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VIRGINIA RECREATIONAL FISHING DEVELOPMENT FUND
SUMMARY PROJECT APPLICATION*

NAME AND ADDRESS OF APPLICANT:	**PROJECT LEADER(name, phone, e-mail)**
Virginia Institute of Marine Science P. O. Box 1346 Gloucester Point, VA 23062-1346	Mary C. Fabrizio 804-684-7308 mfabrizio@vims.edu
PRIORITY AREA OF CONCERN Research	**PROJECT LOCATION** Brackens and Wormley Ponds (York R.), Kamp's Millpond (Rappahannock R.) and Wareham's Pond (James R.)

DESCRIPTIVE TITLE OF PROJECT

Estimating relative abundance of young-of-year American eel, *Anguilla rostrata*, in the Virginia tributaries of Chesapeake Bay, 2010

PROJECT SUMMARY:

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:

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 2000-2006 landed an average of 116,458 lbs. Estimates of year class strength provide an "early warning" of recruitment success or failure, and are vital for proper species management.

COSTS:

VMRC Funding: $46,574
Recipient Funding: $6,706
TOTAL COST: $53,280 1 January – 31 December 2010

Detailed budget included with proposal.

Updated 6/1/05

***This form alone does not constitute a complete application, see application instructions or contact Sonya Davis at 757-247-8155 or sonya.davis@mrc.virginia.gov**

Estimated Cost:

VMRC American eel budget Jan 1, 2010 - Dec 31, 2010

Personnel	Time	MRFAB	VIMS Match	Total
Tuckey, Co-PI	10%	5,985		5,985
Lowery	15%	5,652		5,652
Brooks	15%	5,640		5,640
Halvorson	15%	5,420		5,420
Rhea	5%	1,452		1,452
Total		24,149		24,149
Fringe Benefits @ 40%		9,660		9,660
Supplies				
Field and lab supplies		1,000		1,000
Travel				
Field Sites		2,050		2,050
Regional Meeting		400		400
Indirect Costs @ 25%		9,315	6,706	16,021
TOTAL		**46,574**	**6,706**	**53,280**

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

Proposal Submitted to:

Virginia Marine Resources Commission
Commercial Marine Fishing Advisory Board
2400 Washington Avenue, Newport News, VA 23607

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, 2010

1 January – 31 December 2010

Dr. Mary C. Fabrizio
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Dr. Troy Tuckey
Co-Principal Investigator

Dr. John Olney
Chair, Dept. of Fisheries Science

Jane A. Lopez
Director, Sponsored Programs

Dr. Roger Mann
Director for Research and Advisory Services

April 15, 2009

Title: Estimating relative abundance of the young-of-year American eel, *Anguilla rostrata*, in the Virginia tributaries of Chesapeake Bay, 2010

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 2007 commercial landings in Virginia and Maryland represented only 52% of US landings (pers. comm., National Marine Fisheries Service, Fisheries Statistics Division, Silver Spring, MD), suggesting that some areas may be subject to more pronounced declines in recent years.

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 stock assessment report (ASMFC 2006) 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 (Haro et al. 2000; Meister and Flagg 1997).

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).

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 head 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 to be sampled include 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 early March 2009 (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 six weeks according to ASMFC criteria. To determine the start of the run, Irish eel ramps will be checked once weekly until juvenile eels are collected and a certain threshold value is reached, indicating the start of the sampling period. Later in the season, when catches fall below this threshold, sites will again be checked weekly until the run is complete.

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, wind, 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. Geometric means are calculated using the time period in which 95% of the cumulative total catch was sampled (i.e., catches from dates in which 0-2.5% and 97.5-100% of the cumulative catch was collected are excluded from the calculation of the geometric mean). This computation of CPUE follows the ASMFC request to compute standardized geometric means based on 95% of the cumulative catch; this computation is thought to mitigate the effects of interannual variability in the period of maximum recruitment.

