Invasive Catfish in the Chesapeake Bay

November 6-7, 2017

Virginia Commonwealth University
Rice Rivers Center
Charles City County, VA

Hosted by the Chesapeake Bay Program's
Sustainable Fisheries Goal Implementation Team

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Acknowledgments

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This report was prepared by the workshop scientific experts and researchers listed below with support from workshop staff Sara Coleman of ERT, Inc. at the NOAA Chesapeake Bay Office.

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Executive Summary

An Invasive Catfish Symposium was held on November 6-7, 2017, at the VCU Rice Rivers Center. The purpose of the meeting was to bring together fishery managers, scientists, and interested stakeholders to discuss the latest science on invasive catfish and progress made on previous recommendations from the Invasive Catfishes Task Force. Bruce Vogt, the Invasive Catfishes Task Force Chair, opened the meeting by reviewing the recommendations and progress made since 2014. To date, the development of a large-scale fishery has been the most successful recommendation.

Research results, implications, and the scientists' recommendations are summarized below:

Topic	Research Summary	Implication

Monitoring	• Not all states have a dedicated monitoring program
	• Virginia DGIF has been using electrofishing to monitor since early 2000s
	  ○ surveys in James, Pamunkey, Mattaponi, and Rappahannock (Rappahannock has highest relative abundance but slower growth rates)
	• Maryland DNR has developed more consistent monitoring efforts in the last few years, currently surveying Upper Susquehanna, Upper Potomac (Shepherdstown, Dargan, Taylors Landing), and near Potomac 95 bridge
	  ○ some blue catfish observed in Pocomoke
	• Delaware DNREC: 2 reports of flathead catfish, 3 known locations of blue catfish
	  ○ all information is incidental to other surveys or reported by anglers, commercial watermen
	• VIMS: monthly multispecies trawl survey in James, Rappahannock, and York
	  ○ began to see blue catfish in 1995-1996
	  ○ have seen increasing abundance in all 3 rivers
	• Pennsylvania FBC: statewide catfish management plan developed in 2012
	  ○ monitoring using hoopnets
		• There is a need for more consistent monitoring across Bay jurisdictions
		• Locations in PA have found fairly large fish, suggesting rapid growth rates

	○ ongoing PA Sea Grant research projects ○ will be expanding into Delaware River	
Population dynamics and movement	• A mark-recapture study conducted by VIMS in the James River tagged more than 34,000 blue catfish ○ Estimated 926,307 to 2,914,208 blue catfish in a 3,017-ha area → density of 544 fish/ha • 2015 mark-recapture study conducted by VDGIF and VA Tech in Pamunkey and Rappahannock rivers ○ Electrofishing used to collect individuals ○ 3 mark-recapture events with unique fin clip for each event and each section of river ○ Used Bayesian model to determine fish abundance and density ▪ Pamunkey: 565/ha ▪ Rappahannock: 1127/ha • Telemetry and dart-tagging studies have shown that movement is highly variable, not linked to fish size	• Population densities are high, meaning fishery removals can be increased • Apparent survival rates are low (reflects mortality and emigration from estuarine habitats) • Blue catfish are the most migratory of all ictalurid species • Patterns seen were related to environmental variables like water temperature • Ability to travel long distances suggest blue catfish will continue to expand invasion
Salinity tolerance	• 72-hour LC50 experiments: at 15.7ppt 50% of fish died after 72 hours • Time-to-death analysis: as length increases, median time to death increases ○ Larger fish are more tolerant of salinity • the sublethal effects of salinity (growth and reproduction) are still unknown	• Salinity in Bay varies between wet and dry months • Lower salinity means blue catfish can survive in a greater portion of the Bay (for at least 72hrs) ○ Ability to travel and expand population into more tributaries, particularly during wet months/years
Diet	• Blue catfish experience an ontogenetic shift to piscivory (size varies by river) • In spring, summer, and fall a large portion of blue catfish diet is vegetation • Data suggest that blue catfish are generalists, not apex predators • flathead catfish are strictly piscivorous, function more as apex predators and feed on alosines more so than do blue	• In trying to understand predatory effect of blue catfish in tidal Virginia waters, must look at biomass ○ James had the highest estimate • blue crab predation may be a management concern

	catfish (however, blue catfish are more abundant). • Blue catfish diet overlaps with diet of native white catfish	

Fishery statistics	• Potomac River Fisheries Commission: began to report blue catfish harvest separately from other catfish species in 2003
	  • From 2015-2017, more than 1 million lbs harvested per year
	• Virginia MRC: Prior to 2010, all catfish were reported as 'unclassified catfish'
	  • James is driving harvest numbers
	• Virginia DGIF: in tidal James River System, recreational fishing effort during last several years was less than half of that observed in 2002
	  • in 2002, estimated $2.5 million total economic value of the James River recreational blue catfish fishery
	• Maryland DNR: increasing harvest since 2000, began parsing out catfish species in 2013
	  • By 2015, over 2 million lbs harvested
	• Delaware DNR: in 2015, commercial watermen noted a marked increase in the percentage of blue catfish in landings from the Nanticoke and Choptank River drainages
		• Continue to report harvests of catfishes by species
		• Need to parse commercial catfish landings by species in Delaware waters

Contaminants	• Study conducted at VIMS collected fish from the James, Rappahannock, and Potomac Rivers, examined concentrations of the most common 75 PCBs
	  o Average wet weight of total PCBs was 94 ug/kg (above EPA cancer standard)
	• Increasing contamination with increasing size for most contaminants
	• Vast majority of fish from upper James and Potomac fell into the '2 meals/month' category set by Virginia
	• Most chemicals are found in fat
	• Many data gaps exist, less than 1% of chemicals have had human testing
		• Just looking at average PCB values, we should not be eating invasive catfish
		  o Most states suggest consuming fish in moderation
		• Increasing contamination with increasing size suggest size limits are needed for fish being caught and sold
		• Certain cooking and processing methods may reduce contaminant load
		• This may be a roadblock to develop a thriving fishery

