An Analysis of the Recreational Angler Vector and Associated Pathways to aid in the Prevention of Invasive Species Introductions in Mid-Atlantic Waterways

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Angling is a known vector of invasive species, and also a lucrative industry.

Nontidal angling generates an estimated 406,000,000$ in 2015 alone!

Invasive species pose significant threats to both ecosystems and water-related industries.

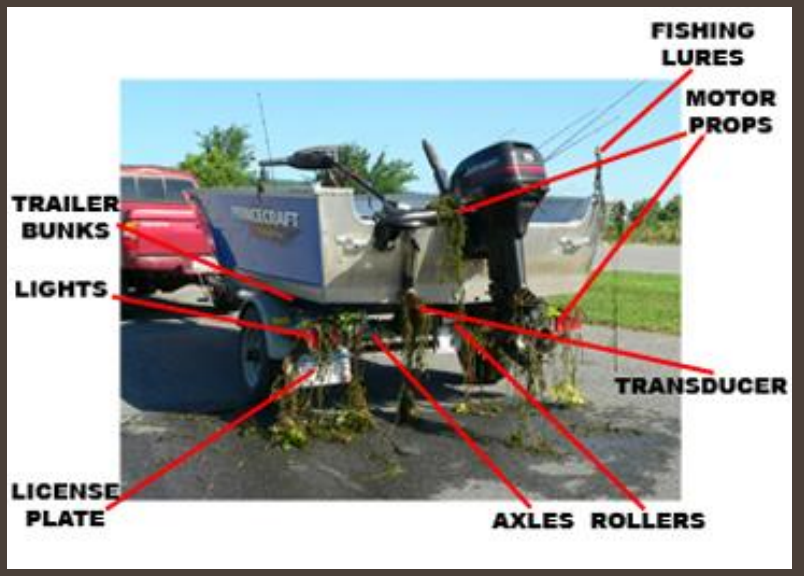
These facts mean there is a great deal of interest devoted to exploring the vectors of freshwater invasive species.

This analysis seeks to evaluate and identify "high risk areas" within the nontidal fishing areas of Maryland.

This is done with the goal of informing better locating of limited management resources.

This analysis follows a three-prong structure, based upon three angler-related vectors that are well known:

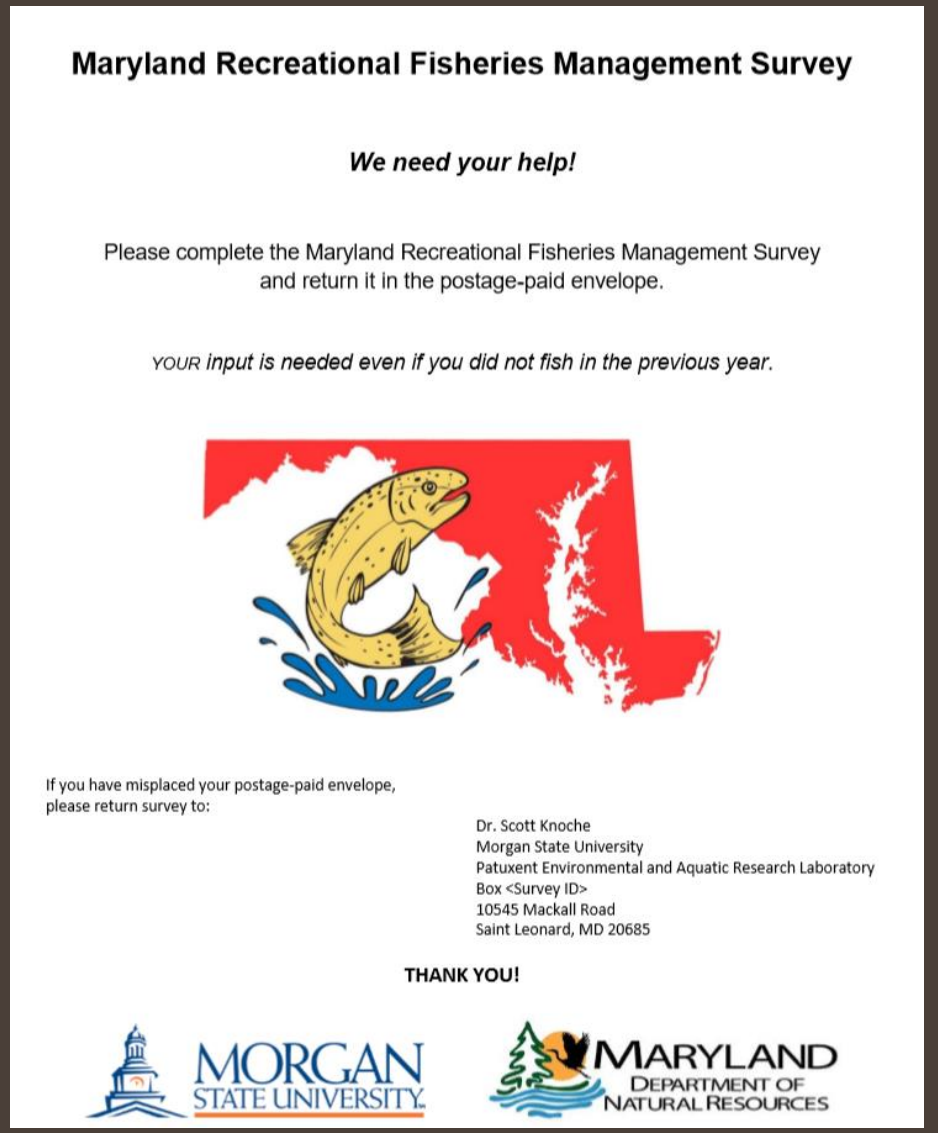
Fly Fishing
Watercraft Use
Live Bait Use



Data for these analyses was collected from a 2015 DNR sponsored survey sent to all persons possessing a Maryland nontidal fishing license

962 anglers responded to the survey, yielding a response rate of 25.1%

This survey was primarily targeted to collect data about behavior, preferences and expenditures of anglers within the state of Maryland, however certain sections of it were co-opted for use in this analysis



Maryland Recreational Fisheries Management Survey

We need your help!

Please complete the Maryland Recreational Fisheries Management Survey and return it in the postage-paid envelope.

YOUR input is needed even if you did not fish in the previous year.

If you have misplaced your postage-paid envelope, please return survey to:

Dr. Scott Knoche
Morgan State University
Patuxent Environmental and Aquatic Research Laboratory
Box <Survey ID>
10545 Mackall Road
Saint Leonard, MD 20685

THANK YOU!

MORGAN STATE UNIVERSITY

MARYLAND DEPARTMENT OF NATURAL RESOURCES

This was the first of several sections of the DNR survey from which we pulled data for this analysis.

Within these questions, which we refer to from here on as the "Trip Details Page", data was collected on the location the angler in question visited, the number of people on the trip, as well as the fishing types and methods used.

Because this page has participants list the waterbody and nearest town to their fishing location, it allowed for more spatially precise analysis than the other datasources within the survey.

4. **During which seasons did you fish in Maryland Non-Tidal waterways? (check all that apply)**

- ☐ **Winter 2015** (Jan. 2015 – Mar. 2015)
- ☐ **Spring 2015** (Apr. 2015 – June 2015)
- ☐ **Summer 2015** (July 2015 – Sept. 2015)
- ☐ **Fall 2015** (Oct. 2015 – Dec. 2015)

☆ **BEFORE PROCEEDING, look back to Question 4 and identify the first season you checked, from Left to Right. We are interested in details of the FIRST Maryland Non-Tidal fishing trip you took during this specific season. On the rest of this page, think back to this trip when answering questions.**

5. **During which month was this fishing trip?** (see ☆ above for instructions) _____

6. **Name of the waterbody and nearest city/town where you fished**

_____ Waterbody

_____ Nearest city/town

7. **Including yourself, how many people went on this fishing trip?** _____

8. **How many nights were you away from home on this trip? (if none, enter "0")** _____

9. **Which fishing types and methods did you use on this trip? (check all that apply)**

- ☐ Natural Bait
- ☐ Artificial Lures
- ☐ Fly Fishing
- ☐ Ice Fishing
- ☐ Watercraft (with motor)
- ☐ Watercraft (without motor)
- ☐ Shore/Wading

10. **Which fish species did you target on this trip?** _____

Another section of the survey from which data was collected was this section, referred to as the "Rivers Matrix".

This data is more spatially vague than that present on the Trip Details page, leading to less spatial certainty in analysis.

However, this data is still useful because it provides up to three spatial locations per angler, as well as knowledge of the number of trips taken.

Fishing in Maryland Non-Tidal Waterways in 2015

In this section, we are interested in your 2015 Maryland fishing activity in two types of Non-Tidal Waterways: **Non-Tidal Rivers/Streams** & **Lakes, Ponds, or Reservoirs**. When responding to questions 13-16, please only consider your fishing activity in these waterbodies.

