

# Research Priorities and Recommendations to Support Interjurisdictional Fisheries Management

## American Eel

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The following research recommendations are based on input from the ASMFC American Eel TC and SAS during the 2012 benchmark stock assessment. A single asterisk (\*) denotes short-term recommendations and two asterisks (\*\*) denote long-term recommendations.

Recommendations formatted in **bold** identify improvements needed for the next benchmark assessment. Notes have been added from the 2017 stock assessment update report regarding work that has been addressed or initiated since the 2012 benchmark.

### Data Collection

#### *Fisheries Catch and Effort*

- **Improve accuracy of commercial catch and effort data (NOTE: Some progress was made on this recommendation through Addenda III and IV)**
  - Compare buyer reports to reported state landings\* (NOTE: Initiated in NY by NYSDEC)
  - Improve compliance with landings and effort reporting requirements as outlined in the ASMFC FMP for American eel (see ASMFC 2000a for specific requirements)\* (NOTE: Initiated in NY by NYSDEC and NJ by NJDFW)
  - Require standardized reporting of trip-level landings and effort data for all states in inland waters; data should be collected using the ACCSP standards for collection of catch and effort data (ACCSP 2004 and initiated in NY by NYSDEC)\*
- Estimate catch and effort in personal-use and bait fisheries (NOTE: Initiated in NJ by NJDFW)
  - Monitor catch and effort in personal-use fisheries that are not currently covered by the MRFSS or commercial fisheries monitoring programs\*
  - Implement a special-use permit for use of commercial fixed gear (e.g., pots and traps) to harvest American eels for personal use; special-use permit holders should be subject to the same reporting requirements for landings and effort as the commercial fishery\*\*
  - Improve monitoring of catch and effort in bait fisheries (commercial and personal-use)\*
- Estimate non-directed fishery losses
  - Recommend monitoring of discards in targeted and non-targeted fisheries\*
  - Continue to require states to report non-harvest losses in their annual compliance reports\*

- **Characterize the length, weight, age, and sex structure of commercially harvested American eels along the Atlantic Coast over time**
  - Require that states collect biological information by life stage (potentially through collaborative monitoring and research programs with dealers) including length, weight, age, and sex through fishery-dependent sampling programs; biological samples should be collected from gear types that target each life stage; at a minimum, length samples should be routinely collected from commercial fisheries\* (NOTE: Initiated in Chesapeake Bay sites (VMRC) and in NY, NJ, DE, MD by NYSDEC, NJDFW, DEDFW, and MDDNR respectively)
  - Finish protocol for sampling fisheries; SASC has draft protocol in development\*
- Improve estimates of recreational catch and effort
  - Collect site-specific information on the recreational harvest of American eels in inland waters; this could be addressed by expanding the MRIP into inland areas\*\*
- Improve knowledge of fisheries occurring south of the U.S. and within the species' range that may affect the U.S. portion of the stock (i.e., West Indies, Mexico, Central America, and South America)\*\*

#### *Socioeconomic Considerations*

- Perform economics studies to determine the value of the fishery and the impact of regulatory management\*\*
- Improve knowledge regarding subsistence fisheries
  - Review the historic participation level of subsistence fishers and relevant issues brought forth with respect to those subsistence fishers involved with American eel\*\*
  - Investigate American eel harvest and resource by subsistence harvesters (e.g., Native American tribes, Asian and European ethnic groups)\*\*

#### *Distribution, Abundance, & Growth*

- **Improve understanding of the distribution and frequency of occurrence of American eels along the Atlantic Coast over time** (see Cairns et al. 2017 for a description of the distribution of American eels from Canada to Florida)
  - Maintain and update the list of fisheries-independent surveys that have caught American eels and note the appropriate contact person for each survey\* (NOTE: Work being done in NY by NYSDEC and NJ by NJDFW)
  - Request that states record the number of eels caught by fishery-independent surveys; recommend states collect biological information by life stage including length, weight, age, and sex of eels caught in fishery-independent sampling programs; at a minimum, length samples should be routinely collected from fishery-independent surveys\* (NOTE: NYSDEC began this in 2014; NJDFW collects numbers and lengths; VIMS collects numbers, lengths, weights, ages, and disease status; NCDMF collects numbers and lengths; work being done through FL FWC and a freshwater electrofishing survey)

