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Virginia Institute of Marine Science

MARINE ADVISORY PROGRAM

A SUMMARY OF COLLABORATIVE DISCUSSIONS ON EXISTING MANAGEMENT WITHIN THE CHANNELED WHELK FISHERY

OCTOBER 2021

Samantha E. Askin
Robert A. Fisher
Virginia Institute of Marine Science
Marine Advisory Program
Virginia Sea Grant-Affiliated Extension

Sea Grant Virginia

INTRODUCTION

In 2014 during the 16th International Conference on Shellfish Restoration, representatives from states along the U.S. Atlantic coast from Massachusetts to Georgia discussed various strategies for management of the channeled whelk fishery. The purpose of that meeting was to initiate a collaborative effort among industry, academia, and regulatory agencies to address concerns related to the channeled whelk resource and to provide guidelines for the development of a sustainable whelk fishery along the U.S. Atlantic coast (Fisher 2015a). This was the first documented attempt to bring state managers together to address inconsistencies involved with what is known about channeled whelk biology and how the fishery is currently being managed. The session provided an extensive review on what biological information needs to be collected to properly assess current management regulations in whelk-producing states. However, by the end of 2020, many of the issues that were identified during the 2014 conference were still unresolved.

With the support of the Executive Committee of the Atlantic States Marine Fisheries Commission (ASMFC), a working group was put together to address existing concerns related to management inconsistencies among whelk-producing states in early 2021. Participants involved in this collaboration include: Robert Glenn, Dan McKiernan, Tracy Pugh, and Steve Wilcox from Massachusetts Division of Marine Fisheries (MAMDF); Shelley Edmundson from Massachusetts Marine Fisheries Advisory Commission; Tom Angell from Rhode Island Department of Environmental Management (RIDEM); Colleen Bouffard from Connecticut Department of Energy and Environmental Protection (CTDEEP); Kim McKown from New York Department of Environmental Conservation (NYDEC); Mike Auriemma from New Jersey Department of Environmental Protection (NJDEP); Rich Wong from Delaware Division of Fish and Wildlife (DDFW); Mitch Tarnowski from Maryland Department of Natural Resources (MDDNR); Patrick Geer and Alexa Galvin from Virginia Marine Resource Commission (VMRC); Bob Fisher, Jan McDowell, John Ward, and Samantha Askin from Virginia Institute of Marine Science (VIMS); Joe Facendola from North Carolina Division of Marine Fisheries (NCDMF); Ben Dyar and Wallace Jenkins from South Carolina Department of Natural Resources (SCDNR); and Carolyn Belcher from Georgia Department of Natural Resources (GADNR). In addition, Pat Campfield from ASMFC also provided a regional perspective on population monitoring and essential data needed for stock assessments.

The objective of the working group was to review existing biological and fisheries related information, determine what information is still needed, and to discuss appropriate management strategies for monitoring and management of the channeled whelk fishery along the U.S. Atlantic coast. Over the course of several weeks, meetings were held to initiate dialogue on potential cohesive management strategies within and between states. Meeting topics included information on biological assessments, population and stock assessments, individual state's whelk fishery management programs, and current descriptions of channeled whelk fisheries in each state (Table 1). The information on whelk biology, life history, and population demographics provided by each state will be useful in identifying stocks and the status of those stocks for conservation purposes. Information on fisheries data including

Date	Time	Topic
January 27, 2021	1:00 – 2:30 pm	Biological Assessments/Life History
February 3, 2021	1:00 – 2:30 pm	Population Information/Stock Assessments
February 10, 2021	1:00 – 2:30 pm	Individual State Management/Fishery Status
February 17, 2021	1:00 – 2:30 pm	Individual State Management/Fishery Status
February 24, 2021	1:00 – 2:30 pm	ASMFC Regional Perspective
March 3, 2021	1:00 – 2:30 pm	Final Discussion

Table 1. Schedule and agenda for channeled whelk working group meetings.

regulations, reporting, and landings were adapted from tables compiled by VMRC. The working group concluded with a final discussion to identify what management decisions are necessary for a more sustainable channeled whelk fishery, however future discussions are needed to address appropriate management strategies. This document is a compilation of biological, economic, and management information to provide support for whelk resource managers responsible for the whelk resource in each jurisdiction or individual state. The agreed upon goal of working group participants is to protect this valuable fishery from over-exploitation and the economic boom and bust cycles observed in other whelk fisheries. This report serves as a medium for documenting and facilitating conversations among scientists, state agencies, and industry members; and as such should be considered a living document.