		• Some contaminant levels in blue catfish are similar to those in striped bass

Stakeholder perspectives	• Expressed concern over change in regulations/inspection authority
	• Gear conflicts: electrofishing is very efficient, perhaps negatively impacting other gear types, but no empirical support for this perception
	• Conflict between recreational and commercial interests persists
	  ○ Decline of trophy fish (especially in James)
	• Currently, no harvest targets or Baywide estimates of population size exist
		• Challenges exist in establishing a market:
		  ○ need a constant supply
		  ○ convincing people wild caught catfish is different than farm-raised
		  ○ coordinated marketing efforts

Introduction

Native to the Mississippi, Missouri, and Ohio River basins, blue catfish (*Ictalurus furcatus*) and flathead catfish (*Pylodictis olivaris*) have quickly spread throughout Chesapeake Bay and have the potential to negatively impact native species and the ecology of the ecosystem. Blue catfish were introduced into the James, Rappahannock, and York Rivers in Virginia during the 1970s and 1980s to establish recreational fisheries in Virginia. Flathead catfish were introduced into the James River in the late 1960s for the same reason. Peaks in 1996 and 2003 of relative abundance of young-of-the-year blue catfish were followed by a surge in adult abundances in later years in several tributaries (Schloesser et al. 2011).

There are concerns about the potential impact of invasive catfish predation on native fish and shellfish species. Blue catfish in Virginia rivers are known to consume Atlantic menhaden, *Macoma* clams, and mud crabs, among many other invertebrates and fishes (Schloesser et al. 2011). In the Delaware and Susquehanna River basins, flathead catfish predation may threaten anadromous species like American shad or endangered fishes such as Atlantic and shortnose sturgeon (Brown et al. 2005). In addition to a long life span, other biological characteristics that are believed to enhance the likelihood of invasive catfish establishment in new environments include large body size, a relatively high salinity tolerance, and parental care of young (Morris and Whitfield 2009). The expanding range and increasing populations, particularly of blue catfish, have resource managers concerned that without management intervention, the damage to Chesapeake Bay resources may be irreversible.

There is no existing management strategy for invasive catfishes, so the Invasive Catfish Task Force (ICTF) was established in 2012 by the Sustainable Fisheries Goal Implementation Team (Fisheries GIT) of the Chesapeake Bay Program. The Task Force was charged with recommending management options that could be applied Bay-wide to respond to the spread of invasive blue and flathead catfish populations in the Chesapeake Bay region. Although it is illegal in all jurisdictions to transport live blue and flathead catfishes for the purpose of introduction into another body of water, and officials in the Maryland Department of Natural Resources, District of Columbia and the Potomac River Fisheries Commission discourage release of angler-caught fish, populations in many water bodies are already established. Some studies of catfish movement suggest greater mobility of blue catfish compared with flathead catfish, and indicate that while localized management programs are appropriate for flathead catfish, blue catfish should be managed on a larger scale (Pugh and Schramm 1999). The high abundance of these invasive fishes may also impact local fisheries; for example, in the Potomac River, blue catfish are bycatch in gillnet fisheries and have the potential to reduce gear efficiencies. Understanding and mitigating potential impacts to the Chesapeake Bay ecosystem and native species has been a major focus of research in recent years.

In November 2017, fishery managers, scientists, and interested stakeholders gathered to discuss the latest research findings on blue and flathead catfish to aid in management decisions.

Workshop Goals

Conduct a workshop to characterize what is known about the life history, diet, movement patterns, and population dynamics of invasive blue and flathead catfishes in the Chesapeake Bay watershed. Discuss the impacts of commercial and recreational fishing as well as marketing efforts and what steps should be taken next.

Annual Monitoring

VDGIF Tidal Rivers Catfish Monitoring
Aaron Bunch

VIMS Juvenile Fish Trawl Survey
Mary C. Fabrizio and Troy D. Tuckey

Maryland DNR Monitoring
Mary Groves

Invasive catfish annual monitoring and focused research projects - Pennsylvania
Geoffrey Smith

Delaware Division of Fish and Wildlife monitoring
Edna J. Stetzar

The first presentations detailed the monitoring programs in place in the various jurisdictions. Most jurisdictions now have a dedicated monitoring program in place, but previously, any data collected were incidental to other surveys. It was shown that the invasion stage varies by tributary. Aaron Bunch shared results from the Virginia Department of Game and Inland Fisheries (VDGIF) monitoring project, which began in the early 2000s. The purpose of this program is to monitor long-term status and trends of blue catfish relative abundance, size distribution, and growth. Catfish are sampled in the James, Pamunkey, Mattaponi, and Rappahannock Rivers using low-frequency electrofishing. In 2017, 6784 fish were collected from the James and Pamunkey Rivers. Recent results show that the Rappahannock River has the highest relative abundance but slower growth rates than the other tributaries surveyed.

Troy Tuckey shared data from the Virginia Institute of Marine Science (VIMS) monthly multispecices trawl. This survey began catching blue catfish in 1995. Using a stratified random sampling design, the survey typically samples more than 100 stations each month. Since the mid-1990s, increasing numbers of blue catfish (age 0 and age 1+) have been observed in the James, Rappahannock, and York Rivers.

Mary Groves presented on monitoring efforts by Maryland Department of Natural Resources (DNR). In the last few years, a more consistent monitoring program has been developed. Currently, surveys occur in the Upper Susquehanna, Upper Potomac (Shepherdstown, Dargan, Taylors Landing), and near the Potomac 95 bridge. Small populations of invasive catfish have also been observed in lower Eastern Shore rivers, including the Pocomoke. A lack of sufficient funding has hampered progress, but in spring 2017, stomach contents from more than 100 blue catfish were sent to the USGS for DNA analysis.

