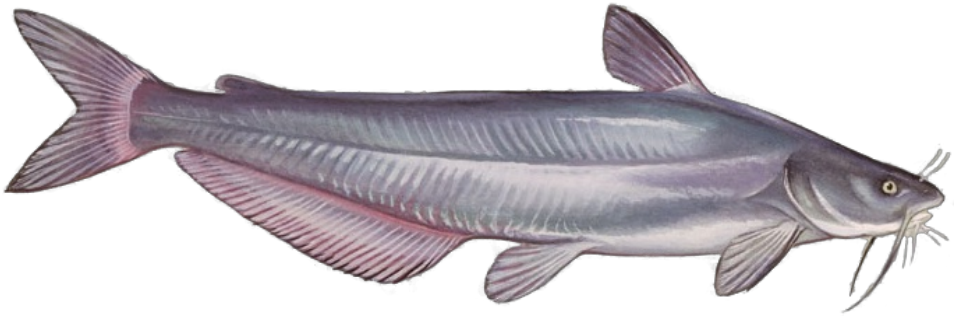
Blue Catfish

Ictalurus furcatus



United States: Chesapeake Bay

Set gillnets, Beach seines, Fyke nets, Stationary uncovered pound nets, Barriers, fences, weirs, corrals, etc.

Report ID 28178

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Seafood Watch Standard used in this assessment: Fisheries Standard v4

Table of Contents

About Seafood Watch

Monterey Bay Aquarium's Seafood Watch program evaluates the environmental sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Seafood Watch's science-based ratings are available at www.SeafoodWatch.org. Each rating is supported by a Seafood Watch assessment, in which the fishery or aquaculture operation is evaluated using the Seafood Watch standard.

Seafood Watch standards are built on our guiding principles, which outline the necessary environmental sustainability elements for fisheries and aquaculture operations. The guiding principles differ across standards, reflecting the different impacts of fisheries and aquaculture.

- Seafood rated Best Choice comes from sources that operate in a manner that's consistent with our guiding principles. The seafood is caught or farmed in ways that cause little or no harm to other wildlife or the environment.

- Seafood rated Good Alternative comes from sources that align with most of our guiding principles. However, one issue needs substantial improvement, or there's significant uncertainty about the impacts on wildlife or the environment.

- Seafood rated Avoid comes from sources that don't align with our guiding principles. The seafood is caught or farmed in ways that have a high risk of causing harm to wildlife or the environment. There's a critical conservation concern or many issues need substantial improvement.

Each assessment follows an eight-step process, which prioritizes rigor, impartiality, transparency and accessibility. They are conducted by Seafood Watch scientists, in collaboration with scientific, government, industry and conservation experts and are open for public comment prior to publication. Conditions in wild capture fisheries and aquaculture operations can change over time; as such assessments and ratings are updated regularly to reflect current practice.

More information on Seafood Watch guiding principles, standards, assessments and ratings are available at www.SeafoodWatch.org.

Guiding Principles

Seafood Watch defines sustainable seafood as originating from sources, whether fished[1] or farmed, that can maintain or increase production in the long term without jeopardizing the structure or function of affected ecosystems.

The following guiding principles illustrate the qualities that fisheries must possess to be considered sustainable by the Seafood Watch program (these are explained further in the Seafood Watch Standard for Fisheries):

- Follow the principles of ecosystem-based fisheries management.
- Ensure all affected stocks are healthy and abundant.
- Fish all affected stocks at sustainable levels.
- Minimize bycatch.
- Have no more than a negligible impact on any threatened, endangered, or protected species.
- Managed to sustain the long-term productivity of all affected species.
- Avoid negative impacts on the structure, function, or associated biota of aquatic habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.

These guiding principles are operationalized in the four criteria in this standard.Each criterion includes:

- Factors to evaluate and score
- Guidelines for integrating these factors to produce a numerical score and rating

Once a rating has been assigned to each criterion, Seafood Watch develops an overall recommendation. Criteria ratings and the overall recommendation are color coded to correspond to the categories on the Seafood Watch pocket guides and online guide:

Best Choice/Green: Buy first; they're well managed and caught or farmed responsibly.

Good Alternative/Yellow: Buy, but be aware there are concerns with how they're caught, farmed or managed.

Avoid/Red: Take a pass on these for now; they're caught or farmed in ways that harm other marine life or the environment.

[1] "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates

Summary

This report provides recommendations for Maryland and Virginia fisheries for blue catfish (*Ictalurus furcatus).* Blue catfish has a native range in the Ohio, Mississippi, Rio Grande, and Missouri River basins, but the species has expanded and been introduced into other areas and is now found in all major tributaries on Maryland's western shore, some of Maryland's eastern shore tributaries, and all major Virginia tributaries of the Chesapeake Bay. Blue catfish is captured commercially using pots and traps (including hoop nets), pound nets, drift and set gillnets, boat haul seines, electrofishing, and set longlines.

Criterion 1
Blue catfish was first introduced to the Chesapeake Bay area when it was stocked in select Virginia rivers for sport fishing during the 1970s, and it has since spread throughout the main fresh and brackish water tributaries in the Chesapeake Bay. A stock assessment has not been conducted for the species' entire range in the Chesapeake Bay, but some density estimates do exist for rivers in Virginia and Maryland. Abundance and fishery landings—though not fully quantified—have increased in Maryland and Virginia since the 1990s. As an invasive species, blue catfish has a low conservation concern for both abundance and fishing mortality.

Criterion 2
In Maryland, catch composition data are largely absent from blue catfish fisheries, while an observer and sampling program provides some information about catch composition for select gear types in Virginia. Bycatch is generally thought to be minimal across gear types in the two states, but a lack of data requires the use of the Unknown Bycatch Matrix (UBM) for all gear types other than set gillnets and electrofishing; the UBM points to bycatch risks for several taxonomic groups, including marine mammals, finfish, and forage fish, across other gear types. In gillnets and pound nets, blue catfish is usually targeted alongside striped bass, an overfished species. Electrofishing has no unintended bycatch, because the low-frequency electrical currents have been shown to primarily affect catfish species and to temporarily stun rather than kill or harm these fish.

Criterion 3
A Chesapeake Bay-wide fishery management plan is not in place, but a management strategy was created in 2020 by the multistakeholder Invasive Catfish Workgroup. This strategy focuses on reducing invasive blue catfish abundance, increasing market demand for blue catfish, and ensuring that native species and ecosystems are not harmed by blue catfish in the Bay. Maryland and Virginia also have their own regulations for blue catfish, including a tidewater catfish fishery management plan in Maryland that also aims to protect native ecosystems and reduce blue catfish populations. Management strategies for other retained species range from moderately effective to highly effective, based on the extensiveness and formality of the strategies. There are not formal bycatch strategies in place for blue catfish fisheries, but regulations regarding gear restrictions and catch moratoriums/limits should help reduce potential bycatch and impacts on sensitive species. There have been previous issues with illegal catfish transport, but enforcement and compliance with the limited blue catfish regulations that are in place are thought to be effective. A number of recent studies have been published about blue catfish in the Chesapeake Bay, and tagging and tracking programs are in place, but total abundance and fishing mortality remain unquantified. Stakeholders from scientific, management, fishing, and production sectors have been involved in developing management and population reduction strategies.

Criterion 4

Although some gear types, such as pots, have more of an impact on bottom habitat than others, impacts across all fisheries do not warrant much concern. Because of this, there are no gear modifications in place to reduce the impacts on bottom habitat. Ecosystem-based fishery management is well incorporated into the 2020 management strategy and Maryland's fishery management plan, because efforts to reduce nonnative blue catfish populations are considered alongside protecting the native Chesapeake Bay ecosystem and its components.

Final Seafood Recommendations

SPECIES | FISHERY	C 1 TARGET SPECIES	C 2 OTHER SPECIES	C 3 MANAGEMENT	C 4 HABITAT	OVERALL	VOLUME (MT) YEAR
Blue catfish | Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia	5.000	1.732	3.000	3.000	**Good Alternative (2.971)**	Unknown
Blue catfish | Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland	5.000	1.000	3.000	3.873	**Good Alternative (2.761)**	Unknown
Blue catfish | Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia	5.000	5.000	4.000	5.000	**Best Choice (4.729)**	Unknown
Blue catfish | Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia	5.000	1.000	3.000	3.000	**Good Alternative (2.590)**	Unknown
Blue catfish | Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia	5.000	1.732	3.000	3.000	**Good Alternative (2.971)**	Unknown
Blue catfish | Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland	5.000	1.000	3.000	3.000	**Good Alternative (2.590)**	Unknown
Blue catfish | Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia	5.000	1.000	3.000	3.000	**Good Alternative (2.590)**	Unknown

Gear-specific landings data are unavailable, but statewide landings data are available via NOAA's commercial landings database: https://www.fisheries.noaa.gov/foss/f?p=215:200:7347971093045:Mail:::: (NOAA Fisheries 2021a). In 2021, 1,333 metric tons were landed in Virginia across gear types, and 967 metric tons were landed in Maryland across gear types. In Maryland, longlines contribute 40% of total catch, pound net contribute 26%, haul seines contribute 21%, pots contribute 5%, and drift gillnets contribute 5% (M. Groves, personal communication 2022). In Virginia, the largest amount of catch comes from pots, with pound nets and stationary gillnets contributing between 15 and 20% of total catch and haul seines and electrofishing contributing about 10%. (A. Galvan, personal communication 2022).

Summary

Blue catfish (*Ictalurus furcatus*) is a large, North American catfish that is found as a nonnative species in all major Virginia tributaries and most major Maryland tributaries of the Chesapeake Bay. This report covers the Chesapeake Bay blue catfish fisheries, which use fish pots, set and drift gillnets, pound nets, boat haul nets, set longlines.

The Yellow rating for most blue catfish fisheries is driven by their status as invasive species fisheries, which are managed toward removing or eradicating the species, combined with the fisheries' minor habitat impacts but largely unknown bycatch impacts or retained catch of species with less effective management plans. The Green rating for the new Virginia low-frequency electrofishing fishery is driven by the fact that this fishery has no bycatch and no lasting, harmful impacts on nontarget species.

Scoring Guide

Scores range from zero to five where zero indicates very poor performance and five indicates the fishing operations have no significant impact.

Final Score = geometric mean of the four Scores (Criterion 1, Criterion 2, Criterion 3, Criterion 4).

Best Choice/Green = Final Score >3.2, and no Red Criteria, and no Critical scores

Good Alternative/Yellow = Final score >2.2-3.2, and neither Harvest Strategy (Factor 3.1) nor Bycatch Management Strategy (Factor 3.2) are Very High Concern2, and no more than one Red Criterion, and no Critical scores

Avoid/Red = Final Score ≤2.2, or either Harvest Strategy (Factor 3.1) or Bycatch Management Strategy (Factor 3.2) is Very High Concern or two or more Red Criteria, or one or more Critical scores.

[2] Because effective management is an essential component of sustainable fisheries, Seafood Watch issues an Avoid recommendation for any fishery scored as a Very High Concern for either factor under Management (Criterion 3).

Introduction

Scope of the analysis and ensuing recommendation

This report assesses the blue catfish (*Ictalurus furcatus*) commercial fisheries in Virginia and Maryland. Blue catfish inhabits a nonnative range in the Chesapeake Bay that includes all major tributaries in Virginia, on the western shore of Maryland, several tributaries in Delaware, and on the eastern shore of Maryland (Invasive Catfish Workgroup 2020). The species is captured by Virginia commercial fishers using anchored gillnets, pound nets, boat haul seines, fish pots, and electrofishing in Chesapeake Bay rivers and tributaries. In Maryland waters, blue catfish is captured commercially using pound nets, fish pots, boat haul seines, set longlines, and drift nets.

Species Overview

Blue catfish is native to the United States in the Mississippi, Missouri, Ohio, and Rio Grande River basins in the central and southern portions of the country (Glodeck 1980, as cited in Graham 1999)(NOAA Fisheries 2022a). The largest of the North American catfish species (Graham 1999), blue catfish has become popular with recreational and commercial fishers. This led to its introduction to nonnative states, including Maryland and Virginia, for sport fishing in the late 1900s. Blue catfish is now found in at least 30 states, but is native only to 20 (Figure 1) (Graham 1999).

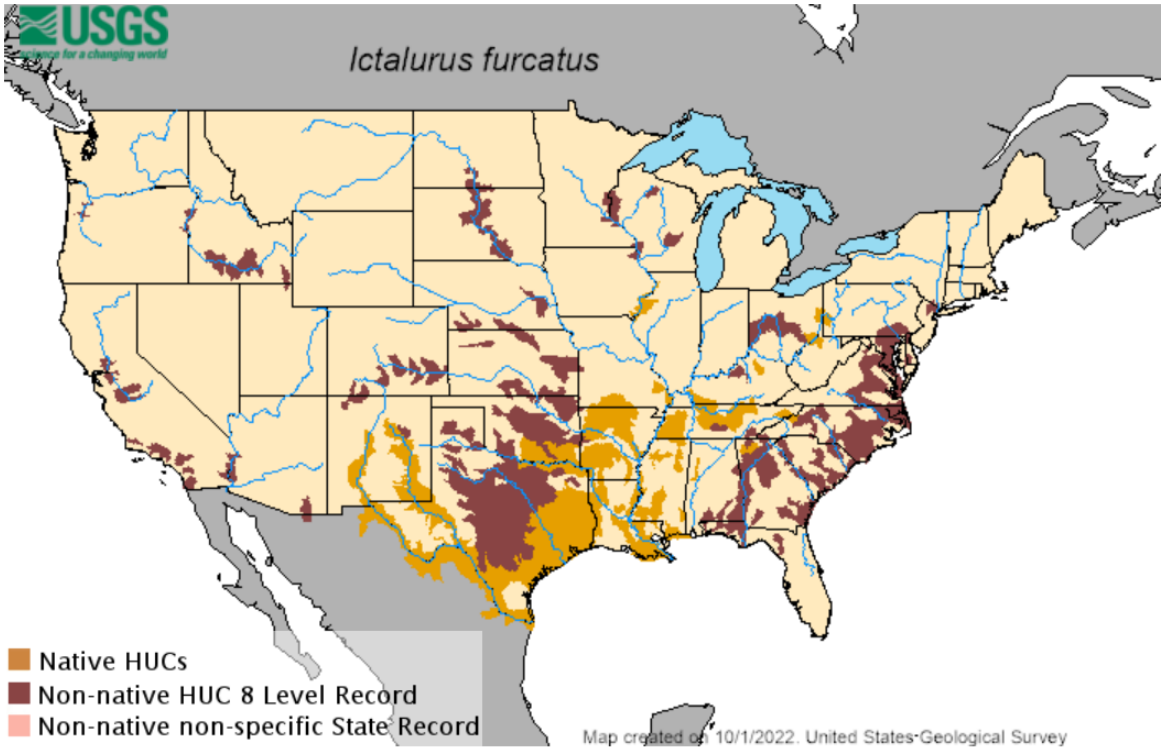

Figure 1: Distribution of blue catfish in the contiguous U.S., using data collected through the U.S. Geological Survey's Hydrologic Unit Codes system. Figure from {Fuller and Neilson 2022}.

Blue catfish is an opportunistic and generalist omnivore, consuming fish, crustaceans, and invertebrates (Schmitt et al. 2018)(Schmitt et al. 2019). This leads to rapid growth during its lifetime, and a single blue

catfish can weigh over 100 pounds {MDNR 2022}. Sexual maturity is reached between ages 4 and 7 years, with annual spawning producing 4,000 to 8,000 eggs per kilogram of body weight in each female (NOAA Fisheries 2022a). Individuals typically live for 9 to 10 years, though some records show blue catfish that have lived up to 25 years (NOAA Fisheries 2022a). Blue catfish is a bottom dweller and prefers larger rivers and channels with swift-flowing, turbid water, and lives above substrate ranging from gravel and sand to silt and mud (Burr and Warren 1986, as cited in Graham 1999)(MDNR 2022a). Although it is a freshwater species, blue catfish has a high salinity tolerance, which allows it to move through and inhabit waters with salinities up to and, in the short term, over 15 ppt (Fabrizio et al. 2017)(Liu and Fisher 2020). This has played a key role in allowing the species to expand its range in nonnative areas.

Since its initial introductions into the James, Rappahannock, York, and Potomac Rivers, blue catfish has expanded to many other Chesapeake Bay tributaries, aided by its salinity tolerance, diet breadth, and rapid growth. Blue catfish is also the most migratory of the North American catfish species, further contributing to its Mid-Atlantic expansion (Graham 1999).

The large size of blue catfish has helped popularize it in sport fishing, thus influencing the species' initial introduction into the Chesapeake Bay area. In Virginia and Maryland, the state records for captured blue catfish are 143 and 84 pounds, respectively (VDWR 2022) (MDNR 2022a). Since the population and range have expanded since the 1980s, commercial fisheries have also been developed for the species. These fisheries have grown as concern has increased about the ecological impacts of blue catfish on native Chesapeake Bay species. Recreational and sport fishing for catfish also remain popular in the Bay.

In Maryland, the Department of Natural Resources (MDNR) oversees commercial and recreational catfish fisheries. In Virginia, commercial fisheries are overseen by the Marine Resources Commission (VMRC), while recreational fisheries are the responsibility of the Department of Wildlife Resources (VDWR). In the Potomac River, fisheries are managed by the Potomac River Fisheries Commission (PRFC). State and local management agencies are also involved, among other stakeholders, in the Chesapeake Bay Program (CBP) Sustainable Fisheries Goal Implementation Team's (GIT) Invasive Catfish Workgroup. This group helps inform and coordinate management of blue catfish populations and fishing efforts across state lines in the Bay.

Production Statistics

Since 2000, blue catfish has been commercially landed and reported to NOAA in 14 states, across its native and nonnative ranges. Of these, Louisiana, Virginia, and Maryland have produced the largest volume of blue catfish (NOAA Fisheries 2021a). While landings—in terms of both weight and monetary value—have stayed relatively stable in Louisiana, landings in Maryland and Virginia have steadily increased since the early 2000s, though it is important to note that landed catfish in Maryland were not universally reported by individual species until after 2013 (Figure 2). In 2021, landings in Maryland and Virginia both exceeded 2 million pounds, while landings in Louisiana, a state in the species' native range, neared 4 million pounds. In Texas, where blue catfish is also a native species, commercial landings over the past two decades were smaller, with total weights between 10,000 and 110,000 pounds. Growth in production of blue catfish has been somewhat hampered by recent changes to federal regulations around catfish food safety oversight (Rodricks 2022).