Recent Observations and Future Work

Overall, the time series shows that the total number of glass eels (total length < 85 mm) captured among all sites differs by several orders of magnitude with most caught at the two sites in the York River (Tables 1 and 2). Fewer glass eels are typically captured in the James and Rappahannock rivers. The greatest number of glass eels captured in the York River drainage peaked in 2007 at nearly 91,000 glass eels (Wormley Pond), whereas the lowest number – 1,165 glass eels – was observed in 2008 (Bracken's Pond, Table 1). In nine years of eel collections in the York River, the fewest number of glass eels were captured during 2008, an order of magnitude decrease. A similar pattern of low glass eel capture rates was observed in the Rappahannock River: 2008 ranked seventh out of nine years of survey data for this system. In contrast, total catch in 2008 from the James River ranked second highest and exceeded the catch observed at either Bracken's Pond or Wormley Pond on the York River.

Indices of abundance for glass eels from the two York River sites showed different patterns with greater variability found in Wormley Pond compared with Bracken's Pond (Figure 2). In the James River, recent glass eel abundance estimates have been stable, whereas those from the Rappahannock River have been low (Figure 3).

The number of elvers (total length between 85 and 255 mm) captured with Irish eel ramps was well below that of glass eels and ranged from as few as 5 elvers to as many as 1,968 elvers per year (Table 2). Peak collections of elvers occurred during 2007 at both sites in the York River and the James River, but in the Rappahannock River 2007 ranked second lowest. The number of elvers captured during 2008 was very low in the Rappahannock River, low in the York River, and high in the James River.

Abundance estimates of elvers from Wormley Pond in the York River have been decreasing in recent years, while elvers in Bracken's Pond have shown wider variation in recruitment (Figure 4). Abundance indices of elvers in the James and Rappahannock rivers have been low aside from the peak observed in 2003 in the Rappahannock River (Figure 5).

Variations in glass eel abundance as measured by the standardized geometric mean index 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 are currently seeking separate funding to sample yellow phase American eels in the freshwater systems currently targeted for glass eel recruitment by VIMS. We intend to estimate the standing stock of yellow phase eels using electrofishing, fyke nets, or outflow traps, which we are now testing in a pilot study at Wormley Pond (York River drainage, Yorktown, VA). The available nine-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 will 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 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 seeking other funding for these additional but complementary investigations. The information collected from this study 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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Table 1. Total number of glass eels collected, the number of glass eels used for 95% index calculations, dates corresponding to 95% index period, the number of days of the index period, and the geometric mean and standard error by site and year.

Site	Year	Total Caught	Total Used	Start Date	End Date	Days	GEOMEAN	STDERR
Wormley Pond	2001	82267	79485	15-Mar	13-Apr	30	737.125	0.464
	2002	31518	30299	24-Feb	9-Apr	45	272.130	0.292
	2003	14385	13678	14-Mar	15-Apr	33	95.949	0.399
	2004	78258	73834	1-Mar	19-Apr	50	980.639	0.161
	2005	56259	53378	23-Feb	19-Apr	56	172.220	0.306
	2006	61211	57698	8-Mar	12-Apr	36	841.993	0.239
	2007	90988	85414	5-Mar	23-Apr	50	184.356	0.499
	2008	9012	8705	4-Mar	17-Apr	45	86.918	0.256
Bracken's Pond	2000	61228	58288	27-Mar	2-May	36	482.177	0.381
	2001	52838	50146	14-Mar	5-Jun	84	261.503	0.156
	2002	7413	7000	8-Mar	20-Apr	44	106.465	0.169
	2003	77592	73431	11-Mar	12-May	63	119.631	0.340
	2004	29914	28403	6-Mar	12-May	68	173.152	0.207
	2005	65983	63009	13-Mar	14-May	63	188.142	0.283
	2006	45738	43268	27-Feb	5-May	68	297.585	0.201
	2007	46758	44637	12-Mar	10-May	60	211.588	0.227
	2008	1165	1113	5-Mar	26-May	83	4.560	0.145
Wareham's Pond	2003	2230	2150	19-Mar	29-Apr	37	12.819	0.244
	2004	158	154	8-Mar	16-May	69	1.032	0.113
	2005	225	214	21-Mar	8-Apr	19	6.312	0.300
	2006	3280	3145	3-Mar	19-Apr	48	29.770	0.216
	2007	953	920	5-Mar	3-May	60	7.547	0.158
	2008	2456	2333	17-Mar	17-Apr	32	32.615	0.259
Kamp's Millpond	2000	139	134	16-Apr	12-May	27	1.531	0.185
	2001	3956	3788	6-Apr	3-May	28	31.468	0.281
	2002	11217	10589	17-Mar	16-Apr	31	136.605	0.251
	2003	2387	2254	26-Mar	8-May	44	28.606	0.222
	2004	524	497	13-Apr	23-May	41	4.993	0.210
	2005	2084	2016	30-Mar	3-May	35	14.942	0.289
	2006	302	283	10-Mar	24-May	76	1.806	0.112
	2007	313	299	30-Mar	1-Jul	94	2.201	0.077
	2008	481	459	31-Mar	4-Jun	62	3.938	0.129