The Pennsylvania Fish and Boat Commission (FBC) developed a state-wide catfish management plan in 2012. Mostly, channel and flathead catfishes are present in PA waters. Geoff Smith shared the results of a SeaGrant project funded in 2016 that sought to examine population and growth characteristics across an establishment gradient. South of Sunbury, the Susquehanna River was divided into a lower, middle, and upper reach, and sample sites were selected at random. Baited, tandem hoopnets were the primary gear type. Relatively large flathead catfish have been recorded in the sampling efforts, suggesting rapid growth rates. Ongoing projects funded through PA SeaGrant will continue to monitor flathead and channel catfish in the state, expanding to new drainages and comparing native and invasive populations.

Edna Stetzar of the Delaware Department of Natural Resources and Environmental Control shared that the state does not have a monitoring program in place for invasive catfishes. All data collected are incidental to other surveys or are reported by anglers and commercial watermen. There have been just two verified reports of flathead catfish in the state, but blue catfish have been observed in the Delaware River drainage, the Choptank River drainage, and in the Nanticoke River drainage, where they are now seen frequently. A handful of commercial watermen harvest catfish in the Nanticoke and Delaware Rivers, but landings are not parsed by species. Anglers are encouraged to kill blue and flathead catfishes if caught and to contact the Division of Fish and Wildlife. Outreach efforts include signs at public access points, webpage links, press releases, and alerts that have been circulated among approximately 50 fishing clubs. There is an invasive finfish law that prohibits the possession, sale, stocking, and transportation of live catfishes or snakeheads. The first offense carries a fine of $25, but it is not seen as a strong deterrent.

Diet

Feeding ecology of blue (flathead) catfish in Virginia's tidal rivers

Joseph D. Schmitt, Aaron Bunch, Jason Emmel, Zach Moran, Brandon Peoples, Leandro Castello, and Donald J. Orth

Can we quantify invasive catfish impacts on the ecosystem?

Corbin D. Hilling, Joseph D. Schmitt, Yan Jiao, and Donald J. Orth

Maryland DNR Diet Analysis

Mary Groves

To better understand how invasive catfish are impacting the Chesapeake Bay ecosystem, we must know what they are feeding on. Multiple studies on invasive catfish diets were presented. Joe Schmitt shared results from a major diet study conducted by Virginia Tech researchers. More than 16,000 catfish stomachs were examined from nearly 700 locations. Fish were collected with low-frequency electrofishing from April to October with a stratified random sampling design. Stomachs were excised on small fish, and larger fish were subjected to gastric lavage. An interesting finding was that blue catfish diets vary seasonally. In spring, summer, and fall, a large portion of the diet is vegetation. This raised the question if anything is being done to address the potential loss of submerged aquatic vegetation. Another substantial contribution to the diet of blue catfish is invertebrates, including insects, Asian clams, and blue crabs. Overall, blue catfish appear to exhibit high diet breadth, higher than the published values for 50 other species of estuarine fishes. Blue catfish experience an ontogenetic shift to piscivory, and the size varies by river system. Many in the region have expressed concern about the effect of invasive catfish on shad and river herring populations. To more closely examine the threat to *Alosa* species, additional stomachs were collected from 331 flathead catfish and 2164 blue catfish in March, April, and May 2015. It was discovered that flatheads are exclusively piscivorous and Alosines were found in 17% of the flathead catfish stomachs but only in 4% of the blue catfish stomachs. The probability of *Alosa* predation increased farther upriver. These findings suggest that there needs to be close attention paid to flathead as well as blue catfish, especially in areas like the York River where the flathead population is growing.

Joe Schmitt also conducted experiments on consumption rates of blue catfish. *Ad libitum* feeding trials were performed at three temperatures in a recirculating system, and fish were fed every three hours for a 24 hour period. As expected, the maximum daily ration consumed increased with temperature, and reached a plateau between 15 and 25°C. The calculated maximum ration was 9.56% of bodyweight. To corroborate this value, fish were collected in the field every three hours and mean stomach fullness was measured. This yielded an estimate of 8.76% body weight for maximum daily ration. The maximum and average daily rations calculated for blue catfish were very similar to the values for channel catfish from the literature.

Blue and white catfish overlap in ranges and have similar salinity tolerances, but blue catfish are larger and longer-lived. Rob Aguilar presented on a study conducted by the Smithsonian Environmental Research Center that examined the diets of these two fishes in three systems, the Patuxent River, the Marshyhope/Nanticoke River, and the Upper Bay. Electrofishing was used to collect catfish in the summer and fall. For analysis, each species of catfish was divided into two groups, individuals less than 300mm TL and individuals greater than 300mm TL. Stomachs were analyzed for fullness score, the contents sieved and frozen, and then identified to the lowest possible grouping. Researchers found a large amount of insects, crustaceans, and bivalves, condensing the prey items found into 42 categories. Fish were more prevalent in blue catfish stomachs than in white catfish stomachs, and the prevalence of fish in the diet increased with blue catfish size. Small white catfish appeared to consume a large amount of vegetation and invertebrates, whereas white catfish greater than 300 mm TL possessed large amounts of sediments in their stomachs. The authors of this study found DNA barcoding to be successful in identifying fish prey items. Overall, a fair amount of overlap in the diets of blue catfish and white catfish was observed, which could perhaps be related to white catfish declines seen in the region.

Maryland DNR has also conducted diet analyses of blue catfish. Mary Groves presented data collected in spring 2017. Blue catfish were collected from the tidal Potomac and stomachs were sampled from 165 fish, all greater than 300 mm total length. Crayfish and unidentified fish remains were the most frequent prey items encountered. Of the fish species identified, researchers found yellow perch, gizzard shad, river herring (alewife and blueback herring), and other catfish species. DNA meta-barcoding performed by the USGS National Fish Health Laboratory on a subset of the stomachs determined the previously unidentified stomach contents to consist of alewife, gizzard shad, and yellow perch. DNR will continue to study the possible impacts of invasive catfish, with the desire to examine small creeks in the spring.

However, the DNA sequencing techniques used are rather expensive, and may limit further research.

