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Proposal Submission to

VIRGINIA MARINE RESOURCES COMMISSION
MARINE RECREATIONAL FISHING ADVISORY BOARD

By

THE VIRGINIA INSTITUTE OF MARINE SCIENCE
COLLEGE OF WILLIAM AND MARY

Estimating relative abundance of young-of-year American eel, *Anguilla rostrata*, in the Virginia tributaries of the Chesapeake Bay, 2017

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VIRGINIA SALTWATER RECREATIONAL FISHING DEVELOPMENT FUND
SUMMARY PROJECT APPLICATION

Please complete all fields. This page should be used as a coversheet for a detailed application.

NAME AND ADDRESS OF APPLICANT:

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DESCRIPTIVE TITLE OF EVENT:
Estimating relative abundance of young-of-year American eel, *Anguilla rostrata*, in Virginia tributaries of Chesapeake Bay, 2017

PROJECT LOCATION:
Brackens and Wormley Ponds (York River)
Kamp's Millpond (Rappahannock River)
Wareham's Pond (James River)

BRIEF PROJECT SUMMARY: (include a detailed description of activity as an attachment)

The need for fisheries-independent data from monitoring surveys is essential to many of the fishery management plans (FMP) for the Atlantic States Marine Fisheries Commission (ASMFC) and other management agencies. Specifically, this project meets the mandates of the ASMFC's FMP for American eel. Monitoring of glass eels (young-of-year) as they enter the estuary will provide estimates of recruitment in Virginia and allow for long-range planning for future harvestable stocks.

EXPECTED BENEFITS: (Describe how your project directly benefits the average Virginia recreational angler)
Recreational and commercial fishermen will benefit from this study as it will provide the Virginia Marine Resources Commission (VMRC) and ASMFC with an index of annual recruitment for juvenile American eels. The American eel is an important bait fishery in Virginia for game fish such as striped bass and cobia. Additionally, the American eel commercial fishery in Virginia from 2008-2012 landed an average of 93,588 lbs. Estimates of year-class strength provide an "early warning" of recruitment success or failure, and are vital for proper species management.

SUMMARY COSTS: (Please attach a detailed budget including all sources of recipient funding)
This proposal is also being submitted to the Commercial Marine Fishing Improvement Fund.

<u>SUMMARY COSTS</u>

Requested VMRC Funding:	$46,960
Recipient Funding:	$ 7,777
Total Costs:	$54,737

Estimating relative abundance of young-of-year American eel, *Anguilla rostrata*,

in Virginia tributaries of Chesapeake Bay, 2017

Introduction

American eel (*Anguilla rostrata*) range from New Brunswick to Florida and in recent years, harvests from US coastal states and the Canadian Maritime Provinces have declined (Meister and Flagg 1997; Haro et al. 2000). Although landings from Chesapeake Bay typically represent about 63% of the annual US commercial harvest of American eel (ASMFC 2000), in 2012 commercial landings in Virginia, Maryland, and the Potomac River represented 72% of US landings (pers. comm., National Marine Fisheries Service, Fisheries Statistics Division, Silver Spring, MD).

In addition to catch statistics, fishery-independent surveys can be used to monitor changes in abundance, particularly for young life stages of American eel. The recent decrease in abundance of young-of-year (YOY) American eel observed along the US coast appears to exhibit some degree of synchrony (Sullivan et al. 2006). Hypotheses for the decline in abundance include locational shifts in the Gulf Stream, pollution, overfishing, parasites, and barriers to fish passage (Castonguay et al. 1994; Haro et al. 2000). Additionally, factors such as unfavorable wind-driven currents may affect glass eel recruitment on the continental shelf and may have a greater impact than fishing mortality or continental climate change (Knights 2003).

Recognizing the need for accurately portraying recruitment declines, US Atlantic coastal states began implementing annual surveys for YOY American eels in 2000. These surveys are intended to "...characterize trends in annual recruitment of the YOY eels over time [to produce a] qualitative appraisal of the annual recruitment of American eel to the U.S. Atlantic Coast" (ASMFC 2000). These surveys fulfill the need to collect American eel data using both fishery-dependent and fishery-independent methods as mandated by the interstate Fishery Management Plan (FMP) for the American eel, which was adopted by the Atlantic States Marine Fisheries Commission (ASMFC) in November 1999. A recent American Eel Benchmark Stock Assessment (ASMFC 2012) emphasized the importance of the coast-wide surveys as indicators of sustained recruitment over the historical coastal range and as an early warning of potential range contraction of the species.

