

2024 Reel Rewards Invasive Fish Bounty Program: Project Summary

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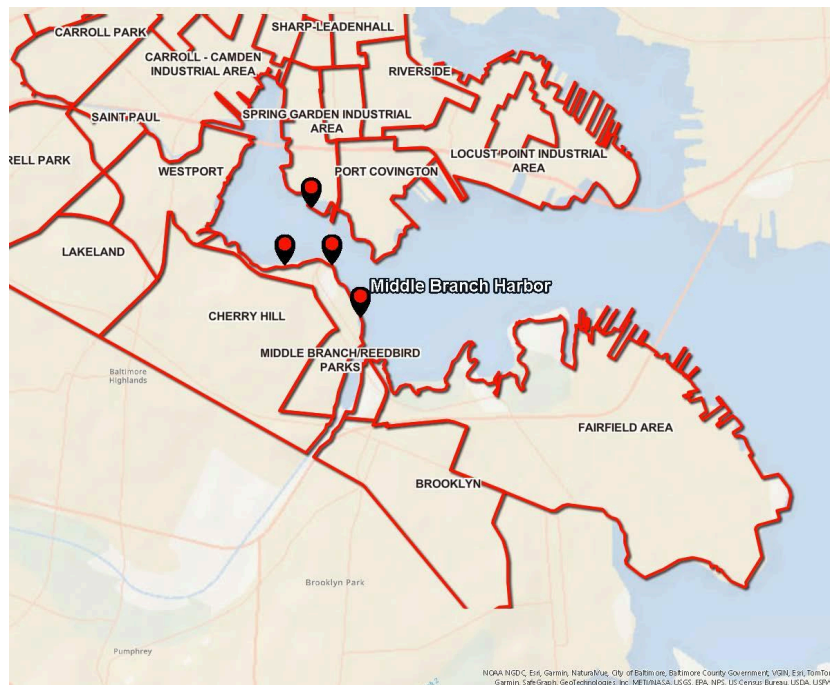
I. Background

A. Harbor History

Beginning with the Indigenous people of the Piscataway, Cherokee, Lumbee, and Susquehannock tribes over 12,000 years ago, the Baltimore Harbor has always been an integral waterbody for fishing and livelihoods (1)(2). Today, the harbor features 6,800 miles of waterfront, offering abundant opportunities for anglers to enjoy fishing along the Chesapeake Bay and its tidal rivers.

Baltimore has been a highly industrial city since the 1600s, resulting in over 400 years of pollution. Chemical waste and other pollutants have settled on the bottom of its waterways, creating a centuries-old contamination. Humans, plants, and animals living in this environment become negatively affected by these pollutants. Predators—primarily larger fish species—accumulate these toxins from smaller prey, making them potentially unsafe for human consumption.

The Middle Branch Harbor (shown in the map below) is part of the Patapsco River in the Chesapeake Bay and has a rich maritime history. Local communities in South Baltimore have faced centuries of environmental racism and injustice, being situated near environmental



hazards such as waste treatment facilities and flood zones (Vargas-Nguyen et al.). The neighborhoods surrounding this waterbody (outlined in red) are home to diverse populations, including a significant number of veterans. Local anglers report that invasive fish species have been present in the Middle Branch since the 1980s. Despite the ongoing environmental injustices, research on this waterbody and its fisheries remains limited.

B. Past and ongoing restoration efforts

The Middle Branch Resiliency Initiative (MBRI) is a subset of the larger Reimagine Middle Branch Project (RMBP). NOAA has provided \$5.5 million to design and restore wetlands in South Baltimore's Middle Branch Harbor. A total of \$47.7 million in grants has been allocated for the Reimagine Middle Branch Project, focusing on flood mitigation for critical infrastructure (MedStar Harbor Hospital and BGE Spring Gardens), wetland restoration projects, air and water quality monitoring, and tracking river herring and invasive fish species. The Reel Rewards program is funded by NOAA as part of these wetland restoration efforts.

C. Native Fish

The Patapsco River's fish community includes anadromous and catadromous species that migrate between the ocean, river, and tributaries, as well as resident fish that spend most of their lives in the river and estuary.

Notable migratory species include alewife and blueback herring, American and hickory shad, white and yellow perch, striped bass, and American eel (Patapsco Shad and Herring Restoration Monitoring Report, 2014; Patapsco River Dam Removal Study, 2013). Declining populations of ecologically and commercially important migratory fish led to restoration projects. American shad was once the most important commercial fishery, but declining populations closed the fishery in the 1980s (Patapsco Shad and Herring Restoration Monitoring Report, 2014).

Resident species include catfish (brown bullhead, yellow bullhead, channel catfish [naturalized], margined madtom, white catfish, invasive blue and flathead catfish); sunfish (bluegill, green sunfish, pumpkinseed, redbreast sunfish); shiner (common, satinfin, spotfin, spottail, swallowtail); bass (largemouth, smallmouth); trout (rainbow, brown); suckers and carp (white sucker, northern hogsucker, common carp, quillback); minnows (river chub, bluntnose minnow, fallfish, central stoneroller); darters (shield, tessellated); and other species like banded killifish, black crappie, gizzard shad, inland silverside, chain pickerel, and rock bass (Patapsco River Dam Removal Study, 2013; Patapsco Shad and Herring Restoration Monitoring Report, 2014).

D. Commercial Value of Maryland Fisheries

From 2012 to 2022, striped bass were valued at \$5.3 million annually, making them one of the most valuable commercial fisheries in Maryland, second only to blue crab (both hard and soft). American eel, channel catfish, and white perch are each valued at just over \$1 million annually (Federal Fishery Disaster Declaration for Invasive Blue Catfish, Governor Wes Moore, 2023).

The introduction of invasive species is often linked to declines in native fish populations and disruptions in food webs and ecosystems. Blue catfish landings are valued at \$276,000 annually, while northern snakehead landings are valued at \$13,000. However, the economic value of the blue catfish fishery is outweighed by its negative impacts, including increased predation and competition with Maryland's two most commercially important fisheries—striped bass and blue crab.

E. Community value



As described in the “Ethnographic Resource Study: Subsistence Fishing on the Potomac and Anacostia Rivers” (2020), both African American and Piscataway fishers have relied on the rivers’ resources for centuries, maintaining long-standing relationships with the waterways and their tributaries. This deep connection has endured through time, with fishing being integral to their subsistence and cultural practices.

The Piscataway chiefdom historically consisted of multiple subgroups, including the Patuxent, Nacochtanks (Anacostans), Pamunkeys, Nanjemoyes, Potapacos (in southern Maryland), as well as the Doegs and Patawomekes of Virginia. These groups formed a confederation led by a head chief or Tayac. The history of the Piscataway people, however, was largely overlooked and silenced by American colonists. Thanks to oral histories from elders, descendants, and other tribes, alongside archaeological efforts, the full story of the Chesapeake Bay's ecology and its inhabitants is being reconstructed, spanning from pre-contact to the present day (Fiske et al., 2020).

Archaeological studies, in collaboration with Piscataway elders, have revealed shell middens along the Potomac River dating back to 100-1,000 A.D. These middens contain pottery shards, chert blades, and oyster shells found at sites such as Battle Creek. Around 500 A.D., the Piscataway became “riverine-adjusted” people, establishing year-round settlements using rivers, marshlands, and intertidal areas for fishing, hunting, and gathering resources (as reviewed in Fiske et al., 2020). The Piscataway harvested oysters, clams, mussels, sturgeon, shad, and herring using weirs, traps, fish spears, and clam rakes. Seasonal fishing camps, like

those on Hunting Creek in Alexandria and Rock Creek, were established to harvest spring runs of herring and shad (as reviewed in Fiske et al., 2020).

Similarly, African American fishers have long relied on these rivers. The Potomac, Anacostia, and Patapsco Rivers served as both physical and symbolic boundaries between the North and South during colonial times. The colonial tobacco industry depended on the Potomac River and the labor of enslaved West Africans. During this period, a small population of free Black fishers harvested bass, catfish, herring, and shad from the Potomac and Anacostia Rivers. For them, fishing symbolized freedom and an alternative to chattel slavery, and it became a source of wealth, dignity, and pride for the Black community.