Corbin Hilling of Virginia Tech presented a research project that sought to quantify the impacts of blue catfish in tidal Virginia waters. Although the food habits of blue catfish across spatial and temporal (seasonal) scales within the James, Mattaponi, Pamunkey and Rappahannock rivers have been described, no previous study has used consumption rates to assess population scale effects. Using existing population estimates (in biomass), consumption-biomass ratio (Q/B) and percent diet composition by weight, researchers estimated the mass of prey items (p) consumed annually. Predation on at-risk and economically important species including American eel (*Anguilla rostrata*), American shad (*Alosa sapidissima*), blue crab (*Callinectes sapidus*) and river herring (alewife and blueback herring) was examined with estimates of biomass consumed. The James River had the highest estimate of blue catfish biomass, but the York River produced the highest Q/B ratio. This study provides a rough estimate of population level consumption, and further research will expand the consumption estimates to additional species and develop a size-structured population model.

Population and Density Estimates

VDGIF Tidal Rivers Catfish Mark-Recapture Studies

Aaron Bunch

Tidal Habitats Support Large Numbers of Invasive Blue Catfish

Mary C. Fabrizio, Troy D. Tuckey, Robert J. Latour, Gary C. White, and Alicia J. Norris

Aaron Bunch presented on several studies by the VDGIF Tidal Rivers Project. Work in Powell Creek and the Pamunkey and Rappahannock rivers sought to estimate blue catfish population density and biomass. A mark-recapture study was conducted in 2007, 2014, and 2015 in Powell Creek, a tributary of the James River approximately 4.8 km in length. Using electrofishing, fish were collected on three consecutive days, with a recapture rate of around 20%. The results showed that blue catfish density decreased by 65% from 2007 to 2014, and there was not much change in densities from 2014 to 2015. In late summer 2015, researchers used low-frequency electrofishing to collect fish in three sections of the Pamunkey and Rappahannock Rivers for another mark-recapture study. Three mark-recapture events were conducted at one-week intervals and only blue catfish greater than 100 mm were marked. Fish received a unique fin clip based on the event and river section, which allowed researchers to look at movement within sections across the same period. Dr. Yan Jiao used a Bayesian model to estimate fish abundance and density. The density estimate for the Pamunkey River was 565 blue catfish per hectare. A larger area was sampled in the Rappahannock River and resulted in a density estimate of 1127 fish per hectare. These density estimates are similar to relative abundance figures gathered from other surveys, including VDGIF electrofishing, and the study by Fabrizio and others in the James River.

Findings were presented by Dr. Mary Fabrizio of VIMS from a mark-recapture study that estimated population size and survival rates of blue catfish in tidal habitats of the James River subestuary. Researchers tagged 34,252 blue catfish during July-August 2012 and 2013. Information from live recaptures (*n*=1,177) and dead recoveries (*n*=279) was used to estimate annual survival rates and population size using Barker's Model in a Robust Design and allowing for heterogeneity in detection probabilities. The blue catfish population in the 12-km study area was estimated to be 1.6 million fish in 2013 (95% confidence interval [CI] adjusted for overdispersion: 926,307 – 2,914,208 fish). Annual apparent survival rate estimates were low: 0.16 (95% CI: 0.10 – 0.24) in 2012–2013, and 0.44 (95% CI: 0.31 – 0.58) in 2013–2014, and represent losses from the population through mortality, permanent emigration, or both. The tagged fish included individuals that were large enough to exhibit piscivory and represented size classes that are likely to colonize estuarine habitats. The large population size estimated was unexpected for a freshwater fish in tidal habitats, and highlights the need to effectively manage such species.

Movement and Environmental Drivers

VDGIF Blue Catfish Movement Study
Aaron Bunch

Movement of Blue Catfish in the Potomac River
Troy D. Tuckey, Mary C. Fabrizio, Alicia J. Norris, and Mary Groves

Salinity Tolerance of Blue Catfish
Vaskar Nepal KC and Mary C. Fabrizio

Multiple studies were presented to examine the movement and range of blue catfish in the Chesapeake Bay Watershed. Blue catfish are the most migratory ictalurid species, but little research has been conducted on their movement in small, tidal systems like those in the Chesapeake Bay. A study at SERC, presented by Rob Aguilar, consisted of implanting acoustic tags in fish from the Patuxent River, the Marshyhope/Nanticoke, and the Potomac River. All tagged fish were greater than 350 mm total length and were collected with hook and line or by electrofishing. In addition to SERC receivers, they relied on receivers maintained by Maryland Department of Natural Resources, the DC Department of Energy and Environment, and the University of Maryland to track fish movement. Passive and active telemetry revealed that blue catfish are highly mobile, but movements were variable. There was evidence of a seasonal pattern, with increased movement in spring and fall. Active telemetry found catfish spending time in river bends and holes up to 5m deep.

VDGIF used Vemco acoustic tags to evaluate the spatial and temporal movement patterns of blue catfish. Aaron Bunch shared study results at the symposium. Fish, ranging in total length from 356 to1152 mm, were collected with electrofishing and then implanted with surgical tags. All fish were released in upper tidal sections in the Rappahannock and Pamunkey rivers. Using both active and passive tracking, researchers saw large variation in movement patterns. One of the larger fish tagged seemed to be resident in the Rappahannock River, yet another fish moved from the Pamunkey River into the Mattaponi River in less than one year. Fish size at tagging was not correlated with distance moved. This study could have major implications for management, because both large and small fish seemed to move large distances; multiple fish moved more than 100 km from the release location. Blue catfish also use Bosher's Dam fishway each year, demonstrating they are not bound to tidal waters in the James River. Whereas this work took a broad view of catfish movement, investigating smaller scale movements could fill some research gaps.