Life History

The American eel is a catadromous species that occurs along the Atlantic and Gulf coasts of North America and inland in the St. Lawrence Seaway and Great Lakes (Murdy et al. 1997). The species is panmictic and supported throughout its range by a single spawning population (Meister and Flagg 1997; Haro et al. 2000).

Spawning takes place during winter to early spring in the Sargasso Sea. Eggs hatch into leaf-shaped transparent ribbon-like larvae called leptocephali, which are transported by ocean currents (over 9-12 months) in a generally northwesterly direction and can grow to 85 mm TL (Jenkins and Burkhead 1993). Within a year, metamorphosis into the next life stage (glass eel) occurs in the Western Atlantic near the east coast of North America. A reduction in length to about 50 mm TL occurs prior to reaching the continental shelf (Jenkins and Burkhead 1993). In the Chesapeake Bay area (Maryland and Virginia), coastal currents and active migration transport glass eels into estuaries from February to June (Able and Fahay 1998). Glass eel migration appears to occur in waves with perhaps a fortnightly periodicity related to tidal currents (Ciccotti et al. 1995), and YOY eel may use freshwater "signals" to enhance recruitment to local estuaries (Sullivan et al. 2006). The magnitude, timing, and spatial pattern of upstream migration of glass eels may be affected by alterations in freshwater flow (Facey and Van Den Avyle 1987).

As glass eels grow, they become pigmented (elver stage), and within 12 to14 months eels acquire a dark color with underlying yellow (yellow eel stage). Many eels migrate upriver into freshwater rivers, streams, lakes, and ponds, whereas other yellow eels remain in estuaries (Jessop et al. 2008). Most of the eel's life is spent in these freshwater and brackish habitats as a yellow eel. Metamorphosis into the silver eel stage occurs during the seaward migration that takes place from late summer through autumn. Age at maturity varies greatly with latitude; American eel from Chesapeake Bay mature and migrate at an earlier age than eels from northern areas (Hedgepeth 1983). In Chesapeake Bay, most mature eels are less than 10 years old, although mature eels have been found to range between 8 and 24 years (Owens and Geer 2003). Upon maturity, eels migrate back to the Sargasso Sea, spawn, and die (Haro et al. 2000; Be´guer-Pon et al. 2015).

Objectives

The objectives of this study are to:

1. determine the spatial and temporal components of American eel recruitment to the Virginia tributaries of Chesapeake Bay by monitoring the run of glass eels; and
2. collect basic biological information (length, weight, pigment stage) on glass eels.

The American eel management plan recommends sampling for YOY eels should be "located at the head of tide in small streams or estuaries, as close to the Atlantic Ocean as possible" (ASMFC 2000). In Virginia, this would include the areas along the Eastern Shore and Virginia Beach. However, these areas are small (most less than one acre) and probably present a sink rather than a source for eels. Because the majority of the fishery occurs in the tributaries to the Bay, areas near the mouth of the major tributaries are better suited for sampling eel recruitment.

Methods

Exploratory surveys were conducted by the Virginia Institute of Marine Science (VIMS) during spring 2000 to establish appropriate sampling gear and methodologies to evaluate YOY American eel recruitment. Since 2001, both the VMRC Marine Recreational Fishing Advisory Board and the Commercial Fishing Advisory Board have supported this project. This study proposes to continue the sampling begun in 2000 to ensure reliable estimates of recruitment success for American eel by using survey designs and methods that insure sufficient temporal and spatial coverage. These methods meet or exceed the minimal sampling criteria for YOY American eel proposed by the ASMFC American Eel Technical Committee and approved by the American Eel Management Board.

To provide the necessary spatial coverage, four sites are sampled: Bracken's and Wormley Ponds on the York River, Kamp's Millpond on the Rappahannock River, and Wareham's Pond on the James River (see Figure 1).

Irish eel ramps will be used to continuously sample the runs at each site beginning in late February or early March 2017 (see Brooks et al. 2002 for details on gear configuration). The ramps will be checked 3 times per week to evaluate catch and determine fishing conditions for a minimum of 6 weeks according to ASMFC criteria. When catches no longer yield glass eels, sampling will be terminated.

