
Patrick J. Geer  
*Virginia Institute of Marine Science*

Julie A. Weeder

Steven Hammond

Rudolph Lukacovic

Follow this and additional works at: [https://scholarworks.wm.edu/reports](https://scholarworks.wm.edu/reports)

Part of the [Aquaculture and Fisheries Commons](https://scholarworks.wm.edu/aquaculture) and the [Marine Biology Commons](https://scholarworks.wm.edu/biology)

**Recommended Citation**  

This Report is brought to you for free and open access by W&M ScholarWorks. It has been accepted for inclusion in Reports by an authorized administrator of W&M ScholarWorks. For more information, please contact [scholarworks@wm.edu](mailto:scholarworks@wm.edu).

March 2000 - June 2000

by

Patrick J. Geer

Department of Fisheries Science
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, VA 23062

Julie A. Weeder
Steven Hammond
Rudolph Lukacovic

Maryland Department of Natural Resources
Biological Monitoring and Analysis
Matapexke Field Station
Stevensville, MD, 21666

Submitted to
Potomac River Fisheries Commission
September 2000

by

Patrick J. Geer
Department of Fisheries Science
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, VA, 23062

Julie A. Weeder
Steven Hammond
Rudolph Lukacovic
Maryland Department of Natural Resources – Fisheries Service
Biological Monitoring and Analysis
Matapeake Field Station
Stevensville, MD, 21666

Submitted to
Potomac River Fisheries Commission
September 2000
Acknowledgements

A large measure of thanks must go out to the individuals who participated in the field collections and helped design and implement this survey, especially Hank Brooks, Wendy Lowery, Todd Mathes, and Steve Owens. Appreciation is expressed to the law enforcement officers of both the Maryland Department of Natural Resources and the Virginia Marine Resources Commission who provided necessary information on potential elver run locations.

This project was supported by the Potomac River Fisheries Commission as a joint effort between Maryland Department of Natural Resources and the Virginia Institute of Marine Science.

Table of Contents

Introduction ............................................................................................................. 2
Methods ................................................................................................................ 4
Results .................................................................................................................. 8
Discussion .......................................................................................................... 10
Conclusions ....................................................................................................... 14
References ......................................................................................................... 14
Tables ................................................................................................................. 16
Figures ............................................................................................................... 20
OBJECTIVES

1. Determine number and size of eels recruiting to the Potomac River watershed.

2. Evaluate various gears and methods of collecting glass eels to determine the most effective and efficient method.

3. Examine the diel, tidal, lunar, and water quality factors which may influence young of the year eel recruitment.

INTRODUCTION

Measures of juvenile recruitment success have long been recognized as a valuable fisheries management tool. In the Chesapeake Bay, these measures have provided reliable indicators for future year class strength for blue crabs (Lipcius and van Engel, 1990), striped bass (Goodyear, 1985), and several other recreationally important fishes (Geer and Austin, 1999).

The American eel, *Anguilla rostrata*, is a valuable commercial species along the entire Atlantic coast from New Brunswick to Florida. Landings along the U.S. Atlantic coast have varied from 290 MT in 1962 to a high of 1600 MT in 1975 (NMFS, 1999). In recent years there seems to be declining harvest, with similar patterns seen in the Canadian maritime provinces. The Mid-Atlantic states (New York, New Jersey, Delaware, Maryland, and Virginia) have comprised the largest portion of the East Coast catch (88% of the reported landings) since 1988 (NMFS 1999). The Chesapeake Bay jurisdictions of Virginia, Maryland, and Potomac River Fisheries Commission (PRFC) alone represent 30, 15, and 18% respectively, of the annual United States (Gulf and Atlantic coast states) commercial harvest for the years 1987-1996 (ASMFC, 1999). Some fishery-independent indices have shown a decline in abundance in recent years (Richkus and Whalens 1999). Hypotheses for the decline include shifts in the Gulf Stream, pollution, over-fishing, parasites, and barriers to passage (Castonguay et al. 1994).

Many fisheries management techniques have not been applied to American eels because little basic biological information is known. Variation in growth rates, length at age, and other biological parameters has complicated stock assessment methodologies and management efforts. Additionally, few studies have addressed the recruitment of glass eels to the estuaries from the spawning grounds in the Sargasso Sea.
The Atlantic States Marine Fisheries Commission (ASMFC) adopted the Interstate Fishery Management Plan for American Eel (FMP) in November 1999. The Plan focuses on increasing the states’ efforts to collect data on the resource and the fishery it supports through fishery dependent and independent studies. To this end, member jurisdictions including the Potomac River Fisheries Commission (PRFC) agreed to implement an annual abundance survey of young-of-year American eel (YOY). The survey is intended to "...characterize trends in annual recruitment of the young of the year eel over time [to produce a] qualitative appraisal of the annual recruitment of American eel to the U.S. Atlantic coast (ASMFC 2000)."