13. **Please list the number of fishing trips you took to Maryland Non-Tidal Rivers/Streams during each season below.** (If you took no trips during a season, please enter "0")

	Winter 2015 (Jan. 2015 – Mar. 2015)	Spring 2015 (Apr. 2015 – June 2015)	Summer 2015 (July 2015 – Sept. 2015)	Fall 2015 (Oct. 2015 – Dec. 2015)
# of trips	_____	_____	_____	_____

14. **Please list the three Maryland Non-Tidal Rivers/Streams where you went fishing the most in 2015. For each waterbody, also list the county, # of trips, and species targeted.**
(If you did not fish in a Maryland Non-Tidal River/Stream in 2015, please skip to question 15.)

Non-Tidal River/Stream	County (list multiple, if necessary)	# of trips	Species Targeted (list multiple, if necessary)

The final section of the DNR survey used in this analysis was referred to as the "Lakes Matrix".

This data is also vague, collected by waterbody name and the county, as is the Rivers Matrix.

However, again we are granted up to three additional locations by this data that allow us to explore the movement of anglers more precisely.

15. **Please list the number of fishing trips you took to Maryland Lakes, Ponds, or Reservoirs during each season below.** (If you took no trips during a season, please enter "0")

	Winter 2015 (Jan. 2015 – Mar. 2015)	Spring 2015 (Apr. 2015 – June 2015)	Summer 2015 (July 2015 – Sept. 2015)	Fall 2015 (Oct. 2015 – Dec. 2015)
# of trips	_____	_____	_____	_____

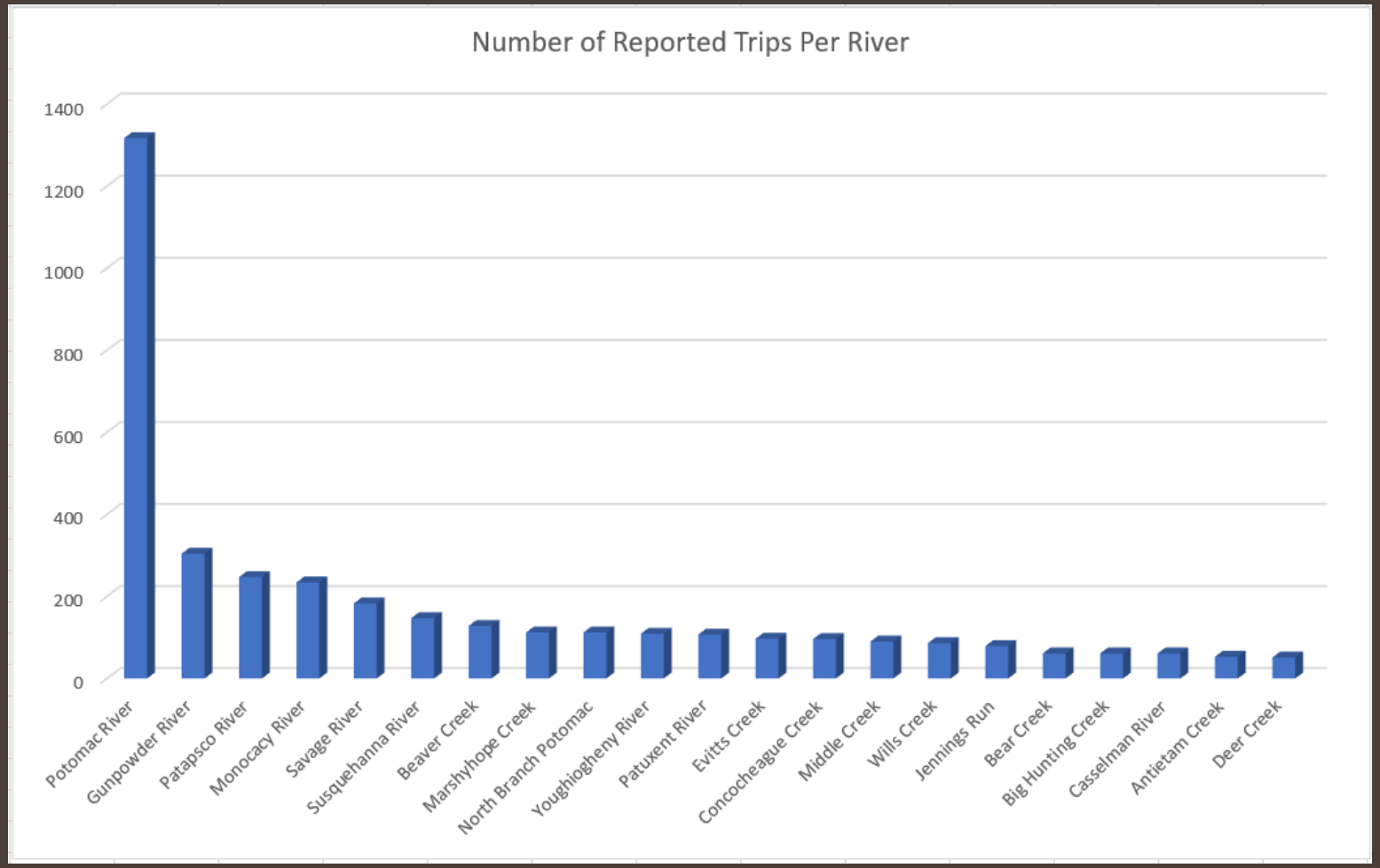
16. **Please list the three Maryland Lakes, Ponds, or Reservoirs where you went fishing the most in 2015. For each waterbody, also list the county, # of trips, and species targeted.**
(If you did not fish in a Maryland Lake, Pond, or Reservoir in 2015, please skip to question 17.)

Lake, Pond, or Reservoir	County	# of trips	Species Targeted (list multiple, if necessary)

From the Rivers Matrix, this bar chart represents the number of total reported trips, or visits, by all anglers to an individual waterway.

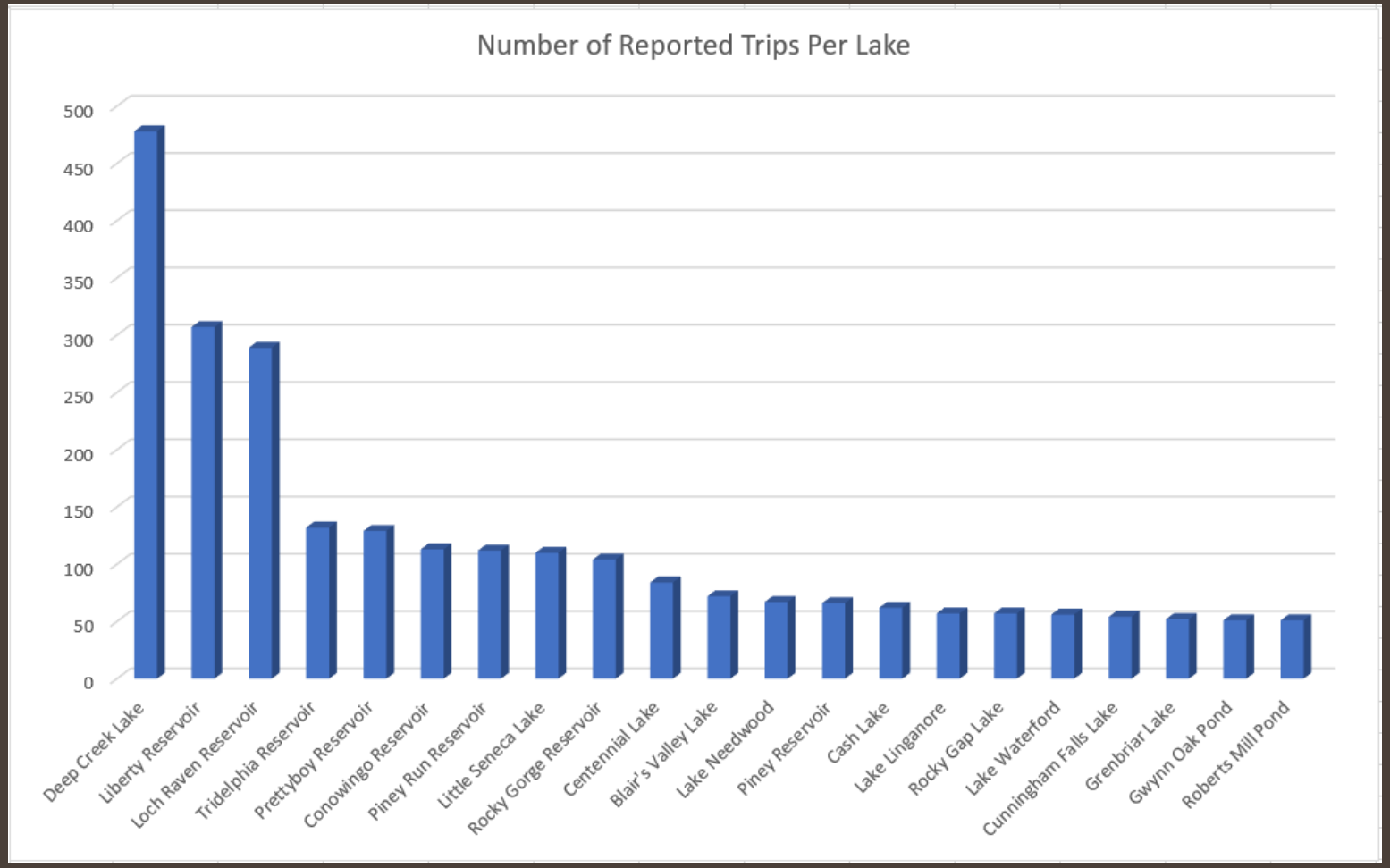
As would be assumed, the Potomac is far and away in the lead, however the Gunpowder, Patapsco and Monocacy Rivers catch the eye as well.