A combined sample of 60 glass eels will be collected (if present), transported back to the laboratory, measured to the nearest 0.1 mm total length, weighed to the nearest 0.01 g, and pigment stage recorded according to Haro and Krueger (1988). The remaining catch will be enumerated and placed above the impediment. At each site, temperature, precipitation, time sampled, and condition of the gear will be recorded.

Glass eel and elver catch-per-unit-effort (CPUE) data for each site are standardized to a 24-hour soak time for the Irish eel ramp. Indices will be calculated by the area-under-the-curve (AUC) method because this method is insensitive to interannual variability in the pattern of recruitment (pattern of peaks and valleys in abundance), and thus, more accurately characterizes recruitment (Tuckey and Fabrizio 2009).

Recent Observations and Future Work

Overall, the time series of glass eel recruitment data shows that the total number of glass eels captured differs by several orders of magnitude among sites, and most are captured in the York River (two sites). The greatest number of glass eels captured in the York River peaked at nearly 150,000 glass eels in 2010, while the lowest number recorded was 69 glass eels in 2009 (Figure 2). Out of 15 years of eel collections at Bracken's Pond (York River), the fewest number of glass eels were captured during 2008 and 2009, representing a two orders-of-magnitude decrease from previous years. Typically, fewer glass eels are captured on the James and Rappahannock rivers compared with the York River (Figure 3). The highest index for glass eels from the Rappahannock River was observed in 2012, while the highest index for the James River occurred in 2011 (Figure 3). Variability of glass eel catches has been found in other systems with no clear pattern related to water temperature or lunar phase, and conflicting results related to water flow and precipitation (Overton and Rulifson 2009).

Throughout the duration of the survey, the number of elvers captured with Irish eel ramps was notably less than that of glass eels and ranged from as few as 3 elvers (Figure 4, Bracken's Pond, 2009) to as many as 1,968 elvers per year (Figure 5, Kamp's Millpond, 2003). Peak collections of elvers occurred in 2007 at all sites in the York River, but in the Rappahannock River, recruitment of elvers in 2007 ranked second lowest (Figures 4 and 5). The number of elvers captured during 2015 was below average at Wormley Pond and Kamp's Millpond, and above average at Bracken's Pond and Wareham's Pond compared with historic averages for these systems (Figures 4 and 5).

The timing of recruitment of glass eels in each pond appears to be related to the distance between the sampling site and the mouth of Chesapeake Bay (Figure 6). Earliest recruitment is observed at Wormley Pond on the York River (55.7 km from the mouth of the Bay), followed by Bracken's Pond (59.4 km), Wareham's Pond in the James River (77.8 km), and finally Kamp's Millpond on the Rappahannock River (101 km). Additionally, two sites located on the Virginia side of the Potomac River (> 101 km from the mouth of the bay) show much later recruitment peaks compared with other Virginia locations.

Variations in glass eel abundance as measured by a standardized index such as the AUC method are thought to reflect changes in annual recruitment of American eels to Chesapeake Bay tributaries, and subsequent adult abundance. However, this assumption has not been fully investigated. We continue to seek separate funding to sample yellow phase American eels in the freshwater systems currently targeted for glass eel recruitment by VIMS. The available fifteen-year time series of glass eel recruitment for sites in the Potomac, Rappahannock, York, and James river drainages provides a basis for comparison with age distributions of yellow or silver phase eels in these systems, as well as assessments of parasitic infection. This additional information could provide production estimates for lower Chesapeake Bay and further corroborate drainage-specific recruitment indices for glass eels.

Expected Results

This study will provide estimates of the timing and relative magnitude of recruitment of young-of-year American eel to the James, York, and Rappahannock rivers, major tributaries of the Chesapeake Bay. Furthermore, exploratory investigations of the eel standing stock will provide additional data with which to evaluate eel production and other biologically relevant concerns such as parasitic infection rates and severity; we are currently working with a VIMS graduate student to address these complementary investigations. The information collected from this study fulfills a requirement of the Atlantic States Marine Fisheries Commission and will be beneficial to resource management agencies at state and federal levels, to better understand the stock-recruitment relationships of this species.

As before, results of the survey will be submitted to ASMFC, thus insuring the Virginia Marine Resources Commission complies with the ASMFC mandate. Survey results will also be provided to the ASMFC for future stock assessments of American eel. Lastly, results from this proposed study will be provided in quarterly reports and a final report to the VMRC MRFAB and presented at appropriate venues (peer-reviewed journals and presentations at professional fisheries meetings).

