. Infante, R. M. Hughes, P. C. Esselman, Y. P. Tsang, D. Wieferich, K. Herreman, A. R. Cooper, L. Wang, and William W. Taylor. 2015. Coal and mineral mines as a regional source of stress to stream fish assemblages. Ecological Indicators 50:50-61. doi: 10.1016/j.ecolind.2014.10.018.

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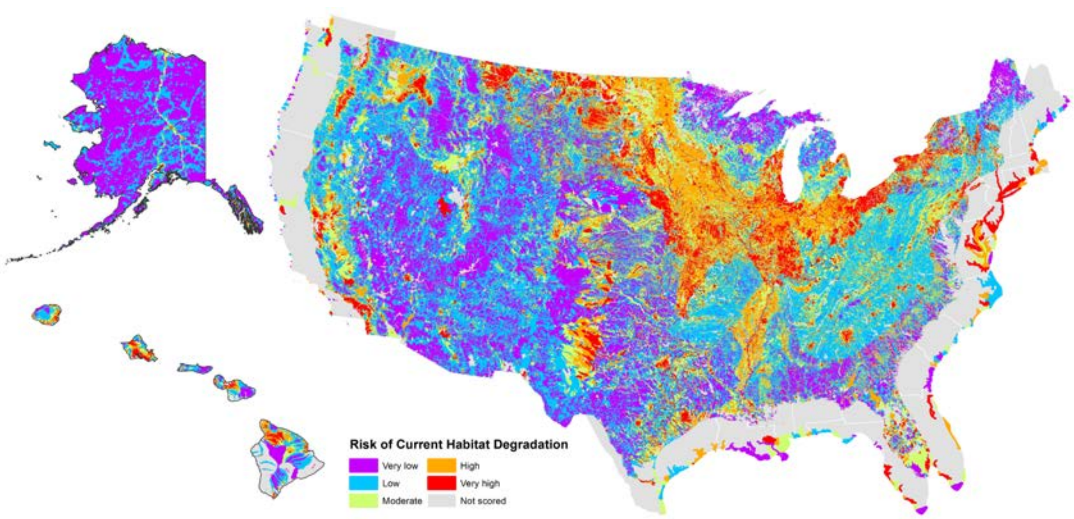

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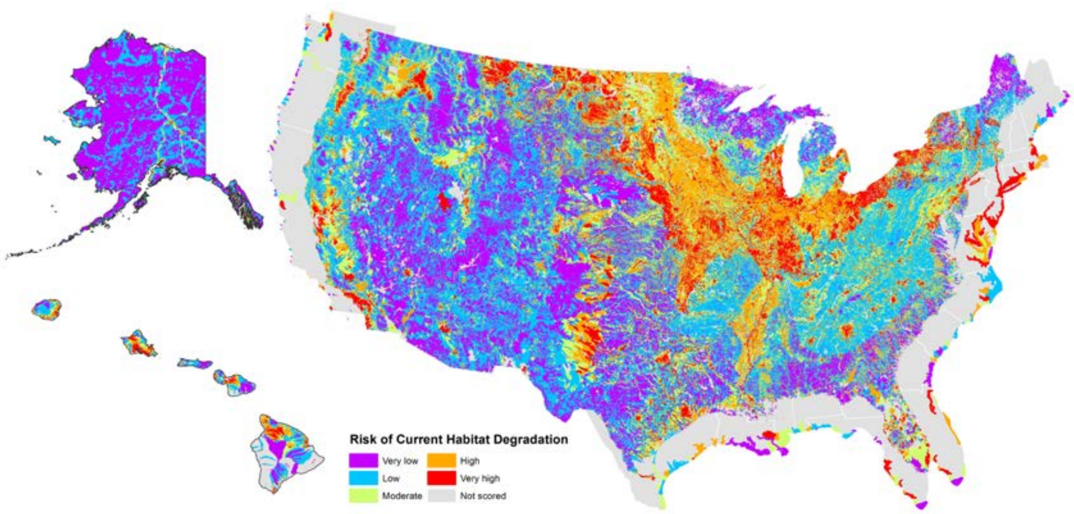

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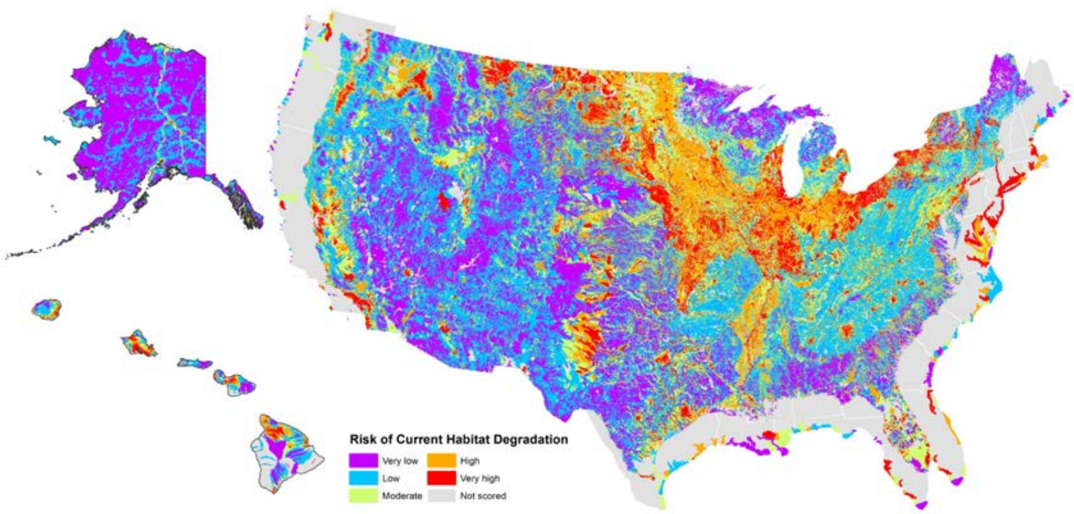

