

REEL REWARDS

**HELP PROTECT THE PATAPSCO RIVER
FROM INVASIVE FISHES**



2025 Reel Rewards Invasive Fish Bounty Program: Project Summary

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Reel Rewards Program

Overview



The Reel Rewards Program is a local initiative to engage the local community to help control invasive fish species—Snakehead, Blue Catfish, and Flathead Catfish—in Baltimore Harbor. Started in May 2024 by the Environmental Justice Journalism Initiative (EJJI), this program has successfully completed its second season and is planning for 2026. For 2025, the program ran from April 26 - July 12, with weekly drop-offs held on Saturday or Sunday at either Middle Branch Park or Broening Boat Ramp, Baltimore. To participate, anglers with a valid fishing license can register on the Reel Rewards iAngler Tournament page for that current year.

Anglers can earn \$30 for each invasive fish turned in. Participants must follow fishing regulations, fish in designated locations, submit proof of catch via iAngler, and submit fresh or frozen fish for the reward. Native species are not accepted, and fish must be caught by the participant.

In the United States, invasive species impact costs \$100 billion per year (Maryland Department of Natural Resources (MD DNR), 2025). The program aims to protect native species and ecosystems, with opportunities for volunteers to help collect fish at drop-off sites. Anglers must be 18 or older to participate. This program helps control invasive species that threaten the local ecosystem and economy while engaging the community in conservation efforts.

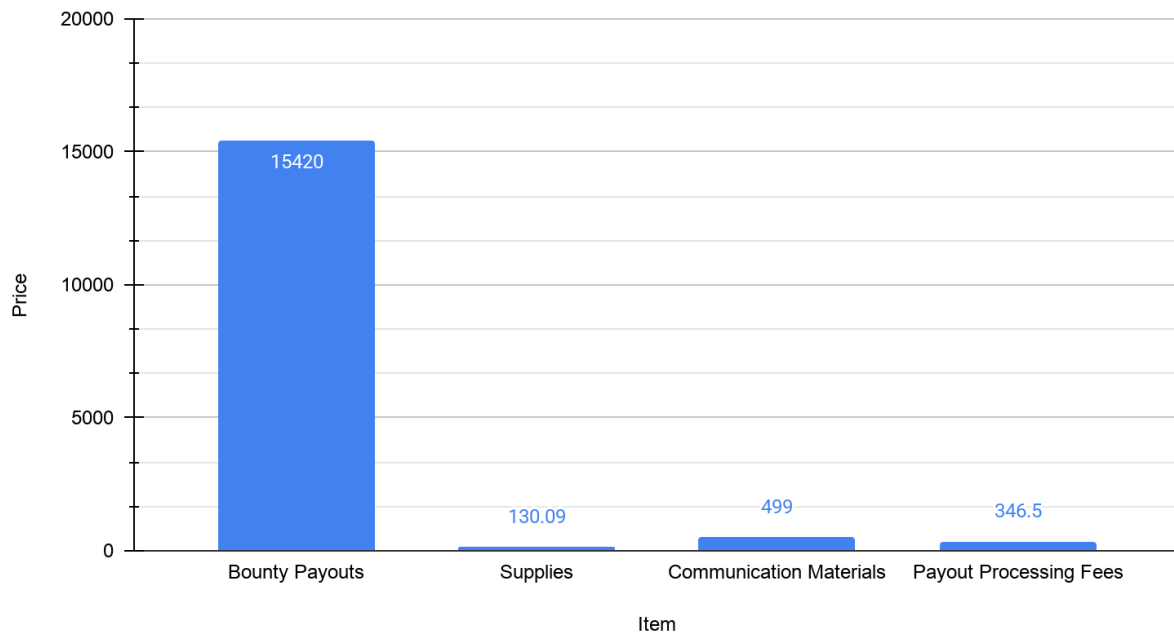
Detailed studies on the ethnography of subsistence fishing on the Potomac and Anacostia Rivers have highlighted the rich history of fishers and the cultural importance of these river systems. However, the Patapsco River has received far less attention, despite the well-documented history of Baltimore 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.

Funding and Costs

The 2025 season of the Reel Rewards program is funded by South Baltimore Gateway Partnership (SBGP). \$22,000 was awarded from SBGP through the Community Grant.

Program costs can be broken down into four categories: Bounty Payout, Staff, Communications Materials, Supplies, and Processing Fees (see figure below).

2025 Total Reel Rewards Program Costs



From May to August of 2025, the [Reel Rewards](#) program paid \$15,420 directly to anglers in the form of bounty payments. This is a 76% increase from last year's payout of \$8,776.03. May had the highest bounty payout of the 3 month season. The majority of the Reel Rewards Program's funds are going directly to the community.

Background

Harbor History

Baltimore Harbor has supported fishing and livelihoods for over 12,000 years, beginning with the Indigenous Piscataway, Cherokee, Lumbee, and Susquehannock peoples who fished shellfish and harvested oysters, supplemented by hunting and gathering (Broadbeck; National Aquarium, 2023). The harbor's expansive waterfront still offers abundant fishing opportunities along the Chesapeake Bay and its tidal rivers (MD DNR, 2025).

Since industrialization in the 1600s, over 400 years of pollution from chemical waste have settled in the waterways' sediments, impacting humans, plants, and animals (City of Baltimore Comprehensive Master Plan). Larger predatory fish accumulate toxins, making them potentially unsafe for consumption (NOAA Fisheries, 2025; Maryland Department of the Environment (MDE), 2021).

Middle Branch Harbor, part of the Patapsco River, has a rich maritime history but South Baltimore communities nearby have suffered environmental racism, being located near waste

treatment plants and flood zones (Vargas-Nguyen et al., 2024). Invasive species such as northern snakehead (*Channa argus*), blue catfish (*Ictalurus furcatus*), and flathead catfish (*Pylodictis olivaris*) have been impacting Chesapeake waters for decades, threatening native fish and related economies (Smithsonian Institution; Love & Newhard, 2021; Robertson et al., 2024). Recently, community programs incentivize anglers to remove these invasives for ecosystem restoration (MD DNR; Chesapeake Bay Program, 2020).

Baltimore Harbor faces periodic fish kills, where large amounts of fish are killed due to lack of oxygen. These are linked to hypoxia and harmful algal blooms caused by nutrient pollution and climate stress, killing thousands of fish like Atlantic menhaden and disrupting the food web and local fisheries (MDE, 2021). Despite recent improvements in water quality and ongoing oyster restoration efforts, nutrient runoff continues to generate dead zones harmful to fisheries (Waterfront Partnership, 2025; Chesapeake Legal Alliance, 2024).

This history and current context reflect Indigenous cultural ties, prolonged industrial pollution, environmental justice challenges, invasive species pressures, and persistent threats to fishery health in Baltimore and Middle Branch Harbors.

Native and Migratory Fish in the Patapsco River

Baltimore Harbor, situated on the Upper Chesapeake Bay and influenced by both freshwater and saltwater environments. The blend of habitats provides spawning and nursery grounds critical for many fish. The key native species found in Baltimore Harbor include (Maryland State Archives; MD DNR):

- **Striped Bass (Rockfish):** Maryland's state fish, highly abundant in the harbor. They are anadromous species, meaning they migrate between fresh and salt water and spawn in freshwater tributaries near Baltimore in early spring. Juveniles spend years in shallow bay waters before moving offshore.
- **Alewife and Blueback Herring:** A highly valued anadromous species in the Bay. The return to freshwater in the spring to spawn.
- **White and Yellow Perch:** Common residents that spend their lives in the Chesapeake Bay system, frequently caught within the harbor and tributaries.
- **Sunfish species:** Including bluegill and pumpkinseed, typically found in fresher, calmer waters of the harbor tributaries.
- **Catfish:** Native species include brown bullhead and white catfish; however, invasive blue and flathead catfish cause ecological impacts.
- **American Eel:** A catadromous species that migrates between freshwater and ocean, present in the harbor waters.

- **Brook Trout:** Found in cooler upper tributaries like Gunpowder Falls and parts of the Patapsco River feeding the harbor, supporting native trout populations.
- **Banded Killifish, Rock Bass, and various minnows:** Also native components of the local fish communities.