HISTORICAL CONTEXT

BACKGROUND OF FISHERY – The channeled whelk (*Busycotypus canaliculatus*) supports a commercial whelk fishery within the United States. The fishery occurs throughout the US Atlantic Coast from Massachusetts to Georgia, with the majority of commercial fishing occurring in the mid-Atlantic and New England regions (Davis and Sisson 1988; Edwards and Harasewych 1988). Historically, channeled whelk have been harvested commercially and recreationally for decades. Between the 1960s – 1980s, participation in commercial whelk fisheries increased due to the reduced availability of fishing alternatives like shrimp, crab, and lobster (Davis and Sisson 1988; Power et al. 2009; Angell 2018). Additionally, changes in market demand fueled this economic boom in the whelk industry (Davis and Sisson 1988; Power et al. 2009; Peemoeller and Stevens 2013; Fisher 2015b). During this time there were inadequate fisheries regulations which resulted in fluctuations in channeled whelk landings. Channeled whelk fisheries in the 1990s – 2010s experienced boom and bust cycles that created issues with overexploitation, which ultimately highlighted the need for regulatory changes that would restore the whelk resource (Peemoeller and Stevens 2013; Fisher and Rudders 2017; Angell 2018; Nelson et al. 2018). States with major participation in the channeled whelk fishery have some knowledge on the current status due to reporting requirements that provide landings data. However, there is still insufficient biological data coast-wide that is crucial for understanding the status of channeled whelk populations in relation to current management regulations.

ECONOMIC IMPORTANCE – Since the 1960s, the channeled whelk resource has provided economic benefits to the fishing industry in the United States. Channeled whelk were originally seen as an opportunity for supplemental income as a winter fishery (Davis and Sisson, 1988). An unregulated commercial fishery developed in New England during the mid-1980s, and by the 1990s the channeled whelk fishery provided an important source of diversity and income for New England and mid-Atlantic commercial fishermen. During the 1990s whelk landings (processed whelk meat) reached 1.4 million pounds at $1.80 per pound, which generated approximately $2.5 million dollars in ex-vessel revenue (Fisher 2015b). Shellstock prices fluctuated between the 1990s – 2010s, but remained three times as high in 2010s than they were in 1990s (Fisher 2015a).

ADVANTAGES OF SOUND MANAGEMENT – Currently, the channeled whelk resource is managed state by state, with minimum legal sizes (MLS) and reporting requirements varying by state. The inconsistencies in MLS by state, including some states without MLS restrictions in place, provide an opportunity for a loophole fishery for the channeled whelk resource. A loophole fishery occurs in areas where regulations are not maintained, allowing resources harvested from states with regulations to be landed in states without or with less restrictive regulations. Available research summarized by participating states has demonstrated the susceptibility of channeled whelk to exploitation, with specific concern for genetically and geographically isolated stocks. While the spatial scale of connectivity among channeled whelk resources throughout their range along the US east coast is loosely known, managers' decisions would benefit from additional data that can further define distinct stock boundaries. In

addition to identifying the appropriate management scale across whelk-producing states, more uniform control on effort with mandatory reporting and monitoring of landings data needs to be addressed so that eventually appropriate management strategies can be established.