Today, subsistence fishing continues to support families and communities, helping to alleviate food insecurity. Multi-generational fishing traditions remain strong, with Black fishers being the most likely to have learned fishing from a family member, according to Fiske's (2020) study. However, these practices now face challenges, including modern consumption advisories and environmental justice issues, which often conflict with historical fishing practices (Fiske et al., 2020).

F. Invasive Fish

Invasive Northern Snakehead, Blue Catfish, and Flathead Catfish threaten the Baltimore Harbor ecosystem, economy, and native species. The following traits enable these fish to take over non-native habitats:

- Apex predators and lack of local predators
- Out-compete native species important to anglers and businesses
- Resilient to environmental and diet changes
- High offspring survival rate

Invasive Snakehead, Blue Catfish, and Flathead Catfish prey on and compete for resources with native species important to anglers and businesses. It is important to remove and study these invasive fisheries to better address their environmental impacts. It is also important that the public recognizes the impacts that these species have and help stop the spread of these fish.

1. Northern Snakehead



Since its discovery in Maryland's riverine system in the early 2000's, the northern snakehead has raised concerns due to its high risk of becoming invasive, driven by aspects of its biology and life

history (Love & Newhard, 2012). Native to the eastern rivers of China, Korea, and Russia, northern snakeheads have established populations in the Chesapeake Bay, particularly in the upper portions of the bay in slow-moving freshwater areas with submerged vegetation and soft substrates (Lapointe et al., 2010; Love et al., 2015; Love & Newhard, 2012).

As predatory piscivores, northern snakeheads have no natural predators as adults in the Chesapeake Bay. Their primary prey is banded killifish (*Fundulus diaphanus*), but they also consume a wide variety of commercially and ecologically important fish and invertebrates, such as white perch (*Morone americana*) (Courtenay & Williams, 2004; Odenkirk & Owens, 2007; Odenkirk & Owens, 2005; Northern Snakehead Working Group, 2007).

The species exhibits high parental care, leading to increased survival rates of offspring through early life stages, although this can result in reduced growth of the parents (Courtenay & Williams, 2004; Qin, 2023).

Northern snakeheads are highly adaptable, with a high thermal tolerance and the ability to survive in low dissolved oxygen environments. They can even survive and move outside of water for extended periods if kept moist. U.S. Fish and Wildlife has documented northern snakeheads in salinities up to 12 ppt, indicating a broader salinity tolerance than previously thought. These factors enable them to establish breeding populations and expand their range despite challenges like poor water quality and terrestrial barriers.

2. Blue Catfish



The invasion of blue catfish (*Ictalurus furcatus*) in the Chesapeake Bay threatens the social and ecological systems of Chesapeake Bay (Robertson et al., 2024). With billions of dollars being invested in bay restoration, it is important to study the dynamics of blue catfish management to address negative impacts (Phillips and others, 2017; USGS, 2024).

An apex predator lacking local predators, blue catfish's diverse diet includes valuable native species in the Chesapeake Bay. Gut content analysis has shown the consumption of mussels, perch (white and yellow), striped bass (rockfish), bay anchovies, menhaden, clams (soft shell and mud), shad, river herring, and blue crabs. They are resilient to environmental changes. This, combined with their consumption of native species, makes them a potential threat to native Chesapeake Bay fisheries.

These catfish also inhabit various habitats, from deep, high-action areas to shallow water areas (Etnier and Starnes 1993; Graham 1999) as well as salinities (Ross 2001; Higgins, 2006; Nepal et al., 2020). With a high offspring survival rate and long lifespan exceeding 29 years (Graham 1999; Higgins), once established, these catfish will persist in the environment without intervention.

3. Flathead catfish



Flathead catfish were first stocked in the Potomac and James Rivers in 1965, with a second stocking in the James River in 1977 (EBFM Alosine Species Team 2009). This species has since been introduced to 11 other states (Jackson, 1999). Native to the Mississippi and Rio Grande drainages and northern Mexico, flathead catfish are typically found near undercut banks, woody debris, and turbid waters

(Jackson, 1999; Bringolf, 2005; Illes, 2020). Their salinity tolerance ranges from 11 ppt to 15 ppt, with larger individuals exhibiting higher tolerance than smaller ones (Bringolf, 2005; Nepal & Fabrizio, 2019). The species displays significant migration potential, covering up to 100 km per year, with three distinct seasonal migrations influenced by temperature and other factors (Montague & Shoup, 2021). Concerns regarding their management arise from competition with striped bass and the decline of native fish populations, which may be negatively impacted by this invasive species (Brown, 2005).

Flathead catfish are opportunistic, generalist predators that primarily feed at night and select prey based on availability (Pine, 2005; Schmitt, 2019; Montague & Shoup, 2021). They compete with juvenile and adult striped bass for prey items such as American shad, gizzard shad, and bay anchovy (Topolski, 2009; Pine, 2005; Schmitt, 2019; Montague & Shoup, 2021). Small flathead catfish (less than 100 mm) mainly consume insects, but once they exceed 100 mm, their diet shifts to include fish and occasionally large crustaceans, primarily crayfish (Jackson, 1999; Brown, 2005).

Flathead catfish are long-lived, with individuals surviving past 19 years and potentially reaching up to 28 years in the wild (Brown, 2005). Males achieve sexual maturity at 3–4 years, while females mature at 4–5 years, with total lengths ranging from 375 to 539 mm (Illes, 2020; Brown, 2005). They prefer low-velocity sites with cavities for nest building (Jackson, 1999; Montague & Shoup, 2021), and spawning occurs from June to July when water temperatures reach 19–24 °C (Jackson, 1999; Illes, 2020). Females can produce up to 100,000 eggs, with clutch sizes commonly ranging from 31 to 579 eggs (Jackson, 1999; Illes, 2020).

G. Data gaps

Detailed studies on the ethnography of subsistence fishing on the Potomac and Anacostia Rivers have highlighted the rich history of fishers and the cultural importance of these river systems. However, the Patapsco River has received far less attention, despite the well-documented history of Baltimore City. The Reel Rewards program aims to document the stories and local knowledge of the Patapsco River fishing community as part of its research in

the Middle Branch. It also seeks to connect recreational and subsistence fishing with environmental justice issues in a waterfront region disproportionately impacted by pollution sources that affect marginalized communities in South Baltimore.

H. Reel Rewards Invasive Fish Bounty Program and Angler Surveys



To address this issue, the Environmental Justice Journalism Initiative (EJJI) is hosting the Reel Rewards Invasive Fish Bounty Program. Anglers are paid \$30 for each invasive fish removed from the Middle Branch of the Patapsco River.

This community-based program compensates residents for their time and participation in the ongoing restoration of the Middle Branch, while also providing valuable data to researchers.

In addition to the \$30 bounty, anglers can receive a one-time payment of \$10 for participating in an angler survey. The survey aims to better understand community behaviors and environmental awareness.

Program partners include ICARE at the University of Maryland Baltimore County, the Integration and Application Network at the University of Maryland Center for Environmental Science, Reimagine Middle Branch, the Middle Branch Resiliency Initiative (MBRI), the Smithsonian Environmental Research Center (SERC), and the Coastal Conservation Association (CCA). The Reel Rewards Program is funded by the South Baltimore Gateway Partnership (SBGP) and the National Oceanic and Atmospheric Administration (NOAA).

II. Methods

A. Registration and Fish Collection

Data for this analysis was collected from the angling community through Google Forms, iAngler, and in-person surveys. Anglers are required to register with the Environmental Justice Journalism Initiative (EJJI) using a Google Form and join the EJJI Reel Rewards Fishing Tournament via iAngler. Invasive fish (one of the three target species) are logged in iAngler at the catch site.

