

Acknowledgements

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Spring 2001 Anacostia Tributary System Herring Reconnaissance and Larval Stocking

Summary

In order to compensate for impacts to tidal and non-tidal wetlands and submerged aquatic vegetation (SAV) in the replacement of the Woodrow Wilson Bridge, a mitigation package is underway which proposes a number of projects to replace the environmental function of affected resources. One of these mitigation projects involves restoration of migratory river herring to historical spawning areas in the Anacostia watershed. Efforts to remove migratory fish blockages are continuing, and in 2000 a larval river herring-stocking program was initiated through the Anacostia Fish Passage Working Group (AFPWG), working in conjunction with the Potomac Crossing Consultants (PCC). In 2001, the Interstate Commission on the Potomac River Basin (ICPRB), the Metropolitan Washington Council of Governments (MWCOG), and PCC performed a migratory fish reconnaissance survey and larval stocking program. Alewife Herring (*Alosa pseudoharengus*) and Blueback Herring (*Alosa aestivalis*) broodstock were collected, the eggs fertilized, then transported to the Maryland Department of Natural Resources (MDDNR) Joseph H. Manning Fish Hatchery at Cedarville State Forest in Charles County, Maryland for incubation and hatching. In 2001, an estimated 2.7 million hatched larval river herring were subsequently stocked back to the Anacostia River tributaries and Rock Creek mainstem, another tributary to the Potomac River. This brings the two-year project total to 5.3 million larvae stocked.

Project Background and Purpose

During construction of the Woodrow Wilson Bridge replacement, unavoidable impacts to wetlands and submerged aquatic vegetation will occur. As part of the Aquatic Resource Conceptual Mitigation Plan (ARCMP) of the Environmental Impact Statement for the Woodrow Wilson Bridge Improvement Study, several out-of-kind options to replace the functions and values of the impacted areas will be conducted. One of the out-of-kind replacement options identified in the ARCMP is the removal of migratory fish blockages in the Anacostia River watershed. This option seeks to open historical spawning areas of migratory fish and as a result, mitigate for impacts on fish habitat from bridge construction.

Organized in 1990 by ICPRB and more recently reconvened by the MWCOG, the Anacostia Fish Passage Working Group (AFPWG) has served as the coordinating body for local, state, and federal agencies. As one of the group's priority tasks, fish barriers throughout the Anacostia River watershed were to be identified and subjected to removal/modification to allow resident and anadromous fish migration. Since 1998, the PCC has worked with AFPWG, and in 2000 a larval herring monitoring and restocking program was conducted. The results of the 2000 study returned nearly 2.6 million herring larvae back to the Anacostia and Rock Creek watersheds, and recommendations indicated continued efforts were needed to restore fish passage in the Anacostia River tributaries. In coordination with AFPWG, PCC agreed to conduct a Spring 2001 larval herring stocking program in conjunction with ICPRB, MWCOG, and MDDNR as an out-of-kind option to mitigation for impacts from the Woodrow Wilson Bridge construction. In 2001, the herring monitoring and restocking program continued, returning nearly 2.7 million larval herring back to the Anacostia and Rock Creek watersheds. This report describes 2001 project results.

The objective of the project was to continue the restoration of the river herring fisheries in the Anacostia Watershed through the stocking of larval Alewife and Blueback herrings. These larval fish were stocked at five AFPWG recommended major tributary sites (specific site description are detailed later in the text). Furthermore, river herring larvae were stocked into a Rock Creek site when the total number of larval

fish stocking quota was reached for the Anacostia watershed. The spring 2001 Larval Herring Stocking Project involved two tasks.