PRFC has recognized the importance of assessing eel recruitment to the Chesapeake Bay to better understand the dynamics of American eel populations and fisheries. It has consulted with the Virginia Marine Resources Commission (VMRC) and the Maryland Department of Natural Resources (MDNR) to agree on common protocols and strategies for capturing YOY eels to achieve these goals. In spring 2000, PRFC asked the Virginia Institute of Marine Science (VIMS) and Maryland Department of Natural Resources (MDNR) to evaluate methodologies and sampling locations for surveying YOY recruitment to Maryland and Virginia tributaries of the Potomac River.

The 1999 Atlantic States Marine Fisheries Commission (ASMFC) Fishery Management Plan (FMP) for American eel has a monitoring requirement which stipulates all East Coast states develop and implement a YOY eel monitoring program by the year 2001 (ASMFC 1999). The results of these surveys will provide much needed data on coastal recruitment success, and further the understanding of American eel population dynamics.

**Life History**

The American eel is a catadromous species which ranges from Greenland to Central America along the Atlantic coasts and inland to the Mississippi and Great Lakes drainages. The species is panmictic, supported throughout its range by a single spawning population. Spawning takes place during winter to early spring in the Sargasso Sea after which the adults die. The eggs hatch into leaf-shaped larvae called, leptocephali, which are transported by the ocean currents in a northwesterly direction. Within a year, metamorphosis into the next stage (glass eel) occurs.
near the western Atlantic coast. Coastal currents and active migration transport the glass eels into rivers and estuaries of Chesapeake Bay from February to June. As growth continues, the eel becomes pigmented and is called an elver. Some eels migrate upriver into freshwater ponds and lakes, while others remain in estuaries. Most of the eel’s life is spent in these habitats as a yellow eel. Age at maturity varies greatly with location and latitude. In Chesapeake Bay, it may range from 8 to 24 years. Upon maturity, eels migrate back to the Sargasso Sea to spawn and die. A metamorphosis into the ‘silver eel’ stage occurs during the seaward migration, which occurs from late summer through autumn.

METHODS

Minimum criteria for YOY American eel sampling has been established by the ASMFC American eel FMP. Due to the importance of the eel fishery in Virginia and Potomac River, additional methods should be implemented to insure proper temporal and spatial coverage, and to provide reliable estimates of recruitment success.

To provide the necessary spatial coverage and to assess suitable locations, numerous sites were evaluated (Figure 1 and Table 1). Final site selection was based on known areas of glass eel recruitment, accessibility, and specific physical criteria which are demonstrated causes of glass eel concentration. The FMP required that at least one site be sampled in each jurisdiction for at least four days a week for a minimum of six weeks. Lengths, weights, and pigment stage (according to Haro and Krugo 1988) were to be collected from at least sixty eels on a weekly basis.

Maryland

Two types of traps were used to collect elvers which were approved in the FMP (ASMFC 2000). Irish elver ramps [ramps] (Figure 2) were used at all sites. The configuration of these ramps as described below proved successful for attracting and capturing small eels at sites in coastal Maryland and upper Chesapeake Bay. Ramp operation required the continuous flow of water over the climbing substrate and through the collection bag. The passive supply of water to the traps through gravity feed required that the water level be considerably higher above the trap
than below it, or that water traveling at high velocity be available nearby. Fine mesh collection bags were attached to 0.5m lengths of flexible hose with nylon cable ties. The hoses were attached to the output adapter on the ramp with adjustable hose clamps. Enkamat™ erosion control material on the floor of the ramp provided a textured climbing surface and extended into the water below the trap. Ramp floatation was provided by sheets of foam insulation, which were secured loosely to the trap bottom to allow ramp inclination and floatation adjustments. Additional styrofoam was applied to one side of the ramp if the weight of the collection bag caused the ramp to list. Water depth under the ramps was approximately 0.5m. Ideal trap floatation allowed 15-20% of the length of the bottom of the ramp to be submerged, providing that most of the top of the ramp remained above water. This arrangement allowed a 10-15° angle to be maintained between the outer top edge of the trap and the water. This angle, in combination with the 4° angle of the substrate inside the ramp, resulted in sufficient slope to create attractant flow. A hinged lid provided access for cleaning and for outflow plug adjustments, which balanced water flow over the climbing surface and through the output hose. Flow over the textured climbing surface was adjusted to maintain a depth of 5-10 mm. Sheldon traps (Figure 3) were used in addition to ramps at Budds Creek and Hoghole Run to increase fishing effort and compare trap efficiency. They were set about 5m downstream of the elver ramps, with the closed end facing upstream. Two wings made of small mesh were extended diagonally out from either side of the entrance (downstream) end of each trap and secured with short lengths of steel reinforcing bar to direct elvers into the trap. Each trap was pressed firmly to the substrate with a cinder block on the lid.

