FINAL REPORT

A decision support mapper for conserving stream fish habitats of the Northeast Climate Science Center region

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SECTION 1. ADMINISTRATIVE INFORMATION:

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SECTION 2. PUBLIC SUMMARY:

Human impacts occurring throughout the Northeast and Midwest United States, including urbanization, agriculture, and dams, have multiple effects on the region's streams which support economically valuable stream fishes. Changes in climate are expected to lead to additional impacts in stream habitats and fish assemblages in multiple ways, including changing stream water temperatures. To manage streams for current impacts and future changes, managers need region-wide information for decision-making and developing proactive management strategies. Our project met that need by integrating results of a current condition assessment of stream habitats based on fish response to human land use, water quality impairment, and fragmentation by dams and road crossings with estimates of which stream habitats may change in the future. Results are available for all streams in the NE CSC region through a spatially-explicit, web-based viewer (FishTail). With this tool, managers can evaluate how streams of interest are currently impacted by land uses and assess if those habitats may change with climate. These results, available in a comparable way throughout the NE CSC, provide natural

resource managers, decision-makers, and the public with a wealth of information to better protect and conserve stream fishes and their habitats.

SECTION 3. PROJECT SUMMARY:

Purpose and Objectives:

The broad goal of this project was to 1) characterize the current condition of streams and the disturbances that may limit stream fishes, and 2) characterize future conditions resulting from changes in climate, and, 3) distribute the results through a decision support web based mapper. One key to this study was that the fish species used in the analysis were based on stakeholders, who identified species that were a priority to their needs (Appendix 1).

Organization and Approach:

Objective 1. Characterizing current condition of stream fish habitats. We consolidated datasets from publicly available databases, recently-completed and on-going efforts (e.g., National Fish Habitat Partnership), and assembled these using the same spatial framework based off stream reaches of the National Hydrography Dataset Version 1 (NHDPlusV1, Wang et al. 2011). Datasets included 1) relative abundances of individual fish species collected from throughout the NE CSC region that were consolidated from various federal and state agencies (some fish assemblage data were provided with privacy agreements by data providers and cannot be shared publically at the stream reach scale), 2) current land use that were summarized from 2006 NLCD in catchments and 90 m buffers as part of work leveraged from the National Fish Habitat Partnership (NFHP), 3) dam fragmentation metrics summarized by Cooper at al. (2016), 3) road crossings summarized from 2006 US Census TIGER roads (US Census 2006) 4) water quality impairment data summarized form EPA 303(d) 2002 listed stream sites (EPA 2009, and 5) current natural variables leveraged from NFHP (e.g., network catchment area, mean annual precipitation and mean annual air temperature, mean catchment elevation and mean catchment slope). The datasets were used to create three indices that reflect changes in fish abundance to human land use, stream fragmentation, and water quality. Data was summarized for analysis and downloadable within Environmental Protection Agency Wadeable Streams Assessment (WSA) ecoregions (USEPA 2006) and by stream size classes (creeks that have network catchment areas <100 km^2 and rivers that have network catchment areas >100 km^2; Goldstein and Meador 2004, Wang et al. 2011. These data (Daniel et al. 2017) were attributed to our spatial framework, and will be publicly available through http://ecosystems.usgs.gov/fishhabitat/.

Human land use

To create the human land use index (based on low, medium, and high intensity urban land use; agricultural land uses of pasture/ hay and row crop; and percent impervious surface cover) we identified thresholds using a duel threshold analyses with indicator analysis and a piecewise linear regression (see Daniel et al. 2015) for each ecoregion and stream size class. There were four spatial extents of interest: local catchments (watershed surrounding stream reach), network catchments (watershed upstream of stream reach including the local catchment), local 90 m buffers on each side of stream in the local catchment, and network 90 m buffers for each side of the stream in the network catchment. We utilized multiple thresholds and plateau points from all tested fish species for scoring each land use disturbance factor. The 5-tier scoring criteria identify the degradation risk classes for each fish species. The very low-risk class (class 5) corresponds to the lowest threshold point identified by the tested fish species. The low-risk class (class 4) was defined by the highest threshold point from the tested fish species. The plateau point is the average point where increased disturbance no longer decreases the abundance of the fish species and defines the highest risk class (class 1). Classes 2 (high risk) and 3 (moderate) were determined by taking the range between the class 4 and 1 and dividing by two (Figure 1). Once these steps were followed, the cumulative habitat condition score for each stream size class in each WSA ecoregion was based on the most limiting spatial extent to a given stream reach or lowest score class.