- I. Under the first task, an electrofishing reconnaissance survey was performed to:
 - verify the presence of herring and other migratory fishes in both the Northwest and Northeast Branches of the Anacostia River,
 - gauge the river herring relative strength of the run, and
 - determine which location(s) provide the greatest probability for the collection of broodstock.
- II. Under the second task, herring broodstock collection and restocking was performed to:
 - remove eggs from approximately 100 or more ripe female river herring, fertilize them with milt from an equivalent number of collected spawning male herring, fertilize the eggs in the field,
 - transport fertilized eggs to the MDDNR's Manning Fish Hatchery in Cedarville, Maryland for incubation and hatching, and
 - stock larval herring into the five major tributary locations in the Anacostia Watershed.

Methodology

Task 1. Electrofishing Reconnaissance Survey

An electrofishing reconnaissance survey of adult migratory fishes was conducted during the spring 2001 migratory fish runs, which include Alewife Herring (*Alosa pseudoharengus*), Blueback Herring (*Alosa aestivalis*), Hickory Shad (*Alosa mediocris*), White Perch (*Morone americanus*), American Eel (*Anquilla rostrata*), and Sea Lamprey (*Petromyzon marinus*). Eight stations (Figure 1) were sampled to determine the presence and strength of the herring run. The stations were located immediately downstream from known or suspected blockages, where migrating herring typically concentrate. Sampling was conducted during daylight hours using a Smith-Root backpack electroshocker employing pulsed direct current. Generally, one person operated the electroshocker while two persons netted stunned fishes. The nets used to capture the stunned fish were two Smith-Root Model #EDN-83-TD with 0.25 inch mesh nets.

The major objectives of each collection trip were to determine the extent and magnitude of upstream river herring migration occurring on that particular day, and the spawning condition of the river herring. At each station, a one pass or "sweep-type" electrofishing was performed for an approximately 400 to 600 foot length of stream. Output power was field adjusted to account for variations in stream conductivity. Sampling times through the day were staggered (i.e. starting at mid-morning to mid afternoon) to increase the likelihood of encountering migrating fish. Depending on stream conditions, the Northwest Branch at US Route 1 was surveyed more than once per day. Collected migratory fish were counted, weighted, length measured, and sexed for evidence of row or milt. Notes were taken on their general conditions, dorsal fins were clipped to identify where they were captured, and then they were released. Attempts were made to capture all fish sighted during electrofishing. If schools were so large that capture of all individuals was not possible or desirable, they were sub-sampled and records were kept on the estimated size of the school observed. Daily water temperature, ph, conductivity, turbidity, dissolved oxygen and general flow and weather conditions were recorded. Information was obtained and recorded from these surveys and used to evaluate the best locations for the collection of broodstock.

During each day of the reconnaissance survey period, efforts were made to determine whether the herring run was weak, i.e. not likely to yield the daily targeted minimum of 0.15 liters of eggs necessary for



Figure 1. Spring 2001 Anadromous Fish Reconnaissance and Monitoring Sites.

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hatchery incubation, or strong, i.e. likely to meet or exceed the daily volume of egg threshold. In addition, an overall project target of at least 100 ripe females was estimated necessary to produce the project target of one to two million stocked larvae. If the overall herring run was not found to be strong enough in the Anacostia River system to support these targets, then the protocol for collection of broodstock was to be modified to include supplemental herring collection in the Potomac River.

Task 2. Herring Broodstock Collection and Stocking

The protocol for collecting Alewife and Blueback broodstock involved a targeted collection of approximately 100 ripe females over an estimated 4-6-week period. The stations designated for broodstock collection were determined from the results of previous 1999 and 2000 reconnaissance survey. Collections occurred during daylight hours using a 50 x 4 foot and $\frac{1}{4}$ inch mesh haul seine, and was employed to capture broodstock in a sweeping arc across the width of the stream. The use of a haul seine can dramatically reduce the stress placed upon the fish, compared with the stress on the fish as a result of electrofishing.

During the course of the project, an attempt was made to supplement river herring egg collections of the Anacostia watershed with a collection of eggs from the Potomac River. With the cooperation of Fletcher's Boathouse staff in the District of Columbia, broodstock were collected at a site on the

mainstem Potomac River. In these instances, collections occurred in pre-dawn hours using two 75 foot and one 150 foot long mono-filament gill nets with 2.75-inch stretch mesh for use in capturing herring. The nets were pulled through the water column until a sufficient number of fish were captured.