Traps were checked four days per week. At ramps, only elvers found in the collection bags (not on the climbing surface) were recorded. Trap performance was rated on a scale of 1 to 4 (1=good, 4=not functioning), and water temperature and level, salinity, and conductivity were recorded during most site visits. All collected elvers were weighed and measured in the lab, and frozen for future study.

Eighteen potential sites were identified from topographic maps and evaluated during field visits (Figure 1, Table 1). No eels were observed at any site upon visual inspection. Twelve of these sites proved to have either insufficient drainage area to create any amount of attractant.
flow, or insufficient head to allow for effective deployment of our trap. Six sites likely to allow effective operation of our gear were ultimately identified on the lower Potomac River drainage in Maryland (Figure 1, Table 1).

One ramp was placed at each of two of these sites on April 6. Both ramps were placed below riffles over cobble substrate. The increased gradient, water velocity, and turbulence caused by the riffle was hypothesized to provide a partial impediment to upstream elver migration. At these sites, water was routed through 3-5m lengths of flexible 4cm hose placed in the upstream current and attached to the input adapter of the ramp. The Gilbert Swamp Run site was located in the Wicomico River watershed, under the Trinity Church Road bridge in Charles County (Figure 4). The substrate at the trap site consisted of a soft, fine silt layer over concrete. The St. Mary’s Lake site in St. Mary’s County was located on the Western Branch of St. Mary’s River, below the dam and just downstream of the lake outflow culvert pipe (Figure 5). Substrate at this site was sand and fine gravel with cobble banks.

Because of low elver collection rates at these sites, the traps were removed from the first two sites on May 4 and immediately relocated to Budds Creek (Figure 6), another tributary of the Wicomico River, and Hoghole Run (Figure 7), a Port Tobacco River tributary. Culvert barriers and fish ladders located at both sites were hypothesized to concentrate fish and provide a strong freshwater attraction flow. The low water velocity through the ramp, compared to the high velocity from the fish ladder nearby, was thought to provide a less tiring and more appealing migration route for elvers. Ramps and Sheldon traps were employed at these latter two sites. The water intake hoses for ramps at Budds Creek and Hoghole Run were secured to the inside of the fish ladders and extended to the top of the ladder, where water intake occurred (Figure 7).

The Budds Creek site was located at the fish ladder below the Route 234 culvert on the Charles/St. Mary’s County line. The fish ladder at Hoghole Run was at the Route 6 culvert in Charles County. The substrate at Budds Creek was silt and mud near the ramp, while at Hoghole run gravel and cobble predominated near the ramp, with sand near the Sheldon trap. All gear was removed from these latter two sites on June 2.
Methods were very similar to those in Maryland. The Irish eel ramp was of the same
design except a bucket with drainage sieves was used instead of the mesh collection bag (Figure
8). The ramps were placed on an incline (15-30°), often on land, with the ramp entrance and
textured mat extending into the water. Submersion of the ramp entrance was considered
undesirable, and as such was placed in shallow water (< 15 cm). In addition to the ramps, dip
nets (45x21cm 800 μm mesh) were used to provide information on the presence and abundance
of eels.