Analysis such as this allows us to establish a baseline for our analysis; as more anglers visiting a single location create more risk of invasive introduction to that location.



From the Lakes Matrix, this bar graph representation parallels the previous slide, however there are some interesting differences to note.

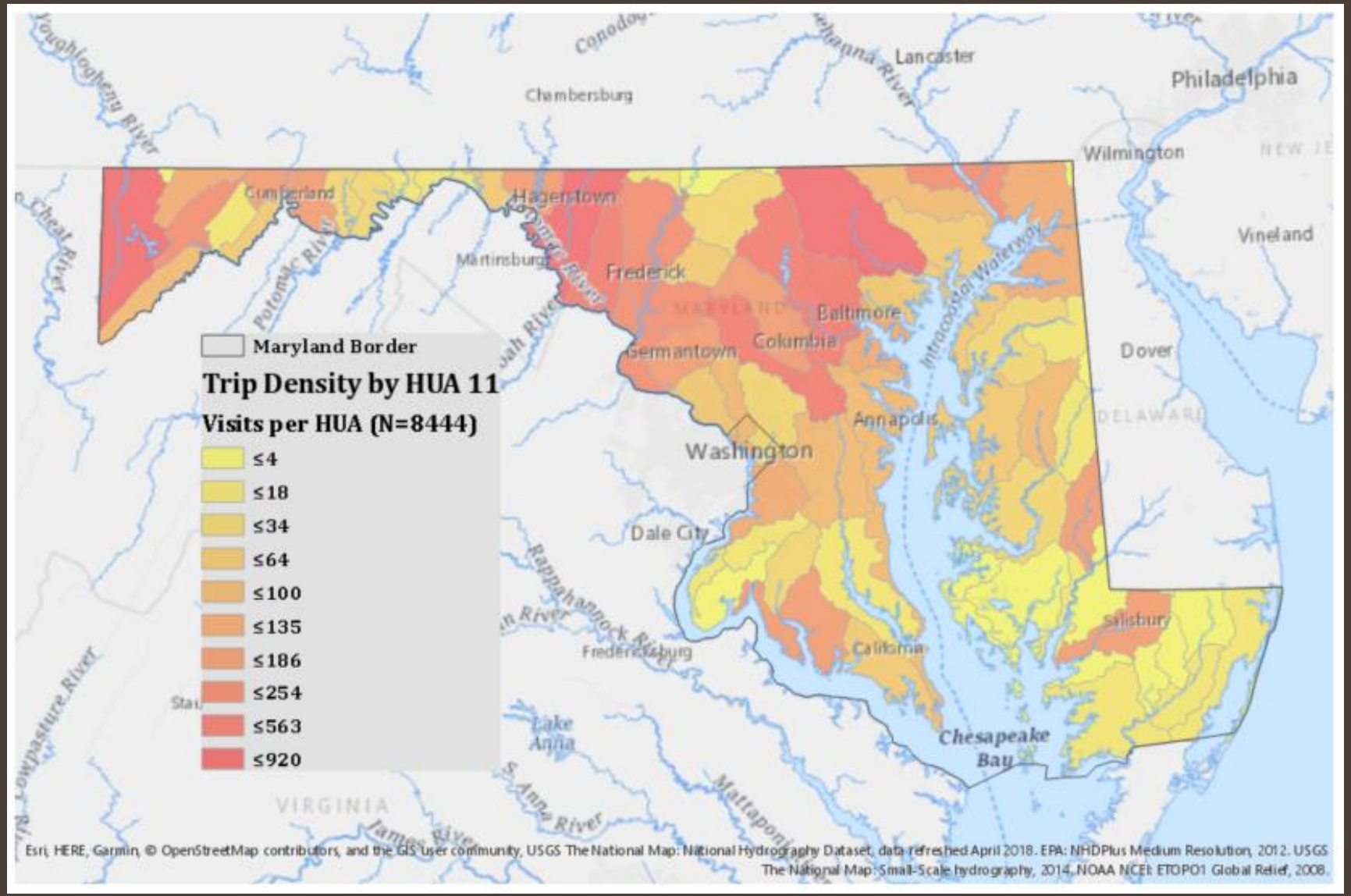
According to this visitation information, the "hotspots" of still freshwater angling within the state of Maryland are Deep Creek Lake, Liberty Reservoir, and Loch Raven Reservoir, which is on the Gunpowder River.



This is a visual representation, taken from both the Rivers Matrix and the Lakes Matrix page information, of the total trips that fell within each Hydrologic Unit Area.

This is a reasonable aggregation of the data based on the spatial precision provided by the survey responses.

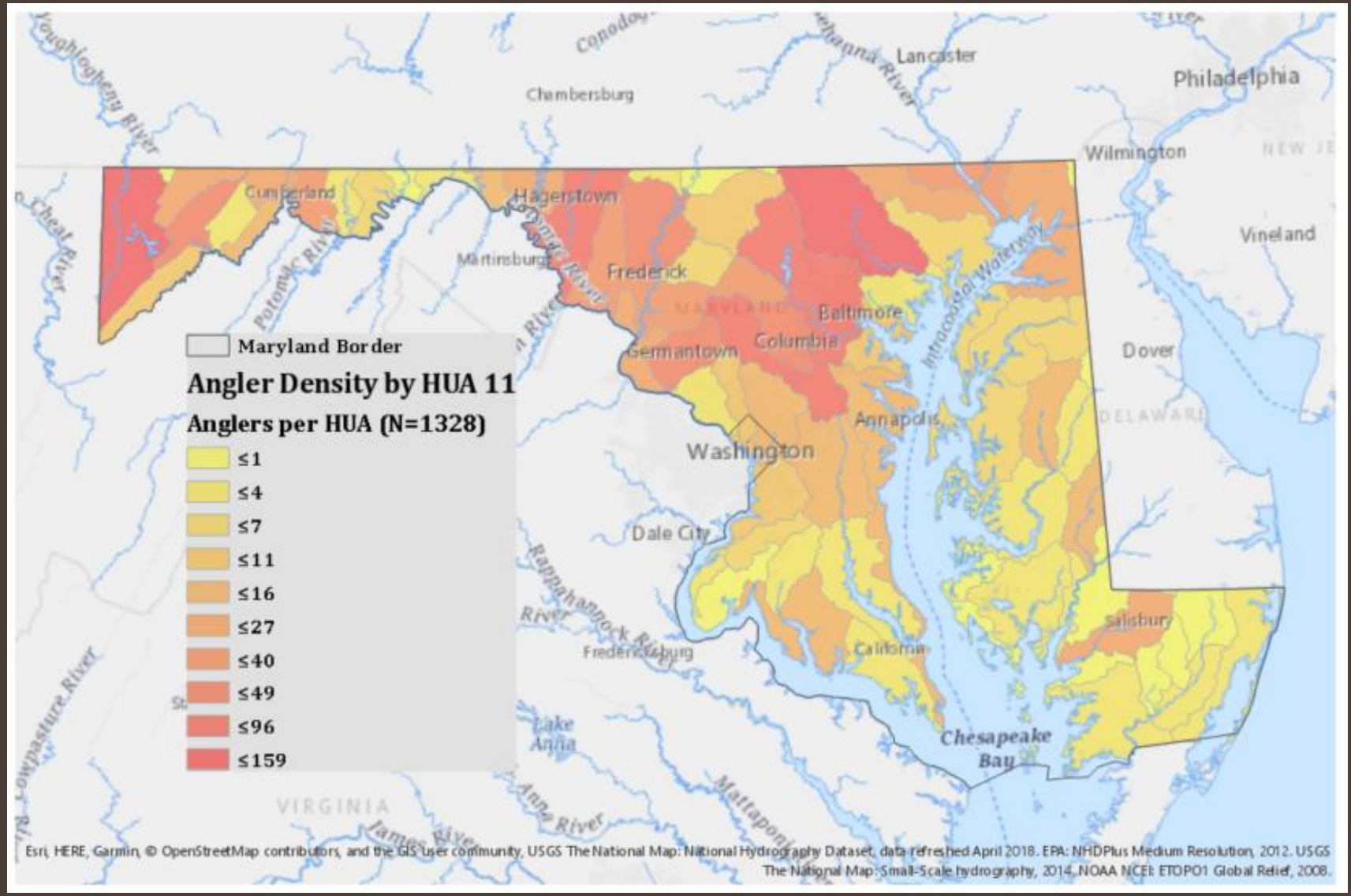
8444 total trips were recorded in this dataset, and were concentrated as shown to the right.