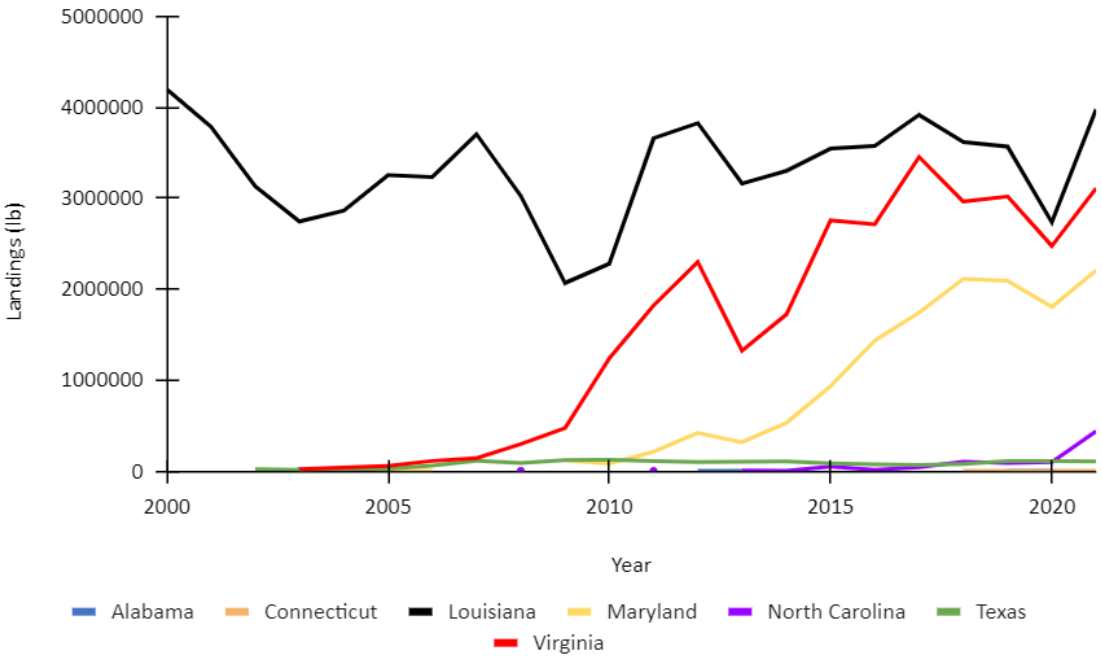

Figure 2: Annual commercial landings of blue catfish from 2000 to 2021, for states with at least 5 years of reported data. Note that Maryland and Virginia managers began recording blue catfish separately from other catfish species in 2003. Data from NOAA Commercial Landings Database.

Importance to the US/North American market.

Blue catfish brings in a sizable amount of money in Louisiana, Virginia, and Maryland. Values from commercial blue catfish exceeded 1 million dollars in both Virginia and Maryland in 2021 (Figures 3 and 4), and Louisiana fisheries brought in over 2 million dollars the same year. Blue catfish is an important recreational species in several states, bringing in considerable profit to recreational fishing economies via sports fishing and guided fishing tours (ACA 2022). Much of their commercial economic viability in the Chesapeake Bay has come out of necessity due to their detrimental environmental impacts, leading to some concerns about growing a reliance on an invasive fishery in Maryland and Virginia (Fabrizio et al. 2020). Still, market demand is increasing in the Bay through efforts by managers to increase blue catfish consumption and, in turn, production.

Figure 3: Growth of the Virginia blue catfish fishery landings and value from 2003 to 2021. Data from ACCSP Data Warehouse.

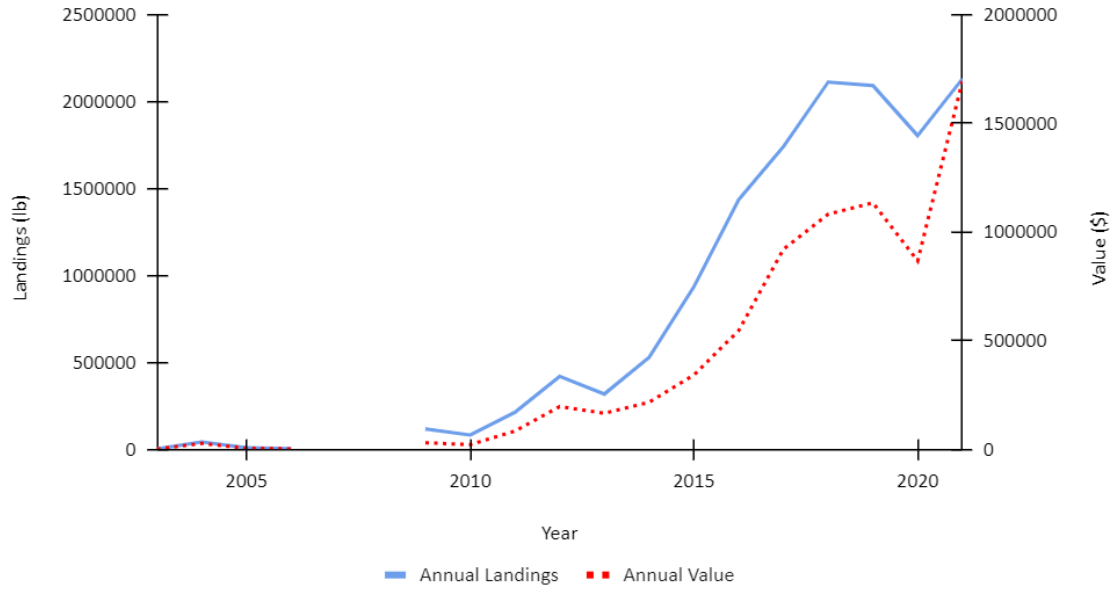

Figure 4: Growth of the Maryland blue catfish fishery landings and value from 2003 to 2021. Notes: (a) 2007 and 2008 data were confidential; and (b) reported catfish landings before 2013 were not required to be separated by species by MDNR, so these data may come from different sources and may be more uncertain than data collected after 2013. Data from ACCSP Data Warehouse.

Common and market names.

Blue catfish is known by a number of different names that are largely area-dependent. Other common

names include white cat, white fulton, fulton, humpback blue, forktail cat, and blue channel catfish (Graham 1999). "Humpback blue" is often used in Maryland, though "blue catfish" remains the primary common name for the species (MDNR 2022a). Shortening the name to "blue cat" is most common in Virginia. Blue catfish resembles channel catfish, and the two used to be conflated in catch composition data: hence, the name "blue channel catfish" (Graham 1999). Finally, names containing "white" likely stem from the whiter appearance of juvenile blue catfish (Graham 1999).

Primary product forms

Blue catfish is sold primarily as whole fillets in markets but can also be found in smaller, portioned fillets and as gutted or ungutted whole fish (Liu and Fisher 2020). The species is a good source of protein, high in omega-3s fatty acids, and low in fat (Liu and Fisher 2020).

Assessment

This section assesses the sustainability of the fishery(s) relative to the Seafood Watch Standard for Fisheries, available at www.seafoodwatch.org. The specific standard used is referenced on the title page of all Seafood Watch assessments.

Criterion 1: Impacts on the species under assessment

This criterion evaluates the impact of fishing mortality on the species, given its current abundance. When abundance is unknown, abundance is scored based on the species' inherent vulnerability, which is calculated using a Productivity-Susceptibility Analysis. The final Criterion 1 score is determined by taking the geometric mean of the abundance and fishing mortality scores. The Criterion 1 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 1.3 (Fishing Mortality) is Critical.

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level*

Criterion 1 Summary

BLUE CATFISH			
REGION / METHOD	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

Criterion 1 Assessments

SCORING GUIDELINES

Factor 1.1 - Abundance
Goal: Stock abundance and size structure of native species is maintained at a level that does not impair recruitment or productivity.

- *5 (Very Low Concern) — Strong evidence exists that the population is above an appropriate target abundance level (given the species' ecological role), or near virgin biomass.*
- *3.67 (Low Concern) — Population may be below target abundance level, but is at least 75% of the target level, OR data-limited assessments suggest population is healthy and species is not highly vulnerable.*
- *2.33 (Moderate Concern) — Population is not overfished but may be below 75% of the target abundance level, OR abundance is unknown and the species is not highly vulnerable.*
- *1 (High Concern) — Population is considered overfished/depleted, a species of concern, threatened or endangered, OR abundance is unknown and species is highly vulnerable.*

Factor 1.2 - Fishing Mortality
Goal: Fishing mortality is appropriate for current state of the stock.

- *5 (Low Concern) — Probable (>50%) that fishing mortality from all sources is at or below a sustainable level, given the species ecological role, OR fishery does not target species and fishing mortality is low enough to not adversely affect its population.*
- *3 (Moderate Concern) — Fishing mortality is fluctuating around sustainable levels, OR fishing mortality relative to a sustainable level is uncertain.*
- *1 (High Concern) — Probable that fishing mortality from all source is above a sustainable level.*

Blue catfish

Factor 1.1 - Abundance

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia
Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Very Low Concern
In the Chesapeake Bay, blue catfish is an introduced, nonnative species. Because it is considered invasive in Bay waters, it has a very low conservation concern, regardless of stock size.

Justification:
Blue catfish in the United States is native to the Ohio, Mississippi, Missouri, and Rio Grande River basins (MDNR 2022a){NOAA Fisheries 2022}. In the 1970s, the species was introduced into Virginia's coastal Rappahannock, York, and James Rivers by the Virginia Department of Game and Inland Fisheries (VDGIF) (now the Department of Wildlife Resources, VDWR) and the U.S. Fish and Wildlife Service (USFWS) to promote recreational and sport fishing (Schloesser et al. 2011)(Orth et al. 2017). These introductions continued in Virginia into the early 1990s (USFWS 2019). Blue catfish was also introduced into Maryland and Virginia's Potomac River—without authorization from the Department of Natural Resources—in the late 20th century (Love & Wilson 2019)(MDNR 2022b). Since then, the species has spread to other areas in Chesapeake Bay tributaries. Although it is a freshwater species, it has a fairly high salinity tolerance and has moved into some brackish waters (Fabrizio et al. 2017)(Liu and Fisher 2020). The blue catfish's spot as an apex predator in the Chesapeake Bay (Schloesser et al. 2011) has allowed its stock to grow significantly since its introduction. Potential transport by fishers and a recent increase in heavy rains have in turn contributed to an expansion in blue catfish's range in the region (Bilkovic & Ihde 2014)(Gaichas 2021).

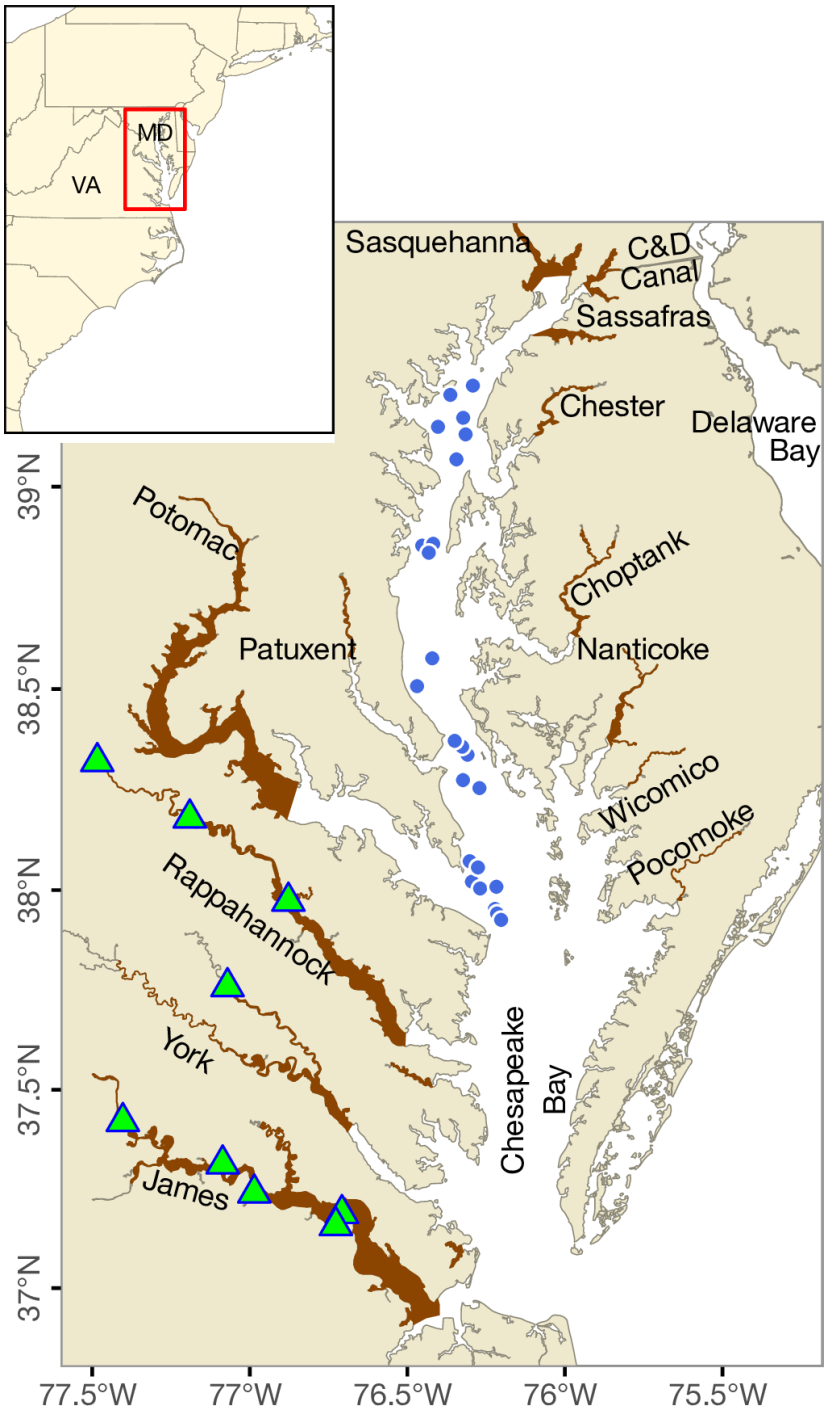

Figure 5. Original stocking locations (green triangles) and 2018–19 observed locations (blue circles) of blue catfish in the Chesapeake Bay. Figure from {Nepal and Fabrizio 2019}.

A Bay-wide population abundance estimate has not been generated, but several studies for individual tributaries have been conducted. These studies point to high blue catfish population densities in the Bay. In the James River, an estimate of 544 fish per hectare (1.6 million total fish in

a 12-kilometer study area) came from 2012–13 tagging efforts (Fabrizio et al. 2017). A later size-based stock assessment in the James River estimated the blue catfish population to be 5.3 million in 2016 (Hilling et al. 2022). This same model suggested that the James River blue catfish population has decreased since 2011 (Hilling et al. 2022), although the population remains too high, given the invasive status of the species. In 2011, electrofishing surveys suggested that blue catfish made up to 75% of the total fish biomass in the James and Rappahannock Rivers (Schloesser et al. 2011). A 2015 mark and recapture study estimated 565 fish per hectare and 1,127 fish per hectare in the Pamunkey and Rappahannock Rivers, respectively (Sustainable Fisheries GIT 2017). Tagging efforts in the Patuxent River in 2020 exhibited an estimated 1,250 blue catfish per acre, for fish longer than 8 inches (Wilson 2021)(MDNR 2022h). Although the entire Chesapeake Bay stock size remains unknown, research efforts show that the population has been increasing throughout Maryland and Virginia tributaries, and it is thought that over 100 million blue catfish are in the Bay (Fabrizio et al. 2018)(Tkacik & Dance 2019).

The abundance increases and range expansions exhibited by blue catfish have raised concerns about its competition with and predation on native species that are ecologically sensitive and economically important to the Bay. Although other introduced species, such as the channel catfish (introduced into Maryland waters in the 1800s) are now considered naturalized (Outdoors Maryland 2021), blue catfish remains an invasive species that is bringing considerable ecological concerns to the Bay.

Factor 1.2 - Fishing Mortality

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia
Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Low Concern
In the Chesapeake Bay, blue catfish is an introduced, nonnative species. Because it is considered invasive in Bay waters, it has a low conservation concern, regardless of stock size.

Justification:
Fishing mortality estimates have not been developed for blue catfish captured in Virginia or Maryland. Trophy and recreational fisheries have been developed since the 1970s and 1980s, with commercial fisheries gaining more momentum in the last two decades. Because blue catfish is an invasive species, managers are focused on increasing catch rates and fishing mortality, in the hopes of ultimately fishing the stock at levels that will affect its abundance.

The primary fishery for blue catfish used to be the trophy fishery, which targeted quite large adult blue catfish, but in recent years, the commercial fisheries in Virginia and Maryland have grown, and they target smaller adult catfish (Sustainable Fisheries GIT 2017). Virginia has recently expanded its commercial fishery—and therefore fishery landings—primarily through the development of its new low-frequency electrofishing (LFE) fishery, while Maryland has focused on encouraging fishers to catch more blue catfish with traditional gear types. Increased marketing efforts have increased the commercial demand for blue catfish, which has led to higher landings than those during the early 2000s (NOAA Fisheries 2022a). In 2007, under 230,000 pounds of blue catfish were landed in the Bay, compared to over 4.1 million pounds landed Bay-wide in 2016 and over 5 million pounds landed by Maryland and Virginia fishers in 2017 (NOAA Fisheries 2018) (Rodricks 2022). Total fishing mortality is not quantified, because a Bay-wide population estimate has not been developed.