A total of ten sites were evaluated for the use of these gears between February 10 and
April 5 (Table 1, Figure 1). Potomac Mills Pond (off Route 3) drains into Pope Creek in
Westmoreland County. The accessibility was poor and the logistic distance from VIMS made
this site unsuitable. Lake Independence (Currioman Bay - Westmoreland County) and Downings
Millpond (Presley Creek - Northumberland County) both had drain pipes leading downstream
which would make eel passage difficult (Figure 1, Table 1). Corbins Pond (Coan River -
Northumberland Co.) was observed to be a tidal inlet and subsequently dropped from
consideration (Figure 1). Beales Millpond (Nomini Creek - Northumberland County) had poor
accessibility and the mill dam had been destroyed (Figure 1, Table 1). Sydnors Millpond (Hull
Creek - Northumberland County) was sampled with dip net on March 30. The dam itself was
destroyed but the pond below and nearby culvert was sampled in sand bottom (Figure 9). One
eel was collected in seven dip net samples. Clarks Millpond (Coan River - Northumberland
County) was sampled with a dip net on March 30. The sediment below the spillway was hard
clay and no eels were collected. However, a ramp was place inside the culvert below the old
state road 634 and was fished for the first time on April 1 (Figure 10). Gardys Millpond
(Northumberland County) was also sampled by dip net on March 30. The site contains a
spillway which drains through five culverts, across rip rap into a course sand area of the
Yeocomico River (Figure 11). The site is maintained by Virginia Department of Game and
Inland Fisheries. Multiple dip nets were made in various locations. The area below the rip rap
produced 41 eels in one dip (0.5m water) (Figure 12), and a sweep across the culvert produced
another 7. Beginning April 12, a ramp was placed inside the north most culvert in approximately
15 cm of water. Clarks and Gardys Millponds were established as the primary sites and continued through out the survey. On April 5, dip nets were made at Courtney’s Pond (Yeocomico River) and Mill Creek Pond (Coan River) (Figure 1, Table 1). The road and dam at Courtneys Pond was destroyed during Hurricane Floyd (9/15/99). Two dip samples produced 7 eels in silt mud sediment. The dam at Mill Creek Pond was completely destroyed by Hurricane Floyd, scouring the creek banks and leaving nothing but hard clay. Nothing was observed at this site.

Dip nets were deployed by sweeping either a set distance (culverts and other concrete substrates) or a set time of 30 seconds (gravel, mud, and sand bottoms). All eels were enumerated and placed above the impediment. At least once per week a sample of approximately sixty eels was collected, which were measured to the nearest millimeter, weighed to the nearest 0.01 g, and pigment stage recorded as described in (Haro and Krugo, 1988). Specimens less than or equal to ~85 mm were classified as ‘glass eels’, while those greater than ~85 mm were considered ‘elvers’. This corresponded to our observation of two obvious modal lengths in the catch which likely reflect differing year classes. At each site temperature, salinity, tidal stage, stream flow, time, condition of the gear, and substrate type were recorded.

RESULTS

Maryland

Sampling began on April 6 and continued through June 2. The gear was checked four times per week. Gear was operational on all but one of twelve sampling days at Hoghole Run, Gilbert Swamp Run, and St. Marys Lake and all but two days of twelve at Budds Creek. Although each gear was fished on twelve occasions, very few eels were captured (Table 2). The Sheldon traps caught no eels, while the ramps caught three eels at Budds Creek, two at Hoghole Run, and one at St. Mary’s Lake (Table 2).

Virginia

Sampling on the Potomac River began on March 30 using dip nets and continued through May 16 with both dip nets and Irish eel ramps. An Irish eel ramp was placed at Clarks Millpond
on April 1, and at Gardys Millpond on April 12. At both sites the ramp was placed in a culvert below the major spillway (Figures 9 and 10). Dip netting occurred at Clarks Millpond below the spillway but was ineffective because of the clay substrate. At Gardys Millpond, dip netting occurred for thirty seconds in course sand in the stream below all impediments, and for a set distance within the culverts (Figures 9 & 10). Syndnors Millpond was accessed and sampled on March 30. Dip net samples were taken from a small pond below the destroyed spillway and in the nearby culverts. Only one eel was captured in seven dip nets. Courtney's Pond was sampled on April 5 and seven eels were captured in two dipnets. Because this pond feeds into the same tributary as Gardys (Yeocomico River) no further sampling was felt necessary (Table 2).

The sampling at Clarks Millpond was not very successful. Dip netting proved insignificant, with no eels observed in the ramp until the May (Table 2, Figure 13). It appears catches were increasing up until the time the gear was pulled on May 16. All eels remaining on the ramp when the gear was removed were recorded as being captured on the following day (May 17.) (Figure 12). This last data point will most likely be removed from future analyses. In comparison, Gardys Millpond was successful both with dip netting and ramp (Table 2). Catches peaked in the ramp the second half of April (Figure 14), with dip net sampling indicating the same peak as well as an early run the first week of April (prior to the ramp being set). The CPUE for the ramp may appear misleading since it is presented as catch per hour fished. If standardized to a twenty four hour day, catch rates would be comparable to those seen dip netting. Again, on the last day of sampling (May 16) a large number of elvers were observed on the ramp and recorded for the following day.

