Abstract

The aim of this study was to analyze threats facing fish taxa protected under the U.S. Endangered Species Act. Utilizing species' federal listing documents, we developed a database of identified threats to threatened and endangered (T&E) fish species based on six general groups: Habitat Destruction/Modification, Overutilization, Pollution, Species-Species Interactions, Environmental Stochasticity, and Demographic Stochasticity. For our analysis, fish were divided into freshwater and diadromous/marine groups. Threats to fish were also compared with threats impacting other vertebrate taxa (e.g., amphibians, birds, mammals, and reptiles). We found that pollution impacted freshwater fish (57.8%) and amphibians (45.8%) more than other groups of taxa (10.5-31.4%), and overutilization impacted diadromous/marine fish (91.1%) and reptiles (51.4%) more than other groups of taxa (6.0-29.2%). Other threats were similar among all vertebrate taxa. Fish taxa were susceptible to threats resulting from human consumption, be it overharvest of diadromous/marine fishes or the majority of pollutants harming freshwater T&E fishes coming from agriculture (fertilizers, pesticides, herbicides, etc.). A growing human population size with an increased appetite appears to be causing fish species to require federal protection to prevent extinction. Recovery of T&E fish taxa will require sustainable fisheries operations to reduce overharvest of global fisheries markets and cleaner farming practices that mitigate pollution from agricultural run-off.

Against the Current – Quantifying Threats Facing Threatened and Endangered Fish Taxa

Fish are the largest group of vertebrates listed as Threatened and Endangered (T&E) under the U.S. Endangered Species Act (ESA). It has been suggested that hydrology changes, detrimental land use, and pollution impact freshwater (FW) fish (Evans et al., 2016; Richter et al., 1997), while diadromous (live in marine and freshwater environments) and marine (DM) fish are threatened by habitat degradation and fishing harvest (McClure et al., 2013). The objective of this study was to quantify threats facing FW and DM fish species protected under the ESA (Figure 1). This information will be helpful in guiding conservation strategies of federal agencies (e.g. U.S. Fish & Wildlife Service, National Marine Fisheries Service) to better protect and help recover T&E fish species.
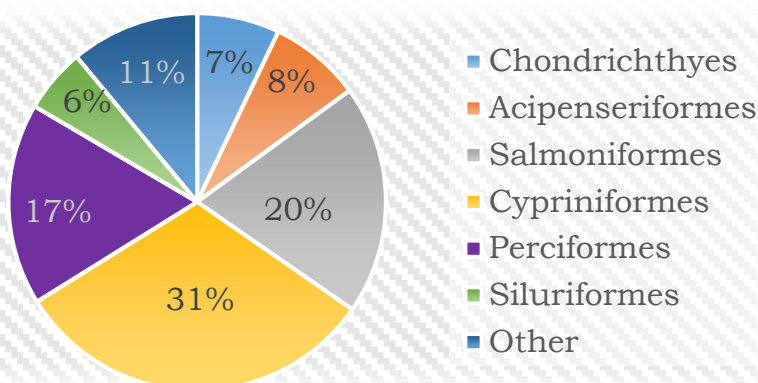

- Chondrichthyes
- Acipenseriformes
- Salmoniformes
- Cypriniformes
- Perciformes
- Siluriformes
- Other

Figure 1. Percentages of fish taxa listed under the Endangered Species Act.

Methods

We accessed Federal Register documents for all federally listed T&E species from 1967 through 2016 to develop a database of threats facing these species at their time of listing. We did not include threats which were potential or historical. Threats were then separated into five broad categories: Habitat Modification (human activities which would harm the species' habitat), Overutilization (e.g. fishing, bycatch, and collection), Pollution (e.g. pesticides, herbicides, and other substances which cause physiological damage to a species), Species-Species Interaction (e.g. invasive species, disease, predation), Environmental Stochasticity (e.g. increasing temperatures, intense weather events), and Demographic Stochasticity (e.g. geographic or genetic limitations). Impacts from each of these categories were then compared between FW and DM fish taxa. All fish species that utilize a marine environment for all or part of their life (i.e., diadromous and marine fish) were grouped together. We also conducted comparisons of threats among all vertebrate taxa (e.g., fish, mammals, birds, reptiles and amphibians). Results were evaluated using a chi-square analysis, with a $p < 0.05$ indicating statistical significance.