At all broodstock collections, ripe females were collected and stripped of eggs into shaded bowls containing ambient stream water temperature (Figure 2). Eggs from Alewife Herring were kept separate from Blueback Herring and each set of eggs was fertilized by milt from males of the appropriate species. A minimum of 0.15 L of fertilized eggs per sampling event was required for incubation. Fertilized eggs were allowed to sit in



Figure 2. Stripping female herring



Figure 3. Separation and clearing of herring eggs

darkened buckets for approximately 45 minutes, then packaged with battery powered aerators at ambient stream temperature, and delivered promptly to the Maryland Department of Natural Resource's (MDDNR's) Joseph H. Manning Fish Hatchery, at Cedarville State Park, located approximately 40 miles away in Charles County, Maryland. Through a cooperative agreement with MDDNR, the fertilized eggs were incubated to yolk sac-stage larvae before they were released.

In preparation for incubation, the eggs were separated by adding 20 grams of salt (NaCl) and 0.375 grams of tannic acid into 5 liters of water. A few drops of de-foamer were added and the mixture agitated and aerated for 6-7 minutes. To clear the eggs, they were extracted from the above mixture (Figure 3), rinsed with well-water and then were added to another solution of 20 grams of Salt (NaCl), 15 grams of Urea, and 5 liters of water. De-foamer was added, and the mixture

agitated/aerated for 6-7 minutes more. The eggs were then rinsed and transferred to incubation containers, which are constantly refreshed with cool fresh well water. Over an approximately 5 to 10 day period, the eggs were incubated and hatched to a larval stage, after which approximate counts of viable eggs and pre-stock larvae survival rates were determined. The larvae were then transported in covered, black, 5-gallon containers from the hatchery back to the Anacostia five stocking sites. The Anacostia stocking locations are shown in Figure 4 and included the following five major Anacostia tributary sites: 1. Indian Creek at Sunnyside Avenue, 2. Little Paint Branch at Sellman Road, 3. Paint Branch at Powder Mill Road (MD 212), 4. Northwest Branch at Riggs Road (MD 212) and 5. Sligo Creek at New Hampshire Avenue (MD 650).



Figure 4. 2001 Stocking Sites

All five Anacostia sites are located well upstream of existing fish blockages and represent what are believed to be near the upper historical range of river herring in the Anacostia tributary system. When placing the larval herring into the stream, the container holding the larvae was first placed into the stream to help the contents acclimate to the ambient temperature of the stream, with additional amounts of stream water slowly poured into the container (Figure 5). After 5-10 minutes of acclimating to the stream temperature, the herring fry were released into a slow moving portion of riffle habitat. Over a 4-6 week period (approximately April 6



Figure 5. Release of herring larvae

to May 31), a project target of one to two million Alewife and Blueback herring larvae were to be released in batches at the five locations. As previously mentioned, once the river herring larval stocking quotas were met for the Anacostia watershed, additional larvae were stocked into the Rock Creek mainstem at Garrett Park Road in Montgomery County.

Results

Task 1. Reconnaissance Survey

Reconnaissance sampling in the Northwest Branch Anacostia River was initiated on March 22, 2001 and occurred intermittently through May 14, 2001. Results from reconnaissance sampling (Table 1) showed both Alewife and Blueback herring migrating up to all stations (i.e., US Route 1, 38th street and the immediately below the NW1 "pump house" blockage) as previously documented in past surveys. Presence of river herring, immediately below the NW1 "pump house" blockage, was observed in higher numbers and more frequently during sampling days in 2001.

Reconnaissance sampling in the Northeast Branch Anacostia River showed no presence of migratory herring in Indian Creek. However, it did show large groups of migrating Alewife herring (i.e., estimated to be about 300 individuals for sampling date April 9, 2001) in the Paint Branch on multiple sampling dates, but only up to the blockage caused by a concrete utility line capping approximately 800 feet upstream from US Route 1. Blueback herring were not collected nor observed at the Northeast Branch sampling sites.