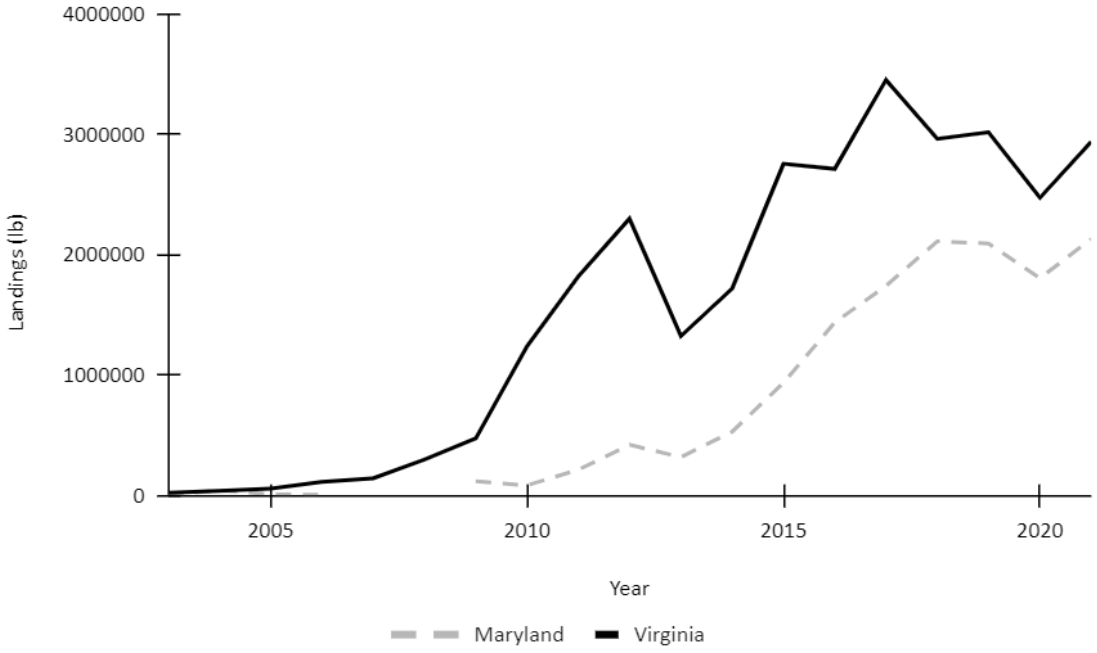

Figure 6: Commercial landings (in pounds) of blue catfish by Virginia and Maryland fishers from 2003 to 2021. Data from ACCSP Data Warehouse.

Criterion 2: Impacts on Other Species

All main retained and bycatch species in the fishery are evaluated under Criterion 2. Seafood Watch defines bycatch as all fisheries-related mortality or injury to species other than the retained catch. Examples include discards, endangered or threatened species catch, and ghost fishing. Species are evaluated using the same guidelines as in Criterion 1. When information on other species caught in the fishery is unavailable, the fishery's potential impacts on other species is scored according to the Unknown Bycatch Matrices, which are based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The fishery is also scored for the amount of non-retained catch (discards) and bait use relative to the retained catch. To determine the final Criterion 2 score, the score for the lowest scoring retained/bycatch species is multiplied by the discard/bait score. The Criterion 2 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Factor 2.3 (Fishing Mortality) is Crtitical

Guiding principles

- *Ensure all affected stocks are healthy and abundant.*
- *Fish all affected stocks at sustainable level.*
- *Minimize bycatch.*

Criterion 2 Summary

Criterion 2 score(s) overview

This table(s) provides an overview of the Criterion 2 subscore, discards+bait modifier, and final Criterion 2 score for each fishery. A separate table is provided for each species/stock that we want an overall rating for.

BLUE CATFISH			
REGION / METHOD	**SUB SCORE**	**DISCARD RATE/LANDINGS**	**SCORE**
Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia	1.732	1.000: < 100%	Red (1.732)
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland	1.000	1.000: < 100%	Red (1.000)
Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia	5.000	1.000: < 100%	Green (5.000)
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia	1.000	1.000: < 100%	Red (1.000)
Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia	1.732	1.000: < 100%	Red (1.732)
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland	1.000	1.000: < 100%	Red (1.000)
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia	1.000	1.000: < 100%	Red (1.000)

Criterion 2 main assessed species/stocks table(s)

This table(s) provides a list of all species/stocks included in this assessment for each 'fishery' (as defined by a region/method combination). The text following this table(s) provides an explanation of the reasons the listed species were selected for inclusion in the assessment.

CHESAPEAKE BAY | AMERICA, NORTH - INLAND WATERS | BOAT SEINES | UNITED STATES | MARYLAND | VIRGINIA			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Forage fish	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Blue catfish	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

CHESAPEAKE BAY | AMERICA, NORTH - INLAND WATERS | DRIFT GILLNETS | UNITED STATES | MARYLAND

SUB SCORE: 1.000 | DISCARD RATE: 1.000 | **SCORE: 1.000**

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Finfish	1.000: High Concern	1.000: High Concern	Red (1.000)
Forage fish	1.000: High Concern	1.000: High Concern	Red (1.000)
Marine mammals	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Seabirds	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Blue catfish	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

CHESAPEAKE BAY | AMERICA, NORTH - INLAND WATERS | ELECTRIC FISHING | UNITED STATES | VIRGINIA

SUB SCORE: 5.000 | DISCARD RATE: 1.000 | **SCORE: 5.000**

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Blue catfish	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

CHESAPEAKE BAY | AMERICA, NORTH - INLAND WATERS | POTS | UNITED STATES | MARYLAND | VIRGINIA

SUB SCORE: 1.000 | DISCARD RATE: 1.000 | **SCORE: 1.000**

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Marine mammals	1.000: High Concern	1.000: High Concern	Red (1.000)
Blue catfish	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

CHESAPEAKE BAY | AMERICA, NORTH - INLAND WATERS | SET LONGLINES | UNITED STATES | MARYLAND

SUB SCORE: 1.000 | DISCARD RATE: 1.000 | **SCORE: 1.000**

SPECIES	ABUNDANCE	FISHING MORTALITY	SCORE
Finfish	1.000: High Concern	1.000: High Concern	Red (1.000)
Marine mammals	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Seabirds	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Blue catfish	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

CHESAPEAKE BAY | ATLANTIC, NORTHWEST | SET GILLNETS | UNITED STATES | VIRGINIA			
SUB SCORE: 1.732	DISCARD RATE: 1.000	**SCORE: 1.732**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Striped bass	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
Gizzard shad	2.330: Moderate Concern	3.000: Moderate Concern	Yellow (2.644)
Blue catfish	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

CHESAPEAKE BAY | ATLANTIC, NORTHWEST | STATIONARY UNCOVERED POUND NETS | UNITED STATES | MARYLAND | VIRGINIA			
SUB SCORE: 1.000	DISCARD RATE: 1.000	**SCORE: 1.000**	
SPECIES	**ABUNDANCE**	**FISHING MORTALITY**	**SCORE**
Marine mammals	1.000: High Concern	1.000: High Concern	Red (1.000)
Striped bass	1.000: High Concern	3.000: Moderate Concern	Red (1.732)
River herring	1.000: High Concern	5.000: Low Concern	Yellow (2.236)
White perch	3.670: Low Concern	3.000: Moderate Concern	Green (3.318)
Blue catfish	5.000: Very Low Concern	5.000: Low Concern	Green (5.000)

The bycatch and retained species in the blue catfish fishery are mostly unknown. A limited observer and sampling program in Virginia provides some insight into bycatch in anchored gillnets and pound nets, especially those targeting striped bass alongside blue catfish. Maryland managers are aware of some nontarget capture species, but bycatch data are not collected and catches are not observed. Thus, aside from a few bycatch species (striped bass, gizzard shad, white perch, and river herring) identified by Virginia and Maryland managers and a collection of anchored gillnet observer data from 2016–21 provided by VMRC, bycatch in this report is scored according to the Seafood Watch Unknown Bycatch Matrix (UBM), based on a synthesis of peer-reviewed literature and expert opinion on the bycatch impacts of each gear type. The UBM ranks the bycatch susceptibility of different taxonomic groups in various gear types. More information is available in Appendix 2 of the Seafood Watch Criteria. Where noted, these scores have been modified based on information specific to the fishery gear type. Electrofishing is the only fishery that does not require use of the UBM. Electrofishing, under certain water depth and current conditions, occasionally can temporarily stun finfish species other than catfish, but these species are not subsequently netted, which allows them to swim away unharmed.

The taxa that are most likely to interact with the blue catfish fisheries include forage fish, finfish, marine mammals, and seabirds. Forage fish are most likely to interact with fisheries using drift gillnets and boat seines. Finfish are most likely to interact with fisheries using drift gillnets and set longlines. Marine mammals are most likely to interact with fisheries using drift gillnets, pound nets, pots/traps, and set longlines. Seabirds are most likely to interact with drift gillnets and set longlines. Sharks and sea turtles identified by the UBM are excluded from this report because their habitat in the Chesapeake Bay does not overlap with blue catfish fishing areas, and most marine mammals—except bottlenose dolphin—also do not have overlapping habitats with blue catfish. Atlantic menhaden is known to interact with anchored gillnets,

but observer data show that this species makes up less than 5% of the total catch, so it is not included in this report. For the drift gillnet, pot/trap, and pound net fisheries, marine mammals limit the score for Criterion 2 because of their inherent high vulnerability and their UBM-identified high potential to interact with these gear types in the Northwest Atlantic. For the drift gillnet fishery, the score for Criterion 2 is also limited by forage fish and finfish, because there are a number of endangered, overfished, or depleted forage and finfish species in the Chesapeake Bay that have a high potential to interact with this gear type. Likewise, finfish limit the Criterion 2 score for set longlines. Forage fish limit the Criterion 2 score for boat seines as well, although they have only a moderate potential to interact with this gear type. Anchored gillnets have a score limited by striped bass, which is an overfished species.

Criterion 2 Assessment

SCORING GUIDELINES

Factor 2.1 - Abundance
(same as Factor 1.1 above)

Factor 2.2 - Fishing Mortality
(same as Factor 1.2 above)

Factor 2.3 - Modifying Factor: Discards and Bait Use
Goal: Fishery optimizes the utilization of marine and freshwater resources by minimizing post-harvest loss. For fisheries that use bait, bait is used efficiently.

Scoring Guidelines: The discard rate is the sum of all dead discards (i.e. non-retained catch) plus bait use divided by the total retained catch.

Ratio of bait + discards/landings	Factor 2.3 score
<100%	1
>=100	0.75

Finfish

Factor 2.1 - Abundance

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland

High Concern
Over 300 species of finfish are found in the Chesapeake Bay (CBF 2022). Many of these species have stocks at healthy levels, but several do not, including American shad, Atlantic striped bass, Atlantic sturgeon, river herring, weakfish, and winter flounder (ASMFC 2022d). Because these species have stocks below biological reference points, this factor receives a high concern rating.

Justification:
Although many of the 348 finfish species in the Bay do not have conservation concerns, several species of both economic and ecological importance in the Bay are overfished, depleted, and/or endangered. Atlantic sturgeon and shortnose sturgeon are among Maryland's endangered species (MDNR 2022c). Threatened species include the freshwater comely shiner (MDNR 2022c).

Factor 2.2 - Fishing Mortality

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland

High Concern
According to the UBM, finfish caught in driftnets in the Northwest Atlantic receive a high concern rating for fishing mortality.

Justification:
Driftnets in Maryland contribute 5% of the total blue catfish catch in the commercial fishery, but no bycatch data are collected by managers {pers. comm., M. Groves 2022}. The primary driftnet fisheries in the Chesapeake Bay are for striped bass and white perch (Versak 2003). Though striped bass anchored gillnet and pound net fisheries also target blue catfish, this dual fishing is less prevalent in the driftnet industry in Maryland {pers. comm., A. Galvan 2022} {pers. comm., M. Groves 2022}. After previous bycatch issues in the striped bass and white perch driftnet fisheries, Maryland has introduced mesh size restrictions for gillnets: the minimum mesh size in this gear during the most active part of the blue catfish fishing season is 2.5 inches (Natural Resources Title 4). Because anchored gillnets are prohibited in Maryland waters, this size restriction only applies to drift gillnets and is meant to help reduce bycatch of juvenile fish. But, adult finfish are often well above this mesh size, which allows them to still get captured in driftnet gear.

Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland

High Concern
According to the UBM, finfish bycaught in set longlines in the Northwest Atlantic receive a high concern rating.

Justification:
Longlines consist of one lengthy horizontal line with a series of perpendicular, vertical hooked lines. Bait choice on the hooks can introduce some selectivity, but otherwise the fishery is not directed, allowing for the possibility of hooking nontarget fish species.

Forage fish

Factor 2.1 - Abundance

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland

High Concern
Thorough bycatch and catch composition data are not collected for hauled boat seines in Virginia or Maryland or for driftnets in Maryland, so the UBM was used to identify at-risk species. Forage fish are the only taxonomic group that surrounding nets such as boat seines pose a significant bycatch risk to. Forage fish are also at risk from driftnets used in Maryland. Many forage fish species are found in the Chesapeake Bay, including juvenile alosines, anchovy species, weakfish, and smaller species such as gobies (Houde 2013). Although some forage species' stocks are stable and healthy, at least three species have recent stock assessments that point to a depleted stock status. American shad (2020), river herring (2017), and weakfish (2019) populations are all depleted along the Atlantic coast (ASMFC 2022d). This factor is rated a high concern, because of the depleted stock status of multiple forage species.

Justification:
The stock status of Chesapeake Bay forage fishes ranges from above target levels to depleted, with some stocks having an unknown stock status. All forage fishes in the Chesapeake Bay are teleosts, which would typically receive a moderate concern rating; however, a depleted stock status overrides this default score. American shad and river herring are both depleted coast-wide, with unknown stock status on smaller scales throughout the mid-Atlantic (ASMFC 2022d). The spawning stock of weakfish, when last assessed, sat several million pounds below the biomass threshold established by managers (ASMFC 2022d). Other stocks, such as Atlantic menhaden, sit above established reference points, but this taxonomic group's overall score is based on the status of the most vulnerable species.

Factor 2.2 - Fishing Mortality

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia

Moderate Concern

According to the UBM, forage fish caught in surrounding nets such as boat seines in the Northwest Atlantic receive a moderate concern rating for fishing mortality.

Justification:

In Virginia, boat haul seines generally bring in just under 10% of the total blue catfish landings, and this percentage is doubled in Maryland {pers. comm., A. Galvan 2022} {pers. comm., M. Groves 2022}. Seine fisheries are typically targeting mixed species, which allows for noncatfish species such as forage fish to be captured. Harvests in seine nets are usually for live markets, thus allowing for nontarget, sensitive forage species to be discarded alive.

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland

High Concern

According to the UBM, forage fish caught in driftnets in the Northwest Atlantic receive a high concern rating for fishing mortality.

Justification:

Driftnets in Maryland contribute 5% of total blue catfish catch to the commercial fishery, but no bycatch data are collected by managers {pers. comm., M. Groves 2022}. The primary driftnet fisheries in the Chesapeake Bay are for striped bass and white perch (Versak 2003). Although striped bass anchored gillnet and pound net fisheries also target blue catfish, this dual fishing is less prevalent in the driftnet industry in Maryland {pers. comm., A. Galvan 2022} {pers. comm., M. Groves 2022}. After previous bycatch issues in the striped bass and white perch driftnet fisheries, Maryland has introduced mesh size restrictions for gillnets: the minimum mesh size in this gear during the most active part of the blue catfish fishing season is 2.5 inches (Natural Resources Title 4). Because anchored gillnets are prohibited in Maryland waters, this size restriction only applies to drift gillnets and is meant to help reduce bycatch of juvenile fish. But, adult forage fish are often well above this mesh size, which allows them to still get captured in driftnet gear.

Gizzard shad

Factor 2.1 - Abundance

Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia

Moderate Concern

The gizzard shad population in the Chesapeake Bay has been increasing since the 1980s (MDNR 2022d), but the total stock size is unknown and has not been assessed. Therefore, a productivity-susceptibility analysis (PSA) was used to determine a vulnerability score for this species. Gizzard shad received a score of 1 for productivity and a score of 2.8 for susceptibility, resulting in a total vulnerability score of 2.97, or medium vulnerability. Because of this PSA score, gizzard shad receives a rating of moderate concern for abundance.

Justification:

Productivity Attribute	Relevant Information	Score (1 = low, 2 = medium, 3 = high)
Average age at maturity	Maturity reached at age 2–3 (USGS 2021)	1
Von Bertalanffy (Brody) Growth Coefficient (K)	Gizzard shad exhibits a rapid growth rate (USGS 2021)	1
Fecundity	Females produce >300,000 eggs per year, on average (USGS 2021)	1
Average maximum size	Maximum length in Virginia is 42 cm (VIMS Shad); Maximum length across range is 57 cm (Froese & Pauly 2022)	1
Average size at maturity	Maturity length is 36.1 cm (Froese & Pauly 2022)	1
Reproductive strategy	Gizzard shad is a broadcast spawner; the eggs often attach to bottom vegetation (Williamson & Nelson 1985)	1

Susceptibility Attribute	Relevant Information	Score (1 = low, 2 = medium, 3 = high)
Areal Overlap	N/A; default unknown score	3
Vertical Overlap	N/A; default unknown score	3
Seasonal Availability	N/A; default unknown score	3
Selectivity of Fishery	Gizzard shad is not targeted and is usually discarded when caught (MDNR 2022d), but adult gizzard shad are larger than the regulatory minimum mesh size for gillnets, reducing their chance of escape when incidentally captured (Pertaining to the Marking and Minimum Mesh Sizes of Gillnets 2007) (Froese & Pauly 2022).	2
Post-Capture Mortality	N/A; default unknown score	3

Factor 2.2 - Fishing Mortality

Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia

Moderate Concern

Virginia has no regulations regarding fishing for gizzard shad, although the species is not targeted for human consumption (MDNR 2022d). Therefore, when caught, gizzard shad is typically discarded, or occasionally kept to be used as bait in other fisheries (MDNR 2022d), but the ratio of dead to live discards is unknown. In Virginia, just under 50% of incidentally captured gizzard shad are retained, while the rest are discarded. Gizzard shad made up 8.7% of total catch in observed set gillnet trips in Virginia from 2016 to 2022 (unpublished VMRC data, 2023). Because overall fishing mortality is thought to be low, but most gizzard shad are discarded when bycaught and may be discarded alive or dead, this factor is rated a moderate concern.

Justification:

Although total fishing mortality is unknown, it is unlikely to be high because this species is most often discarded when bycaught and is not caught in targeted fisheries. There are no concerns about fishing mortality affecting population levels or being above sustainable levels, which allows managers not to have fishing regulations in place. But, adult gizzard shad are larger than minimum gillnet mesh sizes, which reduces their chance of escaping the nets (Pertaining to the Marking and Minimum Mesh Sizes of Gillnets 2007)(Froese & Pauly 2022). Mortality in discarded gizzard shad is unknown, which creates some uncertainty around population impacts from incidentally captured and discarded gizzard shad.

Marine mammals

Factor 2.1 - Abundance

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

High Concern
There are several marine mammal species found in the Chesapeake Bay and Northwest Atlantic region, including a number of whale and dolphin species, harbor porpoise, harbor seal, and occasionally the West Indian manatee (Blaylock 1985). All marine mammal species are protected under the Marine Mammal Protection Act (MMPA), so they receive a high concern score.