Gear comparisons performed at Bracken’s Pond on the York River indicated the ramps (mean = 492.2 ± 249.7) captured significantly more YOY eels than either the Virginia fyke net (37.9 ± 21.3) (Figure 15), or dip nets sampled over a set distance (30.6 ± 15.0) or time (13.5 ± 7.1)(p ≤ 0.05) (Table 3). Results for the Potomac sites were similar but less dramatic, with the mean catch of glass eels at Gardys with ramps two and one half times greater than that of dip nets (mean = 26.45 versus 11.32) (Table 2). Sampling at Clarks Millpond proved to be less effective. The area below the impediment was hard clay, making dip net sampling difficult and ineffective. Glass eels are known to bury into the sediment, with the clay bottom providing little
if any protection. The ramp at Clarks was located in the culvert approximately one meter above
the final spillway. Although flow was low enough to allow migration up this final spillway, the
ramp placement may not have been ideal. Eels were observed passing under the cement culvert
and possibly reaching the pond from some underground passageway.

Environmental parameters were not clearly correlated with catch (Figures 16). Water
temperature rose from 13.0°C to 26.5°C at Gardys Millpond, and from 13.5°C to 30.7°C at
Clarks Millpond. Air temperatures varied greatly from 9.5°C to 35.7°C. River flow was
typically greater at Gardys (0.42 m/s ± 0.07), but more variable at Clarks (0.36 m/s ± 0.14).
Parameters such as lunar phase and water temperature which have been shown to correlate with
glass eel runs, were not consistently observed between the two sites. Air and water temperature
were positively correlated with both glass eel and elver catches with the ramps at Clarks
Millpond (r = 0.75 and 0.81, respectively, p < 0.005). However, there was a significant negative
correlation with both life stages at the Gardys ramp ( r = -0.67 p<0.05, and r = -0.74 p<0.01).
Likewise, lunar phase and catch did not show any consistent patterns between sites or gears.

Average lengths at Gardys declined significantly for the early part of the survey, but
increased the last three sampling periods (non-significantly) (Figure 17. As with adult eels, the
glass eel length-weight regression has a good amount of scatter with r² values similar to those
seen in the commercial yellow eel stocks of Virginia (Figure 18).

DISCUSSION

Maryland

We captured very few eels at the four locations sampled. Several possible reasons are
discussed below. Results of the YOY abundance surveys conducted spring 2000 at two coastal
Maryland sites and several upper Bay eastern shore sites are presented for comparative purposes.

1. Sampling did not occur when small eels were migrating

The FMP directs that gear should be employed to coincide with periods of peak YOY
onshore migration. However, as sampling had not previously occurred in the Potomac River,
these periods were unknown. Our Potomac sampling occurred from April 9 to June 2, which
included the timing of peak catches observed at other sites. Eel catches at two Eastern Shore sites began in late April and peaked in May, although these eels were likely a different year class than the elvers observed elsewhere due to their large size. Elvers were caught at both Virginia Potomac sites from mid-April to mid-May. Immigration to two coastal Maryland sites peaked in April and mid-May. Because our sampling occurred before, during and after the catches observed elsewhere, it is unlikely that we missed the run. We sampled four times per week, thus minimizing the chance that we would miss a run that occurred over only a few days.

2. Gear and site characteristics reduced success of traps

Irish elver ramps have been used for YOY eel sampling primarily in areas with high gradient, rocky streams. The small streams we sampled which feed into tributaries of the Potomac River are of low gradient. The water depth was also likely greater at our sites than those where Irish elver ramps have been shown to be successful. It was necessary to site the traps near impoundments in order to ensure a large difference in water height above and below the trap such that gravity could enable water to flow through the trap. Others have used pumps to direct water through the trap even at low gradient sites with no nearby impoundment. However, we sought impoundments when possible as they concentrate YOY at a discrete location. Overall, our sites allowed sufficient water flow through the ramps and provided some barrier to YOY passage which would have concentrated YOY near the ramp site.

The width of the stream at each site meant that a significant area was not sampled by the ramp. Some YOY may not have encountered the ramp. Discrete sources of freshwater (fish ladders) were thought to attract YOY. Where possible, we placed the ramps near these sources to maximize the chance that YOY would encounter them and employ them as a less strenuous upstream path. Saturation of each site with ramps would ensure that all YOY would encounter capture gear.

Use of Irish elver ramps was very successful at other Maryland sites during spring 2000. Tens of thousands of glass eels were collected at each of two coastal Maryland sites, while hundreds of eels were collected at each of several sites in upper Chesapeake Bay. All of these sites were on low gradient streams below impoundments, and the water flow was gravity fed from above the impoundment. All sites were below sources of freshwater. At all sites, one ramp
was used and floated at the same angles used at Potomac sites. Irish elver ramps were the most effective capture method for eels at the two Virginia Potomac sites. Due to success elsewhere in Maryland and Virginia, we believe that the ramps deployed in the manner described were appropriate for the sites sampled and not the cause of our low catch rates.