Table 1 lists the migratory anadromous fish species and the total number of each species collected during the reconnaissance survey. A total of 377 river herring were captured via electro-fishing from all the survey sites with roughly 70 percent of the fish captured from the Northwest Branch sites. The higher total number of river herring captured at Northwest Branch is a direct result of the highest number of electrofishing surveys (12) conducted at this sampling site. This is an established river herring concentrating area where both monitoring and broodstock adult collections regularly occur.

Additionally, there were a total of three other migratory anadromous fish species captured in the 2001 survey. As in the previous two years, Hickory shad (Figure 6) were collected in very low numbers. In contrast, White perch were collected and observed to be abundant throughout the survey period. Absent from this year's survey were Striped bass and Yellow perch. It should be noted that in past years, young juvenile Striped bass were collected immediately below the US Route 1 fishway site.



Figure 6. Hickory Shad Captured at Northwest Branch US Route 1

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		White Perch		0	0	0	0	0	0	0	qo	qo	qo	qo	0	qo
		Ніскогу Shad		0	0	0	1	0	0	1	1	0	0	0	0	Э
		Blueback Herring		0	0	0	0	0	0	0	0	6	5	8	0	22
		gnirnəH əfiwəlA		0	39	7	19	1	22	0	99	0	1	0	0	155
Stream	Site	Species Observed	2001 Sampling Date	3/22	3/28	4/02	4/06	4/9	4/16	4/20	4/26	5/3	5/4	5/10	5/14	Total

Table 1. Year 2001 Anacostia Watershed River Herring Monitoring/Reconnaissance Survey

Note: Number of migratory fish captured for monitoring/reconnaissance survey does not include migratory herring captured by use of haul seine for broodstock collection.

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Gizzard Shad observed throughout the study. Shaded areas indicate that electrofishing survey was not conducted. ob indicates white perch were observed in large numbers but not counted .

In this year's reconnaissance survey, there were two non-anadromous fish species collected that in prior year's surveys have not been documented. The silverside (*Menidia sp.*) and the quillback (*Carpiodes cyprinus*) both were collected in the Northwest Branch. A young quillback was captured at the Paint Branch site.



Figure 7. Silverside (*Menidia sp.*)



Figure 8. Quillback (*Carpiodes cyprinus*)

Task 2. Broodstock Collection and Stocking

Broodstock collection for both mature males and ripe females occurred from April 6, 2001 through May 10, 2001 for a total of 11 days. A summary of the estimated number of viable eggs and stocked larvae is shown in Table 2. The number of ripe females collected was 219 individuals which is more than double the initial target number proposed. The total volume of fertilized eggs was 10.5 liters, an amount that was 1.6 liters more than 2000's total. It should be noted that the 2001 total volume of fertilized eggs were collected from the Northwest Branch, whereas the 2000's total included supplemental eggs from the Potomac River. An attempt was made to supplement broodstock collections by fish collected at Fletcher's Boathouse on the mainstem Potomac River. Through a cooperative agreement with Fletcher's Boathouse and D.C. Fish and Wildlife program, collections at this site occurred in the early mornings using gillnets. All attempts at harvesting viable eggs at this site proved unsuccessful.