Results

The results of this study show that, as with other vertebrate taxa, the greatest overall threat facing FW and DM fish taxa is Habitat Modification (94% and 84.4% respectively). When compared with other vertebrate groups, Overutilization (6% FW; 91.1% DM) and Pollution (57.8% FW; 28.9% DM) emerged as distinctive threats between the two fish groups (Figure 2). In addition, reptiles (51.4%) were also greatly impacted by Overutilization, while amphibians

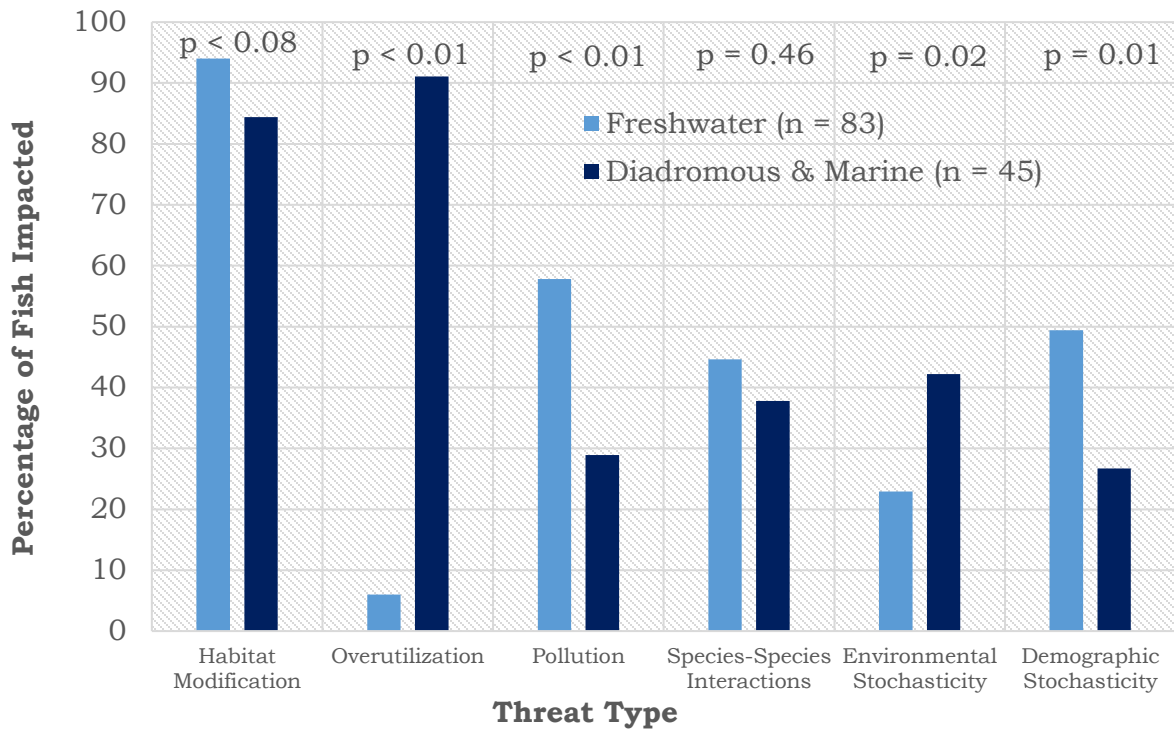(45.8%) were also greatly impacted by Pollution (Figure 3).

