

Chapter 12

FUTURE HABITAT RESEARCH INFORMATION NEEDS FOR DIADROMOUS SPECIES

Group I. Research Needs for All Commission-Managed Diadromous Species

Dams and Other Obstructions

Fish Passage

- 1) Evaluate performance of conventional fishways, fish lifts, and eel ladders, and determine features common to effective passage structures and those common to ineffective passage structures.
- 2) Conduct basic research into diadromous fish migratory behavior as it relates to depth, current velocity, turbulence, entrained air, light, structures, and other relevant factors.
- 3) Use information from (1) and (2) to conduct computer fluid dynamics (CFD) modeling to develop more effective fishway designs.
- 4) Research technologies (barriers, guidance systems, etc.) for directing emigrating fish to preferred passage routes at dams.
- 5) Identify low-cost alternatives to traditional fishway designs.
- 6) Develop effective downstream passage strategies to reduce mortality.

Other Dam Issues

- 1) Document the impact of power plants and other water intakes on larval, postlarval, and juvenile mortality in anadromous fish spawning areas, and calculate the resultant impacts to adult population sizes.
- 2) Evaluate the upstream and downstream impacts of barriers on diadromous species, including population and distribution effects.

Water Quality and Contamination

- 1) Determine effects of change in temperature and pH for all life stages of all diadromous species. Use this information to model impacts of climate change on species.
- 2) Develop studies to document which contaminants have an impact on the various life stages of each diadromous species; also note the life stages that are affected, and at what concentrations.
- 3) Determine unknown optima and tolerance ranges for depth, temperature, salinity, dissolved oxygen, pH, substrate, current velocity, and suspended solids.

Habitat Protection and Restoration

- 1) Use multi-scale approaches (including GIS) to assess indicators of suitable habitat, using watershed and stream-reach metrics if possible (it should be noted, that where site-specific data is lacking, it may not be appropriate to assess at this scale).

- 2) Use multi-scale approaches for restoring diadromous fish habitat, including vegetated buffer zones along streams and wetlands, and implementing measures to enhance acid-neutralizing capacity.
- 3) Conduct studies on the effects of land use change on diadromous species population size, density, distribution, health, and sustainability.
- 4) Examine how deviation from the natural flow regime impacts all diadromous species. This work should focus on key parameters such as rate of change (increase and decrease), seasonal peak flow, and seasonal base flow, so that the results can be more easily integrated into a year-round flow management recommendation by state officials.
- 5) Investigate consequences to diadromous stocks from wetland alterations.

Other

- 1) Determine survival and mortality rates for all life stages of all diadromous species.
- 2) Investigate predator-prey relationships for all life stages of all diadromous species.
- 3) Determine the effects of channel dredging, shoreline filling, and overboard spoil disposal in the Atlantic coast on diadromous species.
- 4) Define restrictions necessary for implementation of energy projects in diadromous species habitat areas, and develop policies on limiting development projects seasonally or spatially.

Group II. Alosine-Specific Research Needs

Water Quality and Contamination

- 1) Review studies dealing with the effects of acid deposition on anadromous alosines.
- 2) Determine if intermittent episodes of pH depressions and aluminum elevations (caused by acid rain) affect any life stage in freshwater that might lead to reduced reproductive success of alosines, especially in poorly buffered river systems.
- 3) Determine if chlorinated sewage effluents are slowing the recovery of depressed shad stocks.

Habitat Protection and Restoration

- 1) Conduct research on habitat requirements for all life stages of hickory shad.

Migration

- 1) Determine factors that regulate and potentially limit downstream migration, seawater tolerance, and early ocean survival of juvenile alosines.
- 2) Conduct research on hickory shad migratory behavior.

Other

- 1) Focus research on within-species variation in genetic, reproductive, morphological, and ecological characteristics, given the wide geographic range and variation at the intraspecific level that occurs in alosines.
- 2) Research predation rates and impacts on alosines.
- 3) Evaluate the effect of bycatch on alosines.
- 4) Ascertain how abundance and distribution of potential prey affect growth and mortality of early life stages of alosines.

Group III. American Eel-Specific Research Needs

Dams and Other Obstructions

Fish Passage

- 1) Research the behavior of American eel approaching hydropower dams to determine searching behavior and preferred routes of approach to confirm best siting options for upstream passage.
- 2) Investigate, develop, and improve technologies for American eel passage upstream and downstream at various barriers for each life stage.
- 3) Investigate how river flow, lunar phase, water temperature, and behavior near artificial lighting impact the behavior of American eel, and influence the amount of time that the eels spend at a dam.
- 4) Research the behavior of silver eels at downstream passages; determine specific behavior of eels migrating downstream, and research how they negotiate and pass hydropower facilities.

Water Quality and Contamination

- 1) Determine the effects of contaminant bioaccumulation on American eel, including impacts on survival and growth (by age), maturation, and reproductive success.
- 2) Research the ability of contaminated eels to carry out successful breeding.
- 3) Examine the environmental conditions required for the hatching success of American eel.