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Marine Recreational Fishing Advisory Board
VMRC American eel budget Jan 1, 2017 - Dec 31, 2017

Personnel	Time	Grant	VIMS Match	Total
F0050V, PI	2.00%	3,421		3,421
FP065V, Co-PI	2.00%	1,517		1,517
00069V	17.00%	8,326		8,326
00010V	16.00%	5,767		5,767
00218V	10.00%	3,150		3,150
00114V	10.00%	2,904		2,904
	Total	25,084		25,084
	Fringe Benefits @ 40%	10,034		10,034
Total Personnel		35,118		35,118
Supplies				
Field and lab supplies		400		400
Travel				
Field Sites		2,050		2,050
SUBTOTAL: Direct Costs		37,568		37,568
	Indirect Costs @ 25%	9,392	7,777	17,169
	TOTAL	**46,960**	**7,777**	**54,737**

Includes 5% raise for all staff.

Facilities and Administrative Costs: F&A costs are assessed at 25% for funds provided by Marine Recreational Fishing Advisory Board. (F&A rates for 2015 are 45.7%.) Due to the critical nature of the funding shortfall, VIMS will provide a major portion (20.7% of the F&A costs associated with this project).

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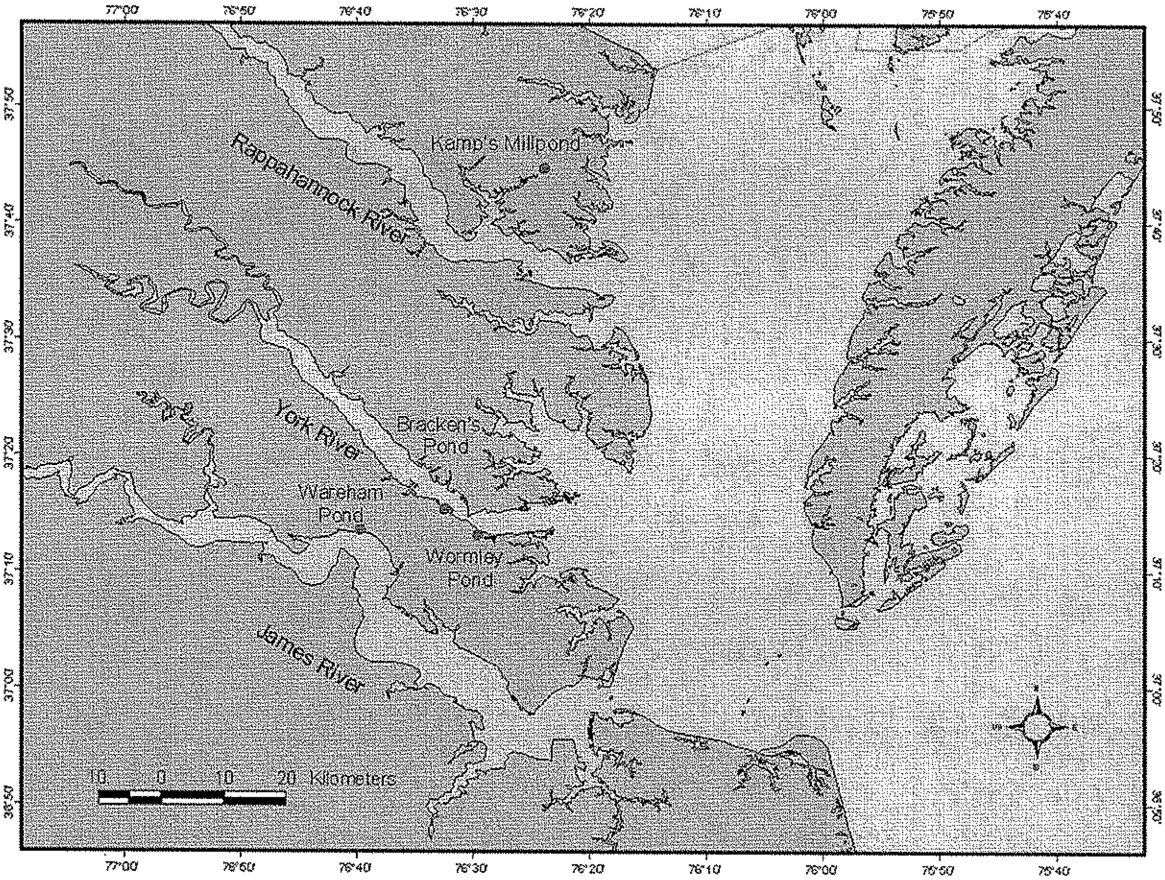

Figure 1. Location of sampling sites in the Rappahannock (Kamp's Millpond), York (Bracken's Pond and Wormley Pond), and James (Wareham's Pond) rivers, Virginia.