Stream fragmentation

We used metrics of upstream dam density, downstream main stem dam density (Cooper et al. 2016), and road crossing density to create an index of stream fragmentation following the same analytical procedures as were used to create the land use index. We utilized multiple thresholds and plateau points from all tested fish species for scoring each fragmentation disturbance factor. We then created a 5-tier scoring criterion identifying the "very low-risk class" or class 5 that corresponds to the lowest threshold point identified by the tested fish and species using the procedures described in the previous section (Figure 1). The cumulative habitat condition score for each stream size class in each WSA was based on the lowest score class.

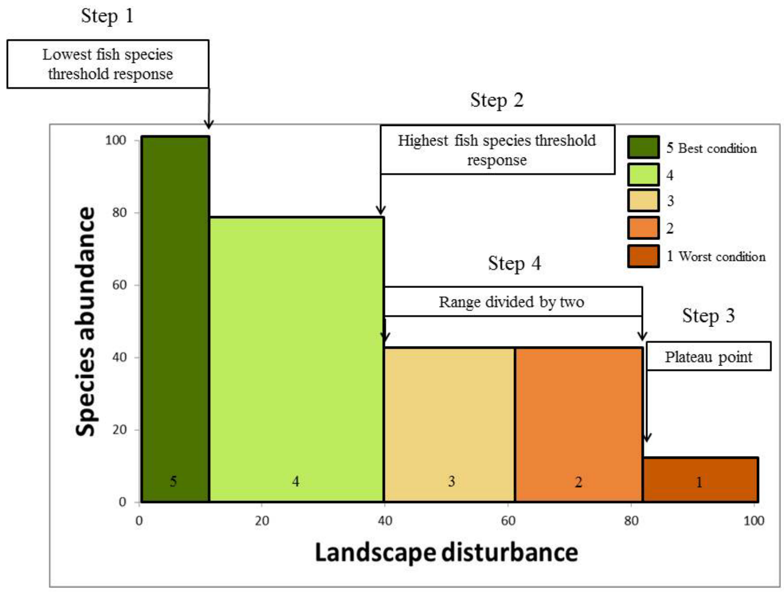

Figure 1. Association between fish indicator (y-axis) and human landscape factor (x-axis) in creation of the 5-tier scoring criteria. Threshold points occurs at the boundary of condition classes 5 and 4, and 4 and 3. The plateau point occurs at the boundary of condition classes 1 and 2.

Water Quality

This index was created by weighting impairments based on their impacts on the fish community. First we divided the data into analysis units comprised of each unique combination of ecoregion, state, and stream size (e.g., Temperate Plains/Missouri/Creek) to account for differences in the data and responses at each level. For each analysis unit, we then identified fish species that were sensitive to each impairment (i.e., those species that were found to be responsive to land use or fragmentation from the previous analyses above) by determining whether the relative abundance (adjusted for natural variation using boosted regression trees) of a species was lower at EPA 303(d) 2002 listed stream sites (EPA 2009) than unlisted sites using an ANOVA ($\alpha < 0.05$) for each impairment. We then developed weights for each impairment using the formula “Weight=1+X” where X equals the proportion of species sensitive to a given impairment within the analysis unit. Impairments that were not analyzed within an analysis unit due to insufficient sample size ($n<10$) received a weight of 1. Raw scores were calculated for each site by adding all weighted impairments that were present. Sites were then classified based on risk of degradation due to water quality impairment as very low (class 5) if there were no listed impairments, low (class 4) if only a single impairment with no additional weight based on fish community response (raw score=1), moderate (class 3) for the lowest 1/3rd of raw scores >1 within a unit, high (class 2) for the middle 1/3rd of raw scores >1 within a unit, and very high (class 1) for the highest 1/3rd of raw scores within a unit.