There has been a resurgence of important migratory fish species in the Patapsco River following the 2018 removal of Bloede Dam. Alewife and blueback herring have returned, with alewife presence increasing to 7% and blueback herring to 13% in just three years post-removal (Legett et al., 2023). The dam's removal has reopened about 62 miles of spawning habitat, facilitating access for other key migrators such as American eel and shad (Martin, 2023). Environmental improvements, like the dam removal, are also influencing invasive populations, increasing their range accessibility and food source. It is critical to combat the invasive species issues in tandem with other environmental initiatives.

Commercial Fisheries Value in Maryland

Maryland's commercial fisheries continue to generate millions annually, with striped bass bringing in at \$5.3 million and blue crab bringing in \$45 million in annual dockside value. American eel, channel catfish, and white perch each contribute over \$1 million annually. While blue catfish have created a new commercial fishery, their ecological threat to higher-valued native species, particularly striped bass and blue crab, maintains significant concern among fisheries managers. Invasive species management remains a priority to safeguard long-term fishery sustainability (Chesapeake Bay Program, 2020; Robertson et al., 2024). Northern snakeheads have an annual dockside value of about \$13,000 (Maryland Office of the Governor, 2023). Since their introduction in the early 2000's, white perch, black crappie, bluegill, and pumpkinseed populations have declined due to the invasive's predation and displacement (MD DNR, 2025). Flathead catfish have an annual dockside value of about \$11,000 (Maryland Department of Legislative Services, 2023). Striped bass, sunfish, shads, herring, and white perch have been impacted by flatheads due to predation (MD DNR; Smithsonian; Chesapeake Bay Program, 2020).

Cultural History

The Chesapeake Bay region has long been a point of arrival and settlement for diverse immigrant communities, drawn by the region's abundant natural resources and navigable waterways (Smithsonian, 2023). The Piscataway chiefdom historically formed an interconnected confederacy across Chesapeake Bay tributaries, living in year-round riverine settlements and relying on fisheries for subsistence. Archaeology and elder's oral histories document extensive use of shell middens, weirs, fish traps, and seasonal camps dating back over a millennium, highlighting sustainable harvests of oysters, clams, mussels, sturgeon, shad, and herring (Fiske

et al. 2020). This ecological knowledge informs modern restoration and cultural resource preservation efforts.

African American fishers, many descendants of enslaved West Africans, have maintained fishing traditions on the Patapsco River for centuries (National Park Service (NPS), 2024). Fishing has symbolized freedom, sustenance, and resilience, providing social and economic benefits beyond food production. Contemporary studies reveal multispecies subsistence fishing remains vital for food security in these communities, often passed down through family traditions despite environmental and regulatory challenges. Environmental justice concerns, especially regarding contamination and consumption advisories, create tensions with historical fishing practices, underscoring the need for inclusive resource management (NPS, 2024).

In the 20th century, new arrivals from diverse international communities and migrants displaced by economic shifts contributed further to the Chesapeake area's complex demographic and cultural landscape. Long-standing residents, some with deep multi-generational ties to the land and waters, continue to uphold traditions associated with Chesapeake Bay fisheries, waterfront industries, and rural agriculture. These communities have played key roles in shaping regional identity, advocating for sustainable resource management, and navigating the environmental and social challenges posed by industrialization, habitat loss, and regulatory changes (NPS, 2000). Over time, these groups became intertwined in the region's maritime economy, particularly through commercial fishing, oystering, and crabbing industries, although often marginalized from political power and resource access.

Invasive Fish

Invasive Northern Snakehead, Blue Catfish, and Flathead Catfish threaten the Baltimore Harbor ecosystem, economy, and native species (Smithsonian Institute; Robertson et al., 2024; MD DNR). The following traits enable these fish to take over non-native habitats:

- Apex predators;
- Lack of local predators;
- Out-compete native species important to anglers and businesses;
- Resilient to environmental and diet changes;
- High offspring survival rate;
- Large size attractive to sport fisherman

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. The Reel Rewards Invasive Fish Bounty Program addresses each of these concerns through a community-based, collaborative approach.

Northern Snakehead

Since its discovery in Maryland waters in 2002, the northern snakehead has established self-sustaining populations across the Chesapeake Bay watershed (MD DNR; National Invasive Species Information Center (NISC)). In Baltimore, Snakeheads are found both in the harbor and smaller tributaries and ponds. Reel Rewards anglers note that they can be found in large communities near warm water outflows from industry, including the Baltimore RESCO incinerator.

Native to the Yangtze River basin in China, Korea, and Russia, Northern Snakehead were introduced to the Chesapeake Bay by aquarists who wanted to create a new local food source as well as for religious ceremonies (NISC; U.S. Geological Survey, 2022). This fish can breathe air and survive out of water for up to four days if moist, enabling overland movement during floods (U.S. Department of the Interior (US DOI), 2021). Snakeheads thrive in slow-moving freshwater and low-salinity brackish waters (up to 12-18 ppt) with mud substrates and aquatic vegetation (MD DNR). They can tolerate a large temperature range (32-85°F) and low dissolved oxygen, making Baltimore Harbor's urban, polluted shallows with submerged structure ideal habitat.

Snakeheads are opportunistic piscivores, or fish eaters, and shift their diet based on seasonal availability of prey (Chesapeake Bay Program, 2021). They primarily consume banded killifish but also white perch, bluegill, black crappie, gizzard shad, brown bullhead, and invertebrates (MD DNR; Chesapeake Bay Program, 2021). Adults serve as apex or near-apex predators with few natural enemies beyond larger snakeheads, bald eagles, and humans.

High reproduction rates, up to 15,000 eggs at five times per year, and high parental care, including mouthbrooding eggs and fry, boosts juvenile survival but slows adult growth (Chesapeake Bay Program, 2021; MD DNR, 2023). They can be over 33 inches and 20 lbs, with the Maryland record being 21.8 lbs in 2025 (MD DNR 2025). There are currently no bay-wide estimates for snakehead populations. However, a study at the Conowingo Dam suggests their populations are in the thousands or higher (Chesapeake Bay Magazine).

Rapid range expansion via natural dispersal during high spring flows and illegal releases, has led to this species spreading into all major tributaries including Patapsco River feeding Baltimore Harbor. Maryland DNR promotes no bag limits, mandatory kill on capture, and consumption (firm white fillets excellent grilled/fried) to control populations (MD DNR). In 2024, it was renamed "Chesapeake Channa" in 2024 to boost harvest.

Blue Catfish

Since their introduction to Virginia rivers in the 1970s, blue catfish (*Ictalurus furcatus*) have become a significant invasive apex predator throughout the Chesapeake Bay watershed, including Baltimore waters (Chesapeake Bay Program, 2020; Robertson et al., 2024). The species was initially introduced in the southern bay by the Virginia Department of Wildlife Resources (VA DWR) in an effort to provide a food source and replacement fishery for the

struggling striped bass. Today, it poses serious ecological and social threats by preying on valuable native species such as blue crabs, striped bass, river herring, shad, freshwater mussels, and various forage fish, disrupting native food webs and fisheries.

Native to the Ohio, Missouri, Mississippi, and Rio Grande river basins, blue catfish are resilient, inhabiting a variety of habitats from deep, high-flow areas to shallow waters and tolerating a wide salinity range (Bilkovic & Ihde, 2014; Chesapeake Bay Program, 2020). They have a diverse and opportunistic diet, consuming mostly mollusks, fish, and crustaceans. However, they are known to eat other, less common fish prey species like ducks and turtles (Robertson et al., 2024). They have high fecundity with females producing 4,000 - 8,000 eggs per kilogram of body weight (National Oceanic and Atmospheric Administration (NOAA)). Their lifespan can exceed 20 years, and they can grow up to 50-80 pounds (Bilkovic & Ihde, 2014).

Management efforts by Maryland DNR include pilot programs to increase harvest through commercial fishing incentives like finfish trotlines and no catch limits for recreational anglers (MD DNR, 2025). These programs aim to reduce blue catfish biomass and mitigate their impact on native species. Programs by the Maryland Department of Agriculture and other institutional partners are promoting an “eat ‘em to beat ‘em” approach, pushing for these fish to be used as affordable proteins for schools and prisons (Chesapeake Bay Program, 2020; Liu & Fisher, 2020). Today, blue catfish populations remain high, with estimates of over 100 million individuals in the bay (Liu & Fisher, 2020).