Table 2. Total number of elver eels collected, the number of elver eels used for 95% index calculations, dates corresponding to the index period, the number of days of the index period, and the geometric mean and standard error by site and year.

Site	Year	Total Caught	Total Used	Start Date	End Date	Days	GEOMEAN	STDERR
Wormley Pond	2001	171	162	12-Mar	4-May	54	1.564	0.129
	2002	315	298	22-Feb	17-Apr	55	3.279	0.135
	2003	138	130	4-Mar	12-May	70	1.099	0.093
	2004	257	239	24-Feb	16-May	83	1.631	0.101
	2005	105	100	22-Feb	19-May	87	0.715	0.073
	2006	160	156	20-Feb	6-May	76	0.985	0.094
	2007	619	559	26-Feb	14-May	78	3.704	0.102
	2008	139	135	2-Mar	28-May	88	0.715	0.081
Bracken's Pond	2000	528	481	28-Mar	9-May	42	2.811	0.253
	2001	334	314	4-Mar	17-Jun	106	1.119	0.099
	2002	52	49	16-Mar	28-Apr	44	0.673	0.102
	2003	411	399	6-Mar	12-May	68	2.263	0.145
	2004	171	158	22-Feb	13-May	82	1.022	0.098
	2005	231	224	23-Feb	15-May	82	1.525	0.099
	2006	166	152	23-Feb	6-May	73	1.305	0.092
	2007	723	692	23-Feb	13-May	80	5.389	0.116
	2008	262	247	4-Mar	26-May	84	1.354	0.105
Wareham's Pond	2003	84	79	19-Mar	24-Apr	32	1.296	0.156
	2004	260	252	8-Mar	9-May	62	1.839	0.131
	2005	148	137	20-Mar	12-May	54	1.791	0.101
	2006	469	442	24-Feb	17-May	83	2.134	0.132
	2007	682	641	15-Mar	17-May	64	5.207	0.150
	2008	511	487	12-Mar	18-May	67	3.261	0.156
Kamp's Millpond	2000	5	4	16-Apr	25-Apr	10	0.390	0.039
	2001	222	215	16-Mar	8-May	54	2.415	0.125
	2002	224	216	13-Mar	19-Apr	38	4.387	0.117
	2003	1968	1907	13-Mar	9-May	58	13.669	0.200
	2004	250	230	10-Mar	20-May	72	2.023	0.094
	2005	196	188	23-Mar	17-May	56	2.331	0.087
	2006	312	301	10-Mar	14-May	66	2.478	0.112
	2007	32	25	15-Mar	27-Jun	105	0.209	0.029
	2008	37	33	24-Mar	8-Jun	73	0.424	0.037