Objective 2. Identify stream reaches with habitat conditions likely to change with climate. We compiled a variety of information, including future climate data, to aid in determining potential changes in stream classes with changes in climate. Data included 1) climate metrics (n=19) (http://www.worldclim.org/bioclim) for two time steps (the 20C3M scenario was used for the current time step [1961-2000], and the SRES A1B scenario was used for future time step [2041-2080]) calculated from downscaled climate models (derived by Jason Robinson, Illinois Natural History Survey, from eight CMIP3 global climate models (Delcambre et al. 2013)) which were used to develop and predict our stream risk classes, 2) in-stream temperature (n=169) and flow (n=171) metrics within 7,000 stream reaches in the study region were used to identify which climate metrics were correlated with in-stream conditions, 3) a variety of temperature and flow metrics were assembled for hundreds of stream reaches located throughout the study region as part of a recently completed effort funded by the NCCWSC in order to identify those metrics which fish were sensitive to, and 4) a list of flow and temperature sensitive fish species that were also from the NCCWSC effort. This information was used to develop stream groupings for streams in each ecoregion using multivariate regression trees which modeled the relative abundance of thermal and flow sensitive species against climate and natural variables. These groupings were then applied to streams for both the current and future time steps for eight climate models. The risk of change in stream group for each segment was then assigned based on the number of models which indicated a change (0 models=very low (class 5), 1-2=low (class 4), 3-4=moderate (class 3), 5-6=high (class 2), 7-8=very high (class 1)).

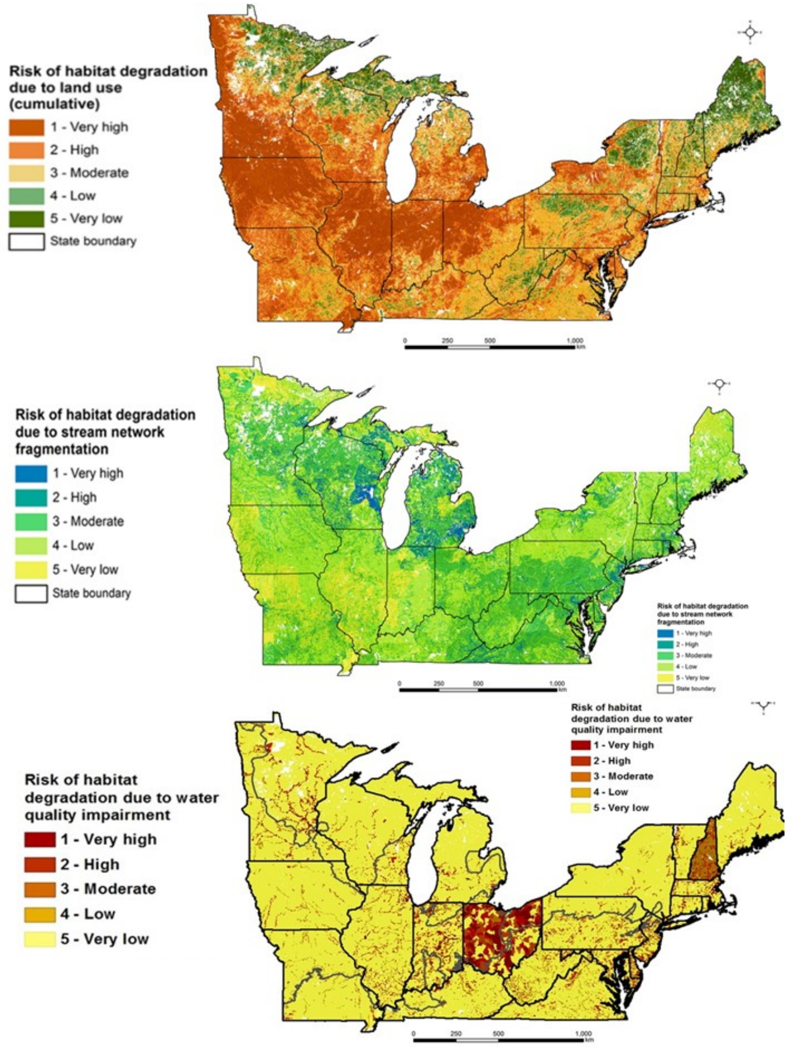

Figure 2. Cumulative human land use index to indicate the relative risk of fish habitat degradation from urban land use, agricultural land use, and impervious surface in catchments or buffers (top), stream network fragmentation index (middle), and water quality index to indicate the relative risk of fish habitat degradation from EPA 303d impaired waters baseline data (bottom) to indicate the relative risk of fish habitat degradation from dams and road crossings.