Fish are then turned in during weekly drop-off hours in the Middle Branch area. EJJI staff and volunteers collect the fish, complete an intake survey on Google Forms, and label and identify the fish heads and bodies by species. The fish are stored in a communal freezer at the Middle Branch Marina. Data from iAngler logs and drop-off hours are verified and compared

before issuing virtual bounties. Anglers are paid \$30 for each valid iAngler log, with payments made via emailed Visa gift cards.

i. Angler Registration

Participating anglers must register with an EJJI Google Form and the Reel Rewards Tournament on the angler tournament website iAngler. Below are the questions asked by both registration forms:

1. EJJI Google Form - Reel Rewards Registration 2024

Questions for this registration form were created based on recommendations from members of EJJI, ICARE, IAN-UMCES, SBGP, SERC, and NOAA. (see Figure 2. A.a. for full, blank Google Form and response choices)

EJJI Google Form Questions	Response Type
Timestamp	Automatic
Have you registered as an angler on iAngler? If no, please register on iAngler before filling out this form.	Yes Only Response
Name (First Last)	Open Short Response
Email address	Open Short Response
Chesapeake Bay and Coastal License number (MD DNR):	Open Short Response
Chesapeake Bay and Coastal License validation dates (ex. Month/Day/2023 - Month/Day/2024)	Open Short Response
What Baltimore neighborhood do you live in? If outside of Baltimore, what city do you live in?	Open Short Response
About how often do you fish in the Middle Branch?	Multiple Choice
What do you usually catch here?	Box Selection
What have you heard about environmental improvements for the Middle Branch shoreline?	Open Short Response

Would you like to learn more about environmental improvements for the Middle Branch shoreline? If yes, we will use your contact information to follow up.	Yes/No Multiple Choice
How did you hear about the “Reel Rewards” invasive species removal program?	Box Selection
I confirm that I can identify the following fish species targeted by this program (select all):	Box Selection
I have read and agree to the above program policies.	Yes Only Response

ii. iAngler Registration

iAngler Log Questions	Response Type
Tournament Name	Choose "EJJI Reel Rewards"
Tournament ID	Automatic
Tournament Date	Automatic
Tournament Fees	Automatic "\$0 USD"
Registration ID	Automatic
Team Name	Drop Down Menu
ID	Automatic
Angler	Open Short Response
Email address and/or phone number *	Open Short Response
Chesapeake Bay and Coastal License number (MD DNR): *	Open Short Response
Chesapeake Bay and Coastal License validation dates (ex. Month/Day/2023 - Month/Day/2024)	Open Short Response

b. Logging Fish on iAngler

Once an invasive fish is caught in the Middle Branch, the angler must take a picture and log the fish in iAngler with the appropriate species ID, location, and time. The following table

contains the iAngler log input anglers are required to provide to receive a Reel Rewards Bounty (\$30 per invasive fish):

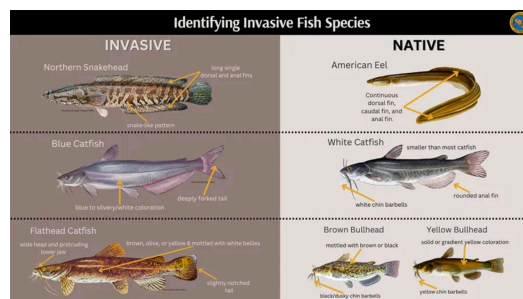
i. iAngler Fish Log Questions

iAngler Fish Log Questions	Response Type
Division* (The Division you are logging this Research in.)	Drop Down Menu of Blue Catfish, Flathead Catfish, and Northern Snakehead
Time of Entry * (The Popup allows you to change both date and time. To change time, click on the Date. You will be presented options to choose Hours and minutes)	Automatic
Participant Name* (The Participant for whom this log is. If you are logging for yourself, choose your name here)	Drop Down Menu of all registered anglers for Reel Rewards
Latitude	Open Short Response or Google Map Geolocation
Longitude	Open Short Response or Google Map Geolocation
Target *	Drop Down Menu of Blue Catfish, Flathead Catfish, and Northern Snakehead
Pictures *	Upload Button

c. Reel Rewards Rules and Guidance

The Reel Rewards Program has the following policies anglers must abide by to receive their bounty:

- Abide fishing regulations for the area in which you fish.
- Follow consumption guidelines to ensure safety in the preparation and consumption of fish.
- Avoid harming native species while fishing for invasives. Intentionally harming protected



wildlife or native wildlife is prohibited. Native species will not be accepted.

- Log accurate information on the catch in iAngler to receive the bounty.
- Fish must be caught in the Middle Branch of the Patapsco River in Baltimore City (see map).
- Fish must be caught by the participant submitting them for the reward.
- Photo or video evidence of catch as well as location must be logged in iAngler. We reserve the right to reject a log if factual inconsistencies exist in the information provided.
- You may log multiple catches per iAngler log for fish caught in the same area and time.
- Submitted fish heads or bodies must be in good condition and identifiable. Fish fry (babies) will not be accepted.
- Anglers may submit a maximum of 15 fish heads or bodies per week.
- There are no restrictions on whether the fish is caught on land or by boat.
- There are no restrictions on where a participant resides.
- Participants may receive \$30 for every invasive species head dropped off. The bounty amount is subject to change due to volume and demand.
- Must be 18 years of age or older to receive the reward.
- Violation of the above policies or abusive, violent, and otherwise disruptive behavior are grounds for restriction or disqualification from the program.

d. Reel Rewards Fish Drop Off and Community Engagement

i. Locations and Times



Fish heads or bodies can be turned in by anglers every Wednesday and Saturday evening from 5-7 PM. These drop-off hours are held from May 15, 2024, to September 28th, 2024. Drop-off locations include local South Baltimore parks and recreation areas like Middle Branch Park, Middle Branch Trailhead 9, West Covington Park, and Broening Boat Ramp. The EJJl Reel Rewards website hosts a Google Calendar displaying the dates, times, and locations of the fish drop-off hours.

ii. Drop-off Events

The following is the equipment needed for each drop-off event:

- Reel Rewards Stickers
- 1 Beach Wagon
- 4 Folding Chairs
- 2 Folding Tables
- 1 Tent
- 2 wireless microphones
- Containers and Cooling:
 - a. 1 Box of Trash Bags
 - b. 2 Coolers for Fish
 - c. Ice (Fill each cooler~ 4 bags)
 - d. 2 Freeze Packs
 - e. 2 Buckets
 - f. *Water Cooler (Depending on volunteer need)
- Clear Storage Bin
 - i. 2 Safety Glasses
 - ii. 2 Pliers
 - iii. 2 Fish Knives
 - iv. 2 Screwdrivers
 - v. 2 Rulers
 - vi. 2 Cutting Boards
 - vii. Painter's Tape
 - viii. Duct Tape
 - ix. Pencil Case Containing:
 - 1. Pens
 - 2. Sharpie
- b. Safety
 - i. 4 Pairs of Work Gloves
 - ii. 1 Box of Food Gloves
 - iii. Hand Sanitizer
 - iv. Sunscreen
 - v. Disinfectant Wipes
 - vi. Paper Towels
- c. Communication and Surveys
 - i. Clip Board
 - ii. Paper Angler Surveys (in folder)
 - iii. Laminated Information Sheets (Invasive Identifier, Reel Rewards Info, Fish Consumption Guidelines, Fish Safety/Handling)

iv. Community Engagement Events

- Reel Rewards Stickers
- 1 Beach Wagon
- 4 Folding Chairs

- 2 Folding Tables
- 1 Tent
- 2 wireless microphones
- Painter's Tape
- Duct Tape
- Pencil Case Containing:
 - a. Pens
 - b. Sharpie
- Safety
 - a. 4 Pairs of Work Gloves
 - b. Hand Sanitizer
 - c. Sunscreen
 - d. Disinfectant Wipes
 - e. Paper Towels
- Communication and Surveys
 - a. Clip Board
 - b. Paper Angler Surveys (in folder)
 - c. Laminated Information Sheets (Invasive Identifier, Reel Rewards Info, Fish Consumption Guidelines, Fish Safety/Handling)
- Activities
 - a. Aquarium Tank
 - b. Bubbler
 - c. Portable Microscope and Pre-Made Slides
 - d. monitor
- Generator

D. Volunteer Recruitment and Training

1. Recruitment

- a. [Google form for interest](#)
- b. Engaging on Social Media
- c. Email Drives
- d. Community events

2. [Training](#) - Middle Branch Park

- a. Going over Drop-Off locations
- b. How to handle equipment
- c. Ethical Fishing Practices Breakdown
- d. Equipment storage policies

ii. Steps for Fish Intake

The following steps are taken by staff and volunteers when receiving fish at drop-off hours:

- Ask if angler is registered with Reel Rewards program
 - If angler isn't registered, direct them to [registration form](https://rb.gy/koh78s) via QR code : <https://rb.gy/koh78s>
 - If angler IS registered, but does not have a fishing license or registration number on file, have them fill out [THIS FORM](https://rb.gy/l4793y) : <https://rb.gy/l4793y>
- Collect the fish heads (and possibly bodies) and put them in a ziplock. Label the bag with the angler's name and fish species before placing them in the coolers with ice.
- Verify with angler that they submitted their catch(es) on iAngler. If they have not, walk the angler through the iAngler log process.
- Internally record angler data on [Volunteer Drop Off Form: Reel Rewards Google Sheet](https://rb.gy/01e5so) using a smartphone or tablet: <https://rb.gy/01e5so>

Fish Intake Form	Response Type
Date	Short Open Response
Time	Short Open Response
Angler Name	Short Open Response
Angler Email	Short Open Response
Species Caught	Box selection with 3 invasive fish species and NA option
Number of Fish Turned in	Short Open Response
Estimate number of fish by age (baby, juveniles, adults): EX. 12 babies, 3 adults	Short Open Response
Does the angler self-identify with a minority community? This can include underserved or underrepresented groups regarding race, ethnicity, gender, disability, etc. If so, list all that apply.	Short Open Response
Social composition of angler party (i.e. who is with the angler when they turn in the fish):	Box selection with Solo, Adult with child(ren), and Adult with adult(s) as 3 options
Ask angler how many people they fished with	Short Open Response

Small, Medium, Large Classification	Short Open Response
Estimated Age Group of Angler (18-24, 25-55, 55 and older)	Multiple Choice
Angler Interaction Response	Box selection from 1-5
Other Notes	Short Open Response

- Anglers can expect a confirmation email and Tremendous Visa virtual gift card from their email within *5-7 business days*.
 - \$30 per invasive fish turned in and valid iAngler log.
- After drop-off is complete, volunteers will take the fish-filled ziplocks to the freezers at the [Middle Branch Marina](#), 3101 Waterview Ave, Baltimore, MD 21230.

E. Angler Survey

The angler survey was designed by members of EJJI, ICARE, IAN-UMCES, SBGP, and SERC. Participating anglers will receive a one-time payment of a virtual \$10 gift card for their contribution to this research. Questions for this survey were selected to understand better anglers' perceptions of the Middle Branch and local environmental management.

i. Angler Survey Questions

The following are the questions asked in the Angler Survey. All responses are open-ended:

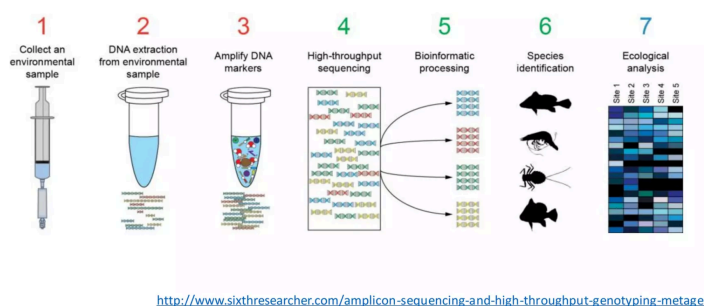
- What do you usually catch here? [as many as you know]
- What are you trying to catch? [as many as you know]
- Why do you like fishing here?
- What do you do with the fish when you catch them?
- Have you caught Blue Catfish, Flathead Catfish, or Northern Snakehead here?
 - [If yes] - Which ones?
- Do you live in Baltimore?
 - [If yes] - Which neighborhood?
 - [If no] - What city do you live in?
- Do you feel like people who fish here, live in the neighborhood?
- What else do you come here [to the Middle Branch] to do?
- What are your opinions on the Reel Rewards program? [If they don't understand, say "paying people for the invasive fish that they catch"]
- Have you noticed any changes in the health of the Harbor or fishing here?
 - [If yes] - What do you think is causing these changes?



- Who or where do you get information from about local environmental or water issues, and what kind of information do you get from them?
- What organizations do you know of that affect the health of the Harbor [good, bad, or other]?

F. eDNA for Detection of Invasive Species & Species Richness

Metabarcoding workflow



Environmental DNA (eDNA) provides a baseline of fish species richness, serving as a reference point for ongoing species monitoring. The eDNA results will facilitate a presence-absence study for the invasive fish species targeted by the Reel Rewards Program. Utilizing eDNA has proven to be an effective and relatively low-cost method for monitoring invasive species, as it does not degrade habitats or require live fish handling, which can be stressful and harmful to fish.

Collecting water samples for eDNA analysis also allows the community to engage in citizen science related to their local environments. When conducted appropriately, this process offers educational experiences and fosters community outreach among the residents of South Baltimore. Educating the public about invasive species will help reduce the introduction of non-native species into ecosystems. The most effective way to manage invasive species is to prevent their introduction in the first place. Connecting people with wildlife and ecosystems is essential for fostering interest in preserving and restoring these natural spaces.

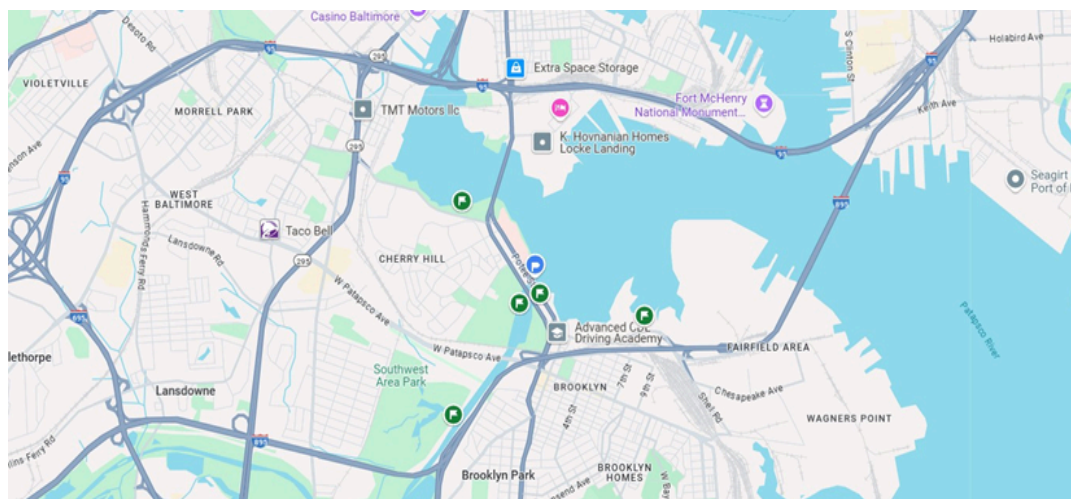
i. Water Sampling



Water samples will be collected four times a year and analyzed for the presence of fish environmental DNA (eDNA) to capture snapshots of spring and fall migrations and summer peaks. Samples are collected at three restoration sites (fishing piers) and three additional control sites (without restoration) in the Middle Branch. Each site will have four replicate samples collected, along with a field blank sample taken at the start of the day.

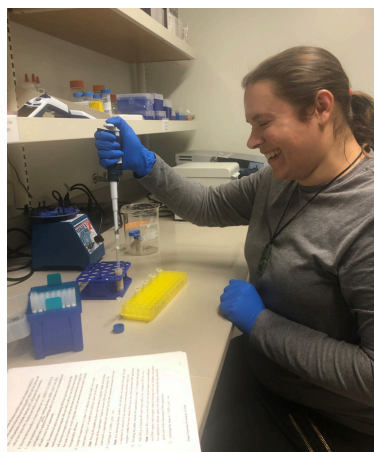
The collection and filtration of three liters of water will occur on-site using the Smith-Root citizen eDNA sampler and a glass filter with a pore size of 1.5 μm (see image to the left for the filter after sampling). All samples were stored on dry ice in a cooler for transport to the University of Maryland, Baltimore County (UMBC) for short-term storage at -80°C . Subsequently, the samples were

transported to the Smithsonian Environmental Research Center for extraction and amplification.