Justification:
Because catch composition data are unavailable for pots/pound nets, driftnets, and longlines used in Virginia and/or Maryland, it is not known which marine mammal species may be at risk from blue catfish gear. Although the above species may enter the Bay, many of them prefer larger, saltier waters than those that blue catfish inhabit. But, bottlenose dolphin is an example of a species that will enter fresher waters of Bay tributaries (Rodriguez et al. 2021). In addition, bottlenose dolphin presence in the Bay peaks during the summer months, and the peak of the year-round blue catfish fishing season runs into early summer (Rodriguez et al. 2021)(Bass Fishing Resource 2022). In the Bay, bottlenose dolphin belongs to two stocks: the Western North Atlantic Northern stock and the Southern Migratory Coastal stock (NOAA Fisheries 2022b). Both stocks are depleted under the MMPA.

Factor 2.2 - Fishing Mortality

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland

Moderate Concern
According to the UBM, marine mammals caught in driftnets in the Northwest Atlantic receive a high concern rating for fishing mortality. But, driftnets are required to be attended in Maryland, which suggests that any captured marine mammals will be released quickly, thus increasing their chance of being released alive. Therefore, the score is modified to a moderate concern rating.

Justification:
Driftnets in Maryland contribute 5% of the total blue catfish catch to the commercial fishery, but no bycatch data are collected by managers {pers. comm., M. Groves 2022}. Driftnets in Maryland must be attended, which increases the likelihood that captured megafauna can be safely released from nets (Natural Resources Title 8), but interactions have not been quantified.

Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

High Concern
According to the UBM, marine mammals caught as bycatch in pots and traps (including pound nets) in the Northwest Atlantic receive a high concern score for fishing mortality.

Justification:
Although the UBM points to a high concern rating, and catch composition data are unavailable to exhibit whether or not marine mammal bycatch exists, it should be noted that marine mammal interactions are fairly unlikely. Blue catfish is primarily a freshwater species, typically residing in rivers up to 15 ppt salinity (Liu and Fisher 2020), which is below the salinity tolerance of many marine mammals, but bottlenose dolphin has been seen in the Bay at salinities as low as 6 ppt (Rodriguez et al. 2021). This fishery is not listed under the MMPA list of fisheries, but two somewhat similar fisheries are.

The Atlantic mixed species trap/pot fishery, which includes blue catfish as a target species, is a Category II fishery under the MMPA (NOAA Fisheries 2021c). NOAA cites interactions with fin whale and humpback whale in this fishery, although these do not occur in inland waters (NOAA Fisheries 2021c). This fishery, though similar in its catch, occurs in the Atlantic Ocean, making whale interactions possible, whereas the Chesapeake Bay blue catfish fishery does not overlap with whale habitats. Blue crab pots across the Atlantic coast are part of a Category II fishery under the MMPA (NOAA Fisheries 2020). Fish pots are configured differently than crab pots, which may alter the risk that they pose to marine mammals. But, fish pots such as hoop nets can still include vertical float lines, which are often the cause of marine mammal entanglements in marine pot fisheries (e.g., those in the Atlantic mixed-species trap/pot fishery). But within the Bay, marine mammals are not a significant component of blue crab pot bycatch (Bilkovic et al. 2016). Pound nets typically do not have vertical float lines, so the only risk to marine mammals is entrapment in the netting itself.

Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland

Moderate Concern
According to the UBM, marine mammals caught in set longlines in the Northwest Atlantic receive a moderate concern rating for fishing mortality.

Justification:
Longlines for blue catfish are more likely to be set deeper, toward the bottom, because blue catfish is a bottom dweller. This reduces the risk to marine mammals compared to that posed by pelagic longlines, but vertical line entanglements and injuries can still occur in this gear type (NOAA Fisheries 2019).

River herring

Factor 2.1 - Abundance

Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

High Concern

River herring was last assessed in 2017 by ASMFC. This assessment found the population to be depleted on a coast-wide basis (ASMFC 2022d). Because of its depleted status, river herring receives a high concern rating for this factor.

Justification:

River herring refers to both alewife and blueback herring in the Chesapeake Bay. In 2012, ASMFC examined 15 river herring stocks in the Chesapeake Bay, of which 9 were determined to be overfished or severely depleted (ASMFC 2017). Continued abundance studies in the Upper Bay since then suggest that river herring populations are still low, with some continuing to decline (ASMFC 2017). A lack of data in major Virginia rivers (James, York, and Rappahannock) prevented the completion of stock assessments in these waters (ASMFC 2017). Across the Atlantic coast, river herring populations were considered depleted in the 2017 assessment.

Factor 2.2 - Fishing Mortality

Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Low Concern

As a result of fishery collapse, the possession of river herring has been prohibited in Maryland and Virginia since 2012, so no formal fisheries for the species exist in these states. Before the landings ban, bycatch of river herring mostly occurred in pound and fyke nets for catfish and perch (ASMFC 2017). Since the ban, there is no system in place to report bycaught river herring in Maryland, although fyke and pound nets are still occasionally sampled for herring (ASMFC 2017). In Virginia, some bycatch is sampled, but no formal observer program for river herring bycatch exists (ASMFC 2017). The latest fishery management plan (FMP) review for river herring shows a recent decrease in bycatch, with bycatch in the Bay making up <0.1% of overall catch (ASMFC 2023). Because bycatch makes a minimal contribution to the overall catch, this factor receives a low concern rating.

Justification:

ASMFC notes that it is "unknown" whether or not overfishing of river herring is occurring (ASMFC 2022d), likely because of the moratorium on commercial and recreational fishing in Maryland and Virginia. Although it is thought that bycatch still occurs in fyke and pound net fisheries, data are not robust enough to determine the extent of mortality from these catches. In the years before the 2012 moratoriums, commercial fisheries for herring in the Chesapeake Bay had already largely collapsed, and most catch came from bycatch in other fisheries (ASMFC 2017). Further, mortality in river

herring in the Bay has stemmed not only from fishing pressure, but also from habitat loss and climate change (ASMFC 2022e). Total mortality and fishing mortality are not known, although any fishing mortality that exists in Maryland and Virginia does stem from bycatch. The proportion of this catch from catfish fisheries versus other fisheries (namely, perch) is not known. But, ASMFC notes in its 2021 shad and river herring FMP review that bycatch of river herring decreased by more than 99% from 2020 to 2021. In 2021, bycatch made up 0.02% of the total catch (directed and incidental), whereas this percentage was 8.18% in 2020 (ASMFC 2023). There is some uncertainty whether or not a shift in sampling programs in Massachusetts helped to drive this apparent decrease in bycatch numbers, but this sampling change did not extend to Maryland and Virginia, which suggests that these states' overall contributions to bycatch are minimal either way.

Seabirds

Factor 2.1 - Abundance

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland

High Concern
Seabirds are an inherently vulnerable taxonomic group, so they receive a high concern rating.

Justification:
Several seabirds with conservation concerns inhabit Chesapeake Bay, including black skimmer (endangered) and gull-billed tern (endangered). It should be noted that many seabirds are found on coasts and at sea rather than farther upstream in freshwater areas, but some may venture to lower salinity areas where catfish are found (Birds of North America 2022).

Factor 2.2 - Fishing Mortality

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland

Moderate Concern
According to the UBM, seabirds caught in driftnets in the Northwest Atlantic receive a moderate concern score for fishing mortality.

Justification:
Driftnets in Maryland contribute 5% of the total blue catfish catch to the commercial fishery, but no bycatch data are collected by managers {pers. comm., M. Groves 2022}. Driftnets in Maryland must be attended, which increases the likelihood that captured megafauna can be safely released from nets (Natural Resources Title 8), but interactions have not been quantified.

Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland

Moderate Concern

According to the UBM, seabirds caught as bycatch in set longlines in the Northwest Atlantic receive a moderate concern score for fishing mortality.

Justification:

Seabirds may predate and then get hooked on longlines or become entangled in attached vertical lines.

Striped bass

Factor 2.1 - Abundance

Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

High Concern

The Atlantic striped bass stock was last assessed in 2022, using data up to 2021. This stock assessment found that the female spawning stock biomass (SSB) was below both the target and threshold SSB values determined by the ASMFC (ASMFC 2022f). Striped bass is targeted alongside blue catfish in anchored gillnets and pound nets in the Bay {pers. comm., A. Galvan 2022}. This factor is scored a high concern, because the stock is below both reference points and is considered overfished.

Justification:

The striped bass stock was also considered overfished in the 2018 stock assessment, and SSB has not risen enough for the stock to no longer be considered overfished. In 2021, the female SSB was 143 million pounds, while target and threshold female SSB values were 235 million pounds and 188 million pounds, respectively (ASMFC 2022f). Virginia managers note that the Virginia abundance surveys have shown average to above-average year classes of juvenile striped bass in the past 10 years, including in 2022 (VIMS 2022). But, Maryland's surveys have exhibited below-average year classes in 5 of the past 10 years, including in 2022 (VIMS 2022)(MDNR 2022e). The Atlantic coastal population was declared overfished in 2019, and in 2020, measures were put in place to reduce fishing pressure by 18%, to help the stock recover (ASMFC 2022a).

Factor 2.2 - Fishing Mortality

Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Moderate Concern

According to the 2022 Atlantic striped bass stock assessment, fishing mortality in 2021 was below both the threshold mortality and target mortality values (ASMFC 2022f). But, preliminary 2022 data

suggest that fishing mortality increased and is now between reference points (Atlantic Striped Bass Technical Committee and Stock Assessment Subcommittee 2023). This factor is scored a moderate concern, because the total fishing mortality is likely between the threshold and target reference points.

Justification:
The 2018 stock assessment determined this stock to be experiencing overfishing, and reductions in fishing levels were consequently introduced by managers (ASMFC 2022a). From 2018 to 2021, the average fishing removal level was 24% lower than in 2017, when the stock was experiencing overfishing. Commercial fishing made up 39% of these removals: 37% for harvest and 2% for discards (ASMFC 2022f). Management reduced its reference points for the population in 2021, following low recruitment levels in Maryland (ASMFC 2022f). Even with these reductions, fishing mortality was below both reference points in 2021: fishing mortality was 0.14, the target level was 0.17, and the threshold level was 0.20. But in 2022, fishing mortality increased by 33% (primarily because of recreational harvest increases), according to preliminary data. Under the 2021 fishing mortality level, ASMFC notes that there is a 97.5% chance that the stock will be rebuilt by the rebuilding deadline of 2029 (ASMFC 2022f), but under the preliminary 2022 level, there is only an 11–15% chance that the stock will be rebuilt by 2029 (Atlantic Striped Bass Technical Committee and Stock Assessment Subcommittee 2023).

White perch

Factor 2.1 - Abundance

Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Low Concern
In the Chesapeake Bay, more of the white perch catch comes from Maryland fisheries than from those in Virginia (NOAA Fisheries 2021a). Although a Bay-wide stock assessment is not available, a 2021 assessment for some Bay regions found the population in the Upper Bay, where most catfish fishing occurs, to not be overfished and to have a high population level compared to the previous two decades (Piavis & Webb 2021). Because the stock size and abundance indices are higher than recent averages and there is no concern that the stock is overfished, this factor is rated a low concern.

Justification:
In the Upper Bay, white perch stock abundance was 8.7 million in 2020 (Piavis & Webb 2021). The peak abundance since 2000 occurred in 2016, at 10.6 million. This population is thought to be stable and healthy, and other abundance indices have also increased throughout the Bay in recent years.

Factor 2.2 - Fishing Mortality

Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Moderate Concern

The same stock assessment noted above used spawning potential reference points established in 2006 to determine the impact of fishing mortality on the stock. It was found that fishing mortality in the Upper Bay was below the limit reference point (1.12) but slightly above the target reference point (0.6) in 2019 (Piavis & Webb 2021). This factor is rated a moderate concern, because fishing mortality sits between the limit and target reference points.

Justification:

Further modeling showed that there was a 74% chance that fishing mortality was above the target in 2019, with a 2% chance that overfishing was occurring (i.e., F was above the limit). From 2000 to 2019, the average fishing mortality was 0.68, although it sat below both the target and limit reference points from 2015 to 2018 (Piavis & Webb 2021).

Factor 2.3 - Discard Rate/Landings

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia
Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

< 100%

Blue catfish is primarily a live harvest species, so dead discards are minimal throughout the blue catfish fisheries {pers. comm., A. Galvan}{pers. comm., M. Groves 2022}. Bait is not used in all catfish gear types, but those that do use bait have a low ratio of bait to catfish landings. Catfish is a large predator and is found in high numbers in the Chesapeake Bay, so it does not require a substantial amount of bait to be captured in significant quantities. In observed set gillnet fishing trips from 2016 to 2022, discards made up 5.3% of the total catch (unpublished VMRC data, 2023).

Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia

< 100%

Electric fishing does not use bait. Any other catfish species stunned by the gear is able to swim away unharmed, after a brief period of time. Therefore, there are no dead discards, and the discard/bait amount is <100% of landings.

Criterion 3: Management Effectiveness

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

- *5 (Very Low Concern) — Meets the standards of 'highly effective' for all five factors considered.*
- *4 (Low Concern) — Meets the standards of 'highly effective' for 'management strategy and implementation' and at least 'moderately effective' for all other factors.*
- *3 (Moderate Concern) — Meets the standards for at least 'moderately effective' for all five factors.*
- *2 (High Concern) — At a minimum, meets standards for 'moderately effective' for Management Strategy and Implementation and Bycatch Strategy, but at least one other factor is rated 'ineffective.'*
- *1 (Very High Concern) — Management Strategy and Implementation and/or Bycatch Management are 'ineffective.'*
- *0 (Critical) — Management Strategy and Implementation is 'critical'.*

The Criterion 3 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Rating is Critical if Management Strategy and Implementation is Critical.

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species.

Five factors are evaluated in Criterion 3: Management Strategy and Implementation, Bycatch Strategy, Scientific Research/Monitoring, Enforcement of Regulations, and Inclusion of Stakeholders. Each is scored as either 'highly effective', 'moderately effective', 'ineffective,' or 'critical'. The final Criterion 3 score is determined as follows:

Criterion 3 Summary

FISHERY	MANAGEMENT STRATEGY	BYCATCH STRATEGY	DATA COLLECTION AND ANALYSIS	ENFORCEMENT	INCLUSION	SCORE
Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**

Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia	Highly effective	Highly effective	Moderately Effective	Highly effective	Highly effective	**Green (4.000)**
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia	Moderately Effective	Moderately Effective	Moderately Effective	Highly effective	Highly effective	**Yellow (3.000)**

Criterion 3 Assessment

SCORING GUIDELINES

Factor 3.1 - Management Strategy and Implementation

Considerations: What type of management measures are in place? Are there appropriate management goals, and is there evidence that management goals are being met? Do manages follow scientific advice? To achieve a highly effective rating, there must be appropriately defined management goals, precautionary policies that are based on scientific advice, and evidence that the measures in place have been successful at maintaining/rebuilding species.

Factor 3.2 - Bycatch Strategy

Considerations: What type of management strategy/measures are in place to reduce the impacts of the fishery on bycatch species and when applicable, to minimize ghost fishing? How successful are these management measures? To achieve a Highly Effective rating, the fishery must have no or low bycatch, or if there are bycatch or ghost fishing concerns, there must be effective measures in place to minimize impacts.

Factor 3.3 - Scientific Research and Monitoring

Considerations: How much and what types of data are collected to evaluate the fishery's impact on the species? Is there adequate monitoring of bycatch? To achieve a Highly Effective rating, regular, robust population assessments must be conducted for target or retained species, and an adequate bycatch data collection program must be in place to ensure bycatch management goals are met.

Factor 3.4 - Enforcement of Management Regulations

Considerations: Do fishermen comply with regulations, and how is this monitored? To achieve a Highly Effective rating, there must be regular enforcement of regulations and verification of compliance.

Factor 3.5 - Stakeholder Inclusion

Considerations: Are stakeholders involved/included in the decision-making process? Stakeholders are

individuals/groups/organizations that have an interest in the fishery or that may be affected by the management of the fishery (e.g., fishermen, conservation groups, etc.). A Highly Effective rating is given if the management process is transparent, if high participation by all stakeholders is encouraged, and if there a mechanism to effectively address user conflicts.

Factor 3.1 - Management Strategy And Implementation

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland

Moderately Effective
As the commercial fisheries for blue catfish in Virginia and Maryland have developed more during the 2000s, management measures have also developed and evolved. Managers recognize the ecological impacts that blue catfish may create in Chesapeake Bay tributaries, so the ultimate goal of management is to decrease the number of blue catfish in the area. The Chesapeake Bay Program's (CBP) Invasive Catfish Workgroup (previously the Invasive Catfish Task Force, hereafter the "Workgroup") was developed by CBP's Sustainable Fisheries Goal Implementation Team (SFGIT) (CBP 2022). The Workgroup released a management strategy for invasive catfish in the Bay in August, 2020. This strategy builds on the group's 2012 policy statement, progress made since the statement's release, and biannual meetings. The goals of this strategy are to 1) "protect, restore, and enhance finfish, shellfish, and other living resources, their habitats, and ecological relationships to sustain all fisheries and provide for a balanced ecosystem in the watershed and Bay" and 2) "reduce [catfish] abundance and mitigate the spread and ecological impacts of invasive catfishes in Chesapeake Bay through increased public education and awareness and development of fishery management strategies that ensure ecosystem health and productivity" (Invasive Catfish Workgroup 2020).

State management agencies also play a role in blue catfish management. In Maryland, it is illegal to transport live blue catfish into a body of water other than the one the fish originated from; this law is meant to prevent further spread of the species (MDNR 2022b). The Department of Natural Resources (MDNR) oversees commercial and recreational fisheries for blue catfish. Harvest is allowed year-round, with no size or creel limits in place for blue catfish (MDNR 2016). To commercially fish for blue catfish in Maryland, fishers must possess a fishing license and must use legal fishing gear (Love & Wilson 2019). In 2021, MDNR released a tidewater catfish fishery management plan, which includes management of invasive blue catfish. This plan has similar goals to that of the Workgroup's management strategy. Under this FMP, fishers are required to report commercial harvest weight to MDNR and to keep a daily log of their activities. Over a dozen ongoing management strategies for invasive catfish are also outlined in the FMP, including developing a monitoring program, increasing research, and performing annual surveys (MDNR 2021). MDNR has also focused management on public education and awareness campaigns: fact sheets, how-to videos, recipes, and a public-institution purchasing initiative in the state are aimed at growing the market for blue catfish, which will increase incentives for fishers to capture the species (MDNR 2018)(Liu and Fisher 2020). In Virginia, the Marine Resources Commission (VMRC) is in charge of commercial fisheries. Stocking blue catfish is illegal in the state, though it is not a fineable crime as

it is in Maryland (Fabrizio et al. 2020).