This representation, derived from both the Rivers Matrix and Lake Matrix data sources, demonstrates how many individual anglers reported visiting each HUA.

While a single angler may have recorded visiting more than one HUA, each angler has not been double counted within an individual HUA.

1328 individual records of anglers visiting HUAs within the survey were collected, even though 962 survey responses were collected. This is because some anglers reported visiting more than one HUA in the year of 2015.



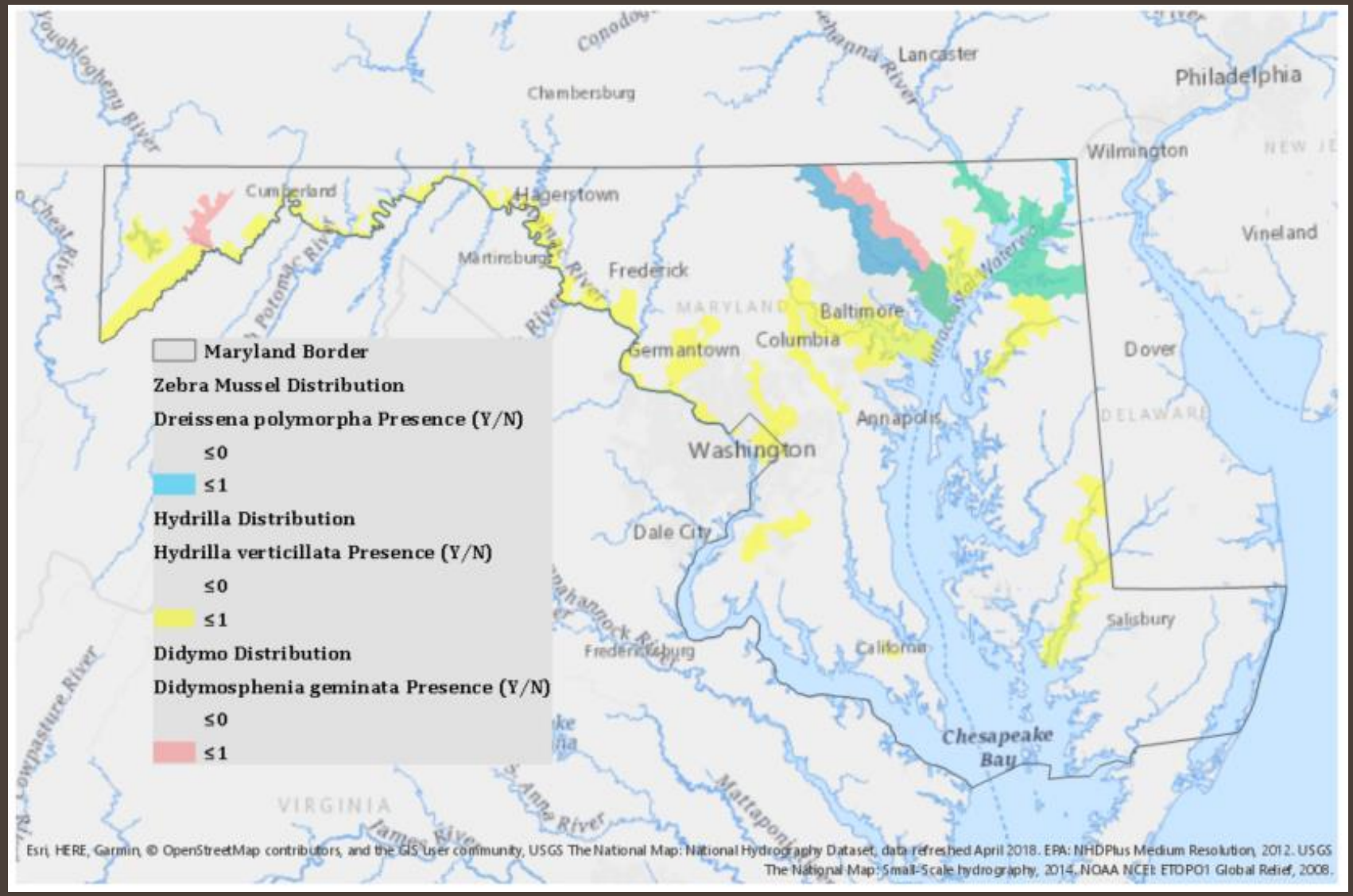
For the purposes of this analysis, three select invasive species have been selected as "stand-ins" for the multitude of potential invasive species that could be spread through angler related vectors.

Zebra Mussels and Hydrilla are both primarily spread through the use of watercraft.

Didymo is primarily spread through fly fishing techniques.

Unfortunately, we did not select a signal species for live bait use, as the variety and incidence of such invasives was judged too broad and complex to be accurately summed by a single stand in species.

These distributions are gathered from the MDNR's records.



Hydrilla (*hydrilla verticulata*) is a freshwater aquatic plant that has become extremely invasive in recent years.

This plant is especially hazardous because it can spread both by seeding and by cutting.

It is often transported on watercraft, and is currently located in Deep Creek Lake, the Gunpowder River, and the Potomac River, among others.

Zebra Mussels (scientific name) are a particularly destructive invasive species that are often spread through watercraft.

They can clog water intakes, damage equipment, and have extremely sharp shells that can cause recreation hazards.

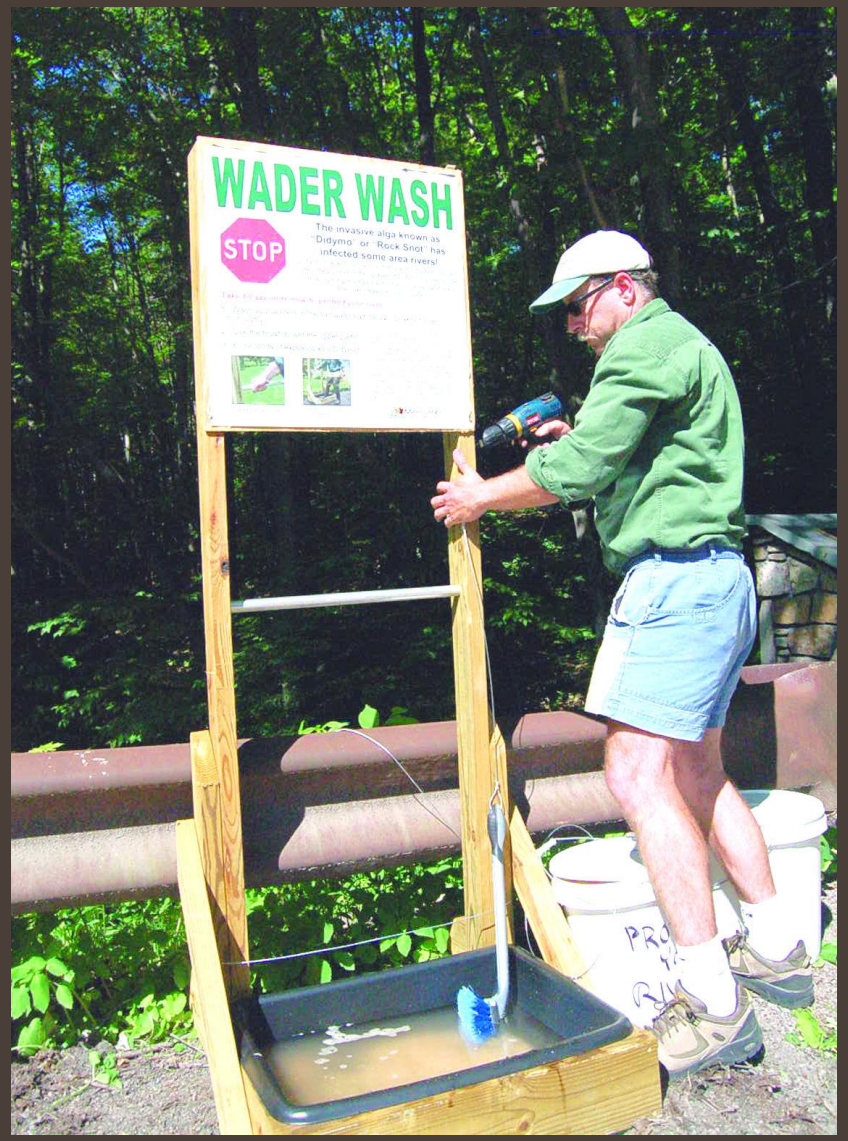
To prevent them, boat wash stations with heated or bleached water are often set up.

