

Survival of Coastal Elasmobranchs in a Small-Scale Fishery

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Description

Addressing vulnerabilities in Small-Scale Fisheries (SSF) has been gaining increasing attention due to their role in securing livelihoods of millions of people in the world, even though when they are subject to susceptible scenarios. We reviewed the literature with the aim of shedding light on the distribution, coping strategies, and common drivers of vulnerabilities in worldwide SSF. Seventy-eight studied cases worldwide, 21 drivers of vulnerability, and 8 coping strategies were identified. Natural and human-induced declining fish catches was the most common driver of vulnerability and disobedience of fishing rules the most common coping strategy. From the three dimensions of vulnerability, exposure (presence of vulnerable scenarios) was the highest (50%), followed by sensitivity (susceptibility to vulnerable scenarios) (29%) and adaptive capacity (ability to cope with vulnerable scenarios) (21%). The literature review highlights the need for adopting a context-specific threefold (resource management and conservation, livelihoods development, and restructured governance) approach to SSF management. The American eel (*Anguilla rostrata*) occupies an enormous range in latitudinal (7000km, Greenland to northern South America), longitudinal (5000 km, Rocky Mountains to the mid-North Atlantic Ocean) and altitudinal (several thousand m, montane streams to 700 m ocean depths) spaces. The 50-million-year history of the genus *Anguilla* adds a time dimension of prodigious duration. Like their congeners, American eels exhibit a multi-habitat and multi-phase life cycle, alternating between the open ocean (migrating and spawning silver eels, eggs and planktonic leptocephalus larvae) and continental waters (glass eels, elvers, yellow eels and developing silver eels). Human interest in American eels is heightened by their commercial value (including lucrative glass eel/elver fisheries), long-standing indigenous cultural links and ongoing biological mysteries.

Economic Viability of Small-Scale Fisheries

A key part of the American eel story is genetic structure. The absence of geographic structure in neutral genetic markers between Newfoundland, Canada, and western Florida, US has led to the widespread conclusion that American eels comprise a single panmictic population. However, a definitive answer on mictic status must await genetic analysis from the vast regions outside the genetically sampled range. From great ecological

success, American and other anguillid eels have fallen into troubled times. Status reviews have declared American eels to be threatened in Canada, depleted in Atlantic US States and endangered internationally. In contrast, the US Fish and Wildlife Service found that the listing of the species in US waters was unwarranted. These reviews accomplished the first level of status evaluation, the cataloguing of threats, that consistently included fisheries overharvest, artificial barriers in fresh water, chemical contamination and introduced parasites. However, firm information is lacking on how these threats impact populations. The second level of evaluation, the compilation and analysis of abundance trends, has shown wide inter-series variation in Canada and in Atlantic US states. Declining time series are more numerous than stable and increasing ones, but the dramatic collapse of recruitment to the upper St. Lawrence River and Lake Ontario, widely taken to represent the American eel as a whole, has not been reported elsewhere. The third level of evaluation, analytic stock assessments leading to quantitative benchmarks, has been developed at local scales, but the only attempt at a region-scale implementation was unable to establish BRPs due to multiple data shortcomings. Difficulties in implementing analytic stock assessments for the American eel have prompted consideration of an alternative approach, in which relations between habitat, distribution and demography are examined by spatially oriented modelling. Uncertainties in American eel status reviews, and an ongoing sense of conservation peril, have prompted calls for assessment efforts that would pool international expertise, match the geographic scope of the species' presumed single stock and provide robust advice for conservation management.

Production and Fishing Effort

However, a road map for such an endeavour is not apparent. The difficulty of the task is underlined by experience with the closely related European eel (*A. anguilla*). That species has a long history of international collaboration and possesses a much larger knowledge base than does the American eel (5.7 more Web of Science hits for 1960–2020). Nevertheless, European eel management continues to be guided by abundance trends because a robust quantitative assessment has not yet been achieved. The form of an eventual range-wide American eel assessment is unknown. The premise of this article is that tools to better gather information on American eel distribution and abundance and understand processes that regulate them are

likely to aid such an assessment in whatever form it takes. To this end, this article first examines major obstacles that frustrate assessment efforts and then outlines 13 novel ideas and underutilised resources that may help overcome them. The American eel has long been considered a panmictic species that spawns uniquely in the Sargasso Sea and whose progeny disperses randomly across its continental range. This narrative may hide complexities yet to be elucidated. For the European eel, genetic analyses suggest that the overall spawning area might contain distinct zones to which female eels preferentially return, whilst genetic flow due to non-philopatric males maintains the symptoms of panmixia. Female philopatry has also

been proposed as a source of geographic genetic variation within the European eel's continental range. For American eels, the timing of larval detrainment from the Gulf Stream, and therefore the latitude of continental rearing destinations, could be passed between generations under a mechanism of maternal inheritance of biological clock components. The possibility that spawning Atlantic eels exhibit a type of philopatry below the species level has implications for conservation management. Vélez-Espino and Koops proposed the construction of a global biological model for American eels based on regional sub-models that reflect latitudinal gradients in major demographic parameters.