Objective 3. Incorporate the results into an online decision support tool. We integrated our results with recent past and ongoing efforts in a web-based thematic decision support mapper, "FishTail", built by the US Geological Survey Wisconsin Water Science Center. The beta version of the mapper can be found at: https://ccviewer.wim.usgs.gov/Fishtail/#

Project Results, Analysis and Findings:
Our metrics of current risk of degradation from land use, fragmentation, and water quality showed distinct patterns throughout the Northeast CSC region (Figure 2). Just under half (49.1%) of the stream fish habitat in the NE CSC region is at high or very high risk of degradation from anthropogenic land use. Most of this risk of degradation was from row crop and pasture land uses within the catchments and riparian zones of the streams. The fragmentation index showed a different story with most of the stream fish habitat in the NE CSC region being in low or very low risk of degradation. Most of the fragmentation in the NE CSC region can be found around urban centers from road crossings and along large rivers and their tributaries from dams. Our index representing risk of degradation due to water quality impairment identified highly and moderately impaired streams in each state (Figure 2). Due to limits of the available data it was not possible to determine if unlisted segments were unimpaired or simply not evaluated. Additionally, there were large differences in the amount of impaired streams among states, although in some cases this is likely due to actual differences in water quality, it may also be the result of differences in protocol for the listing processes of different states (Figure 2). Therefore, comparing water quality degradation among states in not advised.

Our index representing future risk of change due to changes in climate showed prominent patterns (Figure 3). Highest risk of change are across the corn-belt, northern Wisconsin and Michigan, along the coast in the far northeastern portion of the study region, and through a stretch of southeastern Pennsylvania, Maryland, and partially into West Virginia and Virginia (Figure 3). These are all areas in which groups of sensitive species are at the edge of their range and climatic conditions are likely to move outside of the range that is currently associated with those species.

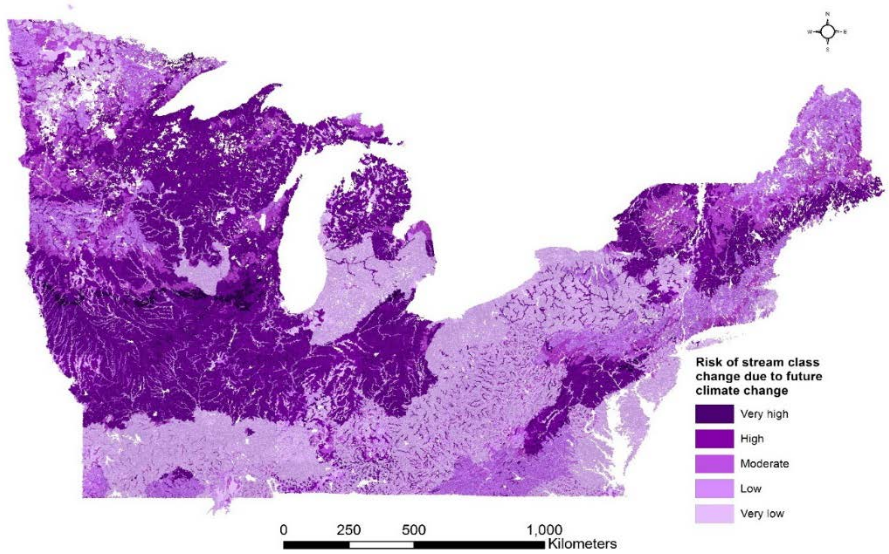

Figure 3. Future climate change index created to indicate the risk of fish groupings changing as a result of changes in temperature and flow.