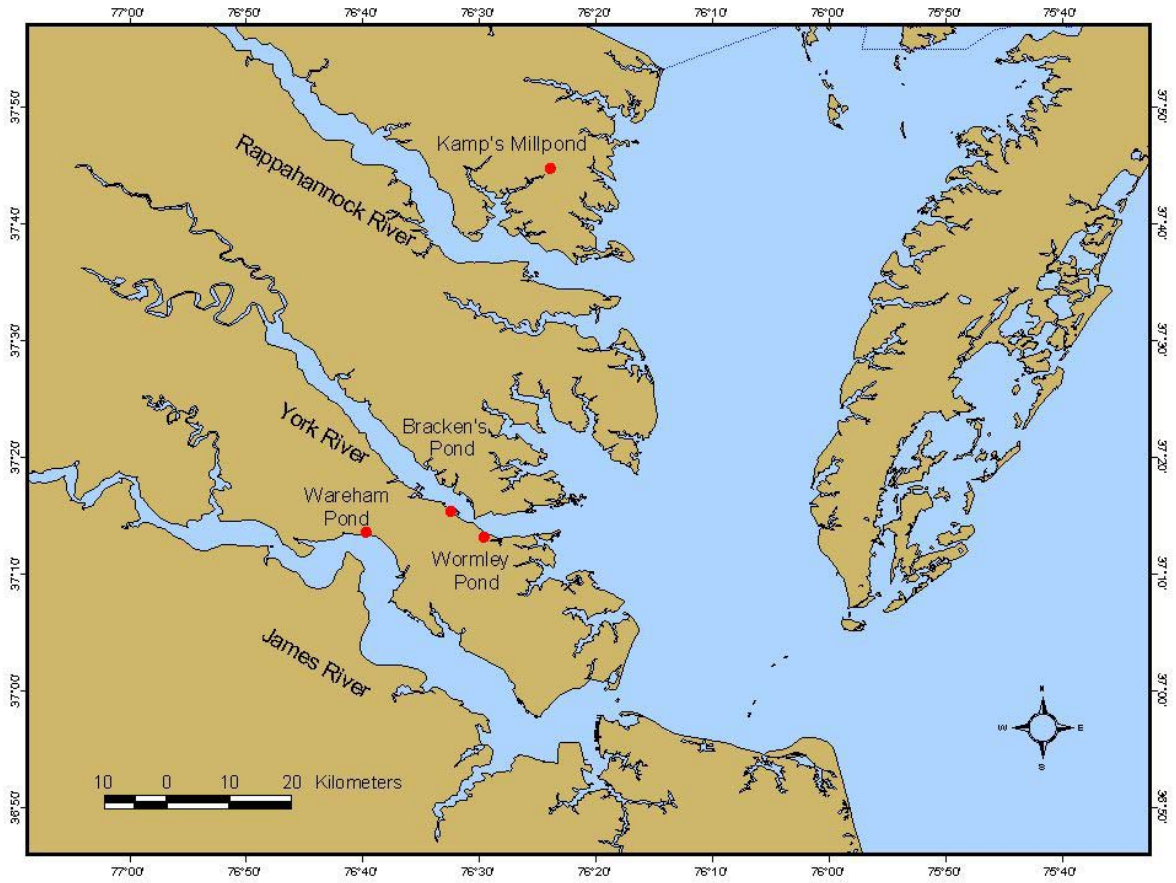

Figure 1. Location of sampling sites in the Rappahannock (Kamp's Millpond), York (Bracken's Pond and Wormley Pond), and James (Wareham's Pond) rivers, Virginia.