Alternative gear types include dip nets, Sheldon elver traps, fyke nets and trawls. We do not expect any of these gear types to be very effective at the sites we sampled. Trawls are not feasible in small systems where a power boat cannot be launched. Fyke nets are most effective when tidal action pushes YOY into the net, and tidal effects were minimal at freshwater Potomac sites. We would not expect dip nets to be very efficient at our sites because the YOY density was likely low and the amount of time that the gear would be actively fishing would be much less than with passive gear. The FMP requires that dip net sampling include night sampling, which may be difficult to implement given available staff. Dip nets were useful at the Virginia Potomac sites, but the number of YOY eels there was obviously higher and large numbers of YOY were often seen grouped at these sites.

3. Sites are not expected to harbor eels in any abundance

In February, MDNR and VIMS personnel met to discuss the characteristics of ideal YOY sampling sites, based on our experience with the ASMFC American eel Technical Committee. We agreed that an ideal site would be:

1. In close proximity to the mainstem of the Potomac or one of its major tributaries. This siting would minimize dispersal, and maximize encounter probability. It also would maximize the salinity difference above and below the trap.

2. A good source of freshwater to attract immigrating YOY.

3. Associated with an impassible blockage, preferably directly below the freshwater source (e.g., dam on lake) to concentrate the YOY at a relatively discrete location.

4. Small enough so that our traps could be effective over a large portion of the total width.

After multiple field surveys of potential sites, we found very few accessible discrete
sources of freshwater with blockages that were also small enough for efficient sampling. Of these sites, few were close to the mainstem of the Potomac. The sites ultimately used were located further upstream than we thought ideal. Due to the distance between the mainstem of the Potomac and the sampling sites, YOY could have dispersed over a wide area before they reached our traps. With lower YOY density upstream, we would have less chance of encountering YOY in any abundance, especially because our gear did not sample 100% of the width of the stream at any site.

Virginia

The success seen at Gardys Millpond, indicates that the criteria for YOY sampling sites, which were derived by VIMS and MDNR personnel based on ASMFC guidelines, were valid. Unfortunately, finding such suitable sites often proved difficult - especially after Hurricane Floyd had destroyed many of the existing sites in September 1999. Many of the sites visited may have historically provided good eel runs, but destruction of habitat in and around these millponds may have restricted recruitment in 2000. Clarks Millpond fit all the criteria for an ideal site - but few eels were captured in the ramps, and dip netting up and down the creek below the spillway produced even fewer eels. If the run is highly variable from year to year (as is suspected), a very productive site one year may be unproductive in future years. Conversely, poor sites in one year may be very productive in others. Logistics were the main obstacle we needed to overcome in the inaugural year of sampling. Travel to, and sampling at, Gardys Millpond takes more than five hours, limiting our ability to sample other Virginia tributaries such as the York River, which have tremendous eel runs. As a result, sampling at these Potomac River sites occurred only two days a week. For ASMFC compliance we must sample at least four days a week. With such infrequent sampling, a run can be missed, or failure of the fishing gear will mean reduced sampling effort. Since 2000 was considered an exploratory year, we believe we have met the goals of identifying the time and places where eels will recruit. In 2001, efforts will focus on increasing the sampling periodicity to meet at least the minimum requirements of the FMP.
CONCLUSIONS AND RECOMMENDATIONS

• Irish elver ramps were an effective gear in upper Chesapeake Bay, coastal Maryland and Virginia. This passive gear would likely prove a cost- and time-effective sampling gear in Maryland’s Potomac River as well, once suitable sampling sites were established.

• Sites with the characteristics described above should be sought out in other areas of the Potomac drainage. The value of these characteristics still holds.

• More gear should be deployed at each site. This will maximize the effective sampling area. Drainages with high densities of eels (perhaps identified from other surveys) could be targeted for YOY sampling. Sites in these drainages may have as yet unquantified characteristics which make them particularly attractive to immigrating YOY.

• Sampling should be considered further upstream in the Potomac. Although the distance from the ocean would increase at such sites, these sites may be closer to the mainstem of the Potomac than the 2000 Maryland sites. Large eels have been observed further up the drainage in electrofishing surveys, and presumed YOY eels are often reported near Great Falls. Personnel may be more easily recruited to this area.

• Sampling should continue at Gardys Millpond on the Virginia side of the Potomac. With a mean catch rate of over 67 eels per sampling day, it was the most successful of all sites. Sampling should start on or around March 1, and continue through June 1 if necessary. Given the great variability associated with spring temperatures in the Chesapeake region, we must sample a wide range of water temperatures to ensure that sampling occurs at optimal temperatures. Dip netting may be an expedient way to determine the presence and relative abundance of eels and act as a barometer indicating when passive gear should be deployed.