Figure 2. Threats facing Threatened and Endangered freshwater and diadromous/marine fish taxa in the United States.
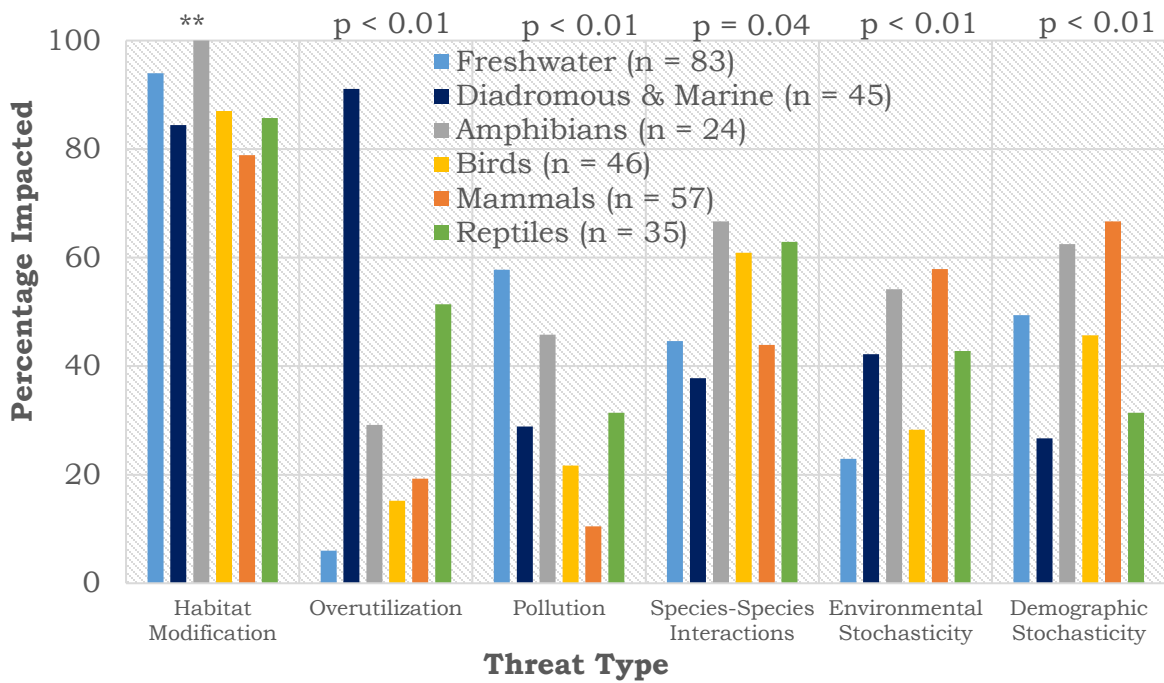
Figure 3. Comparison of threats facing Threatened and Endangered (T&E) freshwater and diadromous/marine fish taxa with those facing T&E reptiles, mammals, birds, and amphibians.

Conclusion

   Even through more fish receive protection under the ESA than any other vertebrate taxa group, there is still a large number of imperiled fish species which are not listed (Evans et al., 2016). Those which are threatened and endangered were susceptible to threats resulting from human consumption, be it overharvest of DM fishes or the majority of pollutants harming FW T&E fishes coming from agriculture (e.g., fertilizers, pesticides, herbicides, etc.). A growing human population size with an increased appetite appears to be causing fish species to become federally listed. Recovery of T&E fish taxa will require sustainable fisheries operations, such as those which consider the health of the populations (in terms of genetic diversity as well as numbers of individuals), as well as cleaner farming practices that mitigate pollution from agricultural run-off (Shelton and Sinclair, 2008). This could include riparian buffers, decreasing use of fertilizers and other chemicals, and use of diverse tilling methods (Huttunen and Peltomaa, 2016).

References

Evans, D. M., Che-Castaldo, J. P., Crouse, D., Davis, F. W., Epanchin-Niell, R., Flather, C. H., Frohlich, R. K., Goble, D. D., Li, Y. W., Male, T. D., Master, L. L., Moskwik, M. P., Neel, M. C., Noon, B. R., Parmesan, C., Schwartz, M. W., Scott, J. M., Williams, B. K. (2016). Species Recovery in the United States: Increasing the effectiveness of the Endangered Species Act. *Issues in Ecology, 20,* 1-28.

Huttunen, S., Peltomaa, J. (2016). Agri-environmental policies and 'good farming' in cultivation practices at Finnish farms. *Journal of Rural Studies, 44,* 217-226.

McClure, M. M., Alexander, M., Borggaard, D., Boughton, D., Crozier, L., Griffis, R., Jorgensen, J. C., Lindley, S. T., Nye, J., Rowland, M. J., Seney, E. E., Snover, A., Toole, C., Van Houtan, K. (2013). Incorporating climate science in applications of the U.S. Endangered Species Act for aquatic species. *Conservation Biology, 27*(6), 1222-1233.

Richter, B. D., Braun, D. P., Mendelson, M. A., Master, L. L. (1997). Threats to imperiled freshwater fauna. *Conservation Biology, 11*(5), 1081-1093.

Shelton, P. A., Sinclair, A. F. (2008). It's time to sharpen our definition of sustainable fisheries management. *Canadian Journal of Fisheries and Aquatic Sciences, 65*(10)*,* 2305-2315.