The FishTail mapper provides stakeholders and managers with a means to navigate, display, view, query, and output results of the current and future condition assessments. For example, the Wisconsin DNR is using results from FishTail for a number of projects related to brook trout. They are testing the cumulative land use metric in their analysis for identifying future brook trout reserves and for evaluating trout stocking guidance. Brook trout reserves would be watersheds that meet selected criteria (landscape characteristics and metrics) to protect for brook trout into the future. In regards to stocking, data would be used to compare watersheds that have been stocked versus those that have not been stocked to test the effects of brook trout and brown trout stocking on brook trout populations for the purpose of updating the Wisconsin Department of Natural Resources trout stocking guidance. The analysis will need to control for other influences including brown trout abundance, habitat quality, and thermal habitat. Our FishTail mapper also provides opportunities to integrate with other themes through web services such as anthropogenic land use and fragmentation data available for public download from the NFHP assessment report: (http://ecosystems.usgs.gov/fishhabitat/). Climate change and 303d data will be available for download in the near future. All datasets are "analysis-ready" as they are all linked to the NHDPlusV1 spatial framework. These indices will allow natural resource managers and stakeholders to plan for potential management scenarios and adaptation strategies under future climate scenarios. Several example applications were provided in webinars to stakeholders. Managers can use this information to identify areas of low anthropogenic land use, stream fragmentation, water quality impairment, and risk of change due to climate to identify areas to protect.

Conclusions and Recommendations:

Below are the primary messages and recommendations from this project:

1. Development of discrete indices allows for more refined characterizations of current and future condition of stream fish habitat when compared to one composite metric that can be used to enhance decision-making. Keeping disturbances grouped as separate indices provides opportunities to identify limiting stressors and management opportunities simultaneously.
2. Using stakeholder-selected priority fish species (Appendix 1) ensures that indices developed are specific to management and conservation goals of the stakeholders.
3. 303d data are limited for characterizing impairments to water bodies over large spatial extents (i.e., anything larger than a single state). Differences in listing procedures by state make these datasets largely not comparable across state boundaries. After considerable discussion among the team (and presenting these results to stakeholders) we could not find a solution to compare impairments across states. Future work over large spatial extents may want to integrate different water quality measures when possible. The SPARROW nutrient and sediment models for the conterminous US that are expected to be released in 2017 or 2018 will help to fill these gaps.
4. Managers need additional information besides characterizations of current and future ecological condition to effectively conserve stream fish habitats, including information on recreational and/or commercial fisheries supported by water bodies and other services they provide. This additional information can be readily adapted into the FishTail decision support platform to improve decision making.
5. The dam layer used to create the fragmentation metrics for the NE CSC (National Anthropogenic Barrier Dataset or NABD) is missing many small dams. Road crossings identified from TIGER roads included bridges and culvert crossings. However, linking up to ongoing efforts to identify road crossings and their quality (e.g., streamcontinuity.org) would increase the utility of the information about stream fragmentation. Improving our ability to comprehensively map locations of all dams and culvert road crossings and consider effects on stream network fragmentation remains a national priority in efforts to conserve stream fish habitats.
6. Predicting change in fish communities due to changing climate is very difficult without stream temperature models. In areas with minimal groundwater influence, air temperatures are highly correlated with water temperatures, land use metrics, and precipitation (see ecosheds.org) and can better predict future change well when compared to groundwater-fed systems Therefore, making future predictions much less certain.
7. The Landscape Conservation Cooperatives (LCCs) were involved in the stakeholder meetings and provided a list of priority species to model for this project (Appendix 1). The project was so well received by the LCCs that the PIs were asked to expand this project to the Lower Mississippi River Basin and be part of a collaborative proposal related to priority watershed planning linked to hypoxia in the Gulf of Mexico. In addition, the Prairie Pothole LCC has also expressed interest in expanding this work; a call was conducted with them December 7, 2016 to discuss this expansion.

Outreach and Products:

We have developed or plan to develop several products from these efforts. There are two manuscripts in preparation as a result of this project:

1. Daniel, W. M., N. Sievert, D. M. Infante, C. Paukert, J. Stewart, J. Whittier, K. Herreman. In prep. Effects of land use, network fragmentation, and water quality on stream fish habitats of the northeastern United States: Information for enhanced decision making. Environmental Management.
2. Sievert, N.A., Y.P. Tsang, W.M. Daniel, D.M. Infante, C.P. Paukert, J.B. Whittier, K. Herreman, J. Stewart. In prep. A broad-scale assessment of the risk of fish community shifts due to climate change in the Northeastern and Midwestern United States. Environmental Management.