Because bycatch species are unknown for pots, longlines, drift gillnets, and haul seines, retained species other than blue catfish are also unknown. Therefore, the effectiveness of the management strategies for all retained species cannot be determined. The management strategy for blue catfish alone is thorough, but significant uncertainty is introduced by the inability to analyze the management strategies of other retained species.

The management strategies of CBP, MDNR, and VMRC are rated together as "moderately effective;" although they are focused on reducing blue catfish population levels, preventing the further spread and expansion of these populations, and reducing the impacts of blue catfish on native Chesapeake Bay species, the effectiveness of management strategies for other retained species remains uncertain.

Justification:
In its 2012 policy statement, the Workgroup laid out its original goals, which were focused on 1) increasing public awareness, 2) improving science, 3) developing models, 4) improving management measures for control and mitigation, and 5) identifying and assessing risks behind creating a more formal fishery for these species (Sustainable Fisheries GIT 2012). The workgroup created seven management recommendations in its first report, which was released in 2014. Since then, some progress has been made toward these recommendations, but managers still lack a Bay-wide management plan, which was highly recommended by a committee of reviewers for the 2014 report (Bilkovic et al. 2014). But, the development of this kind of coordinated plan has not been supported (and therefore not pursued) by the executive committee of the SFGIT (Sustainable Fisheries GIT 2019).

The 2020 management strategy introduced by the Workgroup was developed from an invasive catfish workshop involving stakeholders from Virginia, Maryland, Delaware, and Pennsylvania. The strategy details management goals, partners, current knowledge, knowledge gaps, and approaches that can be used to reach goals (Invasive Catfish Workgroup 2020). The objectives of the strategy focus not only on reducing catfish populations, but also on ensuring the health and success of impacted native fauna populations. Although the strategy is not a coordinated management plan, as recommended by the 2014 report review committee, it does provide Bay-wide goals and potential actions for blue catfish management and population reduction (Invasive Catfish Workgroup 2020). Importantly, the strategy discusses recent and ongoing management efforts in the context of what still must be done to fully understand the biology of blue catfish populations in the Bay. This allows state partners and management agencies to understand the science that is needed to develop effective strategies to reduce blue catfish populations and ecosystem impacts. Following the development of the 2020 management strategy, the SFGIT met in 2021 for a workshop that detailed current Workgroup goals: 1) improving public awareness of the blue catfish problems in Chesapeake Bay, 2) removing processing barriers for the blue catfish industry, 3) conducting new research on blue catfish, and 4) developing tributary-specific management plans throughout the Bay (Sustainable Fisheries GIT 2021).

The "processing barriers" referred to in the current Workgroup goals are the focus of state-level managers as well. A 2017 update to the 2008 Farm Bill moved the responsibility for catfish

processing inspections from the Food and Drug Administration to the U.S. Department of Agriculture (USDA) (Colden 2021). This change has significantly decreased the amount of blue catfish that can be processed in the Bay, because it requires USDA inspectors to be physically present for any processing. This creates additional cost for catfish processors and limits the hours when processing can happen (Invasive Catfish Workgroup 2020). The Workgroup has discussed this hindrance with the USDA, the Potomac River Fisheries Commission planned a roundtable discussion around this issue, Maryland managers worked with state policymakers to create a bill (which has not been signed into law) to exempt invasive catfish from this inspection process, and a Maryland federal Congressman introduced language into a recent USDA Appropriations Bill to provide inspection waivers for blue catfish processors in the area (PRFC 2019)(Invasive Catfish Workgroup 2020)(Office of Representative Andy Harris 2022). Removing this barrier is important for managers who hope that expanding the commercial fishing industry will curb blue catfish population growth and reduce existing population numbers.

Maryland's recent purchasing initiative is also aimed at expanding the commercial fishing industry. Since September 2018, the state has increased sales of blue catfish to state institutions such as public universities and prisons (Liu and Fisher 2020). The initiative was created by MDNR, the Maryland Department of Agriculture, and the Maryland Department of General Services, and began with two seafood companies receiving contracts for these sales (MDNR 2018). Historically, there has been some pushback on blue catfish consumption because of potential toxin accumulation in the species (Schloesser et al. 2011). More recent research has shown that smaller blue catfish are usually safe for human consumption, and state public education campaigns have helped raise awareness of these findings (Sustainable Fisheries GIT 2017)(Invasive Catfish Workgroup 2020)(Jepsen 2021)(Liu and Fisher 2020).

Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia

Highly effective

As the commercial fisheries for blue catfish in Virginia and Maryland have developed more during the 2000s, management measures have also developed and evolved. Managers recognize the ecological impacts that blue catfish may create in Chesapeake Bay tributaries, so the ultimate goal of management is to decrease the number of blue catfish in the area. The Chesapeake Bay Program's (CBP) Invasive Catfish Workgroup (previously the Invasive Catfish Task Force, hereafter the "Workgroup") was developed by CBP's Sustainable Fisheries Goal Implementation Team (SFGIT) (CBP 2022). The Workgroup released a management strategy for invasive catfish in the Bay in August, 2020. This strategy builds on the group's 2012 policy statement, progress made since the statement's release, and biannual meetings. The goals of this strategy are to 1) "protect, restore, and enhance finfish, shellfish, and other living resources, their habitats, and ecological relationships to sustain all fisheries and provide for a balanced ecosystem in the watershed and Bay" and 2) "reduce [catfish] abundance and mitigate the spread and ecological impacts of invasive catfishes in Chesapeake Bay through increased public education and awareness and development of fishery management strategies that ensure ecosystem health and productivity" (Invasive Catfish Workgroup 2020).

State management agencies also play a role in blue catfish management. In Virginia, the Marine

Resources Commission (VMRC) is in charge of commercial fisheries. Stocking blue catfish is illegal in the state, though it is not a fineable crime as it is in Maryland (Fabrizio et al. 2020). Much of the recent management focus has been on developing the low-frequency electrofishing (LFE) fishery in the state. LFE uses a small electric current to temporarily stun fish in the water, thus allowing them to be easily harvested by hand nets. Unlike more traditional fishing methods, LFE allows fishers to more precisely target catfish, because scaled fish are unaffected by the current (Jepsen 2021). The state has developed a small commercial LFE fishery for blue catfish, with a maximum of three licenses in play annually (Pertaining to Commercial Electrofishing 2019). LFE has no bycatch, so 100% of the retained fish are blue catfish.

The management strategies of CBP and VMRC are rated together as "highly effective" for electrofishing because they are focused on reducing blue catfish population levels, preventing the further spread and expansion of these populations, and reducing the impacts of blue catfish on native Chesapeake Bay species.

Justification:
In its 2012 policy statement, the Workgroup laid out its original goals, which were focused on: 1) increasing public awareness, 2) improving science, 3) developing models, 4) improving management measures for control and mitigation, and 5) identifying and assessing risks behind creating a more formal fishery for these species (Sustainable Fisheries GIT 2012). The Workgroup created seven management recommendations in its first report, released in 2014. Since then, some progress has been made toward these recommendations, but managers still lack a Bay-wide management plan, which was highly recommended by a committee of reviewers for the 2014 report (Bilkovic et al. 2014). But, the development of this kind of coordinated plan has not been supported (and therefore not pursued) by the executive committee of the SFGIT (Sustainable Fisheries GIT 2019).

The 2020 management strategy introduced by the Workgroup was developed from an invasive catfish workshop involving stakeholders from Virginia, Maryland, Delaware, and Pennsylvania. The strategy details management goals, partners, current knowledge, knowledge gaps, and approaches that can be used to reach goals (Invasive Catfish Workgroup 2020). The objectives of the strategy focus not only on reducing catfish populations, but also on ensuring the health and success of impacted native fauna populations. Although the strategy is not a coordinated management plan as recommended by the 2014 report review committee, it does provide Bay-wide goals and potential actions for blue catfish management and population reduction (Invasive Catfish Workgroup 2020). Importantly, the strategy discusses recent and ongoing management efforts in the context of what still must be done to fully understand the biology of blue catfish populations in the Bay. This allows state partners and management agencies to understand the science that is needed to develop effective strategies to reduce blue catfish populations and ecosystem impacts. Following the development of the 2020 management strategy, the SFGIT met in 2021 for a workshop that detailed current Workgroup goals: 1) improving public awareness of the blue catfish problems in Chesapeake Bay, 2) removing processing barriers for the blue catfish industry, 3) conducting new research on blue catfish, and 4) developing tributary-specific management plans throughout the Bay (Sustainable Fisheries GIT 2021).

The "processing barriers" referred to in the current Workgroup goals are the focus of state-level

managers as well. A 2017 update to the 2008 Farm Bill moved the responsibility for catfish processing inspections from the Food and Drug Administration to the U.S. Department of Agriculture (USDA) (Colden 2021). This change has significantly decreased the amount of blue catfish that can be processed in the Bay, because it requires USDA inspectors to be physically present for any processing. This creates additional cost for catfish processors and limits the hours when processing can happen (Invasive Catfish Workgroup 2020). The Workgroup has discussed this hindrance with the USDA, the Potomac River Fisheries Commission planned a roundtable discussion around this issue, Maryland managers worked with state policymakers to create a bill (which has not been signed into law) to exempt invasive catfish from this inspection process, and a Maryland federal Congressman introduced language into a recent USDA Appropriations Bill to provide inspection waivers for blue catfish processors in the area (PRFC 2019) (Invasive Catfish Workgroup 2020)(Office of Representative Andy Harris 2022). Removing this barrier is important for managers, who hope that expanding the commercial fishing industry will curb blue catfish population growth and reduce existing population numbers.

Virginia has used the development of its LFE fishery as its main tool to increase the catch of the commercial blue catfish industry in the state. LFE has been used historically for abundance surveys and other management research (Fabrizio et al. 2020)(Invasive Catfish Workgroup 2020) (FishingWire 2021). Testing this method for commercial fishing purposes began in the early to mid-2010s, as managers noticed that using LFE could increase catch and make harvest easier (Trice 2014)(Trice 2015). State managers have now expanded these efforts into testing the efficiency of harvest gear once LFE has been used to stun catfish and resolving processing delays from the 2008 Farm Bill change. In addition to the limit on LFE licenses, this new fishery also limits when and where LFE fishing can take place. LFE fishers cannot fish from October 16 to April 30 or on weekends, and must use their equipment more than 100 yards away from marked commercial fishing gear, public boat ramps, fishing piers, and areas where people are in the water (Pertaining to Commercial Electrofishing 2019). Finally, no species can be captured via LFE other than blue catfish and flathead catfish, which is another invasive species in the Bay (Pertaining to Commercial Electrofishing 2019).

Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia

Moderately Effective

Blue Catfish

As the commercial fisheries for blue catfish in Virginia and Maryland have developed more during the 2000s, management measures have also developed and evolved. Managers recognize the ecological impacts that blue catfish may create in Chesapeake Bay tributaries, so the ultimate goal of management is to decrease the number of blue catfish in the area. The Chesapeake Bay Program's (CBP) Invasive Catfish Workgroup (previously the Invasive Catfish Task Force, hereafter the "Workgroup") was developed by CBP's Sustainable Fisheries Goal Implementation Team (SFGIT) (CBP 2022). The Workgroup released a management strategy for invasive catfish in the Bay in August, 2020. This strategy builds on the group's 2012 policy statement, progress made since the statement's release, and biannual meetings. The goals of this strategy are to 1) "protect, restore, and enhance finfish, shellfish, and other living resources, their habitats, and ecological relationships to sustain all fisheries and provide for a balanced ecosystem in the watershed and Bay" and 2) "reduce [catfish] abundance and mitigate the spread and ecological impacts of invasive catfishes in

Chesapeake Bay through increased public education and awareness and development of fishery management strategies that ensure ecosystem health and productivity" (Invasive Catfish Workgroup 2020).

State management agencies also play a role in blue catfish management. In Virginia, the Marine Resources Commission (VMRC) is in charge of commercial fisheries. Stocking blue catfish is illegal in the state, though it is not a fineable crime as it is in Maryland (Fabrizio et al. 2020).

The management strategies of CBP and VMRC are thorough for anchored gillnets because they are focused on reducing blue catfish population levels, preventing further spread and expansion of these populations, and reducing impacts of blue catfish on native Chesapeake Bay species. But, striped bass and gizzard shad are also landed in set gillnets, so their management is also considered in this factor.

Striped Bass

Atlantic striped bass is managed under a Fishery Management Plan (FMP) implemented by the Atlantic States Marine Fisheries Commission (ASMFC) and by individual states that implement their own regulations and restrictions for both commercial and recreational fisheries. A quota system is in place through the FMP that provides a quota for the Chesapeake Bay (split between Maryland, Virginia, and the Potomac River Fisheries Commission). This quota and other management measures are adjusted based on the results of stock assessment updates and benchmark stock assessments.

The 2019 benchmark stock assessment found that the striped bass stock had been overfished since 2013 and that overfishing was occurring (ASMFC 2019). Based on these results, Addendum VI was added to Amendment 6 of the FMP. This addendum put in place measures to reduce removals by 18% relative to 2017 removals, introduced a size limit into the Chesapeake Bay, and put in place circle hook requirements in recreational fisheries to reduce recreational release mortality (ASMFC 2021).

The most recent (2022) stock assessment update reflects 2 years of management under Addendum VI and shows that management measures to rebuild the stock and reduce fishing mortality are working. Although SSB in 2021 was still below both reference points (i.e., the stock remains overfished), 2021 F was below both reference points, and maintaining the 2021 F value has a 97.5% chance of allowing the stock to reach the SSB target by 2029—the stock rebuilding deadline (ASMFC 2022a). SSB and F reference points in this assessment were adjusted to reflect data through 2021 and to reflect the use of low recruitment assumptions, which were based on the Maryland juvenile survey exhibiting low indices (ASMFC 2022a), thus making reference points more conservative. But, preliminary data from the 2022 season, which management does not expect to significantly differ from the final 2022 data, showed an increase in F, bringing total fishing mortality to between the target and reference points, rather than below both points (Atlantic Striped Bass Technical Committee and Stock Assessment Subcommittee 2023). These preliminary data also significantly reduced the probability of stock rebuilding by 2029. Although the probability that SSB exceeds the SSB threshold in 2029 (using F in 2022) may be as high as 94%, the probability that F also exceeds the SSB target in 2029, as required for stock recovery, may be as low as 11%.

Gizzard Shad

Gizzard shad is largely used as bait and is discarded >50% of the time when captured, because it is not fit for human consumption. Therefore, gizzard shad is retained to a much smaller extent than target species in gillnets. Gizzard shad does not fall under any management plan because it is not a target species for any fishery, and there are no concerns about its population or conservation status. But, because it is not formally managed, not much is known about its status relative to other, economically important species, and no reference points or precautionary policies are in place.

Although blue catfish has an effective management strategy, there is no management strategy in place for gizzard shad, and striped bass management effectiveness is uncertain, leading to a moderately effective score for this factor.

Justification:

In its 2012 policy statement, the Workgroup laid out its original goals, which were focused on 1) increasing public awareness, 2) improving science, 3) developing models, 4) improving management measures for control and mitigation, and 5) identifying and assessing risks behind creating a more formal fishery for these species (Sustainable Fisheries GIT 2012). The workgroup created seven management recommendations in its first report, released in 2014. Since then, some progress has been made toward these recommendations, but managers still lack a Bay-wide management plan, which was highly recommended by a committee of reviewers for the 2014 report (Bilkovic et al. 2014). But, the development of this kind of coordinated plan has not been supported (and therefore not pursued) by the executive committee of the SFGIT (Sustainable Fisheries GIT 2019).

The 2020 management strategy introduced by the Workgroup was developed from an invasive catfish workshop involving stakeholders from Virginia, Maryland, Delaware, and Pennsylvania. The strategy details management goals, partners, current knowledge, knowledge gaps, and approaches that can be used to reach goals (Invasive Catfish Workgroup 2020). The objectives of the strategy focus not only on reducing catfish populations, but also on ensuring the health and success of impacted native fauna populations. Although the strategy is not a coordinated management plan as recommended by the 2014 report review committee, it does provide Bay-wide goals and potential actions for blue catfish management and population reduction (Invasive Catfish Workgroup 2020). Importantly, the strategy discusses recent and ongoing management efforts in the context of what still needs to be done to fully understand the biology of blue catfish populations in the Bay. This allows state partners and management agencies to understand the science that is needed to develop effective strategies to reduce blue catfish populations and ecosystem impacts. Following the development of the 2020 management strategy, the SFGIT met in 2021 for a workshop that detailed current Workgroup goals: 1) improving public awareness of the blue catfish problems in Chesapeake Bay, 2) removing processing barriers for the blue catfish industry, 3) conducting new research on blue catfish, and 4) developing tributary-specific management plans throughout the Bay (Sustainable Fisheries GIT 2021).

The "processing barriers" referred to in the current Workgroup goals are the focus of state-level managers as well. A 2017 update to the 2008 Farm Bill moved the responsibility for catfish processing inspections from the Food and Drug Administration to the U.S. Department of Agriculture (USDA) (Colden 2021). This change has significantly decreased the amount of blue

catfish that can be processed in the Bay, because it requires USDA inspectors to be physically present for any processing. This creates additional cost for catfish processors and limits the hours when processing can happen (Invasive Catfish Workgroup 2020). The Workgroup has discussed this hindrance with the USDA, the Potomac River Fisheries Commission planned a roundtable discussion around this issue, Maryland managers worked with state policymakers to create a bill (which has not been signed into law) to exempt invasive catfish from this inspection process, and a Maryland federal Congressman introduced language into a recent USDA Appropriations Bill to provide inspection waivers for blue catfish processors in the area (PRFC 2019)(Invasive Catfish Workgroup 2020)(Office of Representative Andy Harris 2022). Removing this barrier is important for managers, who hope that expanding the commercial fishing industry will curb blue catfish population growth and reduce existing population numbers.

Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Moderately Effective

Blue Catfish

As the commercial fisheries for blue catfish in Virginia and Maryland have developed more during the 2000s, management measures have also developed and evolved. Managers recognize the ecological impacts that blue catfish may create in Chesapeake Bay tributaries, so the ultimate goal of management is to decrease the number of blue catfish in the area. The Chesapeake Bay Program's (CBP) Invasive Catfish Workgroup (previously the Invasive Catfish Task Force, hereafter the "Workgroup") was developed by CBP's Sustainable Fisheries Goal Implementation Team (SFGIT) (CBP 2022). The Workgroup released a management strategy for invasive catfish in the Bay in August, 2020. This strategy builds on the group's 2012 policy statement, progress made since the statement's release, and biannual meetings. The goals of this strategy are to: 1) "protect, restore, and enhance finfish, shellfish, and other living resources, their habitats, and ecological relationships to sustain all fisheries and provide for a balanced ecosystem in the watershed and Bay" and 2) "reduce [catfish] abundance and mitigate the spread and ecological impacts of invasive catfishes in Chesapeake Bay through increased public education and awareness and development of fishery management strategies that ensure ecosystem health and productivity" (Invasive Catfish Workgroup 2020).

State management agencies also play a role in blue catfish management. In Maryland, it is illegal to transport live blue catfish into a body of water other than the one the fish originated from; this law is meant to prevent further spread of the species (MDNR 2022b). The Department of Natural Resources (MDNR) oversees commercial and recreational fisheries for blue catfish. Harvest is allowed year-round, with no size or creel limits in place for blue catfish (MDNR 2016). To commercially fish for blue catfish in Maryland, fishers must possess a fishing license and must use legal fishing gear (Love & Wilson 2019). In 2021, MDNR released a tidewater catfish fishery management plan, which includes management of invasive blue catfish. This plan has similar goals to that of the Workgroup's management strategy. Under this FMP, fishers are required to report commercial harvest weights to MDNR and to keep a daily log of their activities. Over a dozen ongoing management strategies for invasive catfish are also outlined in the FMP, including developing a monitoring program, increasing research, and performing annual surveys (MDNR 2021). MDNR has also focused management on public education and awareness campaigns: fact

sheets, how-to videos, recipes, and a public-institution purchasing initiative in the state are aimed at growing the market for blue catfish, which will increase incentives for fishers to capture the species (MDNR 2018)(Liu and Fisher 2020). In Virginia, the Marine Resources Commission (VMRC) is in charge of commercial fisheries. Stocking blue catfish is illegal in the state, though it is not a fineable crime as it is in Maryland (Fabrizio et al. 2020).

The management strategies of CBP, MDNR, and VMRC are thorough for pound nets because they are focused on reducing blue catfish population levels, preventing further spread and expansion of these populations, and reducing impacts of blue catfish on native Chesapeake Bay species. But, striped bass and white perch are also landed in pound nets, so their management is also considered in scoring this factor.

Striped Bass

Atlantic striped bass is managed under an FMP implemented by ASMFC and by individual states that implement their own regulations and restrictions for both commercial and recreational fisheries. A quota system is in place through the FMP that provides a quota for the Chesapeake Bay (split between Maryland, Virginia, and the Potomac River Fisheries Commission). This quota and other management measures are adjusted based on the results of stock assessment updates and benchmark stock assessments.

The 2019 benchmark stock assessment found that the striped bass stock had been overfished since 2013 and that overfishing was occurring (ASMFC 2019). Based on these results, Addendum VI was added to Amendment 6 of the FMP. This addendum put in place measures to reduce removals by 18% relative to 2017 removals, introduced a size limit into the Chesapeake Bay, and put in place circle hook requirements in recreational fisheries to reduce recreational release mortality (ASMFC 2021).

The most recent (2022) stock assessment update reflects 2 years of management under Addendum VI and shows that management measures to rebuild the stock and reduce fishing mortality are working. Although SSB in 2021 was still below both reference points (i.e., the stock remains overfished), 2021 F was below both reference points, and maintaining the 2021 F value has a 97.5% chance of allowing the stock to reach the SSB target by 2029, which is the stock rebuilding deadline (ASMFC 2022a). SSB and F reference points in this assessment were adjusted to reflect data through 2021 and to reflect the use of low recruitment assumptions, based on the Maryland juvenile survey exhibiting low indices (ASMFC 2022a), thus making reference points more conservative. But, preliminary data from the 2022 season, which management does not expect to significantly differ from the final 2022 data, showed an increase in F, bringing total fishing mortality to between the target and reference points rather than below both points (Atlantic Striped Bass Technical Committee and Stock Assessment Subcommittee 2023). These preliminary data also significantly reduced the probability of stock rebuilding by 2029. Although the probability that SSB exceeds the SSB threshold in 2029 (using F in 2022) may be as high as 94%, the probability that F also exceeds the SSB target in 2029, as required for stock recovery, may be as low as 11%.

White Perch

White perch in Maryland, where the majority of landings occur, is managed under an FMP that was drafted in 1990 but has not been formally adopted (MDNR 2016). This drafted framework still

guides management through goals and objectives, strategies, and identification of problem areas. Management strategies are also developed in coordination with strategies for the striped bass fisheries because of habitat overlap (MDNR 2016). Gear, area, and size restrictions are also in place in Maryland, though there are not restrictions in place in Virginia. Stock assessments are performed every 2 to 4 years, with the most recent assessment completed in 2020. Proposed biological reference points that have been deemed appropriate are used during the stock assessment process, allowing for abundance and mortality comparisons to historic abundance levels and F target and limit levels.

Abundance was considered healthy and not overfished in the Upper Bay, Choptank River, and Lower Bay in 2019 (Piavis & Webb 2021). Average F was below target and limit levels in the Upper Bay from 2015 to 2019 but rose slightly above the target level in 2019. Similarly, average F has stayed below the F target and limit levels over the past 31 years in the Choptank River, but slightly exceeded the target level in 2019. Overfishing is not occurring in the Upper Bay, Choptank River, or Lower Bay. Current management allows for some precautionary strategies and the use of proposed reference points, but a formal white perch FMP for the Chesapeake Bay is still in process and has not been officially adopted Bay-wide or for Maryland. Further, although management is fairly effective, strategies could be more precautionary in nature to avoid F exceeding target levels.

River Herring

River herring is managed by ASMFC under a joint FMP with American shad. The FMP is reviewed annually and stock assessments are performed every 5 years. The FMP outlines research priorities and needs, management measures and compliance, and stock updates. Management has limited the directed catch of river herring since the population began showing declines in abundance in the 2000s and 2010s. No coast-wide reference points have been developed for river herring because of a lack of data for many areas in the species' range, but some region-specific reference points do exist (ASMFC 2023). Maryland and Virginia do not allow directed harvest of river herring, but the species is still landed as bycatch. Bycatch decreased across all states by 99.7% from 2020 to 2021; however, there is some uncertainty to this figure, because changes in the Massachusetts observer program may be behind the apparent decrease {pers. comm., ASMFC staff 2023}.

Although management of blue catfish is effective, this score is limited by the management of white perch (which lacks a formally adopted FMP) and of striped bass and river herring (for which management effectiveness in rebuilding the populations is uncertain), resulting in a rating of moderately effective.

Justification:

In its 2012 policy statement, the Workgroup laid out its original goals, which were focused on: 1) increasing public awareness, 2) improving science, 3) developing models, 4) improving management measures for control and mitigation, and 5) identifying and assessing risks behind creating a more formal fishery for these species (Sustainable Fisheries GIT 2012). The Workgroup created seven management recommendations in its first report, released in 2014. Since then, some progress has been made toward these recommendations, but managers still lack a Bay-wide management plan, which was highly recommended by a committee of reviewers for the 2014 report (Bilkovic et al. 2014). But, the development of this kind of coordinated plan has not been supported (and therefore not pursued) by the executive committee of the SFGIT (Sustainable Fisheries GIT

2019).

The 2020 management strategy introduced by the Workgroup was developed from an invasive catfish workshop involving stakeholders from Virginia, Maryland, Delaware, and Pennsylvania. The strategy details management goals, partners, current knowledge, knowledge gaps, and approaches that can be used to reach goals (Invasive Catfish Workgroup 2020). The objectives of the strategy focus not only on reducing catfish populations, but also on ensuring the health and success of impacted native fauna populations. Although the strategy is not a coordinated management plan as recommended by the 2014 report review committee, it does provide Bay-wide goals and potential actions for blue catfish management and population reduction (Invasive Catfish Workgroup 2020). Importantly, the strategy discusses recent and ongoing management efforts in the context of what still must be done to fully understand the biology of blue catfish populations in the Bay. This allows state partners and management agencies to understand the science that is needed to develop effective strategies to reduce blue catfish populations and ecosystem impacts. Following the development of the 2020 management strategy, the SFGIT met in 2021 for a workshop that detailed current Workgroup goals: 1) improving public awareness of the blue catfish problems in Chesapeake Bay, 2) removing processing barriers for the blue catfish industry, 3) conducting new research on blue catfish, and 4) developing tributary-specific management plans throughout the Bay (Sustainable Fisheries GIT 2021).

The "processing barriers" referred to in the current Workgroup goals are the focus of state-level managers as well. A 2017 update to the 2008 Farm Bill moved the responsibility for catfish processing inspections from the Food and Drug Administration to the U.S. Department of Agriculture (USDA) (Colden 2021). This change has significantly decreased the amount of blue catfish that can be processed in the Bay, because it requires USDA inspectors to be physically present for any processing. This creates additional cost for catfish processors and limits the hours when processing can happen (Invasive Catfish Workgroup 2020). The Workgroup has discussed this hindrance with the USDA, the Potomac River Fisheries Commission planned a roundtable discussion around this issue, Maryland managers worked with state policymakers to create a bill (which has not been signed into law) to exempt invasive catfish from this inspection process, and a Maryland federal Congressman introduced language into a recent USDA Appropriations Bill to provide inspection waivers for blue catfish processors in the area (PRFC 2019)(Invasive Catfish Workgroup 2020)(Office of Representative Andy Harris 2022). Removing this barrier is important for managers, who hope that expanding the commercial fishing industry will curb blue catfish population growth and reduce existing population numbers.

Maryland's recent purchasing initiative is also aimed at expanding the commercial fishing industry. Since September 2018, the state has increased the sales of blue catfish to state institutions such as public universities and prisons (Liu and Fisher 2020). The initiative was created by MDNR, the Maryland Department of Agriculture, and the Maryland Department of General Services, and began with two seafood companies receiving contracts for these sales (MDNR 2018). Historically, there has been some pushback on blue catfish consumption because of potential toxin accumulation in the species (Schloesser et al. 2011). More recent research has shown that smaller blue catfish are usually safe for human consumption, and state public education campaigns have helped raise awareness of these findings (Sustainable Fisheries GIT 2017)(Invasive Catfish Workgroup 2020)(Jepsen 2021)(Liu and Fisher 2020).

Factor 3.2 - Bycatch Strategy

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia

Moderately Effective

Bycatch throughout the blue catfish industry is thought to be minimal, although the Unknown Bycatch Matrix (UBM) points to a potential risk of forage fish bycatch in boat haul seines. But, haul seines in Maryland have several bycatch regulations in place that restrict which species can be landed and call for bycatch species to be returned, unharmed, to the water. The effectiveness of these measures is not known. Additional protective measures for specific stocks of forage fish are also in place. Because there are bycatch management strategies in place with unknown effectiveness, this factor receives a "moderately effective" score.

Justification:

In two major Maryland counties, haul seine fishing for noncarp and catfish species is prohibited, and any other species captured in haul seines there must be returned unharmed (Natural Resources Title 4 (2013)). Seines in all Maryland waters must be emptied into the water, rather than on land, to increase the chance of survival for any small fish incidentally captured (Natural Resources Title 4 (2013)).

At-risk forage fish include American shad, river herring, and weakfish. In Maryland, American shad, alewife herring, and blueback herring (together, "river herring") commercial fisheries are closed, prohibiting possession of these species (MDNR 2022g). These closures are in place to allow for population recovery, because each of these stocks is depleted.

Catch composition data are not collected or monitored by Maryland managers, so the level of compliance with the above regulations is not known, which brings some uncertainty into their effectiveness.

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland

Moderately Effective

Bycatch in blue catfish fisheries is generally minimal. But, the UBM points to potential bycatch of marine mammals, seabirds, forage fish, and finfish in drift gillnets. Maryland has mesh size restrictions in place and requires drift gillnets to be attended during fishing, and these two measures can help reduce juvenile fish bycatch and megafauna mortality, respectively (Natural Resources Title 8). Specific regulations are also in place to protect sensitive finfish and forage fish, including river herring, American shad, and sturgeon species. Although regulations to reduce bycatch and protect potential bycatch species are in place, the total extent of drift gillnet bycatch is unknown because catch composition data are not collected, resulting in a score of moderately effective.

Justification:

Minimum mesh size restrictions can help reduce juvenile fish bycatch by allowing smaller fish to escape gillnets (DEQ 2020). Reducing the bycatch of juvenile and young of the year fish can help maintain stock productivity and spawning stock biomass. Mandatory attendance of gillnets that capture megafauna such as marine mammals and seabirds increases the likelihood that entangled megafauna can be freed in time before they drown. Endangered Atlantic and shortnose sturgeon, as well as depleted river herring and American shad, cannot be harvested in Maryland. Weakfish, with a stock that also is depleted, has a creel limit in place that does not allow fishers to land more than one fish per day (MDNR 2022g).

Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia

Highly effective

There is no bycatch in the LFE fishery in Virginia, because the electric currents primarily affect catfish species and the subsequent netting of catfish allows fishers to be highly selective. Although other finfish, such as white perch, are occasionally stunned by LFE used in deeper waters, the electric current does not harm individual fish, and catfish LFE fishers do not net these other species. No species of concern are affected by this fishing method. Electric fishing's bycatch strategy is scored highly effective, because the low electric current and netting method allow for catch selectivity and do not harm fauna in the fishing area.

Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia

Moderately Effective

Expert evidence suggests that there are quite low levels of bycatch in catfish traps/pots {pers. comm., A. Galvan 2022}. The UBM points to marine mammals as the only taxonomic group at risk from traps and pots in the Northwest Atlantic, and the fishery may overlap with bottlenose dolphin, which has documented interactions with Atlantic blue crab traps and pots (NOAA Fisheries 2020), though not with Mid-Atlantic eel traps and pots (NOAA Fisheries 2022c). The potential risk to bottlenose dolphin populations—with no mitigation measures in place—earns a moderately effective score.

Justification:

Although a take reduction plan is in place for the Atlantic mixed species trap/pot fishery, which lists catfish as a target species, it focuses on large whales, which are not in the areas where catfish are targeted in the Chesapeake Bay (NOAA Fisheries 2021c). According to NOAA's List of Fisheries, bottlenose dolphin is not listed as a species with known mortalities or injuries in this fishery. But, not all Chesapeake Bay-based catfish traps and pots may be covered by this fishery listing, which leaves open the possibility of bottlenose dolphin interactions in traps and pots that are not part of the mixed-species fishery. Specific mitigation measures to prevent marine mammal entanglements in catfish traps and pots are not in place, though Maryland does have a minimum mesh size in place for trap/pot hedgings, which may reduce the bycatch of small and juvenile fish species.

Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland

Moderately Effective

Bycatch is thought to be minimal throughout the blue catfish fisheries. But, the UBM points to potential risks for marine mammals, seabirds, and finfish from set longlines in the Northwest Atlantic. Moratoriums are in place for sensitive finfish species in the Chesapeake Bay and its tributaries. Some Maryland regulations require the use of offset circle hooks, which help reduce bycatch mortality, but most longlines targeting blue catfish are not subject to this requirement (MDNR 2022h). Bycatch is likely low, but without a comprehensive bycatch plan in place, set longlines receive a score of moderately effective.

Justification:

Endangered Atlantic and shortnose sturgeon, as well as depleted river herring and American shad, cannot be harvested in Maryland. Weakfish, with a stock that is also depleted, has a creel limit in place that does not allow fishers to land more than one fish per day (MDNR 2022g). In Maryland, fishing lines must use offset circle hooks at all times when using live bait and may use offset circle hooks or modified J hooks when using dead bait in March and April (MDNR 2022h). Lines using dead bait from May to December may use offset circle or normal J hooks. Blue catfish may be fished with either live or dead bait, so the use of circle hooks is not required throughout the set longline fishery, although blue catfish fishing is typically best in March through May (Bass Fishing Resource 2022).

Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Moderately Effective

Bycatch is generally thought to be minimal throughout blue catfish fisheries in Maryland and Virginia {pers. comm., A. Galvan 2022}(NOAA Fisheries 2022a). Anchored gillnets and pound nets are used to simultaneously target blue catfish and striped bass, because their seasons and habitats overlap. VMRC's observer program indicates that gizzard shad and striped bass are the most common bycatch species in gillnets {pers. comm., A. Galvan 2022}. White perch is also caught in catfish pound nets in Maryland and Virginia {pers. comm., A. Galvan 2022}{pers. comm., M. Groves 2022}. In addition, the UBM points to a risk of marine mammal bycatch in pound nets.

There is no specific bycatch management strategy in place for anchored gillnets, but some monitoring is performed. VMRC runs an observer and biological sampling program for less selective gear types, including some nets for blue catfish. This program gives managers an idea of catch composition for the dual striped bass–blue catfish fisheries. The program is primarily focused on gillnets, because they pose a higher risk to protected species, although pound nets are also sampled to a smaller extent {pers. comm., A. Galvan 2022}. Maryland does not collect catch composition data for blue catfish fisheries, but Virginia data can be used as a proxy for fisheries using the same gear type. There is no demonstrated concern with ghost fishing from gillnets or pound nets in catfish fisheries, because most ghost fishing concerns in the Chesapeake Bay come from blue crab pots (Bilkovic et al. 2016). Additional fishing conservation measures are in place for sensitive species, including river herring and American shad, and bycatch quotas are in place for menhaden (Pertaining to Atlantic Menhaden 2022). Mesh restrictions for Virginia gillnets and Maryland pound nets are also in place, which help reduce bycatch and bycatch mortality (Pertaining to the Marking

and Minimum Mesh Sizes of Gillnets 2007). Bycatch in gillnets and pound nets is likely not extensive, and some catch data are collected in Virginia; however, the full extent of bycatch species is unknown for pound nets, and bycatch in gillnets does occur—without a reduction strategy in place. Therefore, this factor is rated a moderate concern for both gear types.