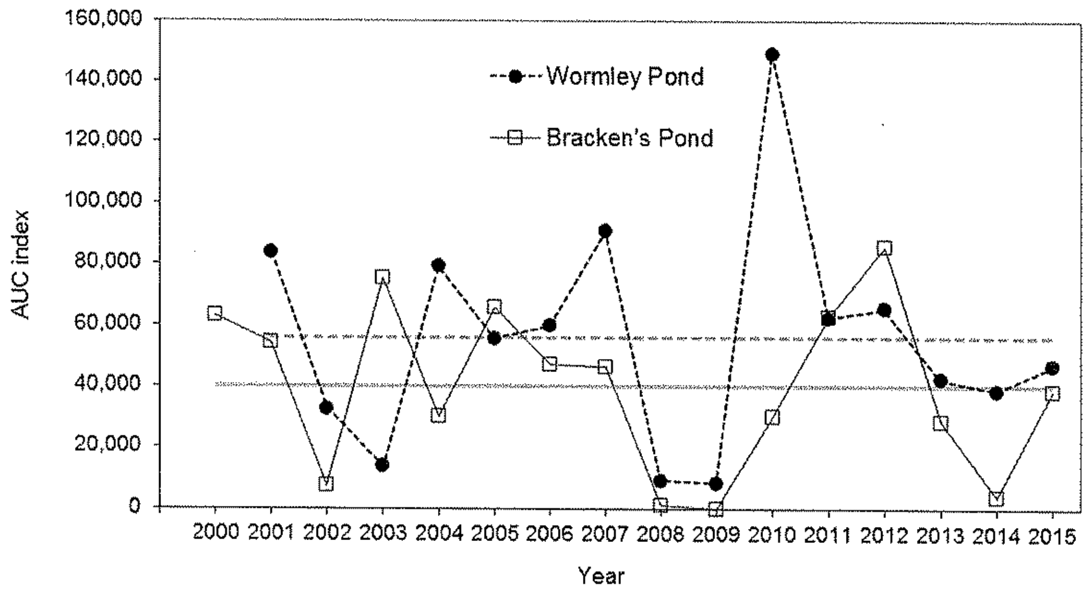

Figure 2. Abundance indices and time series average calculated by area-under-the-curve method for glass eels from Wormley Pond and Bracken's Pond (York River system). Time series averages are shown as solid (Bracken's Pond) and dotted (Wormley Pond) lines.