Troy Tuckey presented the results of a dart-tagging study conducted in 2012-2015 by researchers at VIMS. The goal of the project was to obtain movement patterns of blue catfish in the Potomac River. Maryland DNR applied two external tags to more than 1200 fish. The fish tagged ranged in size from 300 to 1320 mm total length. Tag returns indicated where the fish was caught, thus allowing the researchers to analyze the minimum distance moved by each fish. Most of the recaptured fish moved downriver, and fish were more likely to move a greater distance downriver than upriver. Blue catfish were observed using the entire tidal portion of the Potomac River, in salinities up to 12.8 ppt. The movement of blue catfish reduces the effectiveness of location-specific consumption advisories for contaminants. These results align well with the findings of the acoustic tagging studies.

Examining the salinity tolerance of invasive catfish will allow scientists to better understand their capacity to expand and establish populations in new regions of the watershed. Salinity is considered a major stressor, and as salinity increases, freshwater species richness declines rapidly. Vaskar Nepal of VIMS presented the results of two laboratory experiments that tested the acute toxicity of subadult blue catfish exposed to various salinity regimes. The first experiment placed 10 individuals into each of three treatments, with salinities of 7, 17, and 27 ppt. All the fish survived at 7 ppt, but after 72 hours, all 10 fish in the 17 ppt treatment had perished. The second experiment tested five salinity treatments, again with 10 fish per tank. It was calculated that the lethal concentration at which 50% of the catfish died (LC_{50}) during 72 hours of exposure was 15.7 ppt. Time-to-death analysis showed that as fork length (FL) increased, the median time to death increased, meaning larger fish are more tolerant to high salinity. This study has crucial implications for the continued range expansion and distribution of blue catfish. Salinity throughout the Bay and its tributaries can vary year-to-year, depending on regional rainfall conditions. In wet months, salinity is lower in much of the Bay, meaning blue catfish can survive in a larger portion of the Bay, at least for 72 hours. This could also lead to more connectivity between subestuaries. One factor not considered in this study was the sublethal effects of salinity that catfish may experience and could be the subject of future research.

<u>Fishery Statistics and Removal Methods</u>

VDGIF Fishery Statistics

Bob Greenlee

Maryland Commercial and Recreational Catch

Mary Groves

Commercial Blue Catfish Harvest in Virginia

Ryan Jiorle

Commercial Low-Frequency Electrofishing for Invasive Catfish

George Trice IV, Matt Balazik, Charles Frederickson, Robert Fisher, William Shuart

Low Frequency Electroshock Fishing Invasive Catfish in Chesapeake Bay Tributaries

Bob Fisher

Dronin' on Catfish

William Shuart

Legacy and Emerging Contaminants in Blue Catfish

Drew R. Luellen, Troy D. Tuckey, Mary C. Fabrizio, Robert C. Hale

Wild American Catfish Coalition

Mike Hutt (presented by Marty Gary)

Bob Greenlee (VDGIF) presented a short summary of the status of the James River recreational fishery for blue catfish. The data presented were two snapshots in time (2002 and 2015-16) and included total angler catch and harvest, angler catch rates, and limited economic information derived from a 2002 angler survey. Angler participation declined since 2002, suggesting that the recreational harvest of blue catfish is not having a large impact on overall removal efforts. Additionally, it is likely that the economic benefits provided by a recreational fishery have waned.

Martin Gary (PRFC) reported on the commercial harvest of blue catfish in the Potomac River. A directed fishery exists from the 301 bridge to Mt. Vernon, where the salinity ranges from 4 to 9 ppt. Fish pots and trot lines are the main gear types used. In 2003, the jurisdiction began separating blue catfish from other species in reporting. In 2011, Maryland began to aggressively market blue catfish to grocery stores and restaurants, likely leading to increases in catch. In the last two years, more than 1 million pounds have been harvested per year in the jurisdiction, with the majority coming from just a handful of fishermen.

Mary Groves (Maryland DNR) shared some information about commercial harvest of catfish from the last several years. The jurisdiction began parsing out species of catfish in 2009. In the early 2000s, catches were fairly low, and mostly from the western shore and lower eastern shore. In the last several years, harvest has increased.

Ryan Jiorle (VMRC) presented data on the commercial fishery in Virginia. Prior to 2010, all catfish were reported as ‘unclassified catfish.’ Since separating by species, there have been increases in blue catfish harvests. Fish pots are the predominant gear, which includes hoop-nets. Of the James, York, and Rappahannock River systems, the York has consistently had the lowest commercial blue catfish harvest. It appears the James is driving the harvest numbers, with the highest catch recorded in 2012 with close to 1.4 million pounds. The jurisdiction is starting to see more harvest in the Rappahannock River, but this could also be due to a change in reporting.

Matt Balazik presented results of a project funded by a Fishery Resource Grant (FRG) to examine the use of electrofishing for commercial harvesting of blue catfish. Beginning in 2014, it was clear that electrofishing could be useful with little to no bycatch. The Chesapeake Bay system is now dominated by invasive blue catfish. New ways to remove these fish are needed to reduce the population. Low-frequency- electrofishing (LFE) is typically used for catfish sampling. Since 2014, an experimental commercial LFE study was conducted in the James and Pamunkey rivers. More than 1 million pounds of invasive catfish have been removed by LFE from the two rivers with no apparent effects on any other species. Over 80% of the harvest were fish weighing less than 8 lbs. The experimental fishery continues to be a very effective means of removing invasive catfish in the two rivers.

Some of the concerns surrounding electrofishing are related to its impacts on the hoop-net fishery for invasive catfish. Watermen feared that electrofishing would cause catfish to not go to bait and reduce the number of catfish caught in nets. Bob Fisher presented the results of a collaborative study in the Pamunkey River which was aimed at answering this question. Commercial fishermen were permitted to place hoop-nets wherever they desired, and nets soaked for two to three days. LFE was conducted for 200-220 second durations covering a stretch of river up and downstream from the set hoop-nets, and the fish harvested through electrofishing and from each hoop-net were kept separate through dock grading by size and total poundage. Comparing the total fish caught between nets that received no electrofishing and those that did, it appeared that after the initial removal of resident fish by both gear types, subsequent fish were observed to be removed at decreasing, but similar levels. Using both linear and log-linear models, comparison of hoop-net harvest levels with and without LFE indicated no statistically significant difference in hoop-net harvest levels. This study has direct management implications, as electrofishing is constrained by salinity and temperature, it is there possible to minimize conflict between LFE and hoop-net gear types in the blue catfish fishery by seasonality. Furthermore, hoop-nets are often fished on shallower habitats with flatter bottom contours and lower current velocities. LFE functions best in deeper water habitats with structure and faster flow. Another interesting finding was that catfish become desensitized if repeatedly shocked, and larger fish become desensitized quicker.