We have also disseminated this work at numerous professional society meetings and webinars:

1. Daniel, W., D. Infante, C. Paukert, N. Sievert, J. Stewart, J. Whittier, K. Herreman, N. Estes, and Y. P. Tsang. 2016. FISHTAIL: A decision support mapper for conserving stream fish habitats of the NECSC region. Northeast Climate Science Center webinar (~38 participants), October 12.
2. Daniel, W., D. Infante, C. Paukert, N. Sievert, J. Stewart, J. Whittier, K. Herreman, N. Estes, and Y. Tsang. 2016. FISHTAIL: A decision support mapper for conserving stream fish habitats of the NECSC region. Northeast Climate Science Center stakeholder webinar (~75 participants), June 9. *This webinar was targeted at the original stakeholders identified in the project.*
3. Daniel, W., N. Sievert, D. Infante, C. Paukert, J. Stewart, J. Whittier, T. Wagner, K. Herreman, and Y. P. Tsang. 2016. Current conservation status of stream fish habitat in the Midwest and northeastern United States. 76th Midwest Fish and Wildlife Conference, January 25-27, Grand Rapids, MI.
4. Daniel, W., N. Sievert, D. Infante, C. Paukert, J. Stewart, J. Whittier, T. Wagner, K. Herreman, Y. P. Tsang, and D. Kruger. Invited. 2015. FISHTAIL: A decision support mapper for conserving stream fish habitats of the NE CSC region. Northeast Climate Science Center Colloquium Webinar (~30 participants).
5. Daniel, W., N. Sievert, D. Infante, C. Paukert, J. Stewart, J. Whittier, T. Wagner, K. Herreman, and Y. Tsang. Invited. 2015. FISHTAIL: Conserving stream fish habitats of the NE CSC region. 75th Midwest Fish and Wildlife Conference, February 8-11, Indianapolis, IN.
6. Infante, D., C. Paukert, J. Stewart, J. Whittier, T. Wagner, and D. Krueger. 2013. A decision support mapper for conserving stream fish habitats of the NECSC region. Upper Midwest and Great Lakes Landscape Conservation Cooperative Stakeholder Workshop, November 6-7, Middleton, WI.
7. Infante, D., W. Daniel, T. Tsang, and D. Wieferich. Invited. 2015. Improving opportunities for conserving streams through national data layers and a common spatial framework: Advances in large-scale ecological investigations of aquatic systems. Annual Meeting of the American Fisheries Society, August 15-20, Portland, OR.
8. Krueger, D., C. Paukert, D. M. Infante, T. Wagner, J. Whittier, and J. Stewart. 2014. A decision support mapper for conserving stream fish habitats of the NECSC region. Northeast Climate Science Center stakeholder webinar (~50 participants), May 7. *This webinar was conducted near the beginning of the project to engage stakeholders and ask them what species would be of most interest to them. The species list developed by the stakeholders was used for the remainder of the project.*
9. Sievert, N., Y. Tsang, W. Daniel, C. Paukert, D. Infante, J. Whittier, K. Herreman, J. Stewart, and T. Wagner. 2016. An assessment of potential changes in habitat classes due to climate change in the Northeast Climate Science Center Region. 76th Midwest Fish and Wildlife Conference, January 25-27, Grand Rapids, MI.
10. Sievert, N., C. Paukert, D. Infante, Y. Tsang, W. Daniel, J. Whittier, K. Herreman, and J. Stewart. Development of an index to assess the risk of change in stream fish habitat due to climate change. 2016, USGS Columbia Environmental Research Center Seminar Series, Columbia, MO.
11. Sievert, N., Y. Tsang, W. Daniel, C. Paukert, D. Infante, J. Whittier, K. Herreman, and J. Stewart. 2016. Assessing climate impacts based on observed fish responses to stream temperature and flow metrics. Annual Meeting of the American Fisheries Society, August 20-24, Kansas City, MO.

Our initial goal was to engage stakeholders early and get feedback from them on the species of interest and use those species in our final analysis and mapper results. We engaged all Landscape Conservation

Cooperatives in the region, as well as state and federal agencies and NGOs, and invited them to participate in the May 7, 2014 webinar (item 8 above) or provide a species list to us after the meeting. We then used the species identified by the stakeholders (and had sufficient sample sized in our region) to complete Objectives 1-3, and then disseminated in a webinar to stakeholders and the public on June 9 and October 12, 2016.