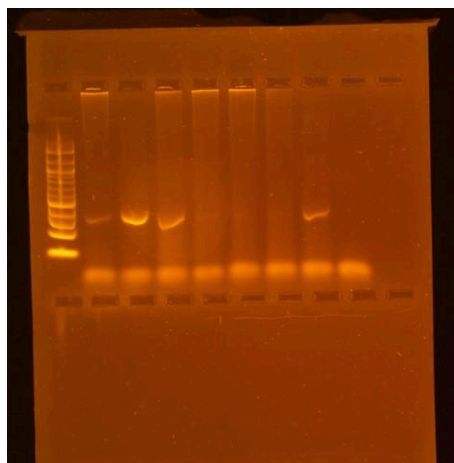
Samples site for eDNA collection by water sampling locations are marked with flags

ii. DNA Extraction



DNA extraction will be performed using the Qiagen DNeasy PowerWater Kit, following the standard protocol with modifications from the Smithsonian Environmental Research Center (SERC) to enhance the overall DNA yield. The DNA lab procedures were conducted under Dr. Katrian Lohan, Principal Investigator of the Coastal Disease Ecology Laboratory at SERC. DNA amplification will target the cytochrome c oxidase subunit 1 (COI) mitochondrial gene, and I followed the SERC protocol for metabarcoding. NanoDrop technology will be used under SERC standard operating procedures (SOP) to quantify DNA concentration and the copy number of sequences, which will help estimate the number of individuals represented by each genetic sequence. The ICARE program covered all costs associated with DNA processing.

iii. DNA Amplification



DNA was amplified using polymerase chain reaction (PCR), which creates millions of copies of the template (sample) DNA. This process involves three key steps: denaturation (breaking apart the template DNA), annealing (attaching primers to the template DNA), and extension (adding nucleotides to elongate the new copy of DNA). This cycle is repeated for 32 rounds, resulting in millions of copies. The PCR product (copied DNA) is

then analyzed through gel electrophoresis, where the PCR products are placed in a gel and subjected to an electric current which separates the DNA samples by strand size. This method allows for visualization of if the PCR reaction successfully amplified DNA and determines the size of the DNA strands. An image of a gel can be seen to the left, showing the amplified DNA samples as bright bands alongside a size scale in the first cell of the gel.

PCR is conducted three times for each sample, and the products are pooled into a new sample. This ensures that each sample contains three unique PCR products, as each PCR reaction is unique and may favor the amplification of different copies of DNA due to the inherent randomness of the reaction.

iv. Preparation for Sequencing

After the samples have been pooled, PCR is conducted once more, during which primers attach a unique nucleotide code to the end of each amplified sequence. This unique code functions like a barcode, enabling the identification of each sample later in the workflow, a process called metabarcoding. The PCR samples are then rerun through a gel, as previously described. Next, the samples are purified using Ampure beads, which bind to pure DNA of the specified base pair length, removing sequences that are too small or too large. The purified samples are quantified for purity using a Qubit, a highly sensitive spectrometer used in genetics. Once quantified, the samples are combined into a single large sample known as the library, with each sample added according to its DNA concentration. The samples undergo a final purification with Ampure beads before being sent to another lab for sequencing.

v. Analysis of DNA Sequences

Genetic sequence data will be provided in Fastq file format, stored on a zip drive, and processed on my computer. The files will be analyzed using R to inspect them, trim primer sequences, and employ a vsearch pipeline to merge forward and reverse reads, enhancing sequence quality. After processing, the files will be uploaded to the National Library of Medicine to perform a BLAST analysis, identifying sequences at the species level. The BLAST results will indicate percentage matches between the uploaded sequences and those in the database, allowing for quantification of the match percentages and assessment of DNA sequence quality. Additionally, I will conduct statistical analyses on the differences between sites using a two-way t-test, with a significance level set at $p = 0.05$.

G. Survey Data Cleaning and Analysis

i. Registration Survey Analysis Methods

a. Data Cleaning in Python and Excel

The survey data from the EJJI Google Form, collected between March 10, 2024, and June 17, 2024, had 457 responses (313 after cleaning). The data was cleaned and formatted using Python, the Pandas library, and Microsoft Excel to ensure accuracy and usability. The following steps were taken:

1. **Formatting and Cleaning in Python:** Converted header row to lowercase and standardized column names.
 - Renamed and labeled key columns (e.g., 'name', 'residence').
 - Standardized name entries and removed irrelevant or duplicate rows.
 - Reformatted the date and time in the 'timestamp' column.
 - Selected only the relevant columns for analysis.
2. **Exporting to Excel:**
 - The cleaned data was saved and exported into an Excel sheet for further analysis.
3. **Residency Classification in Excel:**
 - A new sheet was created with only the 'name' and 'residence' columns.
 - A new column called 'baltimore_residency' was added to indicate whether the respondent lived in Baltimore. Neighborhoods, cities, and zip codes were checked to classify the entries.
 - Responses were labeled as 'y' for yes (Baltimore resident), 'n' for no (non-resident), and 'void' for unclear responses.
 - States outside of Maryland were recorded using their two-letter abbreviations.
4. **Selecting Questions for Analysis:**
 - To determine if living in Baltimore or how often someone fishes influenced their views on the Middle Branch Harbor's improvements or how they learned about the Reel Rewards program, the following survey questions were selected:
 - What neighborhood or city do you live in?
 - How often do you fish in the Middle Branch?
 - What have you heard about environmental improvements for the Middle Branch shoreline?
 - How did you hear about the Reel Rewards invasive species removal program?
 - Would you like to learn more about environmental improvements for the Middle Branch shoreline?

These steps ensured the data was well-organized for further analysis and insights.

ii. Angler Survey Analysis

The survey data from the EJJI Google Form, collected between May 15, 2024, and September 28, 2024, included 44 responses. Unlike the registration process, these surveys were completed by hand in-person. Anglers dropping off fish or fishing at Middle Branch Park, Broening Boat Ramp, West Covington Park, or Middle Branch Trailhead 9 on fish drop-off days were selected to participate in the Angler Survey. The handwritten surveys were scanned and transcribed into an Excel sheet. The data was then cleaned and formatted using R Studio and Microsoft Excel to ensure accuracy and usability. The following steps were taken:

This analysis focused on 4 questions of the Angler Survey:

- What do you usually catch here? [as many as you know]
- What are you trying to catch here? [as many as you know]
- Who or where do you get information from about local environmental or water issues, and what kind of information do you get from them?
- What organizations do you know of that affect the health of the Harbor (good, bad, or other)?

Using R Studio and Microsoft Excel, the data for these questions were cleaned and analyzed using the following steps:

1. Import into R Studio-

- Libraries: ``readxl``, ``dplyr``, ``stringr``, and ``tidyr``.
- Raw response data from an Excel sheet into a dataframe.

2. Data Cleaning

- Reformatted column names by replacing spaces with underscores and added a "q" prefix to any integer column names to avoid errors.
- Retained only the relevant columns for analysis.
- Converted all values to lowercase, removed extra spaces, and stripped special characters (except commas and semicolons).

3. Data Normalization

- Replaced ";" with "," and removed repeated commas for consistency in value formatting.
- Split comma-separated values in the response columns into new columns.
- Removed redundant or irrelevant columns and entries, such as those with specific values like "yes", "no", or "not sure."
- Grouped similar words (e.g., "observations" to "observation") to standardize terms across responses.

4. Data Restructuring

- Transformed the data by collapsing columns with cleaned and normalized data, stacking them into long format to simplify further analysis.
- Removed rows with missing values and finalized the clean dataset for analysis.