Didymo (scientific name) is an invasive single celled algal species that is incredibly hardy, and impossible to remove once it has infected a waterbody.

It grows into long, slimy looking strands, earning its colloquial name, "Rock Snot".

It is primarily transmitted by fly fishermen on the soles of their waders, particularly felt-soled waders.

Its transmission is largely prevented by either using extremely hot or bleached water to kill any didymo on waders or other clothing.

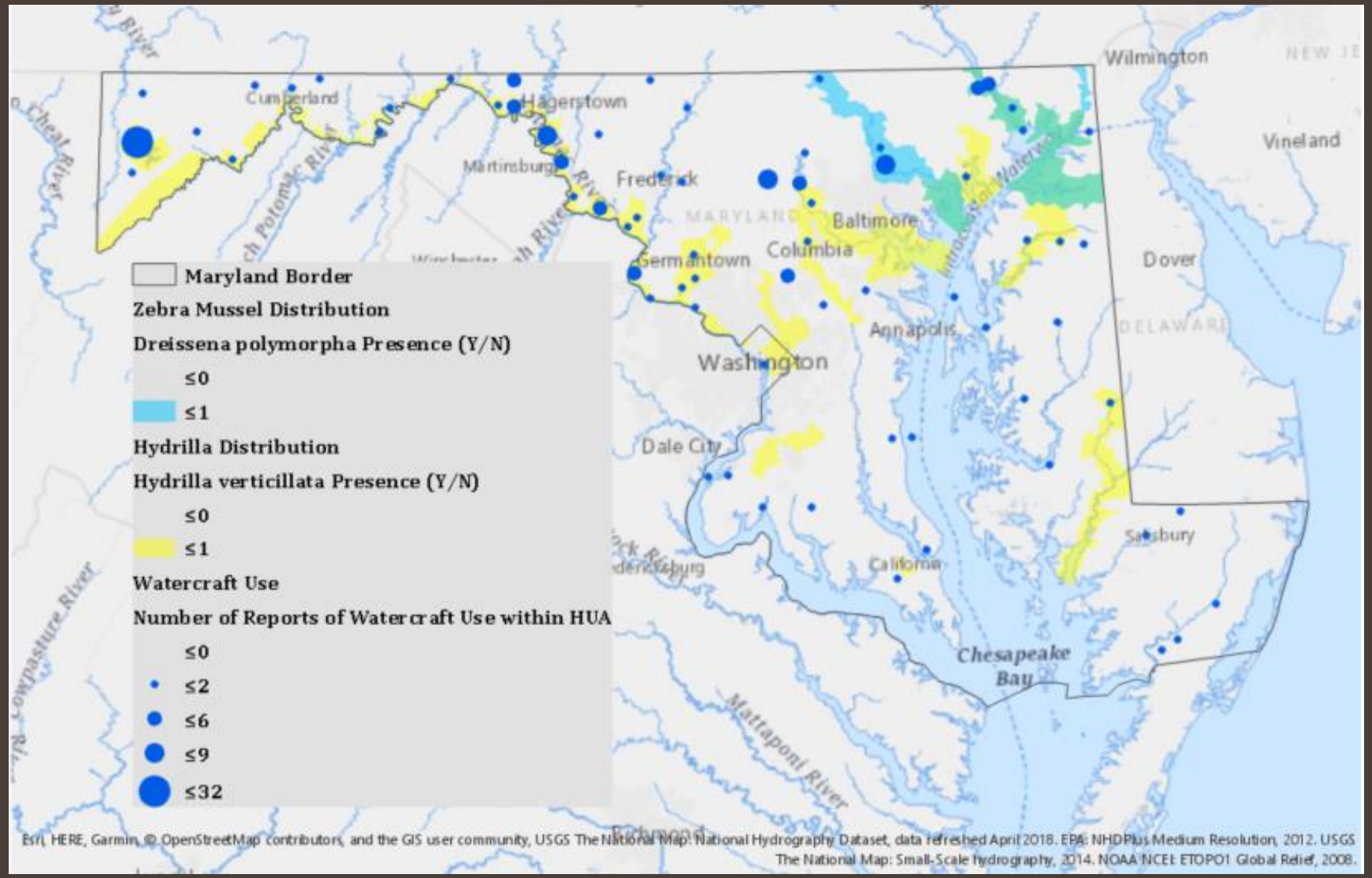


This representation demonstrates self-reported watercraft use combined with areas where invasive species that are known to be spread by watercraft are currently known.

The intersection of these factors of human activity and invasive presence are known risk areas.

Areas that have high watercraft activity as well as an incidence of invasive species are a "source risk" for the spread of that invasive species.

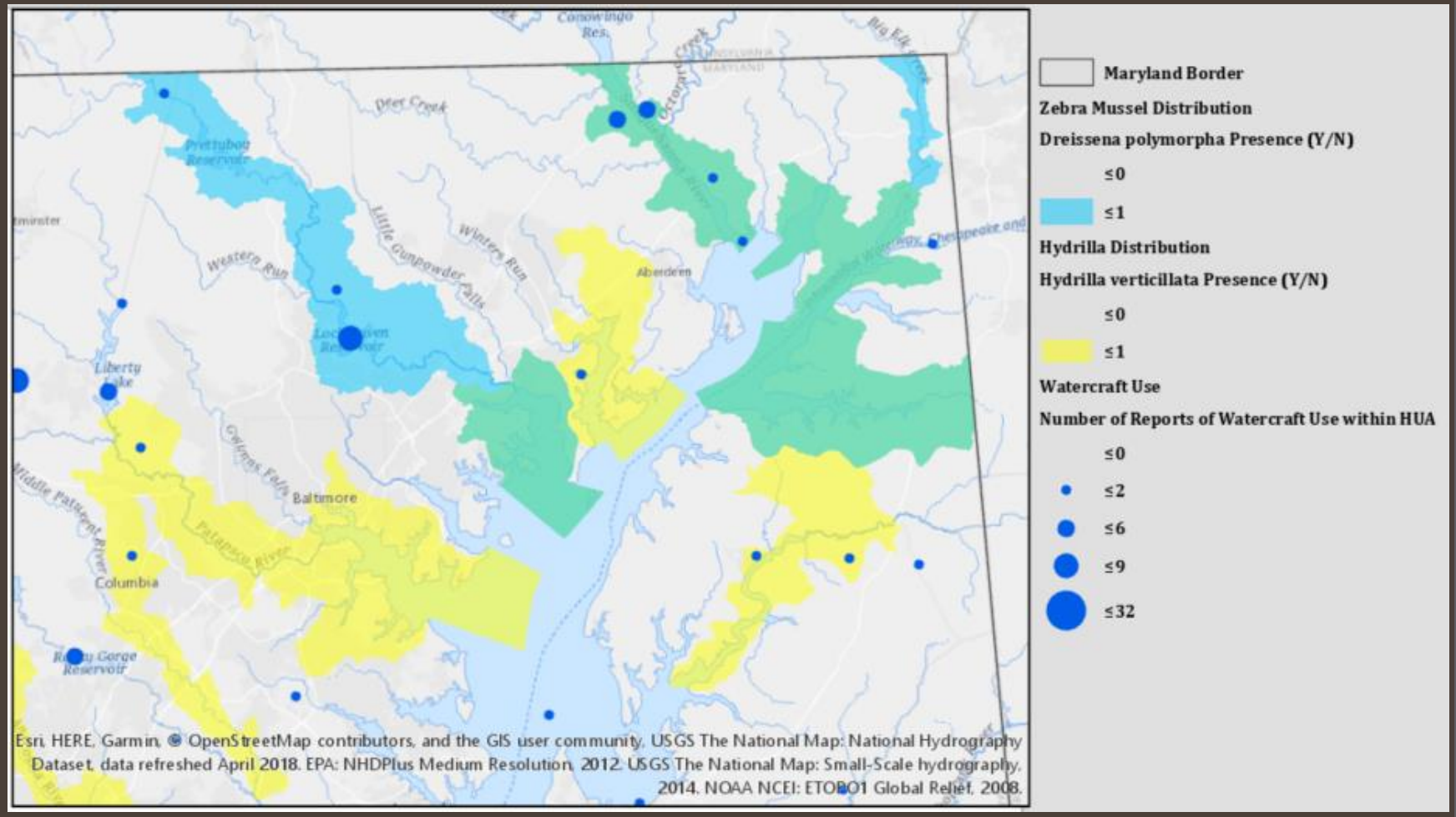
Areas with high watercraft activity but are not currently infected with a particular invasive species are considered a "sink risk" for the purposes of this analysis.



