CARS - Project List

SSP-Estimation of ecosystem-level effects and evaluation of potential control methods for the Asian Swamp Eel (Family: Synbranchidae, Genus: *Monopterus*) (01-FH-01)

Project # 2070B9G, Task 6

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Statement of Problem:

This task is in response to U.S. Fish and Wildlife Services research needs, and is funded by the FWS Science Support Program. The purpose of the task is to fill critical data gaps in our knowledge of the Asian swamp eel through a combination of literature review on eel biology, research on eels populating U.S. habitats, experimental work with captive eels, and modeling spread and impacts. The Synbranchidae (Swamp eels) is a family of eel-like percomorph fishes widely distributed in tropical and subtropical regions of the New World and Old World. No member of the family is native to the United States.

Swamp eels are predators that grow to nearly 1-meter long. Our preliminary field and laboratory data from canals show that they prey on native fishes, crustaceans and other invertebrates, and on amphibians. The eel exhibits broad temperature tolerance, can utilize atmospheric oxygen, survives for long periods out of water, and is capable of surviving droughts by burrowing. In Asia, eels are known to disperse across land. This combination of characteristics suggests that the swamp eel has the potential to colonize and exploit aquatic and wetland communities and ecosystems in many parts of the USA. The Everglades is under immediate threat. For example, if the eel invades the Everglades, it could pose an indirect threat to native wildlife by reducing the abundance of native fishes and crayfishes that form the food base for many wading birds, frogs and fishes. The eel also may pose a direct threat to native aquatic animals through predation on eggs, juveniles, or adults.

At present, management tools for use in controlling the numbers and spread of aquatic invaders are very limited. Control is very difficult in open aquatic systems, such as the Everglades, a vast ecosystem with broad connections to canals that serve as introduction points, dispersal corridors, and thermal/drought refuges. A review of control methods and their success or

failures for aquatic species is needed to select those that may be effective in slowing the population growth and spread of this synbranchid eel.

Objectives:

In the first two years of the study, intensive reviews of published and unpublished literature on synbranchid eel ecology and biology, including habitat associations in native waters, and past and present methods used to control nonindigenous fishes were conducted. Current objectives are:

1. Determination of current geographic distribution, abundance, densities, and habitat requirements.
2. Determination of eel population structure and reproductive parameters.
3. Determination of eel age and growth patterns.
4. Determination of eel diets and predator-prey interactions.
5. Testing of ecosystem effects using mesocosms.
6. Testing of control methods.
7. Modeling eel spread and impacts.

Methodology:

Eel distribution, abundance, densities, and habitat.

We will give priority to sites not adequately sampled during the past few years. Areas needing additional sampling include: (1) the Homestead area in and around Canal C-111; (2) the North Miami area, with emphasis on canals north and south of Snake Creek Canal; (3) the Manatee County area; and 4) Hawaii, mainly streams, ditches, and natural and artificial wetlands in Honolulu County, Oahu.

Sampling of eels in deepwater habitats (i.e., canals and associated waters) is done using boats equipped with electrofishing gear mounted on welded aluminum hull boats). Sampling of eels in shallow-water habitats (i.e., small streams and ditches) will be done using backpack electrofishing gear.

To estimate eel abundance and densities in south Florida canals, we sample canal habitats by dividing canal reaches into several 100-m segments. A single pass is made with an electrofishing boat along one shore of a randomly chosen 100-m segment, and all eels captured during the one pass are collected. To estimate relative abundance, we compare the numbers and biomass of eels taken in a 100-m segment with the numbers and biomass of other native and nonnative fishes collected in the same segment.

Reproduction.

Swamp eels have no visible secondary sexual characters by which to

distinguish the genders. Reproductive information must be obtained by dissecting preserved specimens. Reproductive tissues are examined and weighed. To account for effects of differential body size on gonad size, gonad weight is expressed as a percentage of body weight. This ratio is called the gonadosomatic index (GSI). To determine reproductive phenology, GSIs for various months are calculated. Fecundity is determined by estimating the total number of eggs present in subsamples of female ovaries.

Age and growth patterns.

As part of this study, we have frozen the heads from about 200 eels collected and measured/weighed in the field (during eight different months in year 2000). In the lab, the sagittal otoliths are removed, cleaned, measured, sectioned (when necessary) and mounted on slides for reading. Otolith weights will be measured using an appropriate balance (to nearest 0.0001 g). Measurements include otolith length, depth, and thickness (to nearest 0.01 mm) using digital calipers or a light micrometer. To validate readings of otoliths taken from wild eels, results will be compared with OTC-injected eels raised in captivity. As an additional method of determining age and growth, eel length measurement data are being grouped into size classes at intervals of 10 mm.