Will Shuart of VCU shared results of the drone tests conducted while catfish were being shocked as part of the FRG project. Using unmanned aerial vehicle (UAV) systems for data collection has several advantages, for instance, one can achieve exceptional temporal and spatial resolutions. The systems often provide flexible deployment and relatively simple operation, making rapid and more complete data acquisition and processing possible. Filming with a GoPro Hero Black, researchers were able to collect information on size class, abundance, and biomass of blue catfish, as well as catch efficiency and bird interactions. In the future, possibilities to automate classification will be explored.

Another point to consider when discussing fishery data is the potential impacts of consuming invasive catfish on human health. Drew Luellen presented results of a VIMS study that sought to determine concentrations of multiple contaminants known to pose human health concerns in blue catfish from three Chesapeake Bay tributaries. Contaminants can enter a fish's body through the gills and cross into the bloodstream if they are water soluble, or may be consumed through the diet. Fish greater than 300 mm total length were collected by bottom trawl and electrofishing from the Potomac, Rappahannock, and James rivers. For small fish, a filet was used for sampling, for larger fish, a vertical subsection was removed. Most of the contaminants examined have been banned in commercial use for decades. For instance, polychlorinated biphenyls (PCBs) were banned in 1979. The VIMS study looked for 75 of the most common PCB compounds, and found that the concentration (in ug/kg wet weight of total PCBs) varies by river system. The vast majority of catfish from the upper James and Potomac rivers fell into the '2 meals per month' category set by the Virginia Department of Health (VDH). Fish sampled from the lower James and Rappahannock rivers had lower concentrations. Interestingly, the average of all the fish sampled was 97 ug/kg wet weight total PCBs, above the Environmental Protection Agency's (EPA) cancer standard of 94 ug/kg wet weight. Mercury concentrations were highest in catfish from the upper James and upper Rappahannock rivers. Other contaminants examined included dichlorodiphenyltrichloroethane (DDT), chlordanes, polybrominated diphenyl ethers (PBDEs), the insecticide Mirex, and hexachlorobenzene, a fungicide banned in 1966. Generally, increasing contamination was correlated with increasing fish size.

When it comes to preparing and eating blue catfish, removing fat can decrease PCBs, along with most of the other lipophilic compounds. Conflicting information exists on the proper cooking methods, and VDH advises eating less deep-fried fish, as "frying seals PCBs into the fatty tissue". While fielding discussion questions about the human health risks associated with eating wild-caught fish, Dr. Luellen stressed that contamination is often closely linked with dose and varying one's diet is crucial. However, it can be difficult to articulate to the public that exceeding state or federal recommended levels of contaminants elevates risk of certain diseases.

Another key issue to developing a market for invasive catfish is the regulatory framework in place. A presentation was provided on the Wild American Catfish Coalition (WACC), a group of U.S. based harvesters, processors, distributors and private citizens formed in July 2017. The organization's mission is to preserve accessibility, affordability and responsible management of wild caught American catfish. WACC was mainly galvanized by changes to the Federal Meat Inspection Act (FMIA) to put "Catfish" under the jurisdiction of the public health agency in the USDA responsible for ensuring that meat, poultry, and processed egg products are safe and accurately labeled. The 2014 Farm Bill re-amended the FMIA to include all fish of the order siluriformes. A transitional period meant that the full enforcement of this regulation would begin September 1, 2017, for all catfish sold in the US (with some retail exemptions). While confusion over why this change was made remains, lawmakers introduced the bill in response to human health risks posed by catfish imported from Vietnam and other Asian countries. The Coalition is working to identify administrative and legislative solutions that will provide regulatory relief to the Wild American Catfish community.

Case Studies

Invasive Species: Can We Eat Our Way Out of a Crisis?

Susan Pasko and Jason Goldberg

The last presentation was given by Jason Goldberg and Susan Pasko. They shared ways to encourage the harvest and use of species as a means of controlling or eradicating invasive populations. If used properly, incentivizing and encouraging public or commercial harvest represents a significant opportunity to support ecosystem and natural resource management while simultaneously boosting economic development and environmental awareness. However, if used incorrectly, negative consequences such as further spread can occur. Success depends on interactions between the species, its invasive range, and socioeconomic factors. Good planning and monitoring are as essential as for any other management option. Before pursuing harvest and public consumption of invasive catfish, the Task Force was encouraged to consider several questions. Are the population dynamics of the species and ecosystem effects of removal conducive to harvest? Are the fish free of contaminants and safe to eat? How can outreach encourage harvest at levels required to achieve management goals without creating an incentive to intentionally introduce catfish in unaffected waters? How will management adapt as decreased catch per unit effort results in a reduction of interest in public consumption?

<u>Stakeholder Perspectives</u>

At the end of Day 2 of the meeting, a stakeholder panel was given the floor to discuss their connections to invasive catfish and main concerns. Two commercial fishermen, a recreational fishing guide, a seafood processor, and a representative from the restaurant industry accepted invitations to serve on the panel. The desire to obtain representation from each of the jurisdictions was not fully met, but the diversity of sectors present was useful in understanding a broad array of interests.