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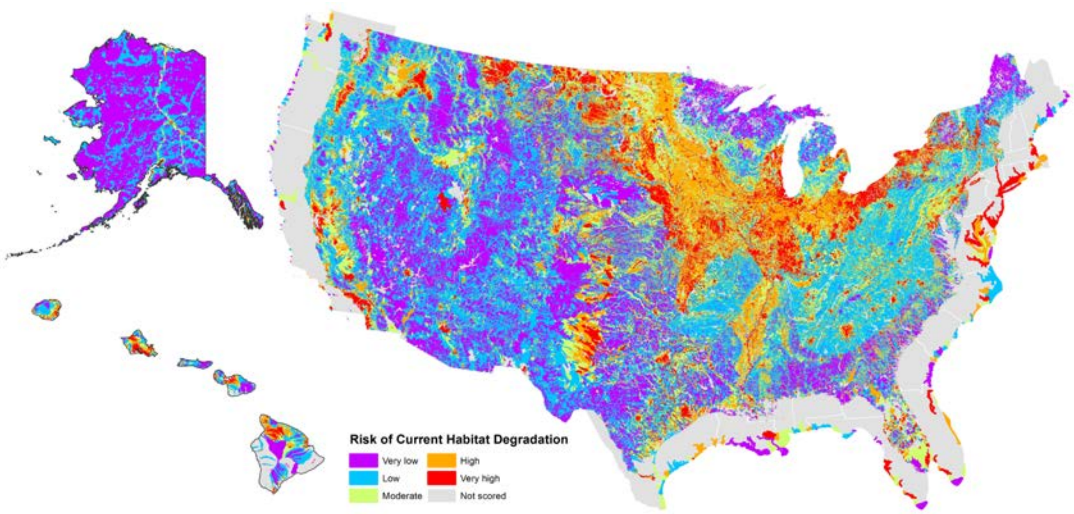

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303(d) list - A list established by the Environmental Protection Agency of impaired waters based on total maximum daily loads of pollution under Section 303(d) of the Clean Water Act

Alkalinity – the capacity of water to neutralize an acid and higher levels are found in water bodies that are exposed to limestone

Anadromous – adult fish live in the sea and return to fresh water to spawn

Anchialine pools - unique brackish water environments that form in lava fields near the ocean and are fed by both fresh groundwater and salty seawater

Anthropogenic –environmental change caused or influenced by people, either directly or indirectly

Ballast water – water carried in the hull of a ship for stability when empty and discharged when the ship takes on cargo

Bankfull bench - height of water in a natural channel at its maximum height before flooding

Base flow – the sustained natural flow of a stream seen during dry weather periods. Typically, the higher the base flow, the more a stream's flow is from groundwater and less from surface runoff.

Buffer –for the modeling purposes of this report, the landscape extending 90 meters on each side of a stream reach. Local buffers include landscapes draining directly to a reach but do not include landscapes drained by tributaries upstream of a given reach. Network buffers include local buffers as well as all buffer landscapes drained by tributaries upstream of a given reach. For headwater streams, local buffers and network buffers are the same. This spatial unit is intended to characterize landscape factors that occur within riparian zones of stream reaches.

Catchments – the landscape that drains to a stream reach and also known as a watershed. Catchment boundaries are determined by elevation of the surrounding landscape. Local catchments include landscapes draining directly to a reach but do not include landscapes drained by tributaries upstream of a given reach. Network catchments include local catchments as well as all landscapes drained by tributaries upstream of a given reach. Note that a catchment for a given reach is nearly always a larger spatial unit than its buffer. For headwater streams, local catchments and network catchments are the same.

Contiguous/Conterminous United States – the lower 48 states, not including Alaska or Hawaii.

Diadromous – fish that live in both fresh and salt water and includes anadromous (spawn in fresh water) and catadromous (spawn in salt water) species

Diversion dam – a dam that diverts all or a portion of the flow of a river from its natural course and into canals for use in irrigation, domestic water supplies or generating hydroelectric power

Ecoregion –a relatively large unit of land or sea that contains a geographically distinct assemblage of natural communities with boundaries that approximate the original extent of the natural environment, communities, and species prior to major land use change

Endemic – a species which is only found in a given region or location and nowhere else in the world

Endemism - the ecological state of a species being unique to a defined geographic location

eDNA (environmental DNA) – genetic material from aquatic organisms in the environment. Water samples can be tested to detect the presence of a species.