Justification:
Anchored gillnets are not a selective gear type, and those targeting catfish have known captures of Atlantic menhaden (<5% of total catch) and gizzard shad (<10% of total catch), which are either released or kept for bait {pers. comm., A. Galvan 2022}(unpublished VMRC data, 2023). Gizzard shad is less regulated because it is an undesirable species, so it is landed less often and do not have a catch quota in place. Blue catfish pound net fisheries are not found in NOAA's List of Fisheries, but the Virginia pound net fishery for weakfish, spot, and croaker is a Category II fishery and includes fishing for these species in all Virginia waters (NOAA Fisheries 2021d). Though some derelict gillnet gear has been found in the Bay, this composed less than two percent of the marine debris retrieved from the Bay from 2009 to 2012, which demonstrates that there is not a significant risk of ghost fishing associated with gillnets in the Bay (Bilkovic et al. 2016). Derelict pound net gear was not retrieved during the study period.

Sensitive species of concern include river herring, American shad, and sturgeon species. In 2012, the commercial fishery for river herring closed, and possession of herring is now prohibited in Maryland (ASMFC 2017). Harvests of American shad, Atlantic sturgeon, and shortnose sturgeon are likewise prohibited in Maryland (MDNR 2022f). Virginia's efforts to sample gillnets and pound nets help to ensure that managers are aware of any interactions with sensitive species. Though striped bass is overfished and is targeted alongside blue catfish, regulations for the striped bass fishing season and quota are aimed at reducing the impacts of fishing on the spawning stock. A commercial harvest quota is in place, alongside seasonal restrictions, to protect the overfished striped bass stock (ASMFC 2022f). The stock status recently shifted from experiencing overfishing to no longer experiencing overfishing, which suggests that the striped bass fishery restrictions are working (ASMFC 2022f).

Factor 3.3 - Scientific Data Collection and Analysis

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia
Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United

States | Maryland | Virginia

Moderately Effective

Numerous past and ongoing studies exist of blue catfish abundance in specific Chesapeake Bay tributaries, but data for a Bay-wide population estimate have not been collected. Therefore, a formal stock assessment does not exist. Managers and researchers have been conducting fairly consistent abundance and range research since the early 2010s. In addition, trawl surveys in the Bay have included blue catfish since 1975 (Nepal & Fabrizio 2019). Recent studies have shown the extensive range expansion of blue catfish since its introduction to the Bay (Schloesser et al. 2011)(Nepal & Fabrizio 2019)(USFWS 2019)(Invasive Catfish Workgroup 2020)(Liu and Fisher 2020)(Gaichas 2021)(Fabrizio et al. 2017), and other studies have focused on the salinity tolerance of the species, because this affects its potential range expansion (Tuckey et al. 2017)(Nepal & Fabrizio 2019)(Liu and Fisher 2020)(Invasive Catfish Workgroup 2020). Finally, some studies have focused on other factors affecting population health, such as diet composition and dietary needs (Schmitt et al. 2018)(Schmitt et al. 2019). Commercial fishery data are collected by managers, and some recreational fishery data exist as well, but total fishing mortality has not been quantified. Bycatch data are collected for select gear types in Virginia, but a thorough bycatch monitoring program across blue catfish fisheries is not in place. Although some population models, density estimates, and habitat and range maps have been developed, the lack of a Chesapeake Bay-wide stock assessment and Bay-wide fishing mortality estimate result in a moderately effective score for this factor.

Justification:

Several tagging and tracking studies over the past decade have provided blue catfish density estimates in specific tributaries. A 2013 study in the James River aimed to estimate the blue catfish population size in the tidal freshwater area of the river (Fabrizio et al. 2017). A more recent James River study created a stock abundance model for this area using trawl and electrofishing survey data (Hilling et al. 2022). Another study created population models for three tidal rivers (James, Rappahannock, and York Rivers), and found that, in each river, the blue catfish population had reached about 80% of its carrying capacity (Orth et al. 2017). Other studies have produced density estimates and movement patterns in the Patuxent and Potomac Rivers (Tuckey et al. 2017)(Wilson 2021)(MDNR 2022h). Population assessments via tracking and trawl surveys have provided data for the James, Pamunkey, Mattaponi, Rappahannock, upper Susquehanna, Potomac, and Chickahominy Rivers, as well as Powell Creek and Eastern Shore areas (Sustainable Fisheries GIT 2017)(Invasive Catfish Workgroup 2020)(FishingWire 2021b). Although it is thought that there are over 100 million blue catfish in the Chesapeake Bay area, an exact figure has not been quantified (Fabrizio et al. 2018)(Tkacik & Dance 2019). Tributary-specific management has been suggested as a way to combat increasing blue catfish population rates, but thus far, tributary-specific population data have not been used in this regard (Invasive Catfish Workgroup 2020)(Sustainable Fisheries GIT 2021). But, a Workgroup subcommittee for tributary-specific management has been developed, so management is beginning this process.

Much of the monitoring and tracking of blue catfish in the Bay is conducted by management agencies. Virginia's Department of Wildlife Resources (DWR) uses LFE to monitor populations in the James, Pamunkey, Mattaponi, and Rappahannock Rivers, a process that began in the early 2000s (Sustainable Fisheries GIT 2017). In Maryland, MDNR conducts its own monitoring in the upper

Susquehanna River, Potomac River, and some areas of the Eastern Shore; this monitoring has increased recently, but managers note the need for additional funding to further expand this process (Sustainable Fisheries GIT 2017). Fishery-independent monitoring in Maryland also includes tidal bass surveys that inform managers of catfish presence, striped bass young-of-the-year surveys that inform managers of relative species abundance indices, and other surveys that encounter blue catfish in the Bay (MDNR 2021). Other monitoring efforts are conducted by university researchers (e.g., Virginia Tech and the Virginia Institute of Marine Science) and management agencies outside of Virginia and Maryland (e.g., the DC Department of Energy & Environment and the Potomac River Fisheries Commission) (Invasive Catfish Workgroup 2020). Finally, some federal agencies help monitor the range (though not abundance) of blue catfish in the Chesapeake Bay (Gaichas 2021) (USFWS 2019).

Salinity plays an important role in the movement and range expansion of blue catfish, and this area has also been researched in the Bay. Although blue catfish is a freshwater species, its salinity tolerance can exceed 15 ppt, which allows it to expand into more brackish areas of the Bay (Liu and Fisher 2020). Nepal and Fabrizio (2019) used long-term survey data and salinity tolerance studies to show that blue catfish is expanding farther down into Bay estuaries, where salinity is higher (Nepal & Fabrizio 2019). Some tagging studies have also collected salinity range data for the species (Tuckey et al. 2017).

A wealth of data continues to be collected by researchers and managers, but knowledge gaps still exist for full population estimates, population movement and connectivity, and population dynamics across the Bay (Invasive Catfish Workgroup 2020). Bycatch data are not publicly available for the fishery, though some bycatch studies have been conducted for certain gear types, and observer and sampling programs exist for select gear types in Virginia (Trice 2014)(Trice 2015)(Trice 2017a)(Trice 2017b){pers. comm., A. Galvan 2022}. Virginia pound net and gillnet fisheries are monitored and sampled by observers, which provides some bycatch data, but other gear types in Virginia and Maryland lack bycatch information. Bycatch monitoring could be more thorough, especially for gear types with bycatch issues in other Bay fisheries, such as blue crab pots and the inshore gillnet fishery for menhaden and croaker. Without quantified bycatch interactions, it is difficult to determine the impacts of blue catfish fisheries on other species' populations.

Factor 3.4 - Enforcement of and Compliance with Management Regulations

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia
Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States |

Maryland

Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Highly effective

There are few regulations in place for blue catfish fisheries, because blue catfish is an invasive species with a management goal of eradication. Maryland has no seasonal or size limits for blue catfish, and Virginia primarily places regulations on LFE fishing, while other gear types are less restricted (Love & Wilson 2019). In Virginia, DWR is the primary regulatory agency for catfish, and it requires fishers to comply with regulations such as catch size restrictions. MDNR does require proper licenses to be in place for anglers to fish for blue catfish. There are no indicators that LFE regulations have not been complied with since the commercial fishery opened or that blue catfish fishing occurs without licenses. Illegal transport of blue catfish into new water bodies had been a pervasive issue in the past, but management has more control over this now, which has largely resolved the problem. Because of the absence of a need for typical fishery regulations such as TACs, portside sampling, and seasonal and area restrictions, alongside management's reduction of illegal catfish transfers, this factor is rated highly effective.

Justification:

Managers believe that transport by fishers contributed to the spread of blue catfish into more Bay tributaries than those where the species was initially introduced (MDNR 2016). Moving blue catfish from one waterbody to another is now illegal in both Maryland and Virginia (MDNR 2022b). To help reduce and track illegal transportation, MDNR created an online Invasive Species Tracker, through which community members can report observations of illegal transfer and transportation of invasive species (MDNR 2022i). Managers' efforts to increase public awareness of the harm blue catfish can cause and to connect with fishers on this issue have helped curb illegal transfers.

Many of the regulations typical of noninvasive fisheries are not in place for blue catfish fisheries. A TAC is not needed because management has a goal of reducing the population, and bycatch is not a large enough issue to require observers or sampling/surveillance in the fisheries. Catch numbers are reported to NOAA. Basic permits and licenses are required for applicable gear types (e.g., location-specific permits for fixed gear types and operation permits for all gear types), and commercial fishers operating without these licenses is not an issue in Chesapeake Bay tributaries. Virginia's LFE fishery is the most regulated of all Chesapeake Bay blue catfish fisheries, with area and time restrictions in place. Only three licenses are given out per season, and in the 2021 season, only three commercial LFE fishers operated in Virginia, each in a separate river, thus appropriately avoiding overlap in these fisheries (Jepsen 2021).

Factor 3.5 - Stakeholder Inclusion

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland

Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States |

Virginia
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia
Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Highly effective
Stakeholder groups involved in the blue catfish fishery include commercial, recreational, and trophy fishers; management agencies and working groups; scientists from Virginia and Maryland institutions; seafood processing companies; and consumers of catfish. The Workgroup plays the largest role in bringing together all stakeholders: biannual meetings include information exchange and management discussions among stakeholders, and the Workgroup focuses on multistakeholder communication (Sustainable Fisheries GIT 2019)(CBP 2022). The Workgroup also recently expanded its membership beyond scientists and managers to include fishers and waterfolk (Sustainable Fisheries GIT 2019). Maryland and Virginia managers also maintain a positive relationship with other stakeholder groups. In Virginia, fishers' concerns over the impacts of LFE on other blue catfish gear types were responded to with research into these potential effects (Trice 2017a)(Sustainable Fisheries GIT 2017). In Maryland, the DNR has worked with fishers and provides online resources to fishers to help increase their catfish catches. Commercial fishing regulations are laid out on management agencies' websites, reports are available online from Workgroup meetings, and public education materials are used to inform fishers and consumers about blue catfish.

Stakeholder inclusion in blue catfish management is rated highly effective, because managers have clear communication and collaboration with all stakeholder groups, are aware of and try to resolve potential user group conflicts, and encourage stakeholders to get involved through workshops, research projects, and public awareness campaigns.

Justification:
The Workgroup was formed in 2012 and has concentrated on encouraging communication between all stakeholders since its inception (CBP 2022). The goals and efforts of the Workgroup have been revisited as progress has been made and new research has been performed. In 2019, the Workgroup shifted its objectives to include more stakeholder-defined outcomes, and shifted its role to involve more stakeholder groups and to increase communication between these groups (Sustainable Fisheries GIT 2019). The Workgroup's 2020 management strategy addresses potential conflicts in expanding the commercial blue catfish industry, including conflicting interests between the more traditional trophy fishery and the newer commercial fishery (Invasive Catfish Workgroup 2020). The strategy was born out of a workshop that involved participants from private industry, tribes and governments, environmental organizations, the fishing industry, and management agencies from across the Chesapeake Bay area (Invasive Catfish Workgroup 2020).

Various blue catfish research efforts have brought together waterfolk, scientists, and managers. The Virginia Institute of Marine Science's Fishery Resource Grant Program brings together scientists and Virginians in the fishing industry (VIMS 2022b). This program has funded research projects for

catfish trap and pot improvements, LFE efficiency and methods, and LFE impacts on other catfish gear types (Bristow 2010)(Trice 2014)(Trice 2015)(Trice 2017a)(Trice 2017b)(Balazik et al. 2018). MDNR and Virginia managers conduct tagging and tracking studies of blue catfish in several Bay rivers, and these organizations often ask fishers to work with them by recording tagged fish, reporting tagged fish to managers, and/or keeping rather than releasing some tagged fish (FishingWire 2021b)(Wilson 2021)(MDNR 2022h). Managers and politicians in Chesapeake Bay have also worked with fishers and catfish processors to try to reduce the impact of industry delays stemming from the Farm Bill changes. The Wild American Catfish Coalition, which is a group of catfish distributors, processors, and individual citizens formed in 2017, also works with elected officials and resource managers to encourage changes to the processing restrictions for wild catfish (Hutt 2017)(Kobell 2017).

Managers in Virginia have especially made an effort to avoid conflicts between user groups, particularly those that may emerge between commercial and recreational/trophy fishers. In addition to funding some of the above research projects, managers have fostered discussions between each other and with different stakeholders. VMRC met and held discussions with trophy fishers and VDWR before approving the LFE commercial fishery (pers. comm., VMRC). This led to a reduction in size limits for the commercial fishery, which left larger blue catfish for the trophy fishery. Collaboration between VMRC and VDWR helps maintain a positive relationship between the two fisheries' interests. MDNR is also cognizant of the balance between recreational and commercial interests and tries to encourage and balance both (pers. comm., MDNR).

Criterion 4: Impacts on the Habitat and Ecosystem

This Criterion assesses the impact of the fishery on seafloor habitats, and increases that base score if there are measures in place to mitigate any impacts. The fishery's overall impact on the ecosystem and food web and the use of ecosystem-based fisheries management (EBFM) principles is also evaluated. Ecosystem Based Fisheries Management aims to consider the interconnections among species and all natural and human stressors on the environment. The final score is the geometric mean of the impact of fishing gear on habitat score (factor 4.1 + factor 4.2) and the Ecosystem Based Fishery Management score. The Criterion 4 rating is determined as follows:

- ***Score >3.2=Green or Low Concern***
- ***Score >2.2 and ≤3.2=Yellow or Moderate Concern***
- ***Score ≤2.2 = Red or High Concern***

Guiding principles

- Avoid negative impacts on the structure, function or associated biota of marine habitats where fishing occurs.
- Maintain the trophic role of all aquatic life.
- Do not result in harmful ecological changes such as reduction of dependent predator populations, trophic cascades, or phase shifts.
- Ensure that any enhancement activities and fishing activities on enhanced stocks do not negatively affect the diversity, abundance, productivity, or genetic integrity of wild stocks.
- Follow the principles of ecosystem-based fisheries management.

Rating cannot be Critical for Criterion 4.

Criterion 4 Summary

FISHERY	FISHING GEAR ON THE SUBSTRATE	MITIGATION OF GEAR IMPACTS	ECOSYSTEM-BASED FISHERIES MGMT	FORAGE SPECIES?	SCORE
Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia	Score: 3	Score: 0	Moderate Concern		**Yellow (3.000)**
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland	Score: 5	Score: 0	Moderate Concern		**Green (3.873)**
Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia	Score: 5	Score: 0	Very Low Concern		**Green (5.000)**
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia	Score: 3	Score: 0	Moderate Concern		**Yellow (3.000)**
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland	Score: 3	Score: 0	Moderate Concern		**Yellow (3.000)**
Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia	Score: 3	Score: 0	Moderate Concern		**Yellow (3.000)**
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia	Score: 3	Score: 0	Moderate Concern		**Yellow (3.000)**

Criterion 4 Assessment

SCORING GUIDELINES

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate
Goal: The fishery does not adversely impact the physical structure of the ocean habitat, seafloor or associated biological communities.

- *5 - Fishing gear does not contact the bottom*
- *4 - Vertical line gear*
- *3 - Gears that contacts the bottom, but is not dragged along the bottom (e.g. gillnet, bottom longline, trap) and is not fished on sensitive habitats. Or bottom seine on resilient mud/sand habitats. Or midwater trawl that is known to contact bottom occasionally. Or purse seine known to commonly contact the bottom.*
- *2 - Bottom dragging gears (dredge, trawl) fished on resilient mud/sand habitats. Or gillnet, trap, or bottom longline fished on sensitive boulder or coral reef habitat. Or bottom seine except on mud/sand. Or there is known trampling of coral reef habitat.*
- *1 - Hydraulic clam dredge. Or dredge or trawl gear fished on moderately sensitive habitats (e.g., cobble or boulder)*
- *0 - Dredge or trawl fished on biogenic habitat, (e.g., deep-sea corals, eelgrass and maerl)*
  Note: When multiple habitat types are commonly encountered, and/or the habitat classification is uncertain, the score will be based on the most sensitive, plausible habitat type.

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts
Goal: Damage to the seafloor is mitigated through protection of sensitive or vulnerable seafloor habitats, and limits on the spatial footprint of fishing on fishing effort.

- *+1 —>50% of the habitat is protected from fishing with the gear type. Or fishing intensity is very low/limited and for trawled fisheries, expansion of fishery's footprint is prohibited. Or gear is specifically modified to reduce damage to seafloor and modifications have been shown to be effective at reducing damage. Or there is an effective combination of 'moderate' mitigation measures.*
- *+0.5 —At least 20% of all representative habitats are protected from fishing with the gear type and for trawl fisheries, expansion of the fishery's footprint is prohibited. Or gear modification measures or other measures are in place to limit fishing effort, fishing intensity, and spatial footprint of damage caused from fishing that are expected to be effective.*
- *0 —No effective measures are in place to limit gear impacts on habitats or not applicable because gear used is benign and received a score of 5 in factor 4.1*

Factor 4.3 - Ecosystem-Based Fisheries Management

Goal: All stocks are maintained at levels that allow them to fulfill their ecological role and to maintain a functioning ecosystem and food web. Fishing activities should not seriously reduce ecosystem services provided by any retained species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity. Even non-native species should be considered with respect to ecosystem impacts. If a fishery is managed in order to eradicate a non-native, the potential impacts of that strategy on native species in the ecosystem should be considered and rated below.