The Upper Chesapeake area is at particularly high risk of watercraft related transmission of invasive species.

Not only are many waterbodies in this area already infected with watercraft-borne invasives, but it must be noted that travel between these waterbodies is difficult to intercept as it may occur over open water.

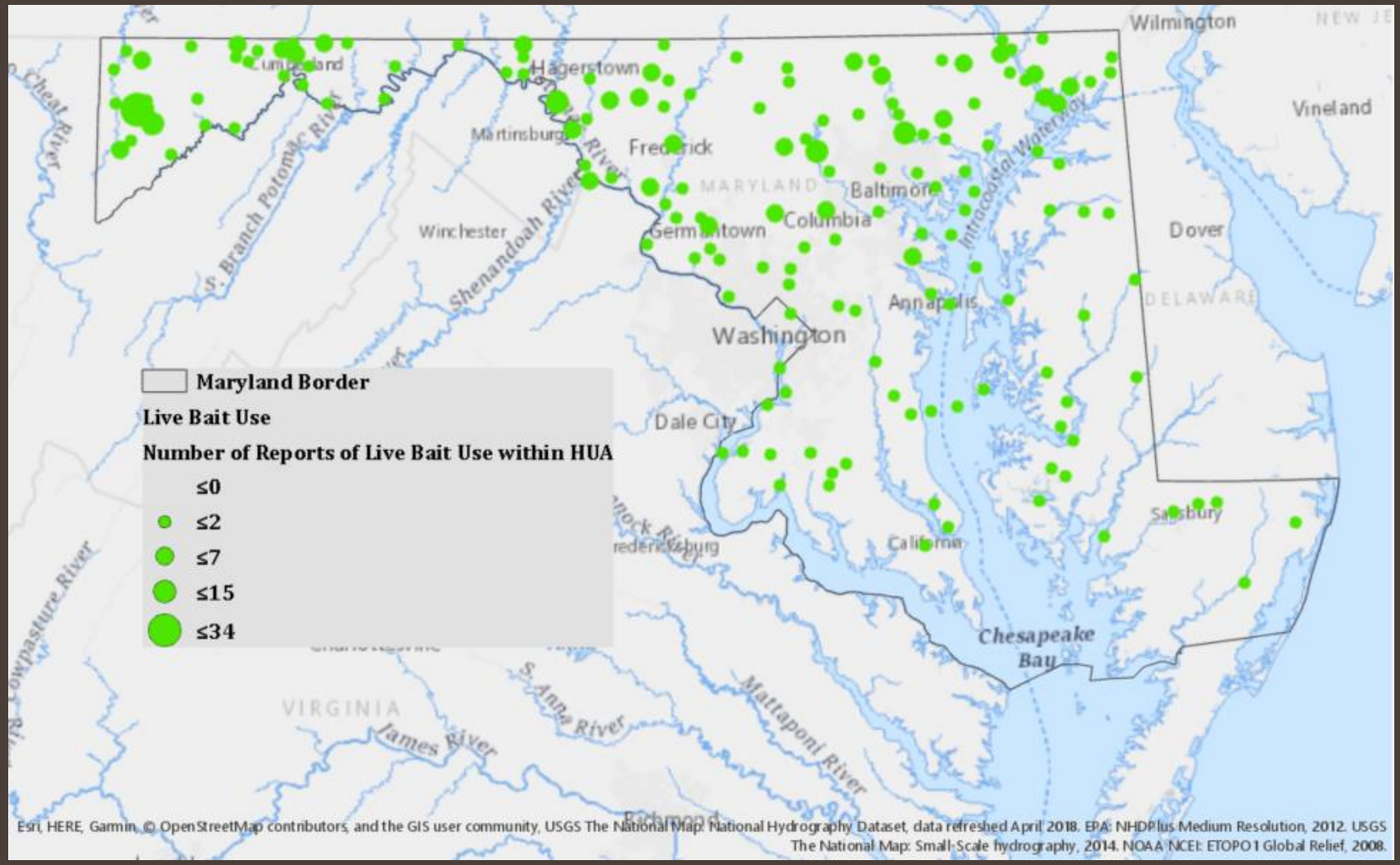
While this analysis only analyzes nontidal angling activities, it cannot be ignored that many of these nontidal areas may be accessed through tidal areas and may serve as vectors.



The incidence of live bait use throughout the state is displayed here, showing that a large number of anglers self-reported using live bait throughout the state.

It is likely that a variety of bait types and species were used throughout the area.

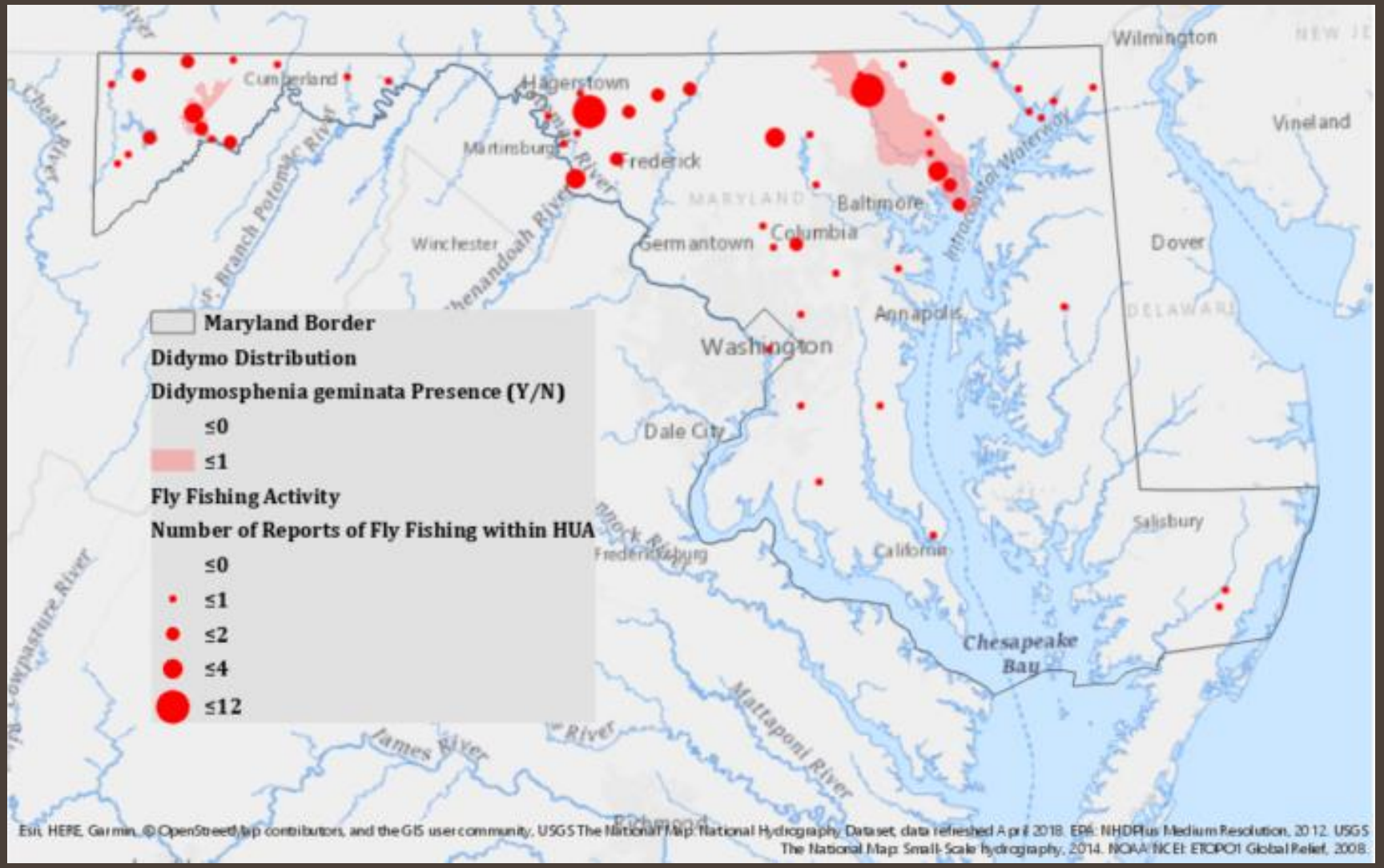
Of especial concern is live bait use in particularly long or well connected waterways, as organisms released may travel along the length of these bodies.



This map presents the known locations of the invasive algae Didymo as well as the rself-reported incidence of fly fishing among anglers.