Some of the main topics discussed included the challenges in establishing a market for invasive catfish, the new United States Department of Agriculture (USDA) rules, and the issue of gear conflicts in the fishery. Bart Farrell of Clyde's Restaurant Group explained that he had to convince chefs and customers to try blue catfish when adding it the menu. Many people assumed that wild-caught catfish would be similar in taste and texture to farmed catfish from the Southern US. Once consumers sampled the wild fish, they were very receptive to it. Another hurdle in developing and growing a commercial market involves a constant supply of the product. Catfish harvest varies by season, and the processors and restaurants in the Bay need to ensure that they receive an adequate supply of catfish throughout the year. Many watermen target different species in the summer months, and this fluctuation in supply presents a challenge for the commercial market. The amount of edible meat that comes from an individual catfish may represent another barrier. As the seafood processor explained, roughly 25% of the weight of a blue catfish can be sold as product. This is less than half the amount of meat that can be harvested from tuna or swordfish, for example.

The USDA inspection authority was a major topic on the panel. While the 2008 and 2014 Farm Bills required the FDA to divest its authority over the inspection of Siluriformes fish to FSIS, the full enforcement began September 1, 2017. Many people feel the wild catfish fishery was overlooked when these changes were made, and it has now become challenging and costly for seafood processors that process wild-captured blue catfish to comply. Under the new Farm Bill, a USDA inspector must be on site wherever any catfish species is being processed. Tim Sughrue of Congressional Seafood explained that it is customary for fish houses to process harvests whenever they come in, and working long hours may sometimes be required; his cutting room is often open 16 hours per day. The USDA inspectors must be paid overtime in such circumstances, which many in the business feel will pressure processors to no longer accept blue catfish due to the additional cost of paying the overtime hours for USDA inspectors. Small-scale processors may be hardest hit, as they do not have the funds to update inspection facilities and comply with the new regulations. While some appeals were made to Congress such as the request for an exception for invasive catfish, no changes have been made to the inspection protocol. There does not appear to be any ongoing efforts to exempt wild catfish from the USDA inspection requirements, and the Wild American Catfish Coalition (formed in summer of 2017) has since disbanded.

There were competing interests among panel members. For instance, one of the commercial fisherman, George Trice, commented that the price of catfish has increased in the last several years. He also expressed a great deal of interest in electrofishing, as that method has been shown to harvest large numbers of catfish with little to no bycatch. However, the other waterman present felt that electrofishing had depleted the amount of catfish in the areas where other watermen typically fish, forcing them to travel farther and farther to catch catfish. In a similar vein, there was some discussion that in the James River, the number of trophy-size blue catfish has been declining. Several panel members agreed that there needs to be clearer, stricter regulations in terms of gear types, size limits, and designated fishing areas if a healthy trophy fishery is to persist alongside a commercial fishery. This again points to the need for coordinated regulations. Virginia does not advocate for kill-on-capture, whereas Maryland and the PRFC does, demonstrating that jurisdictions have not agreed on a consistent management strategy.

Lastly, most panel members agreed that in order to set a target harvest number, an accurate population estimate of blue and flathead catfish needs to be calculated. The original recommendations made in 2014 advocated for increased harvest as well as fishery-independent removals, without any specific number or goal. Although some population estimates have been made on a regional or tributary scale, no estimates exist for the entire Bay ecosystem. A researcher from VIMS expressed concern that a stock assessment would be quite difficult given the relatively low rate of fishery removals. Additionally, surveying with electrofishing has shown to be quite efficient but cannot be used in higher salinities or throughout the year.

To close the stakeholder panel, each member was asked what they desire most from the scientific and management communities. Both commercial harvesters expressed the need for separate areas for different gear types, to avoid perceived conflicts. The recreational fishing guide suggested a slot limit to leave large trophy fish for the recreational fishery. The seafood processor and restaurant representative requested a collaborative marketing effort to increase the success of locally-harvested blue catfish as a product.

<u>Outcomes</u>

After the symposium, attendees were invited to complete a short survey. A general theme emerged that a coordinated action plan should be developed, as well as a synthesis of the research completed to date. One respondent mentioned moving on from diet studies to research on growth rates. Specifically, the attendee wished for growth-at-age data for blue catfish over longer time scales. Another symposium attendee recommended relating diet, population, and movement studies, and another requested funding for research directed at actionable management questions and understanding ecological impacts.

Several participants suggested continued efforts to reduce biomass. This can be done through encouraging the commercial fishery to grow as well as marketing campaigns to develop the market and educate the public about contaminant levels and consumption rates. Adaptive management may allow for jurisdictions to change management strategies as more information becomes available on the response of bluefish catfish to harvesting pressure.

Several people raised concerns about the fate of large blue catfish that may have greater contaminant loads, and multiple participants supported an upper length limit on harvest (due to contaminants). One participant recommended looking into the use of invasive catfishes as fertilizer or pet food, which has been done for other invasive fishes. Another attendee was apprehensive about the marketing of invasive catfish given the possible human health risks. This attendee suggested including PCB warnings on all signage that promotes Chesapeake Bay blue catfish, as well as on menus in restaurants that serve it.

One participant acknowledged the conflicts between user groups and suggested that efforts be increased to reconcile differences. This attendee also advocated that all current research and upcoming research plans be made available to all agencies and stakeholders to avoid redundancy.

Invasive catfish have been present in Bay waters for a number of years, yet there still seems to be some confusion about the best way to manage them. Differing levels of concern among jurisdictions and stakeholders are a challenge when it comes to setting overarching goals.

Appendix A. References

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Appendix B. Symposium Agenda

Invasive Catfish Symposium:

State of the Science & Status of the Fishery

Virginia Commonwealth University Rice Rivers Center

November 6-7, 2017

Purpose: Bring managers, scientists, and interested stakeholders together to gain a common knowledge of invasive catfish research findings and the fishery in the Chesapeake Bay.