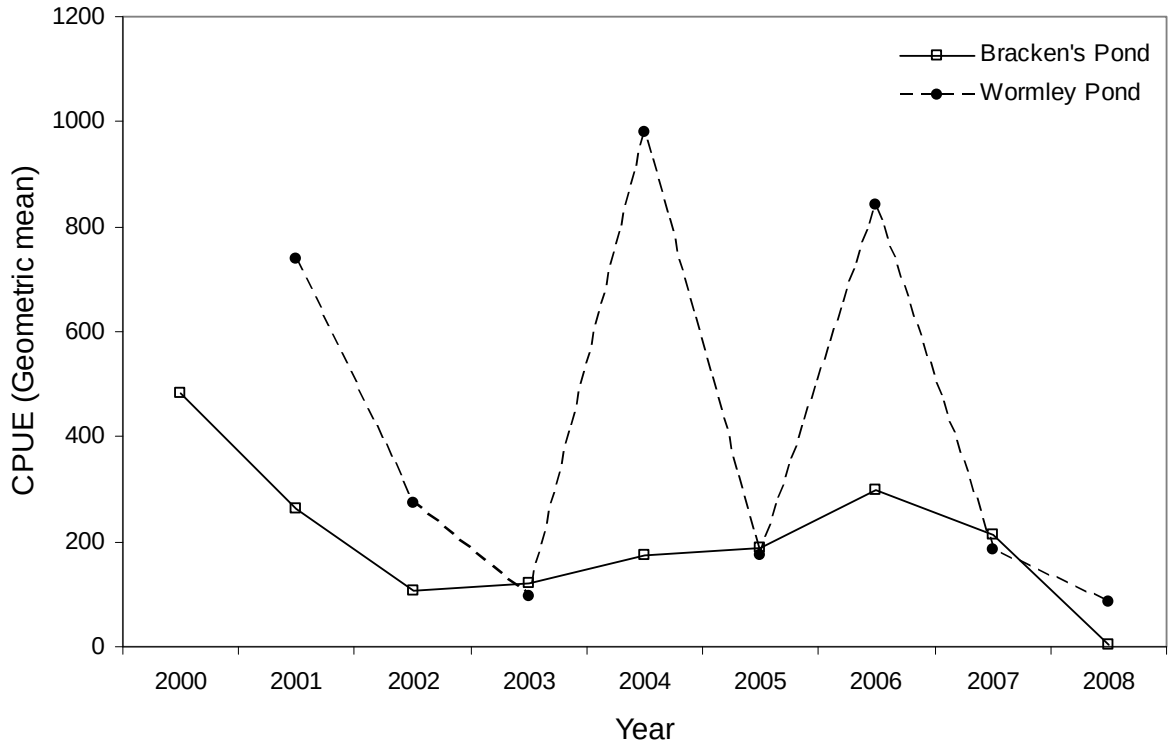

Figure 2. Index of abundance estimates of glass eels from two stations on the York River, Virginia.