- Encourage states to implement surveys that directly target and measure abundance of yellow- and silver-stage American eels, especially in states where few targeted eel surveys are conducted\*\* (NOTE: MA, MD, and NJ yellow eel survey began in 2015 by MADMF, MDDNR, and NJDFW)
- A coast-wide sampling program for yellow and silver American eels should be developed using standardized and statistically robust methodologies\*\*
- Improve understanding of coast-wide recruitment trends
  - Continue the ASMFC-mandated YOY surveys; these surveys could be particularly valuable as an early warning signal of recruitment failure\* (NOTE: All states have a state-mandated YOY survey except for GA)
  - Develop proceedings document for the 2006 ASMFC YOY Survey Workshop; follow-up on decisions and recommendations made at the workshop\*
  - Examine age at entry of glass eel into estuaries and freshwater\*\* (NOTE: see Pratt et al. 2014)
  - Develop monitoring framework to provide information for future modeling on the influence of environmental factors and climate change on recruitment\*\*
- Improve knowledge and understanding of the portion of the American eel population occurring south of the U.S. (i.e., West Indies, Mexico, Central America, and South America)\*\*

## Future Research

### *Biology*

- Improve understanding of the leptocephalus stage of American eel
  - Examine the mechanisms for exit from the Sargasso Sea and transport across the continental shelf\*\* (NOTE: see Rypina et al 2014)
  - Examine the mode of nutrition for leptocephalus in the ocean\*\*
- Improve understanding of impact of contaminants as sources of mortality and non-lethal population stressors
  - Investigate the effects of environmental contaminants on fecundity, natural mortality, and overall health\*\*
  - Research the effects of bioaccumulation with respect to impacts on survival and growth (by age) and effect on maturation and reproductive success\*\*
- **Improve understanding of impact of *Anguillicoloides crassus* on American eel**
  - Investigate the prevalence and incidence of infection by the nematode parasite *A. crassus* across the species range\* (NOTE: Initiated in NC with a Roanoke study and in FL, work currently underway in the Chesapeake Bay through Z. Warshafsky's graduate work at VIMS, see also Zimmerman and Welsh 2012, Campbell et al. 2013, Denny et al. 2013, Waldt et al. 2013, Hein et al. 2014)
  - Research the effects of the swim bladder parasite *A. crassus* on the American eel's growth and maturation, migration to the Sargasso Sea, and the spawning potential\* (NOTE: work currently underway in the Chesapeake Bay through Z. Warshafsky's graduate work at VIMS, see also Zimmerman and Welsh 2012)
  - Investigate the impact of the introduction of *A. crassus* into areas that are presently free of the parasite\*\*

- **Improve understanding of spawning and maturation**
  - Investigate relation between fecundity and length and fecundity and weight for females throughout their range\*\*
  - Identify triggering mechanism for metamorphosis to mature adult, silver eel life stage, with specific emphasis on the size and age of the onset of maturity, by sex; a maturity schedule (proportion mature by size or age) would be extremely useful in combination with migration rates\*\*
  - Research mechanisms of recognition of the spawning area by silver eel, mate location in the Sargasso Sea, spawning behavior, and gonadal development in maturation\*\*
  - Examine migratory routes and guidance mechanisms for silver eel in the ocean\*\*
- Improve understanding of predator-prey relationships\*\*
- Investigating the mechanisms driving sexual determination and the potential management implications\*\*