REFERENCES


14


TABLES
Table 1. Potomac River sites evaluated and/or sampled by Maryland DNR and VIMS in the Spring of 2000.

<table>
<thead>
<tr>
<th>Site</th>
<th>Acres</th>
<th>Location</th>
<th>Code</th>
<th>County</th>
<th>Tributary</th>
<th>Sample</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pope Creek - Potomac Mills Pond</td>
<td>23.06</td>
<td>Rt 3 behind VDOT</td>
<td>PC</td>
<td>Westmoreland</td>
<td>Pope Creek</td>
<td>X</td>
<td>Not accessible. Dropped from survey.</td>
</tr>
<tr>
<td>Sydneys Millpond</td>
<td>28.75</td>
<td>SR 604</td>
<td>SM</td>
<td>Northumberland</td>
<td>Hull Creek</td>
<td>X</td>
<td>Dam washed out. A few eels in culvert on 3/30</td>
</tr>
<tr>
<td>Lake Independence (Mt Airy)</td>
<td>114.03</td>
<td>Stratford Harbor SR639</td>
<td>SH</td>
<td>Westmoreland</td>
<td>Currioman Bay</td>
<td>Spillway inappropriate. Dropped from survey.</td>
<td></td>
</tr>
<tr>
<td>Downing's Millpond</td>
<td>9.34</td>
<td>SR 629</td>
<td>DW</td>
<td>Northumberland</td>
<td>Presley Creek</td>
<td>X</td>
<td>Sampling regularly from 3/30-5/16. Ramp placed inside culvert. Dip netting by time, but was ineffective due to clay bottom.</td>
</tr>
<tr>
<td>Clarks Millpond</td>
<td>14.23</td>
<td>SR 634</td>
<td>CM</td>
<td>Northumberland</td>
<td>Coan River</td>
<td>X</td>
<td>Mill dam destroyed by H. Floyd. No eels in dip nets on 4/5</td>
</tr>
<tr>
<td>Gardy’s Millpond</td>
<td>46.52</td>
<td>SR 617</td>
<td>GP</td>
<td>Northumberland</td>
<td>Yeocomico River</td>
<td>X</td>
<td>Road closed and dam destroyed by H. Floyd. Eels present in dip net 4/5.</td>
</tr>
<tr>
<td>Mill Creek Pond</td>
<td>20.55</td>
<td>Route 360</td>
<td>MP</td>
<td>Northumberland</td>
<td>Coan River</td>
<td>X</td>
<td>Tidal. Dropped from survey.</td>
</tr>
<tr>
<td>Beales Millpond</td>
<td>38.38</td>
<td>SR 612</td>
<td>BE</td>
<td>Northumberland</td>
<td>Yeocomico River</td>
<td></td>
<td>Field evaluation showed insufficient drainage area for attractant flow, or insufficient head to allow for effective diversion to the trap.</td>
</tr>
<tr>
<td>Maryland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>St. Mary’s Lake</td>
<td>250.00</td>
<td>ML</td>
<td>St. Mary’s</td>
<td>St. Mary’s River</td>
<td>X</td>
<td>Sample regularly 5/4-6/2.</td>
<td></td>
</tr>
<tr>
<td>Budds Creek</td>
<td></td>
<td>Rt 234</td>
<td>BC</td>
<td>Charles</td>
<td>Wicomico River</td>
<td>X</td>
<td>Sample regularly 5/4-6/2.</td>
</tr>
<tr>
<td>Trinity Lake</td>
<td></td>
<td>WL</td>
<td>TL</td>
<td>Charles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cedarville Pond</td>
<td></td>
<td>CD</td>
<td>CD</td>
<td>Charles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gilbert Pond</td>
<td></td>
<td>GP</td>
<td>GP</td>
<td>Charles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wherritts Pond</td>
<td></td>
<td>WP</td>
<td>WP</td>
<td>St. Mary’s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locust Grove Cove</td>
<td></td>
<td>LG</td>
<td>LG</td>
<td>St. Mary’s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belvidere Rd. Pond</td>
<td></td>
<td>BP</td>
<td>BP</td>
<td>St. Mary’s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hampton Rd. Pond</td>
<td></td>
<td>HR</td>
<td>HR</td>
<td>St. Mary’s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big Duke Creek Pond</td>
<td></td>
<td>BD</td>
<td>BD</td>
<td>St. Mary’s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redman Branch Pond</td>
<td></td>
<td>RB</td>
<td>RB</td>
<td>St. Mary’s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tom Swamp Run Pond</td>
<td></td>
<td>TS</td>
<td>TS</td>
<td>St. Mary’s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avenue Branch Pond</td>
<td></td>
<td>AB</td>
<td>AB</td>
<td>St. Mary’s</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Statistics on catch by site and gear type. Mean is shown in catch per sampling events. An event is each individual dip net, or each day a static gear was fished.