Overall, blue catfish are a persistent invasive species in the Chesapeake Bay system, requiring coordinated, large-scale management and public engagement to control their populations and protect sensitive native fisheries and ecosystem function.

Flathead catfish

Like blue catfish, flathead catfish (*Pylodictis olivaris*) were intentionally stocked in Virginia's rivers in 1965 and 1977 by VA DWR to enhance sport and recreational fishing (MD DNR; Chesapeake Bay Program, 2020). Today, they have spread to upper Chesapeake Bay tributaries (Maryland Coastal Conservation Association (CCAMD); Chesapeake Bay Program, 2020).

Native to Mississippi and Rio Grande regions, flatheads prefer undercut banks, woody debris, cavities, and turbid low-velocity waters for nesting (MD DNR; USGS 2025). They tolerate 8 -14ppt salinity and migrate up to 100 km seasonally for spawning (June-July at 19-24°C) (Bringolf et al., 2005; USGS, 2025). This allows them to swim into the mainstem of the bay and access other tributaries.

They are nocturnal opportunistic generalists, eating mainly insects and crayfish as juveniles and shifting to fish like shad, river herring, white perch, and sunfish as adults (MD DNR; Smithsonian; Bilkovic & Ihde, 2014; Chesapeake Bay Program, 2020). Their predation and competition have shown reductions in native species such as striped bass and white perch (Bilkovic & Ihde, 2014; Chesapeake Bay Program, 2020).

Flathead catfish can live up to 28 years old and produce 1,600 - 5,000 eggs per kilogram of weight (Chesapeake Bay Program, 2021; USGS, 2025). They are apex predators who fiercely

protect and care for their broods (USGS, 2025). Maryland, Pennsylvania, and Virginia promote no limits, kill-on-catch, and markets.

Methods

Overview

The Reel Rewards Invasive Fish Bounty Program takes a multi-disciplinary approach to addressing invasive fish in Baltimore's waters. The program is community-based and generates both ecological and social data that helps fill Baltimore's ecological data gaps. Methods include:

- Angler Registration
- Program Rules
- Staff, Volunteer, and Participant Recruitment
- Catch Logging
- Fish-Drop Off Events
- Data Analysis

These methods help the program run successfully and generate a variety of data used to improve the program as well as inform strategies and plans for other local environmental groups.

Angler Registration

To participate in the program, anglers must register on the Reel Rewards iAngler tournament page for that current year. The registration consists of filling out a survey that ensures that the participants are in compliance with Maryland fishing regulations and program information and rules. It also is an opportunity to collect ecological and social data. Below are the questions asked by in the registration process, as well as the response type:

iAngler Registration Questions	Response Type
Chesapeake Bay and Coastal License number (MD DNR)	Open Short Response
Chesapeake Bay and Coastal License validation dates (ex. Month / Day / Year - Month / Day / Year)	Open Short Response

What neighborhood do you live in? (Neighborhood Name, Zipcode)	Open Short Response
Over the last year, how often do you fish in Baltimore Harbor?	Multiple Choice: Daily, Weekly, Monthly, 2 times per year, 1 time per year
Over the last year, what do you usually catch in Baltimore waters? Select all that apply. If you selected other, please list the species.	Multiple Choice/Open Short Response: American Eel, Blue Catfish, Bullhead (Yellow or Brown), Channel Catfish, Flathead Catfish, Herring (Atlantic or Blueback), Largemouth Bass, Menhaden, Northern Snakehead, Perch (White or Yellow), Shad, Spot, Striped Bass, Sunfish, Other (list below)
Please list any environmental improvements in the Middle Branch area that you have heard about over the past year. If you are not aware of any, simply type 'NA'.	Open Short Response
How much do you agree or disagree with this statement? "Invasive fish species are a big problem for our local environment and should be dealt with or removed."	Multiple Choice: 1 (Strongly Disagree), 2 (Disagree), 3 (Somewhat Disagree), 4 (Neither Agree nor Disagree), 5 (Somewhat Agree), 6 (Agree), 7 (Strongly Agree)
What is your main reason for wanting to join this fish bounty program? Select all that apply. If you selected other, please list your reasons for joining the program.	Multiple Choice/Open Short Response: To help protect the local environment, To reduce the number of invasive fish, To earn

	rewards or money, To learn more about fishing and local wildlife, Because friends or family are participating, Other (please specify)
Would you like to learn more about environmental improvements along the Middle Branch shoreline?	Multiple Choice: • Yes (Email me more information), Yes (DO NOT email me more information), No
How did you hear about this tournament, Reel Rewards? Select all that apply. If you selected other, please list how you heard about Reel Rewards.	Multiple Choice: • Internet Search, EJJI Website, Newsletter, Flyer, Email, Social Media (select which platforms below), Word of Mouth, Other (list your response below)
If you selected social media, select which platforms you heard about Reel Rewards on. Select all that apply:	Multiple Choice: • Facebook, Instagram, TikTok, X (formally Twitter)
Do you consent to EJJI and its partners using the photos you upload to iAngler in things like social media posts, articles, movies, and other communications, now and in the future? We'll give you credit whenever your photos are used.	Multiple Choice: • Yes (Email me a link to the communications when my photo is used), Yes, No
I can confirm that I can identify the target fish species for this program; Northern Snakehead, Flathead Catfish, Blue Catfish	Multiple Choice: • Yes, No

Program Rules

The Reel Rewards Program has updated rules to ensure participants are in compliance with Maryland Department of Natural Resources policy, Maryland Department of the Environment Fish Consumption Guidelines, local parks and property owner's needs, and stipulations from the current year's funders. These rules are amended on an annual basis and are informed by the most current policy and lessons learned from the year(s) prior. The Reel Rewards Program has the following policies anglers must abide by to receive their bounty:

- Adhere to all applicable fishing regulations for the area in which you fish.
 - Click [here](#) to see Maryland DNR page on fishing regulations.
- Follow consumption guidelines to ensure safety in the preparation and consumption of fish.
 - Click [here](#) to see consumption guidelines from MDE.
- 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 Baltimore Harbor of the Patapsco River (*see map*).
- Fish must be caught by the participant submitting them for the reward.
- Photo or video evidence of catch and 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.
- 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. Bounty amount is subject to change due to volume and demand.
- Participants may submit up to 12 fish, per angler, per week.
- Must be 18 years of age or older to receive the reward.
- Violation of above policies or abusive, violent, and otherwise disruptive behavior are grounds for restriction or disqualification from the program.

Staff, Volunteer, and Participant Recruitment

Recruitment is a key part of the Reel Rewards program, as they help facilitate and generate interest and data for the program. This process occurs before and after the Reel Rewards season, from January to April and July to December.

Staff recruitment for the Fish Deputy positions was a new addition for the 2025 season. Fish deputies help run the on-the ground logistics such as setting up/breaking down fish drop off events, fish collection and storage, catch log verification, and any other related outreach activities. For the 2025 season, Reel Rewards had two, part-time fish deputies who were recruited and trained in March 2025.

Volunteer recruitment is done passively through a running interest form on the EJJI website. Additionally, volunteers are recruited through email and outreach events.

Participant recruitment is done via communications, specifically the iAngler website, social media, partner organizations' outreach, and news coverage. Partners that share the bounty program out to participants for both the 2024 and 2025 seasons include South Baltimore Gateway Partnership (SBGP), the Maryland Coastal Conservation Association (CCAMD), and the Maryland Department of the Environment. The Reel Rewards website is also online year-round for people to learn more about the program.

Catch Logging

Anglers must log fish in the Reel Rewards iAngler tournament page to receive their bounty. Each log must contain 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):

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 four 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

Fish Drop Off

For the 2025 season, fish drop offs were held from 11AM to 1PM, once a week on either Saturday or Sunday. The locations alternated between Middle Branch Park and Broening Boat Ramp. One fish drop off event was held in tandem with the Maryland Department of Natural Resources Youth Fishing Derby on June 14th in Landstowne, MD. The EJJI Reel Rewards website hosts a Google Calendar displaying the dates, times, and locations of the fish drop-off hours. Drop offs were hosted from April 26 - July 12, 2025.

During the drop off, 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 where they are used by local anglers for bait. 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.

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 the Reel Rewards iAngler Tournament page.
 - All anglers turning in fish are permitted one bounty payment if they are not yet registered, given that they register the day they drop off fish.
- 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](#) 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):	Multiple Choice • 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	Multiple Choice • 18-24, 25-55, 55 and older
Angler Interaction Response	Multiple Choice • Selection for a number 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.