Websites (Decision Support Tool):
https://ccviewer.wim.usgs.gov/Fishtail/#

We will plan to provide several data products generated from this project:

- Anthropogenic land use and fragmentation metric data available for public download from the NFHP assessment report: http://ecosystems.usgs.gov/fishhabitat/
- Separate indices showing risk of habitat degradation due to 1) land use, 2) water quality impairment, and 3) stream network fragmentation for the Northeast US
- Indices of potential risk of a stream fish community class changing as a result of climate change
- List of thermally- and hydrologically-sensitive fish species
- List of fish species sensitive to anthropogenic land use and fragmentation

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Appendix 1. Priority fish species identified from Landscape Conservation Cooperative priority species' lists for the Coastal Plains-Southern Appalachians (CPL-SAP), Northern Appalachians (NAP), Temperate Plains (TPL), Upper Midwest (MW) ecoregions, and all federally listed endangered, threatened, proposed and candidate fish species in the NE CSC region; and various stakeholders' feedback. State Wildlife Action Species, game species, climate sensitive species, intolerant or tolerant species to anthropogenic disturbance. X= identified priority species, L= association with land use, F= association with fragmentation, W=association with water quality, C= association with climate change.

Common Name	**Scientific name**	**CPL-SAP**	**NAP**	**TPL**	**UMW**
American eel	*Anguilla rostrate*	C	C		
Atlantic salmon	*Salmo salar*		C		
banded darter	*Etheostoma zonale*	C	C	C	X
banded killifish	*Fundulus diaphanus*	C	X		
banded sculpin	*Cottus carolinae*	C			
banded sunfish	*Enneacanthus obesus*	X	X		
bigeye chub	*Hybopsis amblops*	C		X	
bigmouth buffalo	*Ictiobus cyprinellus*	X	X	C	
black bullhead	*Ameiurus melas*	X		C	C
black crappie	*Pomoxis nigromaculatus*	C	C	C	X
blacknose dace	*Rhinichthys atratulus*	C	L,F,W,C	C	L,F,W, C
blacknose shiner	*Notropis heterolepis*	X	X	X	X
blackside darter	*Percina maculata*	C	C	L,F,W,C	L,F,W,C
bluegill	*Lepomis macrochirus*	L,F,W,C	C	L,F,W,C	C
bluntnose minnow	*Pimephales notatus*	L,F,W,C	C	F,W,C	C
bowfin	*Amia calva*	X		X	C
brassy minnow	*Hybognathus hankinsoni*		X	X	L,F,W
brindled madtom	*Noturus miurus*	X		X	
brook silverside	*Labidesthes sicculus*	X	X	X	X
brook stickleback	*Culaea inconstans*		X	C	F,W,C
brook trout	*Salvelinus fontinalis*	C	L,F,W,C		L,W,C
brown bullhead	*Ameiurus nebulosus*	C	C	X	X
brown trout	*Salmo trutta*	C	L,F,W,	C	C
burbot	*Lota lota*		X		L,F,W,C
central mudminnow	*Umbra limi*		X	C	L,F,W,C
central stoneroller	*Campostoma anomalum*	L,F,W,C	C	L,F,W,C	C
chain pickerel	*Esox niger*	C	C		
channel catfish	*Ictalurus punctatus*	C	C	C	C
chestnut lamprey	*Ichthyomyzon castaneus*				X
coho salmon	*Oncorhynchus kisutch*				X
common carp	*Cyprinus carpio*	C	C	C	C
common shiner	*Luxilus cornutus*	C	L,F,W,C	C	C
creek chub	*Semotilus atromaculatus*	L,W,C	L,W,C	L,W,C	F,W,C
creek chubsucker	*Erimyzon oblongus*	C	X	X	
cutlips minnow	*Exoglossum maxillingua*	C	L,F,W,C		
emerald shiner	*Notropis atherinoides*	C	C	C	C
fallfish	*Semotilus corporalis*	C	C		
fantail darter	*Etheostoma flabellare*	L,F,W,C	L,F,W	C	C
fathead minnow	*Pimephales promelas*	C	C	C	C
flathead catfish	*Pylodictis olivaris*	C		C	
freshwater drum	*Aplodinotus grunniens*	C		C	C
gizzard shad	*Dorosoma cepedianum*	C	C	C	C
golden redhorse	*Moxostoma erythrurum*	C	C	L,F,W,C	C
gravel chub	*Erimystax punctatus*	X	X		
greater redhorse	*Moxostoma valenciennesi*		X	C	X
green sunfish	*Lepomis cyanellus*	L,F,W,C	C	F,W,C	C
greenside darter	*Etheostoma blennioides*	C	C	X	
highfin carpsucker	*Carpiodes velifer*	X		X	
hornyhead chub	*Nocomis biguttatus*	C		C	L,F,W,C