Table 2. Year 2001 Estimated Number of Viable Eggs and Stocked River Herring Larvae

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¹ River herring were not collected from the Northeast Branch at River Road (behind the Maryland-National Capital Park and Planning Commission parking lot) due to relatively low abundance. ² River herring collection technique employed the following sampling equipment: Model 15-D Smith-Root Backpack Electrofisher, 50 and 25 foot-long seine haul nets. ³ Generally, three male herrings were used to remove milt for every one female stripped of eggs. ⁴ Per correspondence with MDDNR, mature Blueback female herrings generally broadcast 800 to 1330 total number of eggs per milliliter. Alewife herrings generally broadcast in the range of 400 to 1030 total number of eggs per milliliter. Since both Blueback and Alewife herring eggs were combined into a hatching jar, the range of 400 to 1330 total number of eggs per milliliter. Since both Blueback and Alewife herring eggs were combined into a hatching jar, the range of 400 to 1330 total number of eggs per milliliter. Since both Blueback and Alewife herring eggs were combined into a hatching jar, the range of 400 to 1330 total number of viable eggs collected. Additionally, the 865 eggs per milliliter was used as the median range value. ⁵ Estimated number of viable eggs collected. Additionally, the 865 eggs per milliliter was used as the median range value.

The Anacostia and Rock Creek watersheds-stocking schedule is shown in Table 3. Approximately 2.7 million Alewife and Blueback herring larvae were stocked to five locations located in the Anacostia Watershed (Figure 4). Approximately 0.13 million herring larvae were stocked in the Rock Creek mainstem near Garret Park in Montgomery County, Maryland. The estimated total of 2.7 million stocked larvae exceeded the original projected target stocking numbers of 1-2 million. The total for the two-year stocking effort, is five million river herring larvae stocked in the Anacostia Watershed and 0.33 million stocked in the Rock Creek mainstem.

Year 2001		A Tribu	Rock Creek Watershed					
	Sligo Creek	Northwest Branch	Paint Branch	Little Paint Branch	Indian Creek	Totals	Mainstem	Totals
	New Hampshire Avenue	Riggs Road	Powder Mill Road	Sellman Road	Sunnyside Avenue		Garrett Park Road	
4/12/01	378,540	378,540	378,540		113,562	1,249,182		1,249,182
4/16/01	386,111	386,111	386,111			1,158,332		1,158,332
4/30/01				130,000		130,000		130,000
5/10/01							129,030	129,030
5/16/01		75,708				75,708		75,708
Totals	764,651	840,359	764,651	130,000	113,562	2,613,222	129,030	2,742,252

Table 3. Year 2001 Anacostia and Rock Creek Watershed Stocking Schedule and total number of viable larvae stocked

Shaded area indicates no stocking.

Discussion

As in past years, Alewife herring dominated the herring collections. A significant number of White perch were also captured on the Northwest Branch, which is consistent with previous years. As previously mentioned, no Yellow perch and Striped bass were captured. For the third consecutive year, Hickory shad were captured in the Northwest Branch at Route 1.

Electroshocking reconnaissance of the Northwest Branch showed a strong run up to the fishway at US Route 1. In many instances, herring were observed swimming in the channel of the fishway or on the concrete pad just above the fishway. Strong runs of herring were observed at the next upstream survey site (38th street), as well as at the first blockage upstream of 38th street (NW1). During the early course of the migratory period, the lowest baffle on the Northwest Branch fishway at Route 1 was temporarily repaired (Figure 9) as recommended in the 2000 study. This seemed to effectively allow herring to run through the fishway at all flow velocities. The success of this repair was evident in the large number of herring captured at 38th street and immediately below the first blockage (NW1) on April 9th (Table 1). Such large numbers of river herring were not observed during the early parts of the migratory periods in past surveys.



Figure 9. Temporary Repair at the Lowest Downstream Baffle on the Northwest Branch fishway at US Route 1

A comparison of the catch per unit effort (CPUE) at US Route 1 with previous years is shown in Figure 6, and indicates an increase in the strength of the herring run. However, the project was not specifically designed to determine CPUE. The larger CPUE in 2000 and 2001 for this station is complicated by the extended effort that was made to capture as many fish as possible for the collection of broodstock, as well as the use of two netters instead of one to capture stunned fish. There are inherent conflicts in a study requiring both reconnaissance and capture of a migratory species in the short time span of several weeks, and therefore a more detailed comparisons of 2000 and 2001 data with previous years data can not be made.