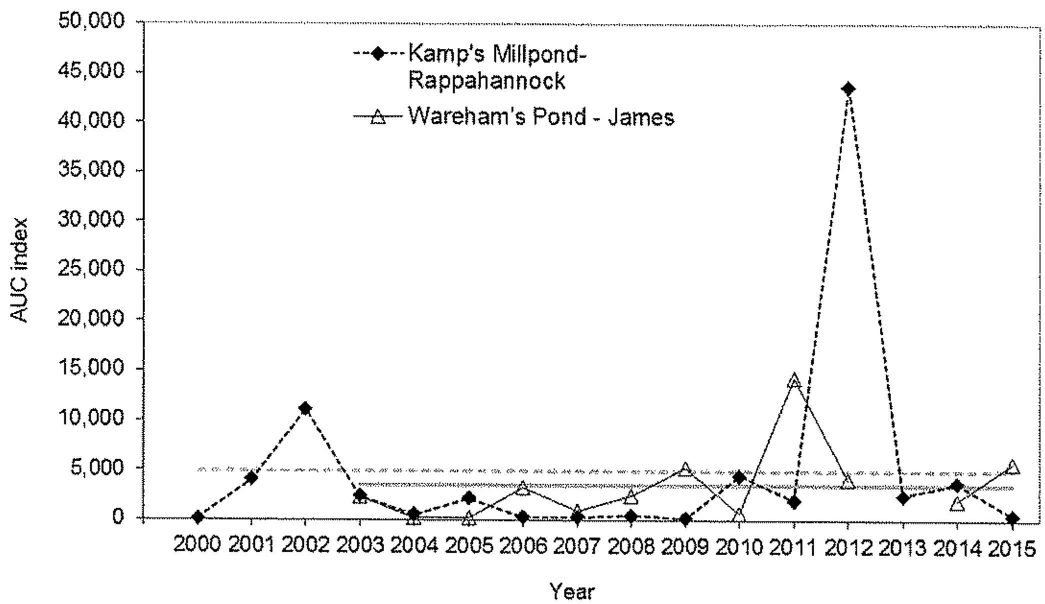

Figure 3. Abundance indices and time series average calculated by the area-under-the-curve method for glass eels from Wareham's Pond (James River system) and Kamp's Millpond (Rappahannock River system). Time series averages are shown as solid (Wareham's Pond) and dotted (Kamp's Millpond) lines.

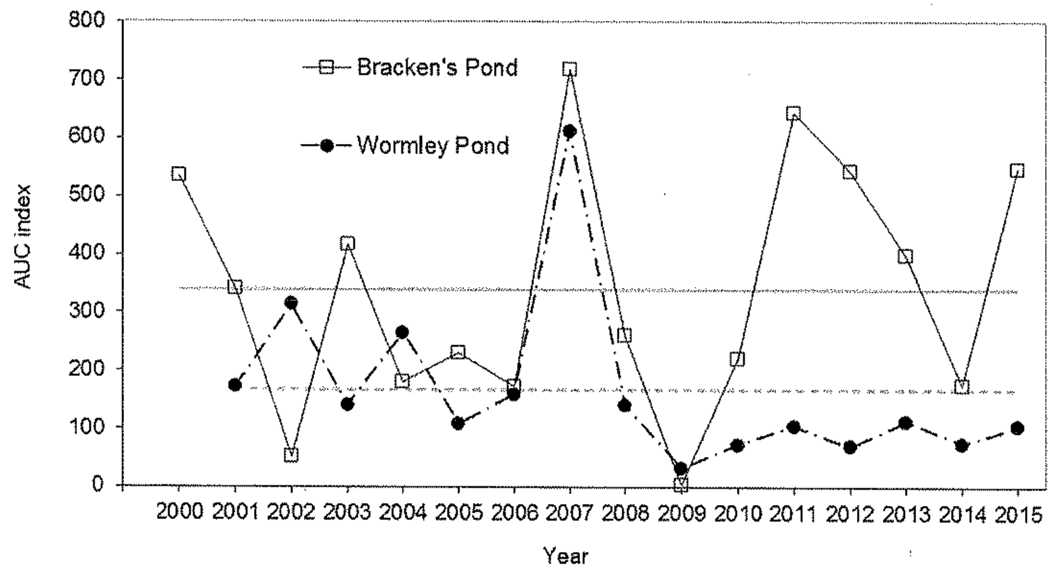

Figure 4. Abundance indices and time series average calculated by the area-under-the-curve method for elvers from Wormley Pond and Bracken's Pond (York River System). Time series averages are shown as solid (Bracken's Pond) and dotted (Wormley Pond) lines.