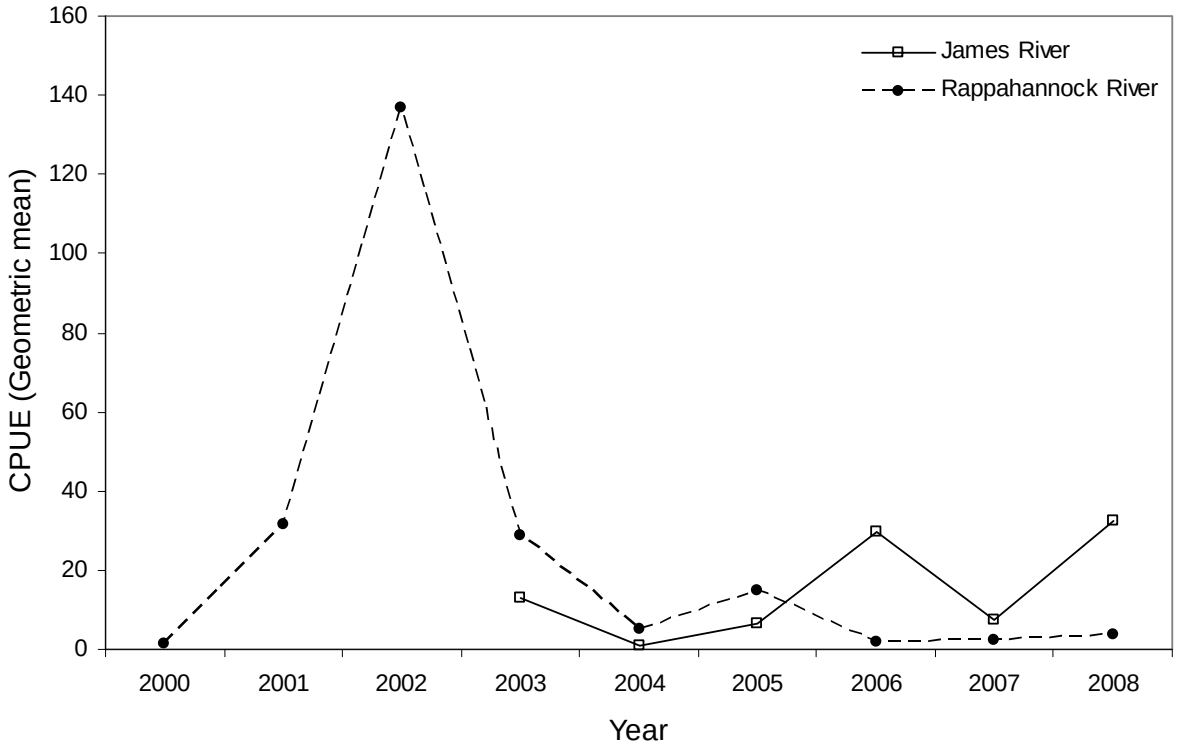

Figure 3. Index of abundance estimates of glass eels from the James (Wareham's pond) and Rappahannock (Kamp's Millpond) rivers, Virginia.