Data Analysis

iAngler Registration Data

The 2025 iAngler registration data had 258 responses. The data was cleaned and formatted using R Studio and Microsoft Excel to ensure accuracy and usability. The following steps were taken:

1. Import data into R Studio-
 - Libraries: ``readxl``, ``writexl``, ``dplyr``, ``sf``, ``readr``, and ``tidyr``.
 - Raw response data from an Excel sheet into a dataframe.
2. Data Transformation for Survey Responses
 - Convert columns with multiple comma-separated entries into character vectors.
 - Split these columns by commas and pad them to equal lengths for consistent column binding.
 - Rename columns for clarity according to question context.
 - Consolidate multiple columns into single columns to simplify analysis.
 - Filter out NA and empty string entries for cleaned datasets.
 - Perform manual data clean-up and standardization by replacing specific values and removing duplicates or ambiguous entries.
3. Spatial and Geographic Data Integration
 - Import Chesapeake Bay watershed shapefile using the `sf` package.
 - Load US zipcode dataset and filter relevant geographic and demographic columns.
 - Clean user-entered zipcode data by isolating numeric/alphanumeric parts, removing special characters, and applying corrections with pattern matching.
 - Merge cleaned survey data by zipcodes with external zipcode geographic data to assign watershed locations.
4. Final Data Assembly and Export
 - Combine separately cleaned and transformed datasets into a master dataframe.
 - Subset master dataframe for specific analyses (e.g., Baltimore vs other counties).
 - Convert multi-column survey response data into single-column formats for downstream analysis.

- Export cleaned and consolidated data tables to Excel files using writexl.

5. Analysis in Excel

- Using the PivotTable function, the frequencies for each response type for each question was calculated.
- These were reorganized and converted into percentages.
- Finally, the percentages were used to create graphs.

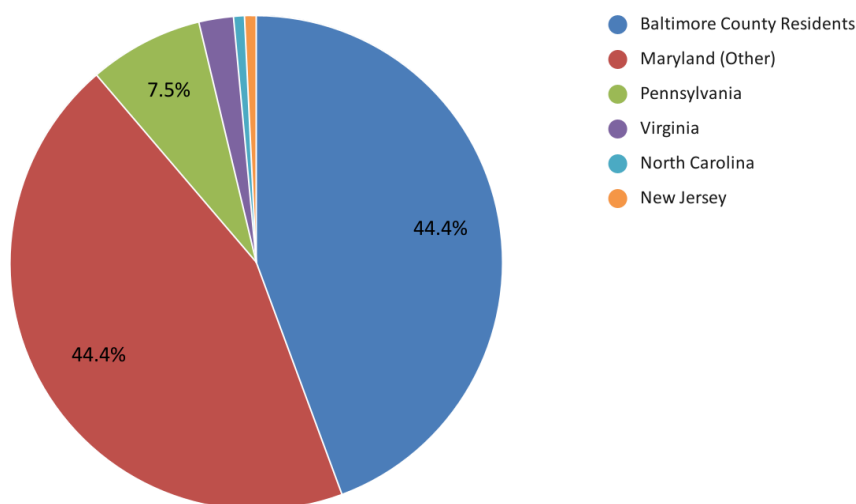
Results

iAngler Registration Results

The responses used in this analysis are from April 26 - July 12, 2025 from 248 participants.

Demographics

Reel Rewards Registrant Distribution



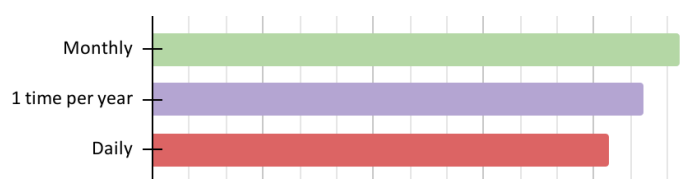
44.4% of Reel Rewards are Baltimore residents. Nonresident participants (55.6%) were from other Maryland areas as well as Pennsylvania, Virginia, New Jersey, and North Carolina. Not all registrants were active participants in the program. There were 65

less registrants in 2025 than 2024. Additionally, there were more non-Baltimore residents in 2025 than 2024. Despite the smaller registration numbers and percentage of residents, there were more anglers who turned in fish in 2025 than in 2024.

Fishing Frequency

Frequency for All Respondents

Over the last year, how often do you fish in Baltimore Harbor?

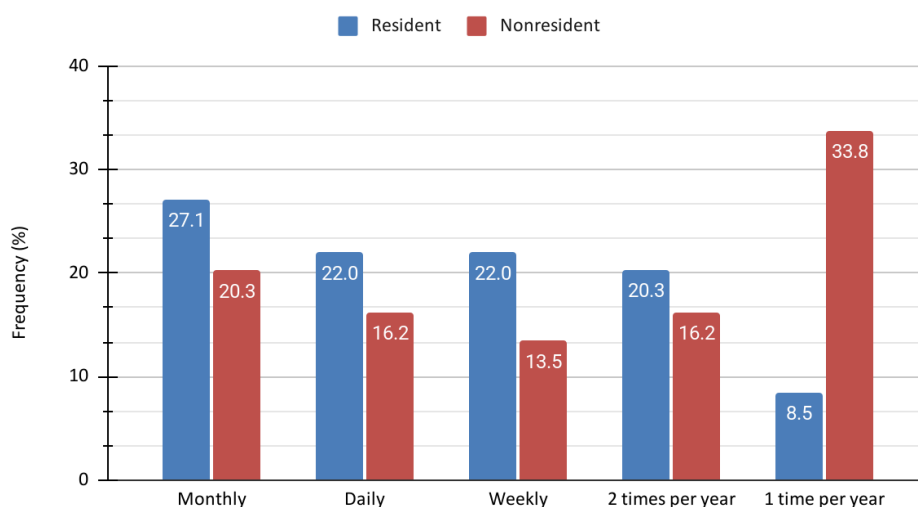


Most respondents fish in Baltimore Harbor at least monthly, with a fairly

even spread across frequency categories and a notable group fishing daily. There is no single dominant category; use is spread across daily, weekly, monthly, and annual users, suggesting a mix of very frequent, moderate, and infrequent anglers. 21% report daily use and 40% report at least weekly (daily + weekly), pointing to a substantial core of high-frequency users who may bear higher exposure to any harbor-related risks or benefits. About 37% (1 or 2 times per year) are infrequent users, or more casual or occasional anglers, compared with the more intensive users in the daily/weekly categories

Frequency for Residents vs. Nonresidents

Over the last year, how often do you fish in Baltimore Harbor?



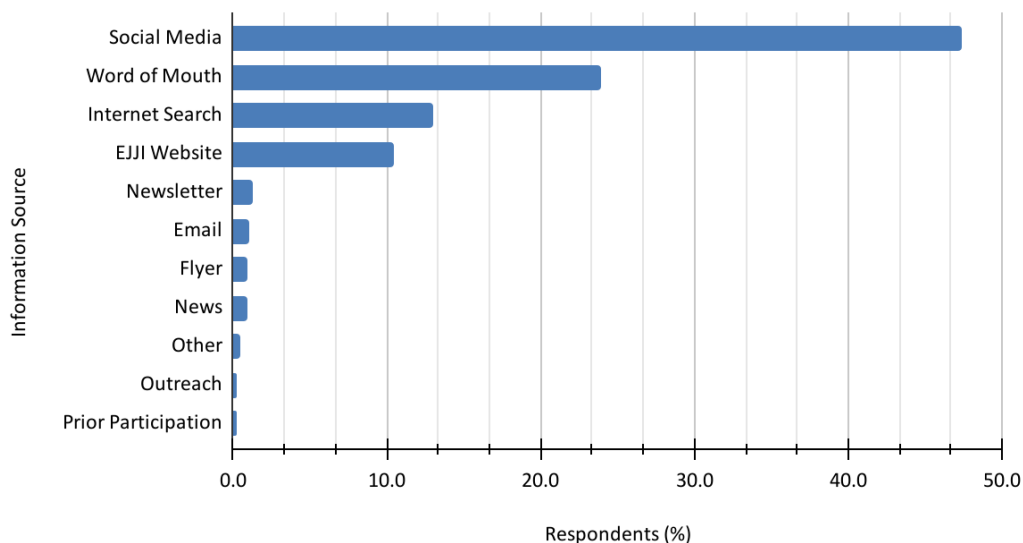
Comparing residents or nonresidents fishing frequency support that Baltimore residents fish more frequently in the Middle Branch (Monthly, Daily, and Weekly). With the exception of 1 or 2 times a year responses, residents outweigh nonresidents. Nonresidents outweigh residents in the first time fishing in

the Middle Branch response. Residents fish more frequently on a monthly, daily, and weekly basis compared to nonresidents. Nonresidents have a much higher proportion fishing only once per year (33.8%) compared to residents (8.5%). The twice per year frequency is somewhat similar between the two, though slightly higher for residents. This pattern suggests residents maintain more consistent and frequent fishing habits in Baltimore Harbor, while nonresidents tend to fish more sporadically or as occasional visitors.