#### *Passage & Habitat*

- **Improve upstream and downstream passage for all life stages of American eels (NOTE: Initiated in ME, also see Hitt et al. 2012, Gardner et al. 2013)**
  - Develop design standards for upstream passage devices for eels. The ASMFC 2011 Eel Passage Workshop (ASMFC 2013) made contributions to this goal.
  - Investigate, develop, and improve technologies for American eel passage upstream and downstream at various barriers for each life stage; in particular, investigate low-cost alternatives to traditional fishway designs for passage of eel\*\* (NOTE: MADMF designed and deployed a gravity fed eel pass)
- Improve understanding of the impact of barriers on upstream and downstream movement (NOTE: Sweka et al. 2014 used an egg per recruit model to evaluate the costs/benefits to reproductive output with transport of eels upstream of hydroelectric dams and found that without downstream passage, transporting eels upstream resulted in a net loss of reproductive output.)
  - Evaluate the impact, both upstream and downstream, of barriers to eel movement with respect to population and distribution effects; determine relative contribution of historic loss of habitat to potential eel population and reproductive capacity\*\*
  - Recommend monitoring of upstream and downstream movement at migratory barriers that are efficient at passing eels (e.g., fish ladder/lift counts); data that should be collected include presence/absence, abundance, and biological information; provide standardized protocols for monitoring eels at passage facilities; coordinate compilation of these data; provide guidance on the need and purpose of site-specific monitoring\*\*
  - Use the information gained from the above evaluation and monitoring of barriers to American eel passage to develop metrics for prioritizing passage restoration projects.

- **Improve understanding of habitat needs and availability**
  - Assess characteristics and distribution of American eel habitat and value of habitat with respect to growth and sex determination; develop GIS of American eel habitat in U.S.\*\*
  - Assess available drainage area over time to account for temporal changes in carrying capacity; develop GIS of major passage barriers\*\*
  - Improve understanding of freshwater habitat and water quality thresholds for American eel.
- Improve understanding of within-drainage behavior and movement and the exchange between freshwater and estuarine systems\*\*
- Improve estimates of mortality associated with upstream and downstream passage
  - Monitor non-harvest losses such as impingement, entrainment, spill, and hydropower turbine mortality\* (NOTE: Data available for the Susquehanna and Shenandoah Rivers from Eyler et al. 2016 and USFWS 2012.)
- Evaluate eel impingement and entrainment at facilities with NPDES authorization for large water withdrawals; quantify regional mortality and determine if indices of abundance could be established as specific facilities\*\* (NOTE: Data available for the Delaware River through work done by the Delaware River Basin Fish and Wildlife Management Cooperative)
- Investigate best methods for reintroducing eels into a watershed; examine approaches for determining optimum density\* (Note: Data available from the Roanoke Rapids and Susquehanna River through a project with Dominion Energy and USFWS-Maryland Fish and Wildlife Conservation Office, respectively)

#### Assessment Methodology & Management Support

- Coordinate monitoring, assessment, and management among agencies that have jurisdiction within the species' range (e.g., ASMFC, GLFC, Canada DFO)\*\*
- Perform a joint U.S.-Canadian stock assessment\*
- Perform periodic stock assessments (every 5–7 years) and establish sustainable reference points for American eel are required to develop a sustainable harvest rate in addition to determining whether the population is stable, decreasing, or increasing
  - Develop new assessment models (e.g., delay-difference model) specific to eel life history and fit to available indices\*\*
  - **Conduct intensive age and growth studies at regional index sites to support development of reference points and estimates of exploitation\* (NOTE: Initiated in the Chesapeake Bay by MDDNR which has collected age information on selected tributaries since 1998)**
  - Develop GIS-type model that incorporates habitat type, abundance, contamination, and other environmental factors\*\*
  - Develop population targets based on habitat availability at the regional and local level\*\*

- Implement large-scale (coast-wide or regional) tagging studies of eels at different life stages; tagging studies could address a number of issues including:
  - Natural, fishing, and discard mortality; survival\*\*
  - Growth\*\*
  - Passage mortality\*\*
  - Movement, migration, and residency\*\*
  - Validation of ageing methods\*\*
  - Reporting rates\*\*
  - Tag shedding or tag attrition rates\*\*