5. Export to Excel

- Export the cleaned data frame to an Excel spreadsheet for manual analysis

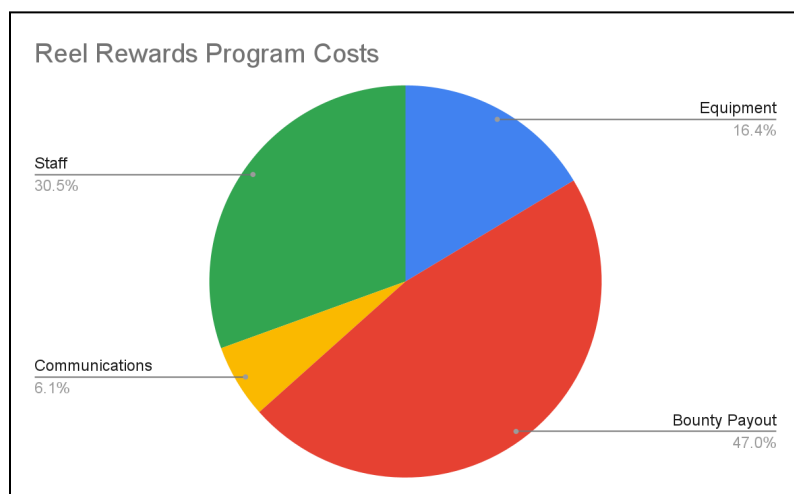
6. Analysis in Excel

- Recategorize specific responses into broader categories (e.g. “facebook” or “youtube” to “social media”)
- Assign each cell a value of 1
- Put the table of responses and their values into PivotTable format to see the frequency of response per category.
- Based on these values and the total sum of category frequency, create percentages.

B. Program Costs

Program costs can be broken down into four categories;

- Equipment
- Bounty Payout
- Staff
- Communications (printed materials)



From May to September of 2024, the [Reel Rewards](#) program has spent around \$18,671 in total program costs. This is just over half of the given budget of \$32,000. The figure above shows that Bounty Payout accounts for nearly 50% of total program cost. This means that the majority of the Reel Rewards Program's funds are going directly to the community.

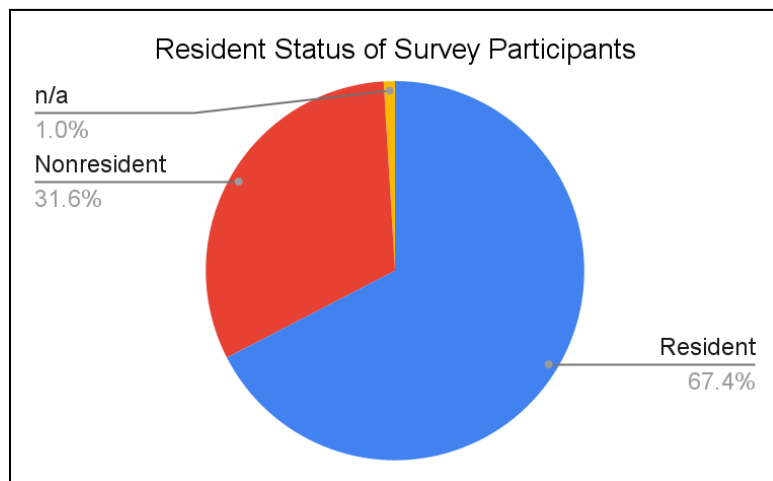
\$8,776.03 were sent directly to anglers in the form of bounty payments.

III. Results

A. Registration Survey Results

The data used to form these graphs are from the Environmental Justice Journalism Initiative (EJJI) Google Forms registration as part of Angler registration for the Reel Rewards Invasive Fish Bounty Program. The responses used in this analysis are from 3/10/2024 to 6/17/2024 and consist of 313 surveys.

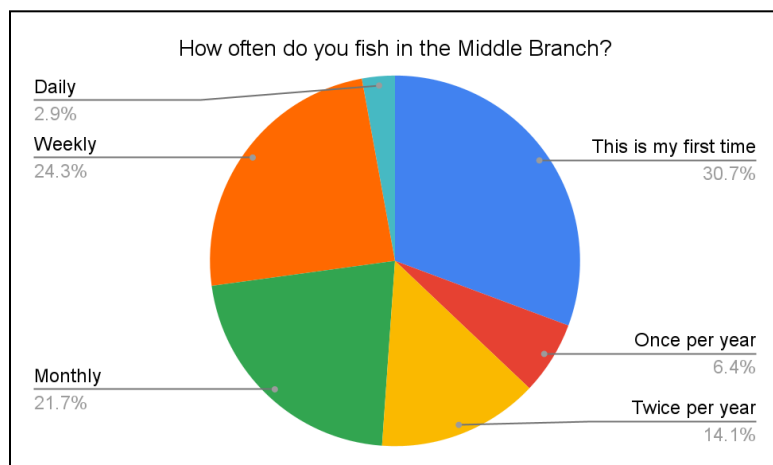
1. Demographics



Majority of registrants (~67%) of Reel Rewards are Baltimore residents. Nonresident participants (32%) were from other Maryland areas as well as Virginia, New Hampshire, Ohio, Michigan, and Pennsylvania. Responses that did not indicate residency (1%) are represented by 'na'.

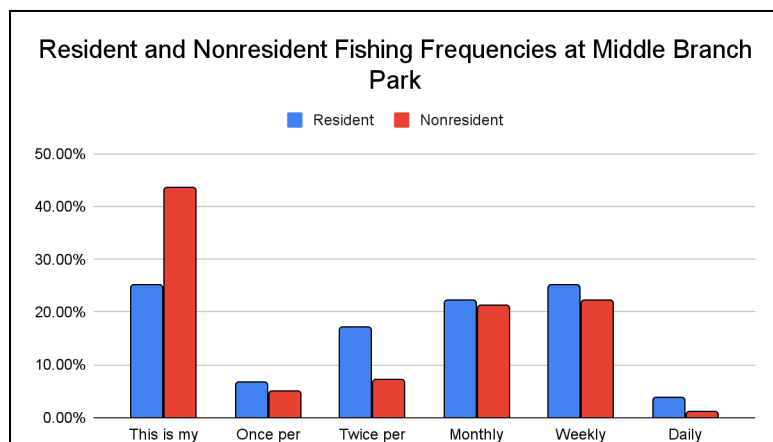
2. Fishing Frequency

a) Frequency for All Respondents



Most registrants stated that this was their first time fishing in the Middle Branch (~31%). Other common responses include weekly (~24%) and monthly (~22%) to fish the area. Fishing daily (~3%) was the least common response.

b) Frequency for Residents vs. Nonresidents

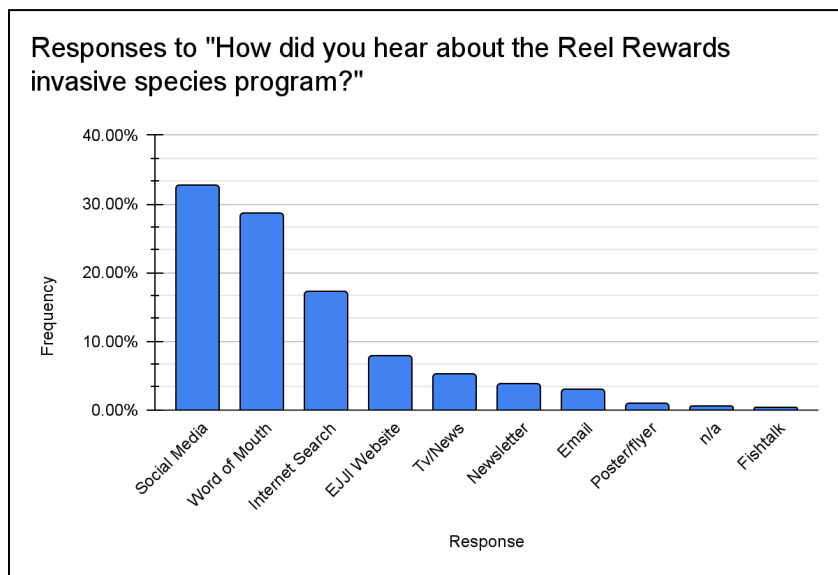


Comparing residents or nonresidents fishing frequency support that Baltimore residents fish more frequently in the Middle

Branch. With the exception of “This is my first time” responses, residents outweigh nonresidents. Monthly and weekly fishing frequency is similar between the two groups. Nonresidents outweigh residents in the first time fishing in the Middle Branch response.