Information Sourcing

Frequency for All Respondents

How did you hear about Reel Rewards?

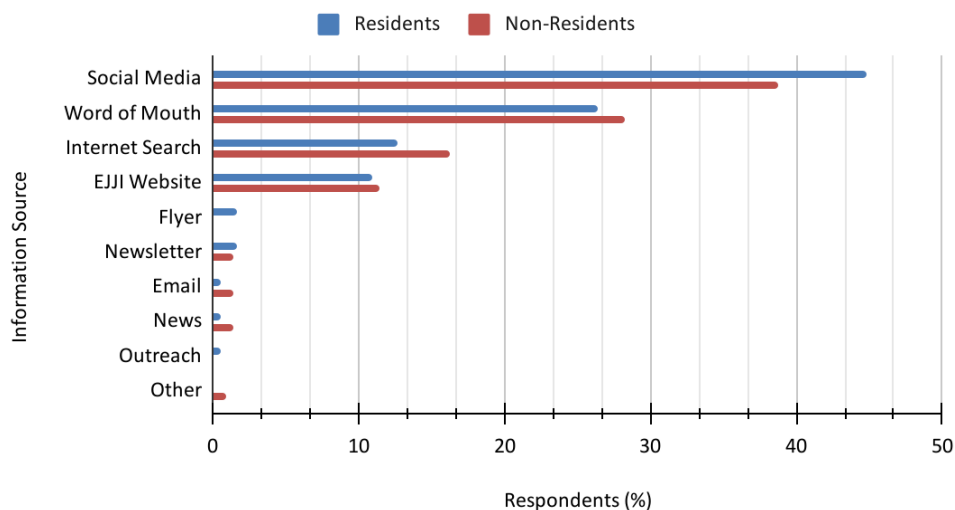


When asked how they heard about the Reel Rewards Program, the majority of responses were “Social Media” or “Word of Mouth”. “Internet Search” is the next most frequent

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.

Frequency for Residents vs. Nonresidents

Residents and Non-Residents

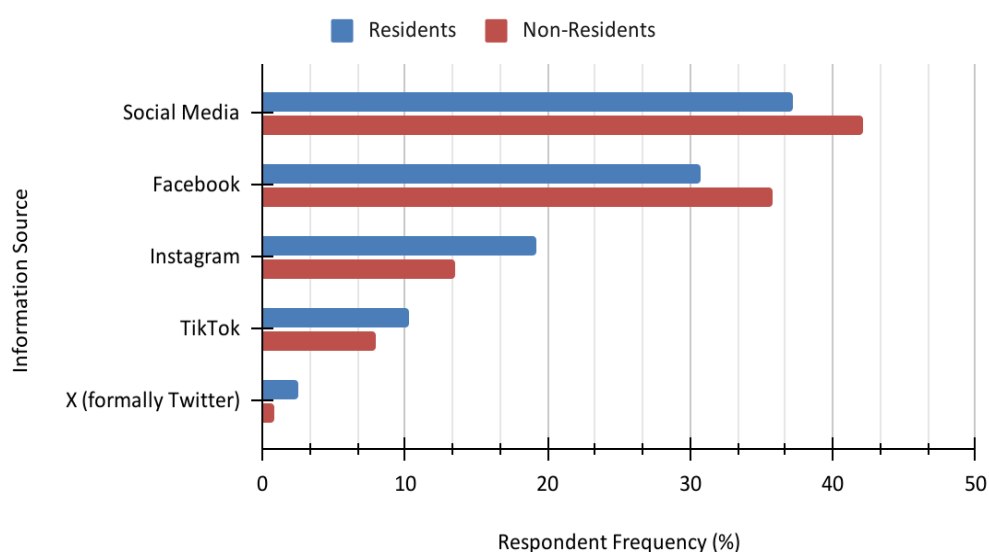


Social media leads for residents at 45% and non-residents at 39%, accounting for over 80% of combined top preferences across both. Residents rely on it more by 6 percentage points. Word of

mouth follows at 26% for residents versus 28% for non-residents, while internet search is 13% versus 16%. Non-residents showing slightly higher preference for these (2-3 points more). EJJI Website ties exactly at 11% for both groups. Minor sources like flyers and outreach favor residents exclusively, while "other" appears only for non-residents.

Social Media Information Sources

Social Media Information Sources for Reel Rewards

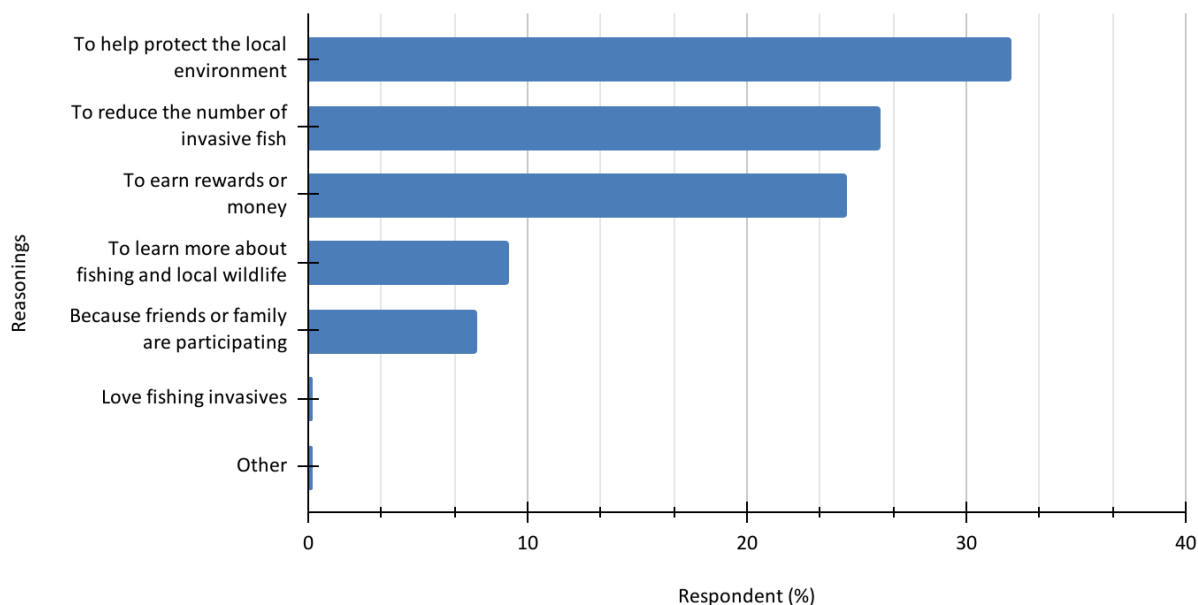


Facebook dominates for both, at 36% for non-residents and 31% for residents, while Instagram sees more resident use (19% vs. 13%). TikTok and X show low, similar engagement across groups (10% vs. 8%

for TikTok; 3% vs. 1% for X).