Iowa darter	*Etheostoma exile*			C	C
johnny darter	*Etheostoma nigrum*	C	C	L,F,W,C	L,F,W,C
largemouth bass	*Micropterus salmoides*	C	C	L,F,W,C	C
largescale stoneroller	*Campostoma oligolepis*	C		X	X
least brook lamprey	*Lampetra aepyptera*	X			
logperch	*Percina caprodes*	C	C	C	C
longear sunfish	*Lepomis megalotis*	L,F,W,C		L,F,W,C	
longnose dace	*Rhinichthys cataractae*	C	L,F,W,C	X	L,F,W,C
longnose sucker	*Catostomus catostomus*		C		
margined madtom	*Noturus insignis*	C	C		
mottled sculpin	*Cottus bairdii*	C	C	C	L,F,W,C
ninespine stickleback	*Pungitius pungitius*		X		
northern brook lamprey	*Ichthyomyzon fossor*		X		X
northern hog sucker	*Hypentelium nigricans*	L,F,W,C	C	C	C
northern pike	*Esox Lucius*		C	C	C
northern studfish	*Fundulus catenatus*	C			
orangespotted sunfish	*Lepomis humilis*	X		C	
ozark minnow	*Notropis nubilus*	C			
pirate perch	*Aphredoderus sayanus*	C	X	X	X
pumpkinseed	*Lepomis gibbosus*	C	F,W,C	C	X
quillback	*Carpiodes cyprinus*	C	C	C	X
rainbow trout	*Oncorhynchus mykiss*	L,F,W,C	C		C
redbreast sunfish	*Lepomis auritus*	C	C		
redear sunfish	*Lepomis microlophus*	X		X	
redfin pickerel	*Esox americanus*	C	C	X	X
redside dace	*Clinostomus elongatus*	X	X	X	X
river chub	*Nocomis micropogon*			X	
river redhorse	*Moxostoma carinatum*	X		X	
rock bass	*Ambloplites rupestris*	L,F,W,C	F,W,C	C	C
rosyface shiner	*Notropis rubellus*	C	C	C	X
rosyside dace	*Clinostomus funduloides*	C			
sauger	*Sander canadensis*	C	X	X	X
sea lamprey	*Petromyzon marinus*		C		X
shorthead redhorse	*Moxostoma macrolepidotum*	C	C	C	C
silver carp	*Hypophthalmichthys molitrix*	X		X	
silver redhorse	*Moxostoma anisurum*	C	C	C	C
skipjack herring	*Alosa chrysochloris*	X		X	
slender madtom	*Noturus exilis*			C	
slimy sculpin	*Cottus cognatus*		L,F,W,C		C
smallmouth bass	*Micropterus dolomieu*	L,F,W,C	L,F,W,C	C	L,F,W,C
smallmouth buffalo	*Ictiobus bubalus*	C		C	
spottail shiner	*Notropis hudsonius*	C	C	X	X
spotted bass	*Micropterus punctulatus*	C		X	
stonecat	*Noturus flavus*	C	X	C	C
striped shiner	*Luxilus chrysocephalus*	L,F,W,C	X	C	
tadpole madtom	*Noturus gyrinus*	C	X	C	X
tessellated darter	*Etheostoma olmstedi*	C	X		
variegate darter	*Etheostoma variatum*	X			
walleye	*Sander vitreus*		X	C	C
warmouth	*Chaenobryttus gulosus*	X		X	
white bass	*Morone chrysops*	X	X	C	X
white crappie	*Pomoxis annularis*	C	X	C	
white perch	*Morone americana*		X		
white sucker	*Catostomus commersonii*	C	L,F,W	L,F,W,C	L,F,W,C
yellow bullhead	*Ameiurus natalis*	C	X	F,W,C	C