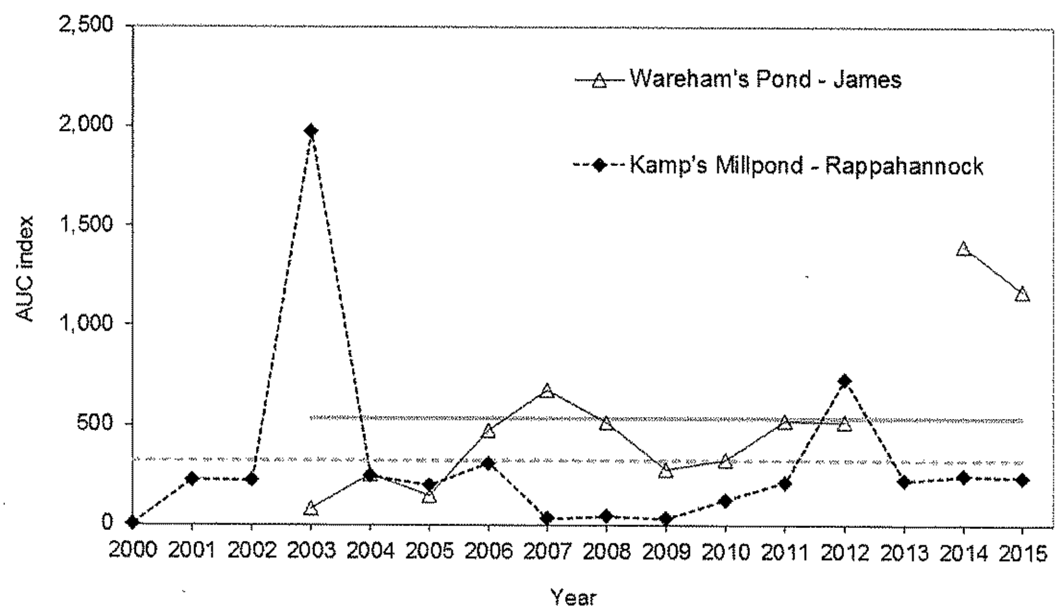

Figure 5. Abundance indices and time series average calculated by the area-under-the-curve method for elvers from Wareham's Pond (James River system) and Kamp's Millpond (Rappahannock River system). Time series averages are shown as solid (Wareham's Pond) and dotted (Kamp's Millpond) lines.

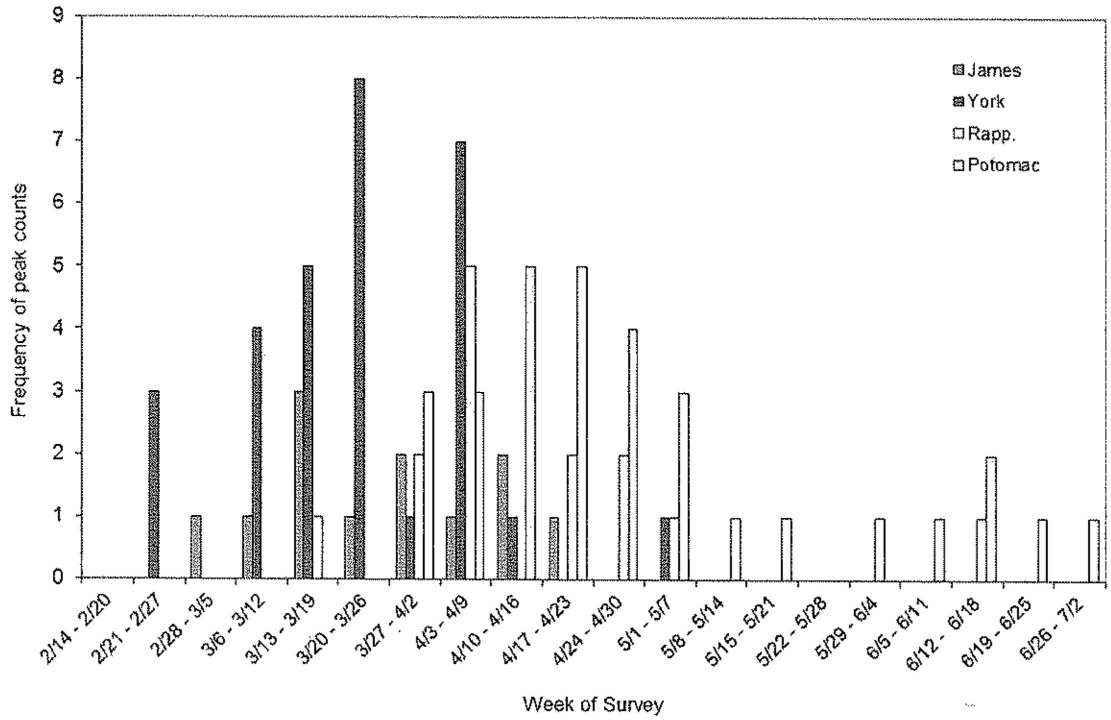

Figure 6. Week of survey when peak counts of glass eels were observed in each river from 2001 to 2015. Two sites are monitored in the York and Potomac rivers each year (n = 30 observations per river). In the James River, one site was monitored beginning in 2003, though this site was not accessible in 2013 (n = 12 observations). In the Rappahannock River, one site was monitored each year (n = 15 observations). Potomac River data are from Tuckey and Fabrizio, 2015.