Currently, according to DNR records, Didymo is confined to the Gunpowder and Savage Rivers in Maryland.

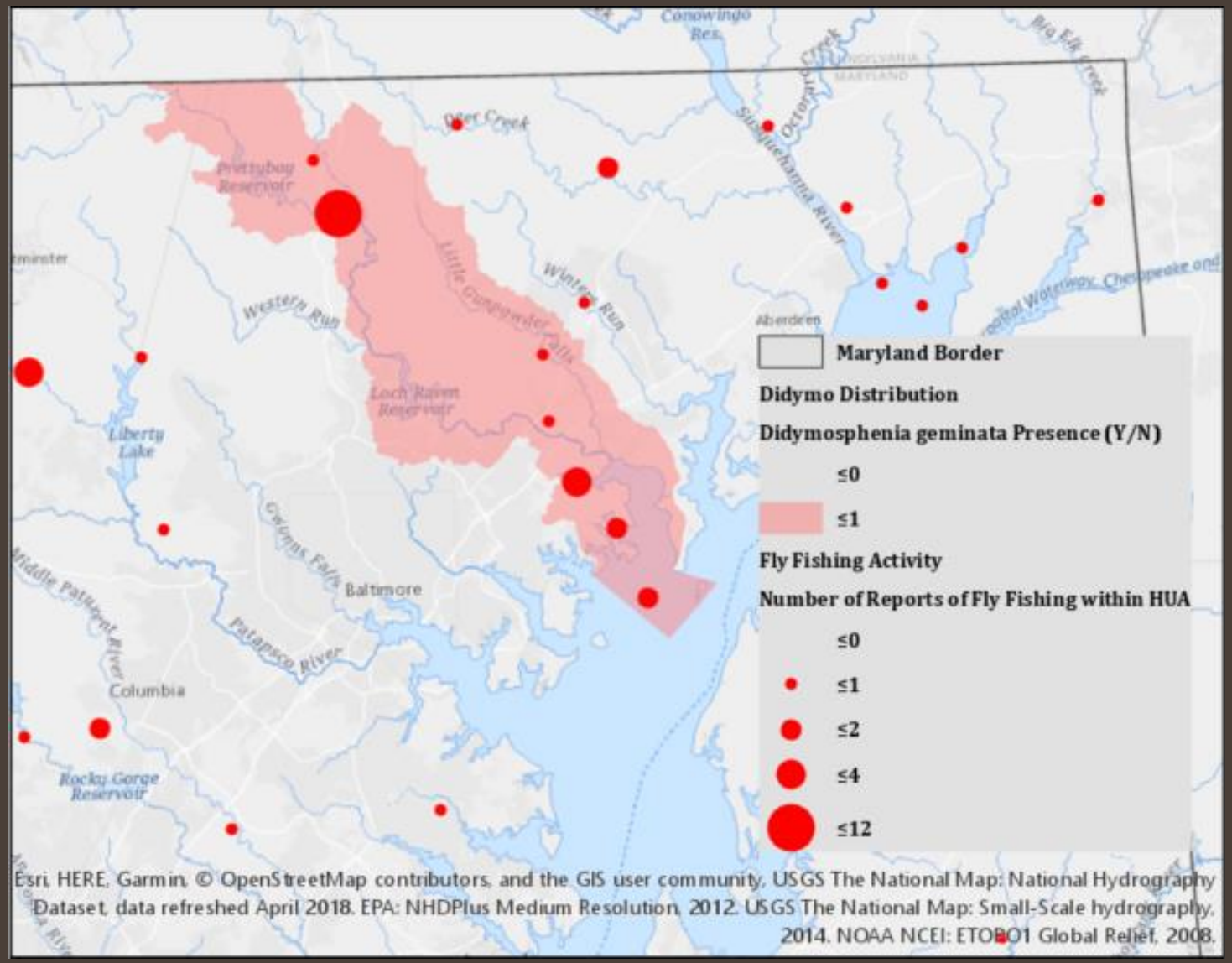
Didymo thrives in cold, fast flowing mountainous streams, presenting a risk for many of the northern and western streams in the state.



The Gunpowder is one of two rivers currently infected with Didymo in Maryland.

It is an area that receives a great deal of angler traffic, and in particular, fly fishing traffic.

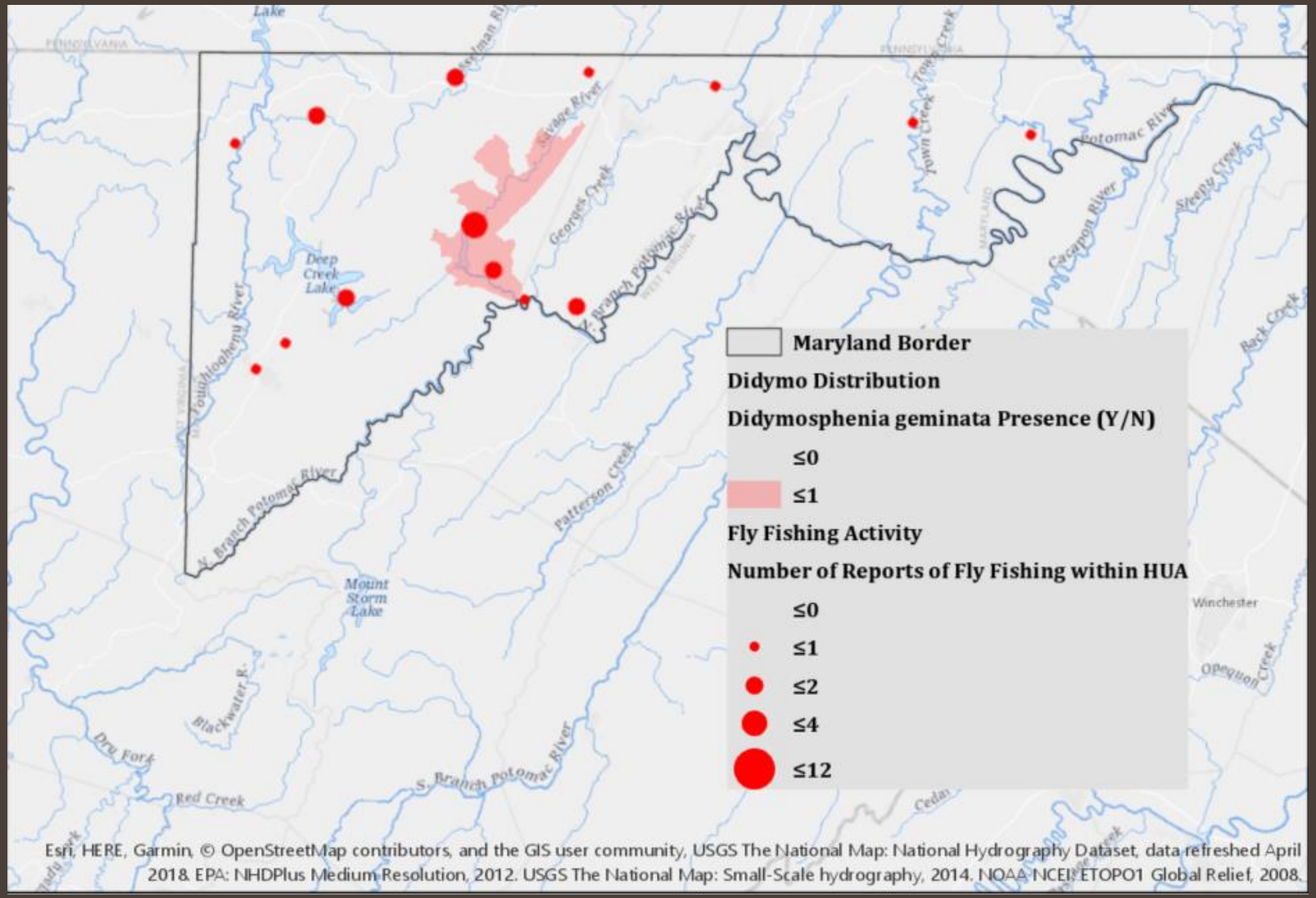
It is a great source risk for Didymo to other small, fast flowing streams in the area, many of which also present with fly fishing activity.



The Savage River in the western area of the state has also had confirmed reports of Didymo.

This presents an extreme risk to nearby waterways, as the majority of the streams in this area are perfect habitat for Didymo.