Motivation for Joining

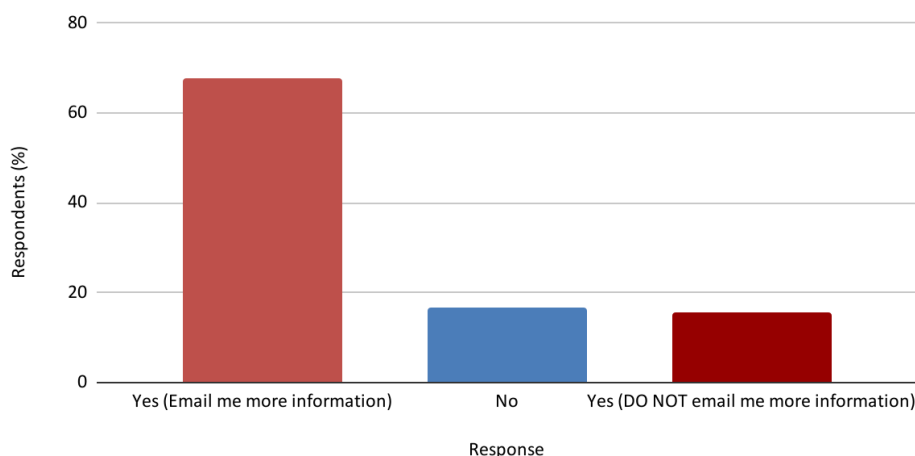
Reasons for Joining Reel Rewards Program



The survey data reveals motivations for participating in invasive fish fishing activities, with environmental protection as the top driver at 32.09%, followed closely by reducing invasive species at 26.12% and earning rewards at 24.57% . These top three reasons account for 82.78% of responses, indicating strong alignment between ecological goals and incentives . Minor motivations, under 10%, include learning about wildlife (9.17%), social influences (7.7%), and niche reasons like enjoyment or other (0.17% each) .

Desire to Learn More

Would you like to learn more about environmental improvements along the the Middle Branch shoreline?

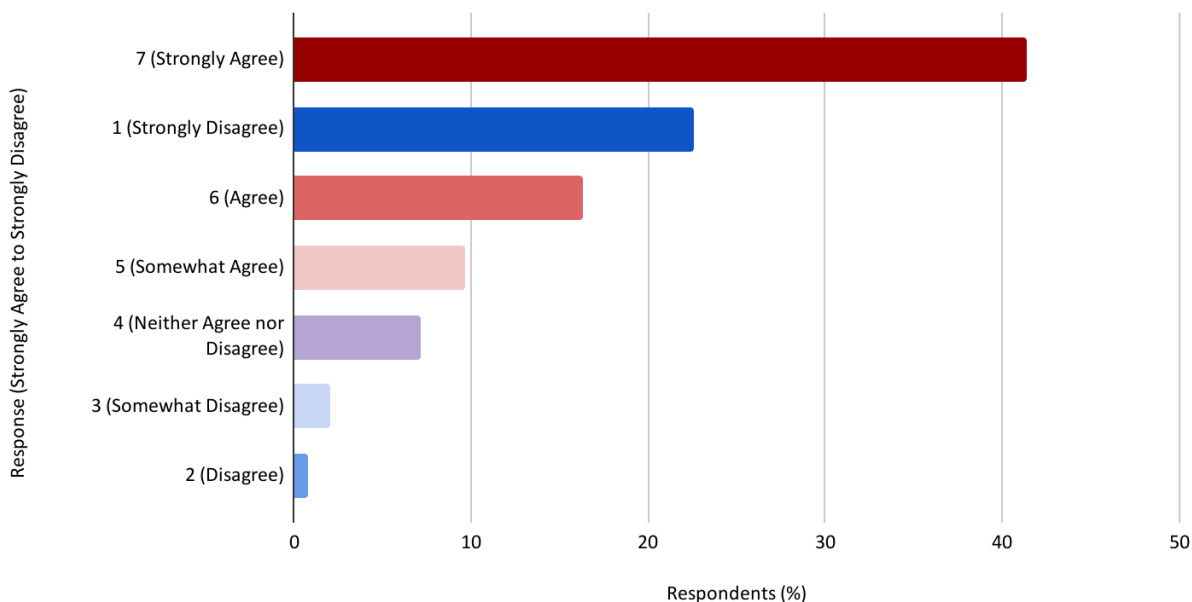


Survey results on interest in learning more about environmental improvements in Middle Branch shorelines show overwhelming positive response, with 84% of participants wanting more information despite 17% declining . Notably, 68% opted for email delivery, indicating strong

preference for direct outreach channels . This aligns with Chesapeake Bay environmental research priorities, suggesting high potential for engagement in shoreline restoration efforts.

Perception of Invasive Species

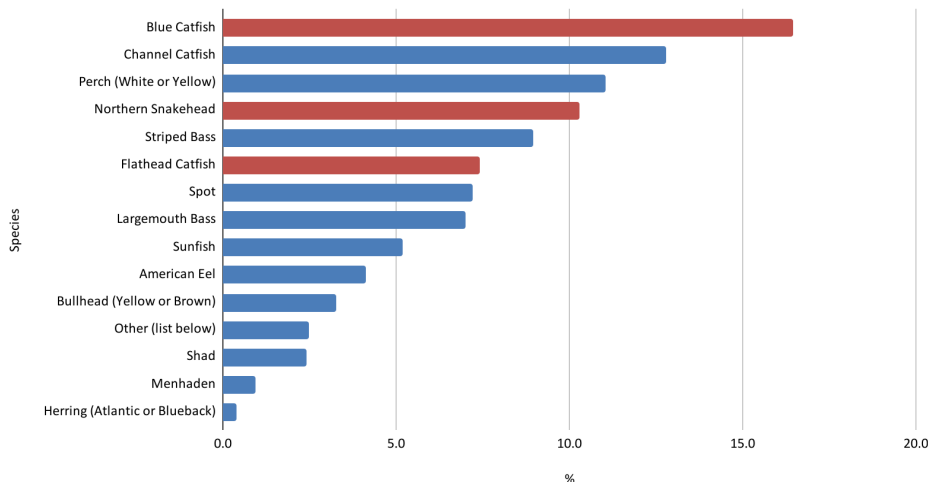
How much do you agree or disagree with this statement? "Invasive fish species are a big problem for our local environment and should be dealt with or removed."



Agreement (Strongly Agree, Agree, and Somewhat Agree) totals 67.4%. This majority supports invasive fish removal in Chesapeake Bay. Disagreement (Strongly Disagree, Disagree, and Somewhat Disagree) is 25.5%, showing polarization amid ongoing removal programs. High standard deviation (14.09) reflects bimodal extreme.

Target Species Comparison to Species Caught

Over the last year, what do you usually catch in Baltimore waters?

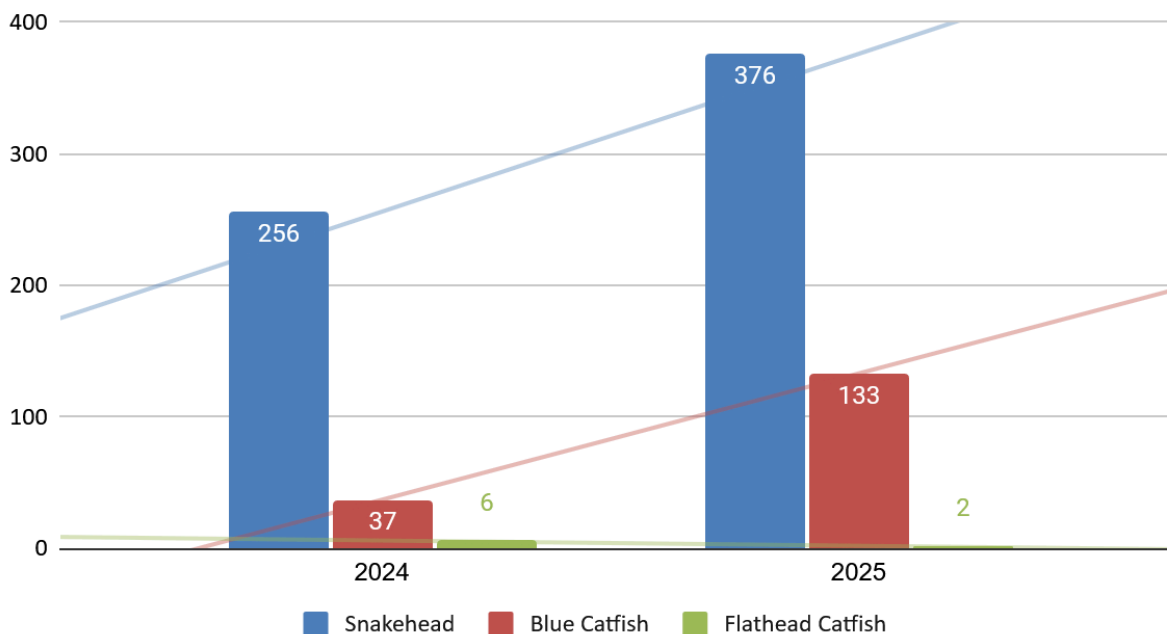


Baltimore waters fishing data from the last year shows invasive species dominating catches: Blue Catfish (16.4%), Northern Snakehead (10.3%), and Flathead Catfish (7.4%) total 34.1%. Native species like Channel Catfish (12.8%), Perch (11.1%), and Striped

Bass (8.9%) follow closely, aligning with 2025 Chesapeake Bay reports of abundant invasives in tidal rivers like Patapsco. Top five species account for 59.5%, indicating focused angler targeting amid removal efforts.

