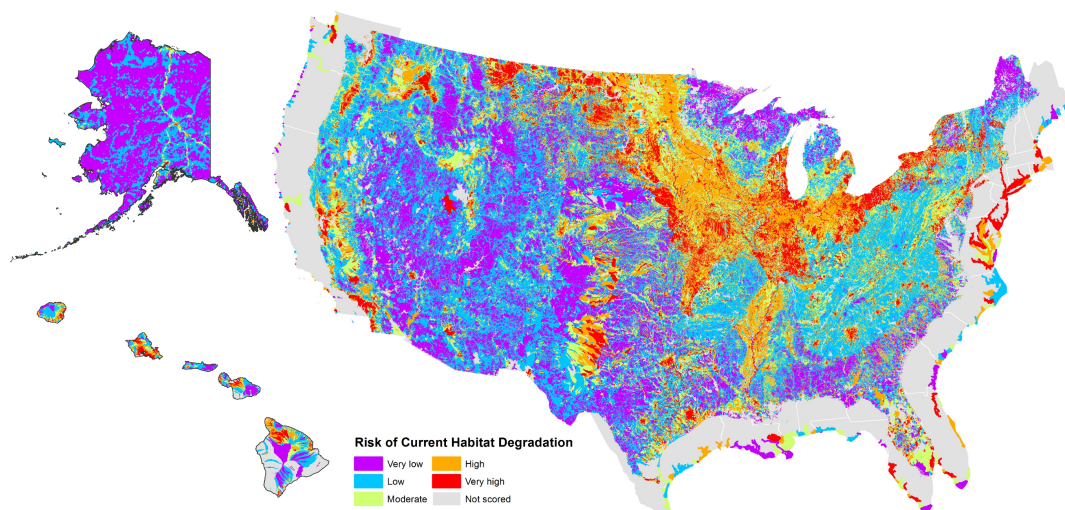


# How to Read this Report

from

## Through a Fish's Eye: The Status of Fish Habitats in the United States 2015



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

<sup>1</sup> Retired Florida Fish and Wildlife Conservation Commission

<sup>2</sup> Michigan Department of Natural Resources

<sup>3</sup> Michigan State University, Department of Fisheries and Wildlife

<sup>4</sup> ECS Federal, Inc. contracted to National Oceanic and Atmospheric Administration

<sup>5</sup> U.S. Geological Survey

<sup>6</sup> Texas Parks and Wildlife Department

<sup>7</sup> National Oceanic and Atmospheric Administration

This pdf was generated from the official online report at <http://assessment.fishhabitat.org/> on 2017-08-01. It is intended to allow readers access to a basic representation of the report for offline access. Please see the online report for full text and capabilities of the report. For report questions or comments please contact Gary Whelan at [whelang@michigan.gov](mailto:whelang@michigan.gov).

# How to Read this Report

## Table of Contents

[How To Read and Understand This Report](#)

[Methodology for Inland Stream Assessment for Lower 48 States](#)

[Generalized Methodology for Stream Assessments of Alaska and Hawaii](#)

[Methodology for National Estuary Assessment](#)

[Methodology for the Regional Estuary Assessment for the Northern Gulf of Mexico](#)

# 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.



Alan M Cressler

Turquoise darter (*Etheostomainscriptum*)



Daniel J Wieferich

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 (*Oncorhynchus clarkii*)

Daniel J Wieferich

# 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.



Sockeye salmon (*Oncorhynchus nerka*)

# 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 controlled 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](#).