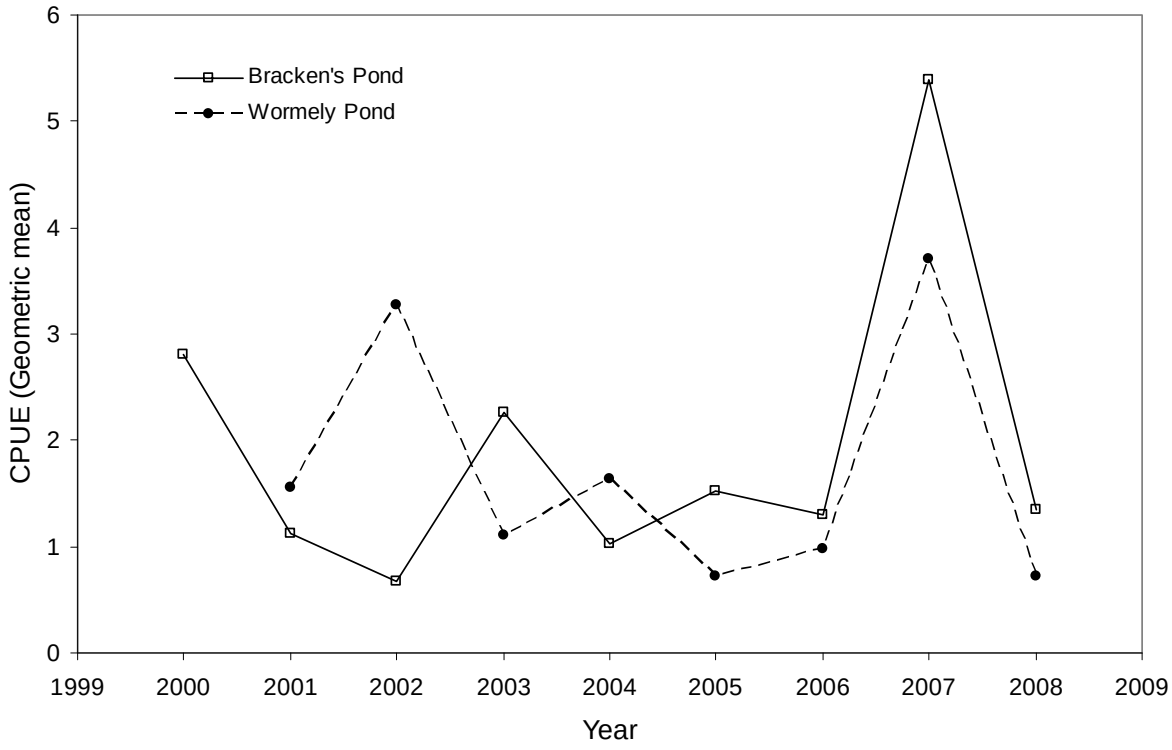

Figure 4. Index of abundance estimates of elver eels from two stations on the York River, Virginia.

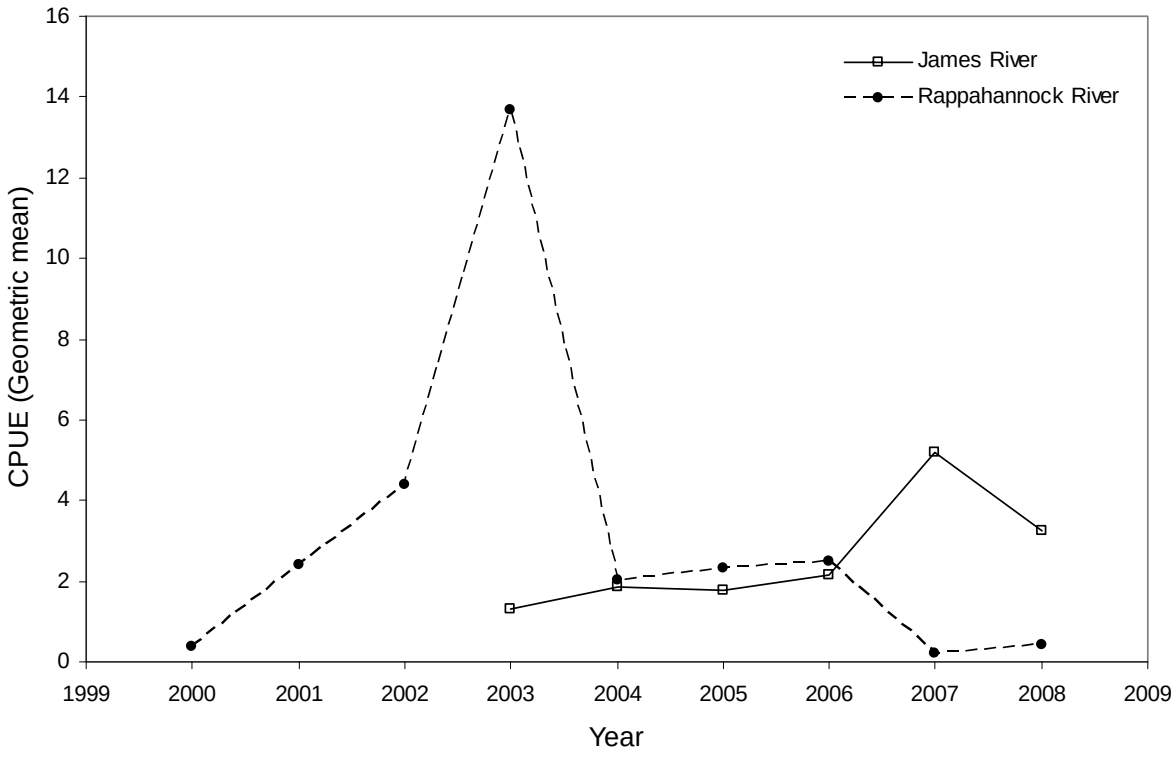

Figure 5. Index of abundance estimates of elver eels from the James (Wareham's Pond) and Rappahannock (Kamp's Millpond) rivers, Virginia.