<table>
<thead>
<tr>
<th>Virginia</th>
<th>Young-of-the-Year</th>
<th>Elvers</th>
<th>Date</th>
<th>N Dips or days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Name</td>
<td>Site Code</td>
<td>Gear</td>
<td>Total</td>
<td>Mean</td>
</tr>
<tr>
<td>Clarks Millpond</td>
<td>CM</td>
<td>Dipnet</td>
<td>2</td>
<td>0.08</td>
</tr>
<tr>
<td>Gardys Millpond</td>
<td>GA</td>
<td>Dipnet</td>
<td>645</td>
<td>11.32</td>
</tr>
<tr>
<td>Courtneys Pond</td>
<td>CP</td>
<td>Dipnet</td>
<td>7</td>
<td>3.50</td>
</tr>
<tr>
<td>Syndnors Millpond</td>
<td>SM</td>
<td>Dipnet</td>
<td>1</td>
<td>0.14</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>961</td>
<td>8.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maryland</th>
<th>Young-of-the-Year</th>
<th>Elvers</th>
<th>Date</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Name</td>
<td>Site Code</td>
<td>Gear</td>
<td>Total</td>
<td>Mean</td>
</tr>
<tr>
<td>Budds Creek</td>
<td>BC</td>
<td>Sheldon Trap</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Gilberts Swamp Run</td>
<td>GC</td>
<td>Irish Ramp</td>
<td>3</td>
<td>0.25</td>
</tr>
<tr>
<td>Hoghole Run</td>
<td>HR</td>
<td>Sheldon Trap</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>St. Mary's Lake</td>
<td>ML</td>
<td>Irish Ramp</td>
<td>2</td>
<td>0.17</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>6</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Maryland Young-of-the-Year Elvers Date
Table 3. Gear comparisons between the Irish eel ramp, Virginia Fyke net, and two types of dip net methods performed at Brackens Pond (York River) Yorktown Virginia. Mean represents the mean catch per sampling event (N).

<table>
<thead>
<tr>
<th>Gear Type</th>
<th>Glass Eels</th>
<th>Elvers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Per Event</td>
<td>Maximum Catch</td>
</tr>
<tr>
<td>Dipnet (Distance)</td>
<td>30.646</td>
<td>314</td>
</tr>
<tr>
<td>Dipnet (Time)</td>
<td>13.458</td>
<td>67</td>
</tr>
<tr>
<td>Irish Eel Ramp</td>
<td>492.16</td>
<td>8025</td>
</tr>
<tr>
<td>Virginia Fyke Net</td>
<td>37.864</td>
<td>392</td>
</tr>
</tbody>
</table>
Figure 1. Sites evaluated and sampled in Spring 2000.
Figure 2. Maryland Irish elver ramp with open lid.
Figure 3. Sheldon trap downstream of Irish elver ramp at Budds Creek.
Figure 4. Gilbert Swamp Run

Figure 5. St. Mary's Lake
Figure 8. Virginia Irish eel ramp at Bracken's Pond (York River) Yorktown. Location is inside the culvert beneath the Colonial Parkway.
Figure 9. Sydnors Millpond
Figure 10. Clarks Millpond (Coan River) with the location of the Irish ramp and dip net sampling.
Figure 12. Gardys Millpond (Yeocomico River) and location of set distance and timed dip net sampling.
Figure 13. Catch per unit effort for YOY and elvers (> 85mm) for the Irish eel ramp and dip nets at Clarks Millpond.
Figure 14. Catch per unit effort for YOY and elvers (> 85mm) for the Irish eel ramp and dip nets at Gardys Millpond.
Figure 15. Virginia fyke net being fished at Brackens Pond (York River), Yorktown Virginia.
Figure 16. Physical parameters measured at Gardys and Clarks Millponds.
Figure 17. Mean, 95% confidence intervals and minimum/maximum length for Gardys Millpond from weekly samples
Figure 18. Length/Weight regression from yoy eel samples taken weekly from Gardys Millpond.

\[ \text{TotWt} = 45.57 \times \text{TotLen} + 48.88 \]

\[ r^2 = 0.6175, \ p \leq 0.0001, \ df = 196 \]