Habitat Protection and Restoration

- 1) Establish characteristics and distribution of American eel habitat (using conventional methods as well as GIS), and the value of that habitat with respect to growth and sex determination.

- 2) Determine the effects of loss of historic habitat to potential American eel population and reproductive capacity.
- 3) Investigate the impact of seaweed harvesting on American eel.
- 4) Research the changes in ocean climate and environmental quality that might influence larval and adult eel migration, spawning, recruitment, and survival, including oceanic heat transport and interactions with the atmosphere and greenhouse gas warming.
- 5) Determine the importance of coastal lakes and reservoirs to American eel populations.

Migration

Silver-phase

- 1) Identify migratory routes and guidance mechanisms of silver eels migrating to the ocean.
- 2) Determine mechanisms for the recognition of the spawning area by silver eels, mate location in the Sargasso Sea, spawning behavior, and gonadal development in maturation.
- 3) Identify verify specific American eel spawning locations in the Sargasso Sea.
- 4) Research the factors that cause American eel to initiate downstream migration and affect their patterns of movement.

Leptocephalus

- 1) Identify the precise mechanisms of larval transport for American eel.
- 2) Examine the mechanisms for leptocephalus exit from the Sargasso Sea and transport across the continental shelf.
- 3) Determine mechanisms of recruitment of leptocephali and glass eels to coastal areas.

Glass Eel

- 1) Investigate the impact of stream velocity/discharge and stream morphology on upstream migration of glass eel and elvers.

Yellow-phase

- 1) Research behaviors and movements of American eel during their freshwater residency.

Parasitism

- 1) Evaluate the occurrence and impact of the nematode parasite, *Anguillicola crassus*, on all life stages.

Feeding

- 1) Examine the mode of nutrition for leptocephali in the ocean.
- 2) Examine food habits for glass eels at sea.

Other

- 1) Research all aspects of the leptocephalus life history stage.

Group IV. Atlantic Sturgeon-Specific Research Needs

Dams and Other Obstructions

Fish Passage

- 1) Fish passage requirements and appropriate structures for Atlantic sturgeon are largely unknown. Research all fish passage requirements for Atlantic sturgeon.

Bycatch

- 1) Determine levels of bycatch and compare to F_{50} target levels for individual Atlantic sturgeon populations.
- 2) Characterize Atlantic sturgeon bycatch in various fisheries by gear and season; include data on fish size, health condition at capture, and number of fish captured.
- 3) Develop markers that permit identification of bycatch of Atlantic sturgeon by population origin.

Population Status

- 1) Conduct assessments of population abundance and age structure in various river systems, with particular emphasis on documenting occurrence of age 0-12 juveniles and spawning adult Atlantic sturgeon as indicators of natural reproduction.
- 2) Continue to determine the extent to which Atlantic sturgeon are genetically differentiable among rivers, and interpret biological significance of findings.
- 3) Conduct further analyses to assess the sensitivity of F_{50} to model inputs for northern and southern stocks of Atlantic sturgeon.

Culture and Stock Enhancement

- 1) Further develop techniques for capture, transport, and long-term holding of wild Atlantic sturgeon brood stock.
- 2) Refine maturation-induced spawning procedures, and sperm cryo-preservation techniques for Atlantic sturgeon to assure availability of male gametes.

- 3) Continue basic cultural experiments at all life stages of Atlantic sturgeon to provide information on:
 - a. Efficacy of alternative spawning techniques
 - b. Egg incubation and fry production techniques
 - c. Holding and rearing densities
 - d. Prophylactic treatments
 - e. Nutritional requirements and feeding techniques, and
 - f. Optimal environmental rearing conditions and systems.
- 4) Identify suitable stocking protocols for hatchery-reared Atlantic sturgeon (e.g., individual size, time of year, site, and marking technique).
- 5) Conduct and monitor pilot-scale Atlantic sturgeon stocking programs before conducting large-scale efforts that encompass a broad geographic area.
- 6) Establish Atlantic sturgeon stocking goals and success criteria prior to development of large-scale stock enhancement or recovery programs.

Tagging and Tissues

- 1) Standardize collection procedures, and develop a suitable long-term repository for Atlantic sturgeon biological tissues for use in genetic and other studies.
- 2) Establish coordinated tagging programs to delineate migratory patterns and stock composition, giving priority to marking juveniles in important sturgeon rivers before they migrate to the ocean.
- 3) Maintain database for tagged Atlantic sturgeon.
- 4) Identify rates of tag loss and tag reporting for Atlantic sturgeon.
- 5) Analyze existing sea sampling data to characterize at-sea migratory behavior. Use electronic tagging to model coastal migrations of juvenile and adult Atlantic sturgeon.

Maturity and Aging

- 1) Develop methods to determine sex and maturity of captured Atlantic sturgeon.
- 2) Evaluate aging techniques for Atlantic sturgeon with known-age fish, with emphasis on verifying current methodology based on fin rays.
- 3) Determine length, fecundity, and maturity at age for all Atlantic sturgeon stocks.
- 4) Develop a protocol for ageing validation in Atlantic sturgeon.

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