Fish Logs Results

Fish Catch Data (2024-2025)



In 2025, the program recorded 376 Snakehead, 133 Blue Catfish, and 2 Flathead Catfish catches, totaling 511 fish across these species. Snakehead dominated at 73.6% of total catches, reflecting their expanding presence as a top invasive predator in Chesapeake Bay. Blue Catfish followed at 26.0%, underscoring their rapid proliferation amid targeted removal tournaments. Compared to the 2024 season, there was a substantial increase for invasive Snakehead (+47%) and Blue Catfish (+256%) in 2025, while Flathead Catfish (-67%) declined sharply.

Content and Engagement

With 248 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 [Chesapeake Bay Magazine](#), [Fox](#), [South Baltimore Gateway Partnership](#), [Chesapeake Inspired](#), [Sport Destination Management](#), [Maryland Department of Natural Resources](#), [Rated](#)

[Red/ Nashville Media Partners](#), [Catfish Now](#), [Reef Builders](#), [the Southern Maryland Chronicles](#), [Outdoor Life Magazine](#), and others.

Discussion

Participant Diversity and Reach

Despite fewer registrants than in 2024, the 2025 Reel Rewards season attracted broader diversity among anglers, with greater participation from varied groups. Promoted across more than 15 publications, the program demonstrated sustained popularity and growth. Women appeared on the leaderboard for the first time, with one achieving some of the highest fish submissions, highlighting the program's expanding appeal to local demographics. While most registrants hailed from Baltimore, others came from additional Maryland regions as well as Pennsylvania, Virginia, New Jersey, and North Carolina.

Fishing Frequency Shifts

The 2025 season showed a 16-18% increase in daily and once-per-year fishers compared to 2024, while weekly fishing declined; monthly and twice-per-year frequencies saw slight rises. This indicates a polarization toward more daily or infrequent anglers, with fewer moderate-frequency participants, including newcomers. Baltimore residents fished more often in the Middle Branch (monthly, daily, weekly), underscoring the need to educate high-frequency users on consumption guidelines for harbor-related risks and benefits.

Both residents and nonresidents reported sharp drops in "first-time" fishers from 2024 to 2025. Once- or twice-per-year fishing rose substantially for both groups, while daily frequency surged for residents and nonresidents. Monthly and weekly rates fell or stabilized, with steeper declines among nonresidents, reflecting a shift to extreme intensities—daily or occasional—over moderate habits. This may suggest that the Reel Rewards program is encouraging more people to visit and fish in Baltimore.

Awareness Channels

Most participants learned about Reel Rewards through social media or word of mouth, followed by internet searches; over half used online sources like social media, search engines, and the EJJI website. Residents leaned more on social media, while nonresidents favored word of mouth and searches slightly more. Facebook led for both groups, followed by Instagram (preferred by residents), with TikTok and X showing low but equal engagement across years and demographics. This highlights the importance of continued communication via online resources.

Motivations and Interests

Helping the environment and earning rewards drove most participation, while learning about wildlife, social influences, and enjoyment ranked lower. This points to opportunities for programs stressing environmental impact and incentives to enhance invasive species management in Chesapeake Bay. Interest in Middle Branch environmental improvements grew 44% from 2024 to 2025, with respondents able to specify email preferences per a prior report's recommendation.

Species Trends and Support

Strong majority support exists for removing invasive fish from Chesapeake Bay, though a vocal minority disagrees; high standard deviation signals polarized views, with broad agreement that invasives pose problems. In 2025, invasives dominated Baltimore catches: blue catfish took #1 (displacing perch), channel catfish and northern snakehead rose to #2 and #4, and striped bass held top five but fell from #3. Snakehead and blue catfish submissions increased amid population growth and management efforts like MD DNR tournaments, validating targeted removal in Patapsco/Middle Branch while monitoring striped bass and addressing forage fish declines like herring.

Recommendations

1. Community Fishing Classes
2. Pursuing More Diverse Volunteers and Community Facilitators
 - a. College Students and Professors
 - b. Veterans
3. Improving In-Person Communications Leveraging Local Outreach Events
4. Pushing for Updated Consumption Guidelines and Research from the Maryland Department of the Environment
5. Creating a Tiered Bounty Pay-Out System
 - a. \$10 Payment for Each of the Categories for Each Catch
 - i. Fish Head/Catch Location
 - ii. Gut Content Image and Description
 - iii. Fish Fillets for Consumption
6. More Operations Equipment Leveraging Partners
 - a. Baltimore Community Fridge Network for More Fridge and Freezer Space
 - b. Maryland Coastal Conservation Association for Community Fishing Classes
 - c. Tochemans and Yamaha for Fishing Gear

References

1. Bilkovic, D. M., & Ihde, T. F. (2014). *Review of the final report of the Sustainable Fisheries Goal Implementation Team Invasive Catfish Task Force* (STAC Publication 14-007). Chesapeake Bay Program Scientific and Technical Advisory Committee. <https://www.chesapeake.org/stac/wp-content/uploads/2025/03/FINAL-STAC-Invasive-Catfish-Review-Report-11.7.14.pdf>
2. Bringolf, R. B., Kwak, T. J., Cope, W. G., & Larimore, M. S. (2005). Salinity tolerance of flathead catfish: Implications for dispersal of introduced populations. *Transactions of the American Fisheries Society*, 134(4), 927–936. <https://doi.org/10.1577/T04-195.1apastyle.apa+1>
3. Brodbeck, C. (n.d.). A brief history of the Susquehannock Nation and other American Indians in the Susquehanna Valley. Gardner Library. Retrieved October 3, 2024, from <https://gardnerlibrary.org/encyclopedia/brief-history-susquehannock-nation-and-other-american-indians-susquehanna-valley>
4. Chesapeake Bay Program. (2020). *Invasive catfish management strategy* (August 2020). https://d18lev1ok5leia.cloudfront.net/chesapeakebay/documents/Invasive%20Catfish_Management Strategy Aug 2020 final.pdf
5. Chesapeake Bay Program. (2021). *Northern snakehead*. <https://www.chesapeakebay.net/discover/field-guide/entry/northern-snakeheadchesapeakebay>
6. Chesapeake Bay Program. (2021). *Flathead catfish (Pylodictis olivaris)*. <https://www.chesapeakebay.net/discover/field-guide/entry/flathead-catfishchesapeakebay>
7. Chesapeake Legal Alliance. (2024). *Baltimore backwater and Patapsco wastewater treatment plants*. Chesapeake Legal Alliance. <https://www.chesapeakelegal.org/case/baltimore-backwater-and-patapsco-wastewater-treatment-plants>
8. Chesapeake Bay Magazine. (n.d.). *Double the snakeheads: Study finds invasive species may spawn twice a year in the Bay*. <https://www.chesapeakebaymagazine.com/double-the-snakeheads-study-finds-invasive-species-may-spawn-twice-a-year-in-the-bay/#:~:text=Love%20and%20DNR%20biologists%20conducted%20this%20studychesapeakebaymagazine>
9. City of Baltimore Comprehensive Master Plan. (n.d.). History of Baltimore. https://www.baltimorecity.gov/sites/default/files/5_History.pdf
10. Coastal Conservation Association Maryland. (n.d.). The great Chesapeake invasives count. <https://www.ccamd.org/the-great-chesapeake-invasives-count/>
11. Fiske, S.J., & Callaway, D. (2020). Ethnographic Resource Study: Subsistence Fishing on the Potomac and Anacostia Rivers. *Resource Stewardship and Science*. 6-62. <https://www.nps.gov/articles/subsistence-fishing-on-the-potomac-and-anacostia.htm>