Figure 7. 2001 Electrofishing Catch per Unit Effort of River Herring on Northwest Branch at US Route 1.

Results of the electroshocking reconnaissance showed that the best locations for collection of herring broodstock in the Anacostia watershed were the Northwest Branch below Route 1 and in the Northeast Branch at the Paint Branch blockage above Route 1. The blockage on Paint Branch above Route 1 was first discovered in 2000. This structure is a utility line crossing with a concrete cap, which developed into a fish blockage as a result of urban sediment movement. It remains a blockage to river herring migration.

In the 2000 study, broodstock collections using gillnets on the mainstem Potomac River at Fletcher's Boathouse proved highly successful and provided large numbers of viable eggs. In 2001, attempts were made to duplicate previous year collections there and supplement collections from the Anacostia watershed. Unfortunately, in 2001, not enough ripe females were collected, and no viable eggs were produced from this site. Future attempts of broodstock collections may still occur at this site since past success showed much promise.

Overall, the broodstock collection efforts at all stations resulted in the capture of more than 2000 alewife and blueback herring individuals with 219 ripe females bearing eggs. Such collections on the Northwest Branch at Route 1 using haul seines proved successful and provided ample spawning herring with the least amount of collection effort and placed the least amount of stress on captured fish. All attempts were made to minimize egg mortality, however egg mortality is inherent with the "field strip/spawn" technique. Egg mortality may be due to several factors, such as variations in sunlight, water temperature, oxygen saturation and time allowed for fertilization or transport. Larval mortality may include such factors as limited food supply in hatchery holding tanks, the exchange of larvae from holding tank to the stocking containers and transport time.

As stated earlier, for the past two years an approximate total of 5.3 million larval river herring has been reared under the larval stocking program and of that total, five million have been stocked into the major tributaries of the Anacostia watershed with the remainder stocked into the Rock Creek mainstem. This five million total easily surpasses the two-year stocking target total range of 2 to 4 million. As per the AFPWG's restoration priorities, larval stocking was proportional to stream needs, size, habitat quality and expected herring utilization and thus the Northwest Branch, including Sligo Creek, received a greater proportion (>60%) of the total stocked fry for the Anacostia watershed than the other three stocking sites combined in each of the past two years.

The specific intention of this stocking program should promote the return of spawning adult herring by chemically imprinting these larval fish to their historic spawning stream reaches. By the end of the 5-year stocking program, it is envisioned that existing downstream fish blockage(s) will have been removed and/or modified thereby permitting full upstream migration and utilization of spawning habitat.

Recommendations

The findings of this study support the priorities and objectives of the Anacostia Fish Passage Workgroup with the following additions:

- 1. Continue the broodstock collection and stocking of river herring larvae into the upper reaches of the Anacostia Watershed to continue to restore these fish to historic spawning ranges and rebuild the their populations.
- 2. Future broodstock collections in the Anacostia Watershed should continue to employ the use of haul seines.
- 3. Attempts should be made to continue collection of broodstock from the Potomac River through the collaborative arrangement with Fletchers Boat House.
- 4. The Paint Branch blockage located upstream of Route 1 should be modified to permit fish passage.
- 5. Work with the respective agencies (USACE, and M-NCPPC) and local government (Prince George's County) to install a "No Fishing" sign at the Northwest Branch US route 1 USACE fishway site.
- 6. If possible, preparations are needed to begin checking for hatchery marks on returning herring.

Appendix A: Sampling Sites

The following are descriptions of the sampling sites. These sites are based on historic migratory fish sampling study areas in the Anacostia River watershed. The Northwest Branch, identified by the Anacostia Fish Passage Workgroup as the area of highest priority for fish passage, received the study's highest priority. Sampling station locations are shown in Figure 1, Page x

Northwest Branch:

1. (Us Route 1 fishway): The structure supporting the MD Route 1 Bridge crossing the Northwest Branch has, at times, had an adverse affect on fish migration. This area was modified in the fall of 1995, and the glide leading under the bridges was replaced with a notched weir and Denil fish passage. The area below the weir was designated as the furthest downstream point. This point was used to assess the strength of the migratory run and to establish the abundance and species that might employ the fish passage. In 1999 and 2000, it was determined that the baffle on the lowest cell of this fishway is in need of repair.