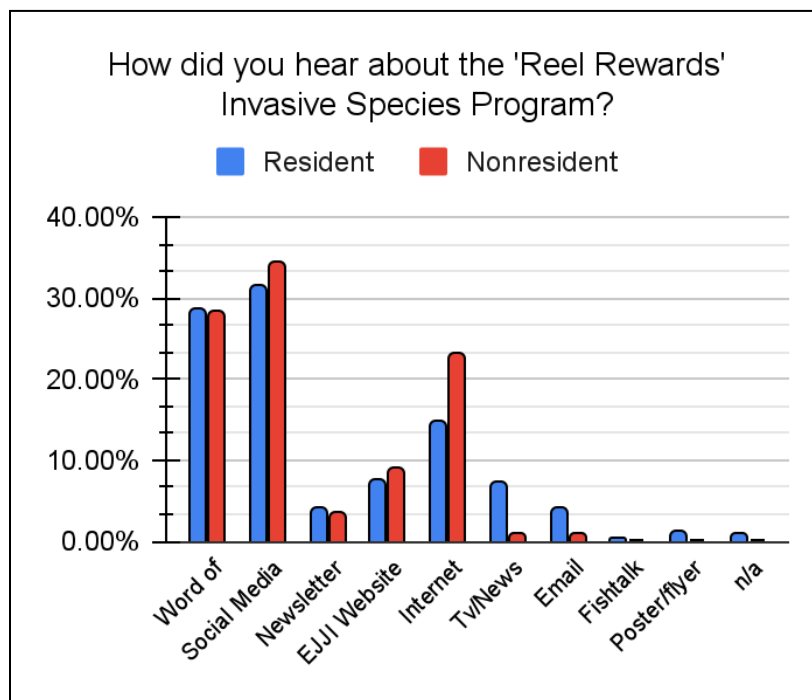
3. Information Sourcing

a) Frequency for All Respondents



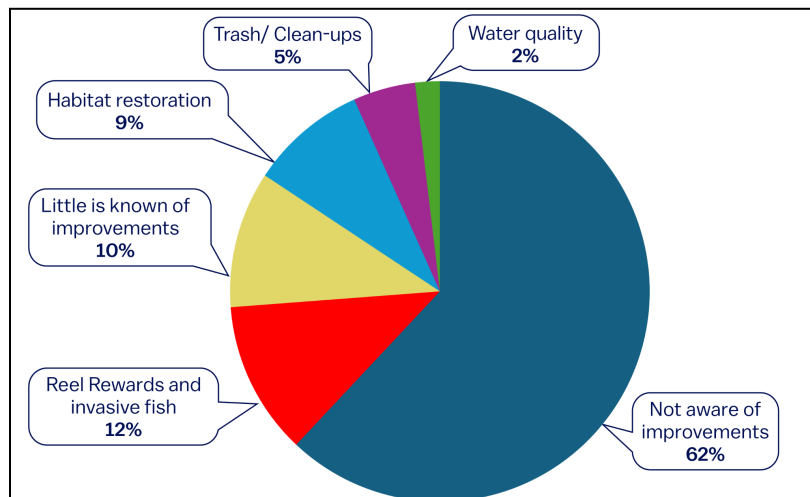
When asked how they heard about the Reel Rewards Program, the majority of responses were “Social Media” or “Word of Mouth”. “Internet Search” is the next most frequent response for this question. With internet-based information sources making up over half of the responses (social media, internet search, EJJI website) it will be important to continue building an online presence. Note that Respondents had the option of selecting multiple choices

b) Frequency for Residents vs. Nonresidents



Again, the majority of responses were “Social Media” or “Word of Mouth” for both residents and nonresidents. “Internet Search” is the next most frequent response for both groups. About 10% more nonresidents than residents stated that they learned about Reel Rewards through internet search. TV/News and email are more frequent responses for residents.

4. Perception of Improvement

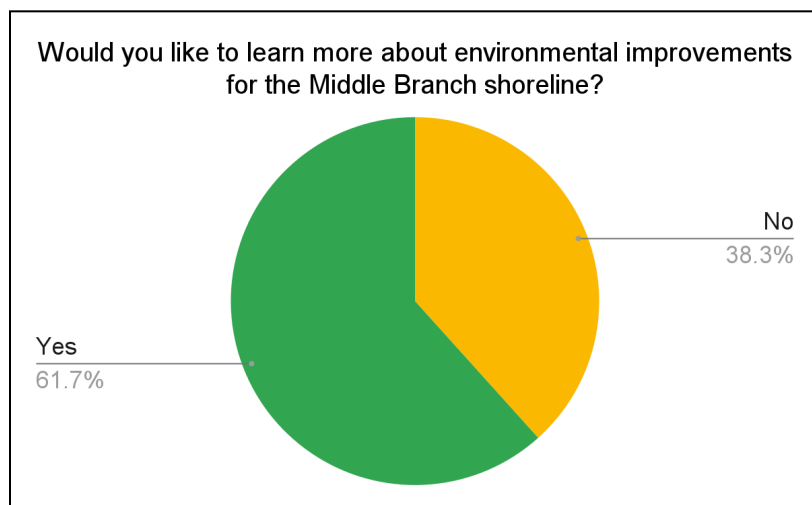


The responses to “What have you heard about environmental improvements for the Middle Branch shoreline?” show that ~72% were not aware or knew little. “Reel Rewards and invasive fish” and “Habitat restoration” are the next most frequent responses.

While it is concerning to see such a large percentage of patrons of Middle Branch are unaware of environmental improvements occurring, it is

quite interesting to see that the EJJI and Reel Rewards Program for some people is an introduction to conversations about the environmental well-being of the Harbor. Additionally, the spread of knowledge of those who stated having awareness shows the positive effects of the Reel Rewards Program and the prevalence of efforts in the waterbody.

5. Desire to Learn More



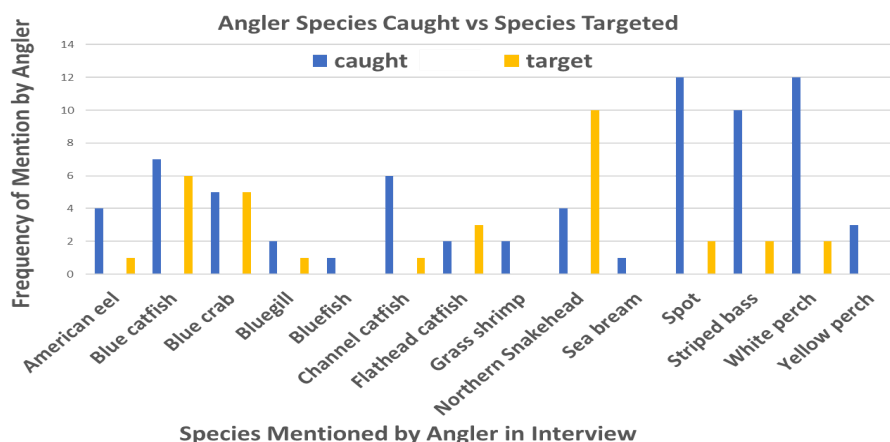
Response to this question shows that, despite current unawareness, registrants are willing to learn more about environmental improvements. It is hypothesized the “No” responses may be influenced by avoidance of spam messaging. The type of information we would be sharing was not stated in the survey.

B. Angler Survey Results

The angler survey results differed from the registration results in several key ways. Unlike the registration data, which provides a broad overview of participants in the angling community, the angler survey was conducted directly with anglers at the parks where fish drop-offs are taking place, providing a more granular perspective. These in-person surveys, where participants were compensated \$10 for their time, offered insights into what anglers are actually catching on the ground, as well as their personal perceptions of the fishing experience.

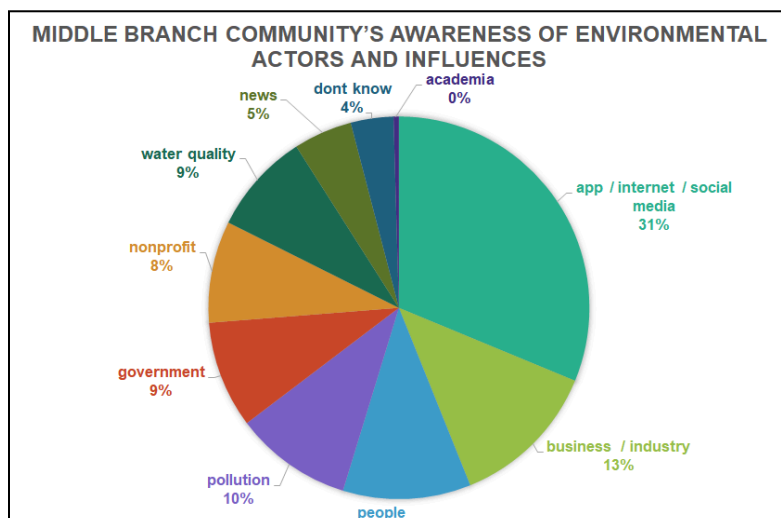
The survey aimed to gather more than just catch data; it also delved into who anglers engage with regarding their activities. It captured valuable information about their social interactions within the angling community, helping to build a better understanding of local fishing networks and the flow of information among fishers. This on-the-ground data contrasts with the registration results, which may not reflect the same real-time, location-specific nuances or the personal views and interactions of the anglers themselves.