12. Legett, H. C., Huang, C., Aguilar, R., Heggie, K., Richie, K., & Ogburn, M. B. (2023). Early detection and recovery of river herring spawning habitat use in response to a mainstem dam removal. *PLOS ONE*, 18(5), e0284561.
<https://doi.org/10.1371/journal.pone.0284561>
13. Liu, C., & Fisher, R. (2020). *Chesapeake Bay blue catfish: Invasive, but delicious and nutritious!* (FS-1142). University of Maryland Extension.
https://dnr.maryland.gov/fisheries/Documents/Chesapeake_Blue_Catfish.pdf
14. Love, J. W., Newhard, J. J. (2021). Using Published Information to Predict Consumption by Northern Snakehead in Maryland: PREDICTING NORTHERN SNAKEHEAD CONSUMPTION, *Transactions of the American Fisheries Society*, Volume 150, Issue 4, Pages 425–434, <https://doi.org/10.1002/tafs.10306>
15. Martin, E. H. (2023). Chesapeake Fish Passage Prioritization: An assessment of dams in the Chesapeake Bay watershed (2023 revision) [Report]. The Nature Conservancy.
https://cbtrust.org/wp-content/uploads/ChesapeakeFishPassagePrioritization_2023_Report.pdf
16. Maryland Department of the Environment. (2021). 2020 fish kill summary annual report.
https://mde.maryland.gov/programs/water/FishandShellfish/Documents/Fish_Kill_Report_s/2020_FK_ANNUAL_REPORT_FINAL.pdf
17. Maryland Department of Legislative Services. (2023). Fiscal and policy note for Senate Bill 80: Natural resources – blue and flathead catfish finfish trotline license – establishment [PDF]. Maryland General Assembly.
https://mgaleg.maryland.gov/2023RS/fnotes/bil_0000/sb0080.pdf
18. Maryland Department of Natural Resources. (n.d.). Catch invasives and win monthly prizes. Fish and Hunt Maryland.
<https://fishandhuntmaryland.com/catch-invasives-and-win-monthly-prizes>
19. Maryland Department of Natural Resources. (n.d.). Alewife and Blueback Herring. Retrieved November 20, 2025, from
<https://dnr.maryland.gov/fisheries/Pages/fish-facts.aspx?fishname=Alewife+and+Blueback+Herring>
20. Maryland Department of Natural Resources. (n.d.). Flathead catfish. Maryland DNR Fisheries. Retrieved November 24, 2025, from
https://dnr.maryland.gov/fisheries/Pages/flat_cat/flathead_main.aspx
21. Maryland Department of Natural Resources. (n.d.). *Chesapeake Channa aka Northern Snakehead*. Fisheries Service. Retrieved December 1, 2025, from
<https://dnr.maryland.gov/fisheries/pages/snakehead.aspx>
22. Maryland Department of Natural Resources. (n.d.). *Invasive catfish in the Chesapeake Bay* [Fact sheet].
https://dnr.maryland.gov/fisheries/documents/Invasive_Catfish_%20Fact_Sheet.pdf
23. Maryland Department of Natural Resources. (2023). *Northern snakehead control and management plan for the Chesapeake Bay watershed* (3rd ed.).
https://dnr.maryland.gov/fisheries/Documents/fmp/ChesapeakeBay_NorthernSnakehead_FMP_3-2023.pdf

24. Maryland Department of Natural Resources. (2025). *DNR study: Other fish species declined after arrival of Chesapeake Channa in Maryland waters*. Maryland.gov.
<https://news.maryland.gov/dnr/2025/01/30/dnr-study-other-fish-species-declined-after-arrival-of-chesapeake-channa-in-maryland-waters/>
25. Maryland Department of Natural Resources. (2025). Maryland fishing report.
<https://dnr.maryland.gov/fisheries/pages/fishingreport/index.aspx>
26. Maryland Department of Natural Resources. (2025). *Anne Arundel County angler breaks Maryland state record for Chesapeake Channa*.
<https://news.maryland.gov/dnr/2025/06/16/anne-arundel-county-angler-breaks-maryland-state-record-for-chesapeake-channa/news.maryland>
27. Maryland Department of Natural Resources. (2025). *Maryland DNR introduces commercial blue catfish pilot programs*.
<https://news.maryland.gov/dnr/2025/02/07/maryland-dnr-introduces-commercial-blue-catfish-pilot-programs/>
28. Maryland Office of the Governor. (2023). Maryland fishery disaster determination [PDF].
<https://dnr.maryland.gov/Documents/Maryland-Fishery-Disaster-Determination.pdf>
29. Maryland State Archives. (n.d.). Fish - Maryland state wildlife. Maryland Manual Online. Retrieved November 20, 2025, from
<https://msa.maryland.gov/msa/mdmanual/01glance/wildlife/fish/html/fish.html#mdfish>
30. National Aquarium. (2023). Baltimore Harbor: Replenishing what we've depleted. Retrieved October 3, 2024, from
<https://aqua.org/stories/2023-11-13-replenishing-what-weve-depleted>
31. National Invasive Species Information Center. (n.d.). *Northern Snakehead*. U.S. Department of Agriculture. Retrieved December 1, 2025, from
<https://www.invasivespeciesinfo.gov/aquatic/fish-and-other-vertebrates/northern-snakehead/invasivespeciesinfo>
32. National Oceanic and Atmospheric Administration. (n.d.). *Blue catfish*. NOAA Fisheries. Retrieved December 1, 2025, from
<https://www.fisheries.noaa.gov/species/blue-catfishfisheries.noaa>
33. National Oceanic and Atmospheric Administration. (2025). Contaminants affect fish and wildlife in the Chesapeake Bay. NOAA Fisheries.
<https://www.fisheries.noaa.gov/topic/chesapeake-bay>
34. National Park Service. (2000). *Chapter five: Contact and colonization, A.D. 1500 to 1775*. In *Bay, plain, and Piedmont: A landscape history of the Chesapeake heartland from 1.3 billion years ago to 2000* (pp. 50-60). Chesapeake Bay Program.
https://d38c6ppuvigmpf.cloudfront.net/content/publications/cbp_19653_19663.pdf
35. National Park Service. (2024). Subsistence fishing on the Potomac and Anacostia. U.S. Department of the Interior.
<https://www.nps.gov/articles/subsistence-fishing-on-the-potomac-and-anacostia.htm>
36. Robertson, E., Malpass, J., Ottinger, C., Griffin, J., Densmore, C., & Hyer, K. (2024). *Invasive blue catfish in the Chesapeake Bay: A risk to realizing Bay restoration investments* (U.S. Geological Survey Fact Sheet 2024–3033). U.S. Geological Survey.
<https://doi.org/10.3133/fs20243033>

37. Smithsonian Institution. (n.d.). *Northern snakehead (Channa argus) species summary*. National Exotic Marine and Estuarine Species Information System. Retrieved November 20, 2025, from https://invasions.si.edu/nemesis/species_summary/164029
38. Smithsonian. (2023). The bay of opportunity and hope. Smithsonian Ocean Portal. <https://ocean.si.edu/human-connections/history-cultures/bay-opportunity-and-hope>
39. U.S. Department of the Interior. (2021). Snakeheads: A horror story. <https://www.doi.gov/employees/snakeheads-horror-story#:~:text=They%20can%20thrive%20in%20some>
40. U.S. Geological Survey. (2022). *How did snakehead fish get into the United States?* <https://www.usgs.gov/faqs/how-did-snakehead-fish-get-united-states#:~:text=Some%20snakeheads%20living%20in%20naturalusgs>
41. U.S. Geological Survey. (2025). *Flathead catfish (Pylodictis olivaris) - species profile*. Nonindigenous Aquatic Species Database. <https://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=750>
42. Vargas-Nguyen, V., Edgerton, J., Nair, R., Anderson, S., Badri, L., Lucchese, V., Fife, A., Kelsey, H., & Dennison, B. (2024). 2023/2024 Chesapeake Bay & Watershed report card. University of Maryland Center for Environmental Science. <https://ian.umces.edu/publications/2023-2024-chesapeake-bay-watershed-report-card>
43. Waterfront Partnership. (2025). *Water quality monitoring | Baltimore Harbor*. Waterfront Partnership of Baltimore. <https://www.waterfrontpartnership.org/water-quality-monitoring>