2. (38th Street V-notched sheet pile weir): The blockage is immediately upstream of 38th Street and is a sheet pile weir notched to allow fish passage. A small boulder field lies downstream of the weir to concentrate baseflow and provide an approach channel to the V-notch.

3. (NW1): Northwest Branch at the Pumping Station is approximately 400 feet upstream from 38th Street. It is a severely deteriorating gabion weir with two large pools below it.

4. (NW2): Approximately 2850 feet above the pumping station site. This site is a gabion weir 10 meters downstream from a tot lot. This weir might pass fish near a cascade on the right side (looking upstream) during high flows. During lower flows, it becomes a 6- to 18-inch cascade.

5. (NW3): Approximately 500 feet below Queens Chapel Road are two large concrete and gabion capped pipes that cross close to one another, with a deep, narrow pool between the two pipes and a large deep pool below the second pipe.

Northeast Branch:

6. (NEB1 @ MNCPPC): The furthest downstream point in the Northeast Branch to be sampled for this study is under River Road, near the Maryland National Capital Park and Planning Commission Offices (identified as Northeast Branch at MNCPPC), where a large metal weir spills over boulders and chunks of concrete into a deep pool. In the past this weir was a complete blockage to migration but in 1991 was modified to permit fish passage. Large numbers of herring can usually be spotted just below this weir during the peak of the run.

7. (Paint Branch 1 @ US Route 1): This blockage is located approximately 500 feet upstream of the Route 1 crossing. A large pool below a concrete rubble dam seems to have concentrated migrating herring in 2000.

8. (Paint Branch 2 @ Indian Creek): Two sweep sampling stations are located closely together upstream at the junction of Paint Branch and Indian Creek (see below, Indian Creek1). Monitoring was performed in a sweep section above the confluence with Indian Creek.

9. (Paint Branch 3 @ I-495): Paint Branch at I-495, to determine whether fish had migrated that far upstream. Both Alaska steep-pass and concrete step-pool fish passages have been installed at this site by the Maryland State Highway Administration to assist fish in bypassing blockages. The first, just on the south end of the inner loop, is a two-tier concrete step-pool that allows the fish to make three small attainments rather than one large one. Downstream of the outer loop of I-495, a small Denil fish passage has been built to help fish make the attainment over the foundation of the bridge. A previous blockage just below the Washington Beltway on Paint Branch has ceased to function as a blockage. The concrete casing for the pipe has continued to erode to a point where the flow is smooth, laminar, and slow when going over the structure. This area will be visually examined to ensure that this situation did not change.

10. (Indian Creek1 @ Paint Branch): Two sweep sampling stations are located closely together upstream at the junction of Paint Branch and Indian Creek (see above, Paint Branch1). Monitoring was performed in a sweep section above the confluence with Paint Branch. Turbidity in Indian Creek is typically much higher than Paint Branch.

11. (Indian Creek2 @ Greenbelt Road): Downstream from the box culvert crossing.

12. (Indian Creek3 @ I-495): at and immediately upstream from I-495 (Washington Beltway) bridge, along a glide where fish tend to congregate. This is the furthest upstream that herring have been found in the recent past (1992). At that time a large beaver dam created a blockage that made monitoring more conclusive. The beaver dam was removed in 1993 and sweep electrofishing was performed here on occasion.

13. (Lower Beaverdam Creek1 @ Kenilworth Avenue): Immediately below the concrete channel

Potomac River

14. (Fletcher's Boathouse) Gill net sampling site located in the mainstem Potomac River approximately 5000 feet downstream of Chain Bridge, and approximately 400 ft downstream of Fletchers Boathouse landing.