Diet.

We fix the entire gastrointestinal tract in 10% formalin and later transfer it to 70% ethanol. We examine the stomach contents and record the frequency of occurrence, number, and volume of each prey item. Food items are identified to lowest taxonomic level. An independent estimate of trophic position and carbon source for the eels is obtained by analysis of stable-isotope signatures for nitrogen and carbon in muscle tissues (Peterson and Fry 1987). Comparisons with native fish diets and trophic positions will use data from Loftus (2000).

Mesocosm.

We will test prey preferences and predation effects of swamp eels using combinations of prey species. Experiments will be run in small and large mesocosms. To duplicate natural patchy environments, some experimental tanks will include various types of cover, and will be stocked with various combinations of native aquatic animals at natural density levels. Control tanks will be used to assess population levels of prey without eels present.

Control methods.

We will carry out mark/recapture studies to evaluate the efficiency of electrofishing in sampling eels as a method of eel removal. Some of this work

will be done in conjunction with eel removal efforts to be conducted during the next 6 months in Canal C-111 and vicinity.

Communication Plan:

Literature Review Data Recording and Storage: Copies of all articles, reports, and portions of books covering information on synbranchid eels will be stored at the Florida Integrated Science Center in Gainesville. Complete citations (i.e., author, year, title, journal, key words, etc.) will be stored on computers in a database form accessible by others. All citations will be accessible with reference to author, title, and key words.

All field data collected will be electronically archived. Preliminary results will be presented at scientific meetings and in reports. A center web page will provide information about the study to the public. Manuscripts will be submitted to appropriate journals.

Highlights and Key Findings:

Although electrofishing is proven method to sample swamp eels, preliminary results indicate electrofishing is not very effective as a control measure. Preliminary results from salinity tolerance experiments indicate that individuals from one introduced eel population are more tolerant of higher salinity than eels from the other two Florida populations. These differences mirror findings from other studies on genetic differences among introduced populations. Age of eels based on otoliths indicate that swamp eels may live more than 10 years. Recent surveys indicate that introduced swamp eels have broader distributions in Florida than originally thought; some may be the result of recent range expansion.

FY: 2004

Statement of Work:

During FY-03, we plan to complete all or most of the field and laboratory work associated with this project.* Following is current status of the various work units and focus of work for FY-03:

Work Unit 1: Literature Review Of Eel Biology And Ecology. Mostly complete, there are still a few articles in foreign languages that need to be translated.

Work Unit 2: Literature Review Of Control Methods. Mostly complete, information needs to be analyzed and summarized.

Work Unit 3: Determination Of Eel Geographic Distribution, Abundance, Densities, And Habitat Requirements. Much of the fieldwork has been

completed. Some areas still require additional survey work.

Work Unit 4: Determination Of Eel Population Structure And Reproductive Parameters. Much of this work has been completed. Some of the data needs to be analyzed and summarized.

Work Unit 5: Determination Of Eel Age And Growth Patterns. All preliminary aging work has been completed. Anticipate need to prepare a small contract with University of Florida researchers to complete much of remaining laboratory work.

Work Unit 6: Determination Of Eel Diets And Predator-Prey Interactions. Much of this work has been completed. Currently we are dissecting additional specimens from selected samples to complete diet content analysis. Preliminary work on isotopes has been completed. Additional samples have been obtained and require laboratory analysis to complete isotope work.

Work Unit 7: Testing Of Ecosystem Effects Using Mesocosms. A preliminary experiment has been completed. Additional experimental work is scheduled for FY-03.

Work Unit 8: Testing Of Control Methods. Some preliminary field and laboratory work has been completed. Testing of freeze branding to mark eels has shown it to be of some limited use. Additional experimental field and laboratory work is scheduled for FY-03.

Work Unit 9: Modeling Eel Spread And Impacts. Dr. John Curnutt, researcher who was to lead and conduct most of this analysis, no longer works for USGS. During FY-03 we will contact Dr. Curnutt to determine what is needed to complete this phase of the project.

*(Because of loss of technicians and constraints in hiring, some necessary work may be curtailed or forced to continue into FY-04.)

Implement the work identified in:

- Subtask 6 Fish Communities and Swamp Eel Populations of South Florida Canal and Stream Ecosystems as Indicators of Habitat Quality and Restoration Success (Task EP/IS 99-1)