Agenda

Day 1

10:30am Welcome (Bruce Vogt, Sean Corson, Greg Garman)

Theme I: Context

11:00am Invasive Catfish Task Force and 2014 Report (Bruce Vogt-NOAA)

- Task Force Coordinator Bruce Vogt will provide background on the Invasive Catfish Task Force and a review of their 2014 report and recommendations.
- Jurisdiction Intro:
  - What's happened since 2014?
  - Expectations from this workshop?
  - What do you plan to do with the workshop information?

LUNCH 12:00-1:00pm

Theme II: Science

A. Population Dynamics

1:00pm Annual Monitoring

- Jurisdictions and academic institutions will review data, including relative abundance trends, from annual monitoring programs in various tributaries.
  - VDGIF – Aaron Bunch
  - MDDNR – Mary Groves
  - PAFBC – Geoff Smith
  - DNREC – Edna Stetzar
  - VIMS (Trawl Survey) – Troy Tuckey

BREAK

2:45pm Population Estimates and Range Expansion

- James River Population Study and Range Expansion – Mary Fabrizio (VIMS)
- Pamunkey and Rappahannock Rivers – Aaron Bunch (VDGIF)

3:20pm Wrap up Population Dynamics

B. Movement and Habitat Use

3:45pm Movement

- Scientists will discuss telemetry studies that are tracking the movements and habitat use of blue catfish in specific tributaries.
  - VDGIF (Aaron Bunch)
  - SERC (Rob Aguilar)
  - VIMS (Troy Tuckey)

4:30pm Environmental Drivers

- Salinity and Blue Catfish Habitat Use – Vaskar Nepal (VIMS)

4:50pm Wrap up Movement and Habitat Use

5:15pm End Day 1

Day 2

9:00am Welcome back

Theme II (cont'd): Science

C. Diet

9:15am Diet - What do blue and flathead catfish eat? How does this vary among tributaries and seasonally? How is this different from other catfish species?

- VT – Joe Schmitt
- SERC – Rob Aguilar
- MDDNR – Mary Groves

10:30am Potential Ecosystem Impacts - Can we quantify invasive catfish impacts on the ecosystem? Are they targeting species of concern?

- VT – Corbin Hilling

11:00am Wrap up Diet

BREAK

Theme III: Fisheries

11:15am Fishery Stats

Overview of commercial blue catfish harvest and recreational fishing activity in the Bay

- VMRC – Ryan Jiorle
- VDGIF – Bob Greenlee
- PRFC – Marty Gary
- MDDNR – Mary Groves

LUNCH 12:00-1:00pm

Theme III (cont'd): Fisheries

1:00pm Commercial Electrofishing Pilot Project - Matt Balazik (VCU), Bob Fisher (VIMS), George Trice (commercial fisherman), and Will Shuart (VCU)

1:20pm PCB/Contaminants Study (Drew Luellen- VIMS)

1:50pm USDA Regulations (Mike Hutt- Virginia Marine Products Board)

2:20pm Wrap up Fishery Discussion

BREAK

Theme IV: Looking Ahead

2:30pm Addressing Invasive Species with Fisheries: Case Studies

- Jason Goldberg/Susan Pasko of USFWS (remote)

3:00pm Industry and Fishery Stakeholder Perspectives (Panel)

- Commercial, recreational, processors, markets, non-profit

5:00pm Next Steps

- Management implications based on information heard at this workshop?
- Moving forward with science, monitoring, and fishery?

Appendix C. List of Attendees

Scientific experts and researchers:

Rob Aguilar	Smithsonian Environmental Research Center
Matt Balazik	Virginia Commonwealth University
Aaron Bunch	Virginia Department of Game and Inland Fisheries
Mary Fabrizio	Virginia Institute of Marine Science
Bob Fisher	Virginia Institute of Marine Science
Marty Gary	Potomac River Fisheries Commission, SFGIT Executive Committee
Jason Goldberg	US Fish and Wildlife Service
Bob Greenlee	Virginia Department of Game and Inland Fisheries
Mary Groves	Maryland Department of Natural Resources
Corbin Hilling	Virginia Tech
Ryan Jiorle	Virginia Marine Resources Commission
Drew Luellen	Virginia Institute of Marine Science
Vaskar Nepal	Virginia Institute of Marine Science
Susan Pasko	US Fish and Wildlife Service
Joe Schmitt	Virginia Tech
Will Shuart	Virginia Commonwealth University
Geoff Smith	Pennsylvania Fish and Boat Commission
Edna Stetzar	Delaware Department of Natural Resources and Environmental Control
George Trice	Commercial waterman
Troy Tuckey	Virginia Institute of Marine Science

Stakeholder panel:

Bart Farrell	Clyde's Restaurant Group
Neal Leatherwood	Commercial waterman
Captain Mike Ostrander	Recreational fishing guide (Discover the James)
Tim Sughrue	Congressional Seafood
George Trice	Commercial waterman

Workshop staff:

Sara Coleman	ERT, Inc. for NOAA
Kara Skipper	Chesapeake Research Consortium

Other participants:

Mike Bednarski	Virginia Department of Game and Inland Fisheries
Karl Blankenship	Bay Journal

Sean Corson	NOAA Chesapeake Bay Office, SFGIT Chair
Steve Ellis	NOAA Greater Atlantic Regional Fisheries Office
Corrin Flora	North Carolina Division of Marine fisheries
Dewayne Fox	Delaware State University
Tim Groves	Maryland Department of Natural Resources
Deb Iwanowicz	USGS Leetown Science Center
Ann Jennings	Chesapeake Bay Commission
Sara Mirabilio	North Carolina Sea Grant
Chris Moore	Chesapeake Bay Foundation
Rob O'Reilly	Virginia Marine Resources Commission, SFGIT Vice Chair
Don Orth	Virginia Tech
Tom Powers	VMRC Finfish Management Advisory Committee
Reid Priest	Virginia Commonwealth University
Wendy Stuart	Wide Net Project
Elise Trelegan	ERT, Inc. for NOAA
Bruce Vogt	NOAA Chesapeake Bay Office, SFGIT Coordinator
David Whitehurst	Virginia Department of Game and Inland Fisheries