- *5 — Policies that have been shown to be effective are in place to protect species' ecological roles and ecosystem functioning (e.g. catch limits that ensure species' abundance is maintained at sufficient levels to provide food to predators) and effective spatial management is used to protect spawning and foraging areas, and prevent localized depletion. Or it has been scientifically demonstrated that fishing practices do not have negative ecological effects.*
- *4 — Policies are in place to protect species' ecological roles and ecosystem functioning but have not proven to be effective and at least some spatial management is used.*
- *3 — Policies are not in place to protect species' ecological roles and ecosystem functioning but detrimental food web impacts are not likely or policies in place may not be sufficient to protect species' ecological roles and ecosystem functioning.*
- *2 — Policies are not in place to protect species' ecological roles and ecosystem functioning and the likelihood of detrimental food impacts are likely (e.g. trophic cascades, alternate stable states, etc.), but conclusive scientific evidence is not available for this fishery.*
- *1 — Scientifically demonstrated trophic cascades, alternate stable states or other detrimental food web impact are resulting from this fishery.*

Factor 4.1 - Physical Impact of Fishing Gear on the Habitat/Substrate

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia

Score: 3

Boat seines are primarily used to target demersal species (FAO 2022a), and blue catfish spend most time on river bottoms. Bottom seines operating on muddy, sandy bottoms receive a score of 3.

Justification:

Boat seines may be operated in bottom, midwater, or surface environments, but those targeting catfish are more likely to operate closer to the bottom. Seine nets can be designed similarly to trawls (FAO 2022a), though dragging from bottom trawls is more destructive than dragging from seines.

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland

Score: 5

Drift gillnets, unlike anchored or set gillnets, are not affixed to the seafloor. Instead, the nets are attached to buoys or vessels and drift in the upper and middle areas of the water column (FAO 2022b). Therefore, drift gillnets have no bottom contact and are scored a 5.

Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia

Score: 5

Low-frequency electrofishing does not come in contact with bottom substrate, because the electric currents used to stun fish are run through wires that sit toward the top of the water column (Outdoors Maryland 2021), and nets used to capture stunned catfish are typically handheld scoop nets that are used on the surface of the water (Jepsen 2021). In a 2014 study, LFE use displayed no impacts on local plants and wildlife (Trice 2014). Therefore, no bottom contact occurs with this gear type, and it receives a score of 5.

Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia

Score: 3

Bottom traps set on nonrocky reefs/boulder and corals receive a score of 3 for physical impact on the habitat.

Justification:

Catfish pots sit on sandy, gravel, and muddy bottoms, which are the primary habitats for catfish. During the setting and retrieval of fish pots and traps, bottom habitat may be affected because of gear dragging and/or trap movement (Stevens 2020). Further impacts are possible from abandoned and lost traps and pots, although derelict pots in the Chesapeake Bay almost always stem from crab pots rather than fish pots (Bilkovic et al. 2016).

Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland

Score: 3
Longlining for blue catfish involves a series of lines set in the species' habitat with anchors. Longlines that contact the bottom receive a score of 3.

Justification:
Catfish spends most of its time on sandy, gravel, and muddy substrates (Graham 1999), so longlines targeting this species are likely to contact the bottom because they are more likely to be set lower in the water column to target catfish. In addition, set longlines, unlike drift longlines, use an anchor to weigh them down, which also creates bottom contact that may disturb the benthic ecosystem.

Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia

Score: 3
Bottom gillnets not anchored on rocky reefs/boulder or corals receive a score of 3 for physical impact on the habitat.

Justification:
Bottom gillnets contact bottom habitat through their anchors set in substrate, their bottom leadlines resting on substrate, and the net resting on substrate (DFO 2010). These components of the gear are most likely to create an impact when currents are swift enough to shift the nets or when gear is removed from the water (Sorenson et al. 2015).

Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Score: 3
Pound nets operate similarly to fish traps, using a fence leader to guide fish into a trap (NOAA Fisheries 2019b). Bottom traps not set on rocky reefs/boulder and corals receive a score of 3 for physical impact on the habitat.

Justification:
Catfish traps such as pound nets sit on the sandy, gravel, and muddy bottoms. During the setting and retrieval of pound nets, the bottom habitat may be affected by gear dragging and/or movement (Stevens 2020).

Factor 4.2 - Modifying Factor: Mitigation of Gear Impacts

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia

Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland
Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Score: 0
No specific gear modifications are in place to protect bottom habitats from the impacts of blue catfish fishing gear. Therefore, no extra points are awarded for this factor.

Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia

Score: 0
This factor is not applicable because the gear used is benign and the fishery received a score of 5 for Factor 4.1.

Factor 4.3 - Ecosystem-based Fisheries Management

Chesapeake Bay | America, North - Inland Waters | Boat seines | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Drift gillnets | United States | Maryland
Chesapeake Bay | America, North - Inland Waters | Pots | United States | Maryland | Virginia
Chesapeake Bay | America, North - Inland Waters | Set longlines | United States | Maryland

Moderate Concern
Blue catfish has become an apex predator in the Chesapeake Bay ecosystem, which has raised concerns about its competition with and predation on native species (Schloesser et al. 2011)(NOAA Fisheries 2022a). Management efforts are focused on controlling and limiting blue catfish populations by increasing the commercial catch of the species. The GIT Workgroup's management strategy also focuses on minimizing impacts to native fauna from blue catfish invaders. By increasing fishing practices such as LFE, managers are working to more efficiently target blue catfish without capturing other, native species in the process (Trice 2017a). Unlike channel catfish, blue catfish is not considered naturalized in the Bay, so it does not play a significant role in the ecosystem and does not have species that rely on its presence in the food web. But, other retained species in pots, haul seines, longlines, and drift gillnets are unknown, so ecosystem-based management for all retained species in these fisheries cannot be evaluated, which introduces uncertainty into the scoring. This factor is rated a moderate concern: management policies to reduce blue catfish populations also focus on reducing harm to native populations, but the ecosystem impacts of capturing other retained species are unknown.

Justification:
Blue catfish is an opportunistic predator that consumes 2%–9% of its body weight daily (Sustainable Fisheries GIT 2017)(Schmitt et al. 2021), preying on a range of native species such as blue crab, white perch, gizzard shad, menhaden, American eel, and other finfish, shellfish, and invertebrates (CBP n.d.)(Orth et al. 2017)(Love & Wilson 2019)(Liu and Fisher 2020)(MDNR 2022h). Some prey items of blue catfish are both ecologically and economically important in the Chesapeake Bay region (Schloesser et al. 2011). With few natural predators in the Chesapeake Bay, the population of blue catfish has quickly increased since the species was introduced to the region. A 2017 study of blue catfish suggested that its removal would most likely result in increases in stocks of white catfish, a native species with a population that has declined in recent decades (Schloesser et al. 2011), and of blue crab, which is an economically vital species that has also experienced population decline (Orth et al. 2017). Thus, increasing the harvest of blue catfish will likely positively affect native marine and freshwater communities, because the presence of blue catfish has promoted ecological imbalances.

The 2020 management strategy of the catfish Workgroup includes two primary goals, one of which focuses on aiding the natural inhabitants and habitats of the Chesapeake Bay in order to balance the ecosystem, particularly with respect to imbalances created by the growing presence of blue catfish (Invasive Catfish Workgroup 2020). Similarly, Maryland's tidewater catfish FMP includes a goal of maintaining ecological integrity in the Bay while depleting invasive catfish populations (MDNR 2021). Stakeholders in the Bay agree that the largest concerns about blue catfish are its impacts on native habitat and native species, and management has reacted to this by focusing efforts on curbing blue catfish population growth, spread, and negative ecosystem impacts (Invasive Catfish Workgroup 2020). Managers are also considering how the future incorporation of minimum harvest lengths may affect blue catfish predation on native shad species, with the goals of reducing this predation while maximizing blue catfish harvest (Sustainable Fisheries GIT 2021). In addition, managers are focused on avoiding a long-running blue catfish economic reliance if fishing efforts begin to curb population growth. The creation of a successful blue catfish commercial fishery may create an incentive for fishers to continue fishing this species, even once the stock is more depleted. Managers do not plan to restock blue catfish populations in order to continue the fishery in the future, thus ensuring that conservation goals will outweigh economic gains (Fabrizio et al. 2020).

Chesapeake Bay | America, North - Inland Waters | Electric fishing | United States | Virginia

Very Low Concern
Blue catfish has become an apex predator in the Chesapeake Bay ecosystem, raising concerns about its competition with and predation on native species (Schloesser et al. 2011){NOAA Fisheries 22a}. Management efforts are focused on controlling and limiting blue catfish populations by increasing the commercial catch of the species. The GIT Workgroup's management strategy also focuses on minimizing impacts to native fauna from blue catfish invaders. By increasing fishing practices such as LFE, managers are working to more efficiently target blue catfish without capturing other, native species in the process (Trice 2017a). Unlike channel catfish, blue catfish is not considered naturalized in the Bay, so it does not play a significant role in the ecosystem and does not have species that rely on its presence in the food web. This factor is rated a very low concern, because management policies to reduce blue catfish populations also focus on reducing harm to native populations, and the removal of blue catfish from the Bay will not create detrimental ecosystem

impacts.

Justification:
Blue catfish is an opportunistic predator that consumes 2%–9% of its body weight daily (Sustainable Fisheries GIT 2017)(Schmitt et al. 2021), preying on a range of native species such as blue crab, white perch, gizzard shad, menhaden, American eel, and other finfish, shellfish, and invertebrates (CBP n.d.)(Orth et al. 2017)(Love & Wilson 2019)(Liu and Fisher 2020)(MDNR 2022h). Some prey items of blue catfish are both ecologically and economically important in the Chesapeake Bay region (Schloesser et al. 2011). With few natural predators in the Chesapeake Bay, the population of blue catfish has quickly increased since the species was introduced to the region. A 2017 study of blue catfish suggested that its removal would most likely result in increases in stocks of white catfish, a native species with a population that has declined in recent decades (Schloesser et al. 2011), and of blue crab, which is an economically vital species that has also experienced population decline (Orth et al. 2017). Thus, increasing the harvest of blue catfish will likely positively affect native marine and freshwater communities, because the presence of blue catfish has promoted ecological imbalances.

The 2020 management strategy of the catfish Workgroup includes two primary goals, one of which focuses on aiding the natural inhabitants and habitats of the Chesapeake Bay in order to balance the ecosystem, particularly with respect to imbalances created by the growing presence of blue catfish (Invasive Catfish Workgroup 2020). Stakeholders in the Bay agree that the largest concerns about blue catfish are its impacts on native habitat and native species, and management has reacted to this by focusing efforts on curbing blue catfish population growth, spread, and negative ecosystem impacts (Invasive Catfish Workgroup 2020). Managers are also considering how the future incorporation of minimum harvest lengths may affect blue catfish predation on native shad species, with the goals of reducing this predation while maximizing blue catfish harvest (Sustainable Fisheries GIT 2021). In addition, managers are focused on avoiding a long-running blue catfish economic reliance if fishing efforts begin to curb population growth. The creation of a successful blue catfish commercial fishery may create an incentive for fishers to continue fishing this species, even once the stock is more depleted. Managers do not plan to restock blue catfish populations in order to continue the fishery in the future, thus ensuring that conservation goals will outweigh economic gains (Fabrizio et al. 2020).

Chesapeake Bay | Atlantic, Northwest | Set gillnets | United States | Virginia

Moderate Concern
Blue catfish has become an apex predator in the Chesapeake Bay ecosystem, raising concerns about its competition with and predation on native species (Schloesser et al. 2011)(NOAA Fisheries 2022a). Management efforts are focused on controlling and limiting blue catfish populations by increasing the commercial catch of the species. The GIT Workgroup's management strategy also focuses on minimizing impacts to native fauna from blue catfish invaders. By increasing fishing practices such as LFE, managers are working to more efficiently target blue catfish without capturing other, native species in the process (Trice 2017a). Unlike channel catfish, blue catfish is not considered naturalized in the Bay, so it does not play a significant role in the ecosystem and does not have species that rely on its presence in the food web. Striped bass management includes requirements to protect the species' habitat. Many of the species' prey species are managed to ensure their availability to the striped bass population, although striped bass' effects as a predator

are not currently addressed in its management plan. Gizzard shad lacks a management plan because of its abundant nature and the lack of fisheries targeting this species. Detrimental food web impacts are unlikely to occur from the retention of some gizzard shad bycatch, and detrimental food web impacts are also unlikely based on the current management of the striped bass fishery. This factor is rated a moderate concern, because management policies to reduce blue catfish populations also focus on reducing harm to native populations, the removal of blue catfish from the Bay will not create detrimental ecosystem impacts, and the lack of a management plan for gizzard shad and an ecosystem-based management plan for striped bass present a limiting factor for scoring.

Justification:
Blue catfish is an opportunistic predator that consumes 2%–9% of its body weight daily (Sustainable Fisheries GIT 2017)(Schmitt et al. 2021), preying on a range of native species such as blue crab, white perch, gizzard shad, menhaden, American eel, and other finfish, shellfish, and invertebrates (CBP n.d.)(Orth et al. 2017)(Love & Wilson 2019)(Liu and Fisher 2020)(MDNR 2022h). Some prey items of blue catfish are both ecologically and economically important in the Chesapeake Bay region (Schloesser et al. 2011). With few natural predators in the Chesapeake Bay, the population of blue catfish has quickly increased since the species was introduced to the region. A 2017 study of blue catfish suggested that its removal would most likely result in increases in stocks of white catfish, a native species with a population that has declined in recent decades (Schloesser et al. 2011), and of blue crab, which is an economically vital species that has also experienced population decline (Orth et al. 2017). Thus, increasing the harvest of blue catfish will likely positively affect native marine and freshwater communities, because the presence of blue catfish has promoted ecological imbalances.

The 2020 management strategy of the catfish Workgroup includes two primary goals, one of which focuses on aiding the natural inhabitants and habitats of the Chesapeake Bay in order to balance the ecosystem, particularly with respect to imbalances created by the growing presence of blue catfish (Invasive Catfish Workgroup 2020). Stakeholders in the Bay agree that the largest concerns about blue catfish are its impacts on native habitat and native species, and management has reacted to this by focusing efforts on curbing blue catfish population growth, spread, and negative ecosystem impacts (Invasive Catfish Workgroup 2020). Managers are also considering how the future incorporation of minimum harvest lengths may affect blue catfish predation on native shad species, with the goals of reducing this predation while maximizing blue catfish harvest (Sustainable Fisheries GIT 2021). In addition, managers are focused on avoiding a long-running blue catfish economic reliance if fishing efforts begin to curb population growth. The creation of a successful blue catfish commercial fishery may create an incentive for fishers to continue fishing this species, even once the stock is more depleted. Managers do not plan to restock blue catfish populations in order to continue the fishery in the future, thus ensuring that conservation goals will outweigh economic gains (Fabrizio et al. 2020).

Chesapeake Bay | Atlantic, Northwest | Stationary uncovered pound nets | United States | Maryland | Virginia

Moderate Concern
Blue catfish has become an apex predator in the Chesapeake Bay ecosystem, raising concerns about its competition with and predation on native species (Schloesser et al. 2011)(NOAA Fisheries 2022a). Management efforts are focused on controlling and limiting blue catfish populations by

increasing the commercial catch of the species. The GIT Workgroup's management strategy also focuses on minimizing the impacts to native fauna from blue catfish invaders. By increasing fishing practices such as LFE, managers are working to more efficiently target blue catfish without capturing other, native species in the process (Trice 2017a). Unlike channel catfish, blue catfish is not considered naturalized in the Bay, so it does not play a significant role in the ecosystem and does not have species that rely on its presence in the food web. Striped bass management includes requirements to protect the species' habitat. Many of the species' prey species are managed with ecosystem-based reference points to ensure their availability to the striped bass population, though striped bass' ecosystem effects as a predator are not currently addressed in its management plan. White perch management in Maryland is based on a proposed, but not formally adopted, FMP (MDNR 2016)). White perch is managed in coordination with striped bass because of habitat and fishing gear overlap, but the ecosystem role of white perch as a prey species is not currently addressed by the FMP. Detrimental food web impacts from fishing white perch are unlikely because of its resilience, but ecosystem-based reference points and management measures have not been developed for the species. This factor is rated a moderate concern, because management policies to reduce blue catfish populations also focus on reducing harm to native populations, and the removal of blue catfish from the Bay will not create detrimental ecosystem impacts, but the lack of ecosystem management for white perch and striped bass present a limiting factor for scoring.

Justification:
Blue catfish is an opportunistic predator that consumes 2%–9% of its body weight daily (Sustainable Fisheries GIT 2017)(Schmitt et al. 2021), preying on a range of native species such as blue crab, white perch, gizzard shad, menhaden, American eel, and other finfish, shellfish, and invertebrates (CBP n.d.)(Orth et al. 2017)(Love & Wilson 2019)(Liu and Fisher 2020)(MDNR 2022h). Some prey items of blue catfish are both ecologically and economically important in the Chesapeake Bay region (Schloesser et al. 2011). With few natural predators in the Chesapeake Bay, the population of blue catfish has quickly increased since the species was introduced to the region. A 2017 study of blue catfish suggested that its removal would most likely result in increases in stocks of white catfish, a native species with a population that has declined in recent decades (Schloesser et al. 2011), and of blue crab, which is an economically vital species that has also experienced population decline (Orth et al. 2017). Thus, increasing the harvest of blue catfish will likely positively affect native marine and freshwater communities, because the presence of blue catfish has promoted ecological imbalances.

The 2020 management strategy of the catfish Workgroup includes two primary goals, one of which focuses on aiding the natural inhabitants and habitats of the Chesapeake Bay in order to balance the ecosystem, particularly with respect to imbalances created by the growing presence of blue catfish (Invasive Catfish Workgroup 2020). Similarly, Maryland's tidewater catfish FMP includes a goal of maintaining ecological integrity in the Bay while depleting invasive catfish populations (MDNR 2021). Stakeholders in the Bay agree that the largest concerns about blue catfish are its impacts on native habitat and native species, and management has reacted to this by focusing efforts on curbing blue catfish population growth, spread, and negative ecosystem impacts (Invasive Catfish Workgroup 2020). Managers are also considering how the future incorporation of minimum harvest lengths may affect blue catfish predation on native shad species, with the goals of reducing this predation while maximizing blue catfish harvest (Sustainable Fisheries GIT 2021). In addition, managers are focused on avoiding a long-running blue catfish economic reliance if fishing efforts begin to curb population growth. The creation of a successful blue catfish commercial fishery may create an incentive for

fishers to continue fishing this species, even once the stock is more depleted. Managers do not plan to restock blue catfish populations in order to continue the fishery in the future, thus ensuring that conservation goals will outweigh economic gains (Fabrizio et al. 2020).

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Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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