Estuary - a partly enclosed coastal body of brackish water with one or more rivers or streams flowing into it, and with a free connection to the open sea

Eutrophication - the enrichment of an ecosystem with chemical nutrients, typically compounds containing nitrogen, phosphorus, or both. Estuary eutrophication is also greatly affected by estuary water circulation patterns and geomorphological structure. Only evaluating nutrient levels can underestimate trophic level because numerous chemical and biological process can affect nutrient measurements. Instead, the Overall Eutrophication Condition score used in the estuarine assessment was calculated based on categorical and quantitative measures of the primary (algal abundance, epiphyte abundance, and macroalgae) and secondary (loss of submerged aquatic vegetation, harmful algae, and low dissolved oxygen) symptoms of eutrophication. These variables were only available nationally for estuaries.

Extinct/Extinction – species that is no longer present; died out

Fluvial –produced by or found in a river or stream

Geomorphic - of or relating to the form of the landscape and other natural features of the earth's surface

Groynes – a structure built of wood, rock, or concrete that extends from a shoreline and is designed to reduce erosion by interrupting water flow

Hierarchical models - A type of statistical model that allows for predictions using multiple, related levels of predictor variables. Predictor variables may be organized into a tree-like structure to better account for regional or other structural differences in data patterns. For example, presence of different fish species may be the target for prediction, and fish presence data may have been collected using different types of surveys conducted within different estuaries that are located within different states. Hierarchical models allow users to account for such “nested” relationships to achieve more accurate predictions than would be achievable with single-level models.

Hydrofracture drilling ("fracking") – a process for drilling for natural gas and petroleum where the rock is fractured by injecting pressurized water and chemicals

Hydrology - the scientific study of the movement, distribution, and quality of water. Also, simply refers to the movement, distribution, or quality of water.

Imperiled species – rare and in danger of extinction

Impervious – not allowing fluids, such as water, to pass through and used to describe surfaces such as concrete, asphalt, and solid rock

Leach bed – area of sand and gravel that is used to filter contaminants as water drains through it

Limestone doser – an automated water powered apparatus that dispenses limestone slurry from an attached storage silo into a stream to counteract acidification caused by mining by-products

Low-head dam – very short, rather than tall, dams (~1 – 4 feet tall) that usually span the entire river; also called run-of-river dams

Macroinvertebrate – organisms that lack backbones and are large enough to see without a microscope, such as insects, mussels, and snails

Mainstem - is the principal watercourse in a riverine drainage system with multiple streams

Mesquite bosque – an oasis-like vegetated strip along streams in the Sonoran Desert of the Southwestern United States. Mesquite is a small tree, native of the deserts Southwest U.S. and Mexico.

Neotropical - a zoogeographical region comprising Central and South America from which birds sometimes migrate to Southwest United States

Normalized - a process of converting measurements to a neutral or standard scale and can be an effective way to compare distributions of variables that characterize different scales of information.

Oligotrophic – water bodies that are relatively low in nutrients, such as nitrogen and phosphorus, and containing abundant oxygen

Oxidizing pond– employs a combination of plants, substrates and microorganisms in an artificial pond to remove suspended solids and clarify waste water

Point-sources of water pollution - U.S. Environmental Protection Agency (EPA) defines point source pollution as "any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack"

Riparian zone - lands that occur along watercourses and water bodies such as flood plains and stream banks

Rock toe protection – low structures of rock placed along the water's edge; a method of bank stabilization

Shellfish – crustaceans and mollusks used as seafood that bear an outer shell; shrimp, crabs, lobsters, clams, mussels, oysters, and scallops

Smolts - a young salmon or trout when it becomes silvery and migrates to the sea for the first time

Stream reach – a length of stream that extends between confluences, between a stream origin and confluence at the downstream end, from a confluence to the upstream end of an impoundment or inland lake, from the downstream end of an impoundment or inland lake to a confluence, or from a confluence to a pour point into a receiving water body (estuary, ocean, Great Lake, or inland lake with no outlet).

Sub-region - part of a larger region or continent and is usually based on location

Watershed - the area of land where all of the water that falls in it and drains off of it goes to a common outlet. *Watersheds*can be small or large depending on the scale of concern

Water withdrawal – water diverted from a surface water source or from the ground (http://water.usgs.gov/water-basics_glossary.html). For the 2015 assessment, total volumes of water withdrawn for various purposes from throughout individual counties were compiled by states and provided to USGS who synthesized county-level summaries into a national spatial data layer. EPA then attributed this layer to large watersheds, which is the version that we used for the assessment.

WSA ecoregion – U.S. EPA's Wadeable Stream Assessment ecoregions are aggregations of Omernik's level III terrestrial ecoregions (Omernik 1987) and are defined by distinct large units of land that contain geographically distinct assemblages of biological communities and are similar in landform and climate characteristics within each.