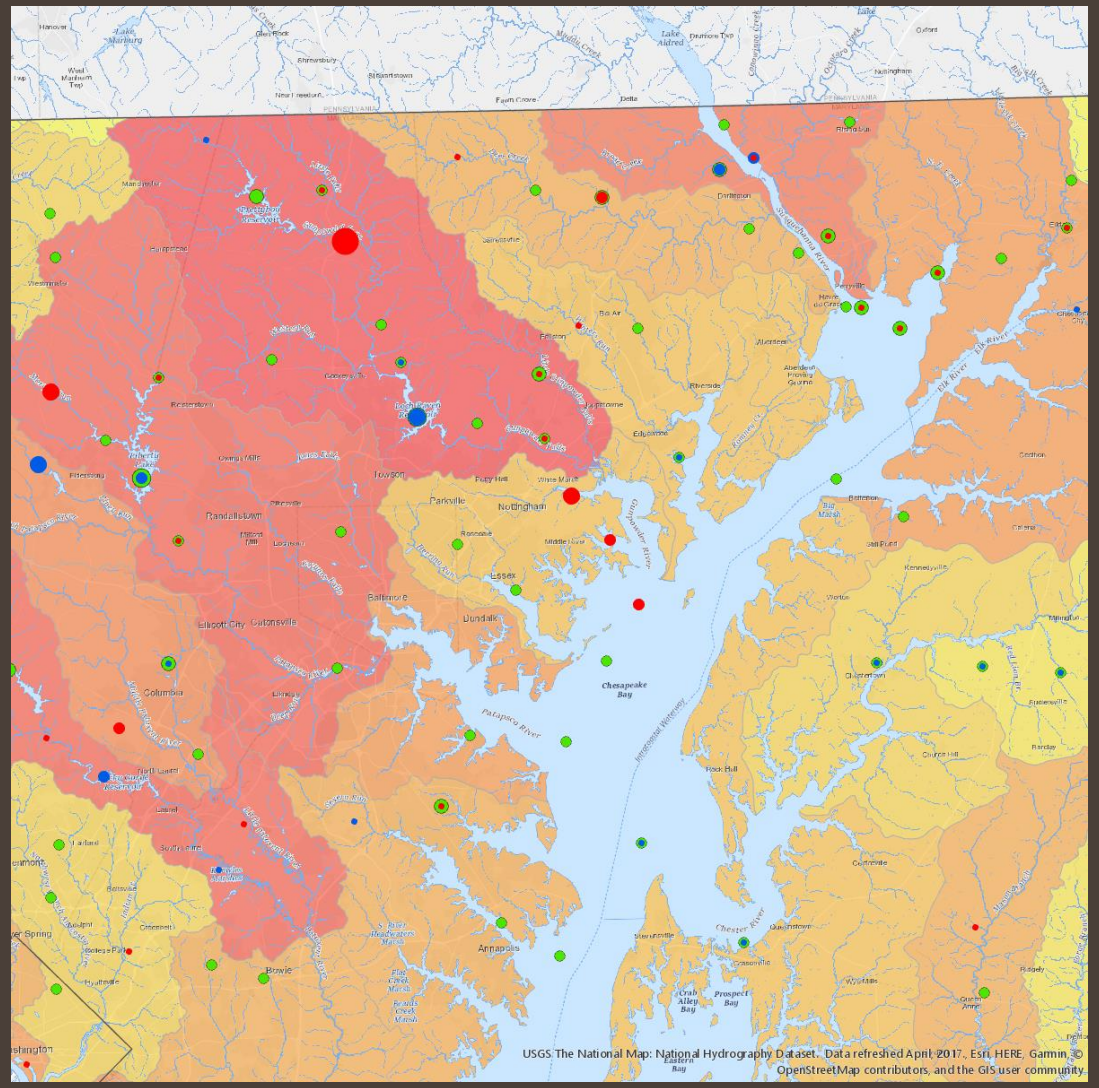
The many small streams here also present a significant management challenge.



Overall, the Northeastern area of the state appears to be at particularly high risk of both being a source of invasive species and a sink.

Many of the nontidal waterways here are some of the most popular fishing locations in the state, with a great deal of angler travel to and from these areas.

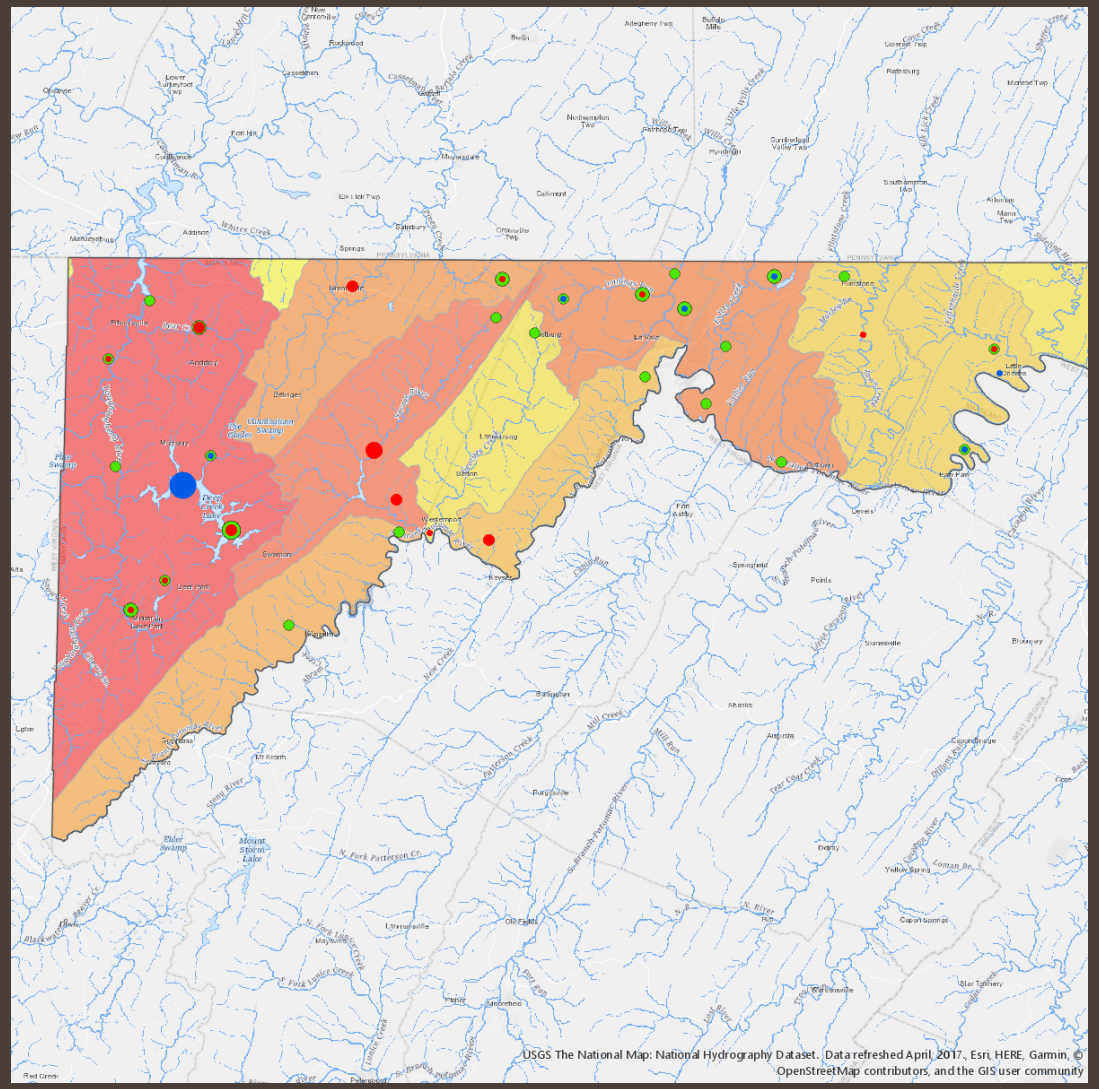
The Gunpowder is of primary concern, not only with presence of all three of our key invasive species and high rates of our three risk methods along its length, but with an estimated 12,400 anglers visiting it yearly.



The westernmost area of the state is also an area of primary concern. It features not only infections of Didymo in the Savage River, but also of Hydrilla in the Northern Potomac and Deep Creek Lake.

The waterways in the area are also extremely susceptible to infection by coldwater invasives such as Didymo.

The Deep Creek Lake area is also an extremely popular fishing location, especially for tourists and those from far away areas who may present a higher risk of introduction of invasives. Deep Creek Lake is estimated to have 19,400 angling visitors a year!



This analysis will produce detailed spatial data to assist resource managers in the Maryland DNR to spatially allocate anti-invasive techniques and methods most effectively.

Results will also be presented to MAPAIS, primarily focusing on the methodology of this analysis and how it could be applied to other areas within the Mid-Atlantic Region.

Information will be disseminated to Trout Unlimited in order to provide more effective education to anglers and citizens on invasive species prevention.

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

Mid-Atlantic Panel on
Aquatic Invasive Species

TROUT
UNLIMITED

Questions?


Aquatic invasive species are destroying
the environment, damaging fisheries,
and costing American taxpayers
billions of dollars annually.
John M. McHugh
quotefancy