1. Target Species Comparison to Species Caught



This plot is based on the analysis of two questions for the angler survey; "What do you usually catch here?" and "What are you trying to catch?". These questions were designed to identify and compare what species of fish and invertebrates anglers were targeting vs. catching. This helped identify recreationally important species and what species were caught in high abundance by anglers but may have been less important to recreational fishing.

2. Information Sourcing



The chart is based on an analysis of responses to the last two questions of the angler survey: "Who or where do you get information from about local environmental or water issues, and what kind of information do you get from them?" and "What

organizations do you know of that affect the health of the Harbor (good, bad, or other)?" These questions were designed to capture anglers' awareness of environmental actors and sources of information relevant to their activities.

The results show that citizens are not well connected to government agencies responsible for managing local resources. The top three sources of information cited by respondents are "apps/internet/social media", "business/industry", and "people". These findings suggest that anglers primarily rely on informal networks and technology for environmental information. While government agencies, nonprofits, and academic organizations are not recognized as primary sources of influence by the anglers themselves. This disconnect highlights a communication gap between institutions that influence environmental policies and the fishing community, underscoring the need for more effective outreach and engagement efforts.

C. Fish Log Results

1. Invasive Species Caught

During the first three months of the program, the following amount of fish were turned in:

- 256 Snakeheads
- 37 Blue Catfish
- 6 Flathead Catfish

D. Content and Engagement

1. Videos

- a) [Angler Interview Danaz](#)
 - An interview with a local Baltimore Angler, Danaz Williams. He discusses his views on the environmental issues in Baltimore, and the impact of Reel Rewards on the community.
- b) [Reel Rewards Summary Video](#)
 - A short, informative Summary of what the Reel Rewards program is, including a statistical breakdown of our initial session.

2. Brochures and Flyers

- a) Reel Rewards [Brochure](#)
 - This document highlights the ongoing environmental restoration efforts in Baltimore Harbor, focusing on issues like invasive fish species. It also details EJJI's initiatives, such as the Reel Rewards program.

b) [July 20th Flier](#)

- A flier from our July 20th Special Community event. This event was held with some of our partners to help educate the community about Reel Rewards, and environmental issues impacting their communities.

c) Social Media Posts

- (1) Posting on the EJJI Instagram, Facebook, and Baltimore / Invasive Fish Facebook groups
- (2) Sharing with partners: South Baltimore Gateway Partnership (SBGP), Chesapeake Bay Trust (CBT), Smithsonian Environmental Research Center (SERC), Reimagine Middle Branch (RMB), Baltimore ToolBank, Baltimore Community Rowing (BCR), Integration and Application Network - University of Maryland Center for Environmental Science (UMCES), and the Institute of Marine and Environmental Technology - UMCES

3. Blogsa) [Danaz Blog](#)

- A short written recap of the Danaz Williams Angler Interview video mentioned above.

b) [Reel Rewards Blog](#)

- Summary of the Reel Rewards Programs initial session. Included are statistical breakdowns of the Reel Reward fish drop-off data, and potential plans for the future.

4. Engagement**a) Engagement Dashboard**

During the 2024 Reel Rewards program, EJJI engaged in-person with 466 individuals, ages 8 to 75. 100% of outreach events, including tabling, fish collection, and presentations, had representation from minority communities, including people of color, women, individuals with disabilities, and veterans. 100% of these interactions had the potential for future engagement. Of these, 37% were active interactions, where participants were deeply involved in discussions or activities. Direct interactions, which made up 59%, involved clear communication and exchange of information but with less engagement than active interactions. The remaining 3% were passive, where people received information or observed without direct participation. These varied levels of interaction demonstrate the program's wide-ranging impact on community engagement.

b) Interaction Takeaways

IV. Discussion

With over 400 registrations, the Reel Rewards Invasive Fish Bounty Program was successful in reaching both local Baltimore anglers and anglers across the United States. Strategic communication with partners and their networks spread interest across states, which could have led to multistate participation. External groups that promoted the Reel Rewards Program include the [Washington Post](#), [Maryland Department of Natural Resources](#), [Fish and Hunt Maryland](#), [WBAL-TV](#), [Fox 45 News Baltimore](#), [Sports Destination Management](#), [NewsBreak](#), [Assateague Island Surf Fishing Facebook Page](#), [r/MarylandFishing](#)

The Reel Rewards 2024 program successfully engaged diverse minority communities, including people of color, women, and veterans. Interactions ranged from active participation to direct communication and passive information sharing, all providing opportunities for future involvement and demonstrating the program's broad and meaningful outreach.

The program successfully engaged both local and nonresident anglers, with participants drawn from across the U.S. through strategic outreach by partners and media outlets. While some anglers were fishing in the Middle Branch for the first time, many residents fished there regularly, highlighting the area's appeal to both newcomers and frequent fishers. The survey showed that most participants learned about the program via social media, word of mouth, or internet searches, emphasizing the importance of maintaining a strong online presence to reach a wider audience.

A significant gap in environmental awareness was noted, with many anglers unaware of improvements along the Middle Branch shoreline. Despite this, the program has introduced some participants to discussions about the Harbor's environmental health, showing its potential to spread awareness beyond invasive species management. Anglers also expressed a strong interest in learning more about environmental efforts, signaling an opportunity for further engagement.

On-the-ground angler surveys revealed insights into the social networks and fishing behaviors of participants, offering a more localized and nuanced view compared to registration data. These surveys highlighted that anglers rely heavily on informal networks and technology for environmental information, with little connection to government agencies or formal organizations. This disconnect underscores the need for more targeted outreach to better align resource management efforts with the fishing community.

Angler survey results are used to identify fish and invertebrate species that are important food sources from the fishing community of the Middle Branch. Improved understanding of which species are important to community members will inform regulatory agencies of management priorities for the community. Catfish, perch, and crabs were found to be species commonly targeted as food sources. Environmental justice issues are addressed by angler interviews to identify and document which fish are consumed by the community and incentivize future research in potential contaminants associated with commonly consumed fish.

Environmental DNA research conducted for the program serves as a pilot for urban estuary sampling, evaluating how effective eDNA sampling is at estimating species richness using the meta-barcoding method and cost-effective detection of aquatic invasive species. Collections of eDNA by water sampling are a user-friendly method that could be incorporated into community-engaged research creating an opportunity for an internship. There is also a greater potential for integrating eDNA sampling with other routine sampling for water quality parameters increasing the cost effectiveness of the method.

The program's success in removing invasive species—particularly snakeheads and blue catfish—demonstrates its potential to contribute meaningfully to ecological restoration efforts in the Middle Branch. There was a dedicated group of 3-4 bow fishermen who were directly targeting snakeheads. Their efficient fishing style, including bows and light attractants, likely contributed to the high representation of snakehead in the total program catch. Going forward, continued engagement and education will be crucial for addressing both invasive species and broader environmental challenges.

V. Recommendations

- A. Earlier Program Start (March 1st)
- B. Community Fishing Classes
- C. Pursuing More Diverse Volunteers and Community Facilitators
- D. Improving In-Person Communications
- E. Simplifying Logging
- F. Expanding Fishing Boundaries
- G. Pushing for Updated Consumption Guidelines and Research
- H. Pursuing Alternative Disposal for Turned-In Fish
- I. Simplifying Sign-Up
- J. Consider Removing Flathead Catfish From the Program
- K. Clear Disqualification of Recently Hatched Fish Bounty

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