BIOLOGICAL ASSESSMENTS

MASSACHUSETTS – Multiple biological studies have been conducted on channeled whelk in Massachusetts waters. Peemoeller and Stevens (2013) and Stevens and Peemoeller (2016), collected channeled whelk from 2010-2011 in Buzzards Bay and examined age (counting opercula rings), size at sexual maturity (histology), and growth based on a mark-recapture study. Biological information collected included whole weight, standard length, lip width (maximum distance across the upper edge of the largest whorl), sex, and male penis length (2011 only). Massachusetts Division of Marine Fisheries (MADMF) collected samples from Buzzards Bay, Nantucket Sound, New Bedford Harbor, and Vineyard Sound in 2010-2011 and additionally from Nantucket Sound 2015 (Wilcox et al. 2021). Biological information included total weight, shell length (SL, spire apex to edge of siphonal canal), shell width (SW, maximum straight-line distance measured across shell perpendicular to shell length with opercular opening flat on surface), weight without shell, sex, gonad weight (both sexes), nidamental gland weight (females), age (opercula), growth, and seasonal change in female gonad cycles. Results from both studies found that there were no females mature at the original MLS (2 ¾" SW, 1992-2013). MADMF found that there were differences in the size and age of sexual maturity between the different areas sampled in Massachusetts waters. Female size at maturity was inversely correlated with water temperature within the study area. This trend was also detected when results from Peemoeller and Stevens 2013, Fisher and Rudders 2017, Angell 2018, and Wilcox et al.2021 were compared, with the largest female size at maturity occurring where water temperatures were the coolest. Massachusetts regulates harvest sizes by defining the gauge size used to measure whelk instead of a specific shell size. The current gauge size for 2021-2022 is equivalent to 3 5/16" SW measurement **(video tutorial)**. By regulation there will be a 1/8" gauge size increase every other year culminating with a whelk size equivalent of 3 7/8" SW in 2029, which is the size that 50% of the female whelk reach sexual maturity (L_{50}) in Nantucket Sound **(gauge increase information)**. Additionally, MADMF has collected size distribution data aboard commercial whelk trap boats in Massachusetts state waters in 2003, 2004, 2011, 2013, and 2015-present. On each trip the sampler identifies each whelk by species and measures its standard width to the nearest millimeter using a slide style measuring board as seen in Wilcox et al. 2021. All whelk are measured from each trap that is sampled. A truncation in the size distribution has occurred between commercial catch sampled in the early 2000s and recent years. There were fewer large whelk observed in the catch in recent years, specifically those larger than the female L_{50}. For additional information, please reference: **Wilcox et al. 2021**.

RHODE ISLAND – An ongoing biological assessment examining age, growth, size-at-maturity, and age-at-maturity of channeled and knobbed whelks in Narragansett Bay, Rhode Island has been conducted by Thomas Angell from 2012 – present; data collected from 2012-2017 was published in 2018 (Angell 2018). Both whelk species were sampled from areas throughout Narragansett Bay, Mount Hope Bay, and Little Narragansett Bay. Biological information collected for all whelks included: sex, SL, SW, shell height (SH, maximum straight-line distance measured across the shell parallel to shell length), total weight, weight without shell, age estimation (using opercula), gonad (males and females) and nidamental gland (females) weight, and penis length (males). A maturity scale was developed, and maturity status was assigned based on macroscopic visual and physical characteristics of the gonads and reproductive structures (size, weight, color, relative oocyte size, sperm accumulation). Data were aggregated by species and sex, with each species treated as a single population within RI state waters. Data analyses included:

estimates of age and growth rate (age at size), age-at-maturity, size-at-maturity, and gonadosomatic index (GSI). Female channeled whelk had the highest mean annual growth rates and reached MLS quickest and at the youngest age; the minimum legal shell length and width were attained at 8.5 years and 8.2 years respectively. Estimated age at 50% maturity (A_{50}) for female channeled whelk was 8.46 years and 7.35 years for male channeled whelk. Once half of the female whelk reached maturity, the time span for most of the remaining females to mature was relatively short, greatly increasing the reproductive potential of the population. Estimated age at 95% maturity (A95) for female channeled whelk was 9.83 years and 8.66 years for males. Estimated size at 50% maturity (SL50 and SW50) for female channeled whelk was 136.8 mm SL and 77.5 mm SW and male channeled whelk was 116.0 mm SL and 64.9 mm SW. Based on MLS of 136.5 mm SL (5.375") or 76.2 mm SW (3"), female channeled whelk are ≈45% mature (SL) and ≈32% mature (SW), while males are ≈100% mature (SL) and ≈98% mature (SW). Estimated size at 95% maturity (SL95 and SW95) for female channeled whelk was 152.0 mm SL and 84.6 mm SW, while the estimated size for males was 128.0 mm SL and 72.9 mm SW. For additional information, please reference: **Angell 2018**.

CONNECTICUT/NEW YORK – An assessment to determine the size at maturity of channeled and knobbed whelk in the waters of NY Marine District, including all of Long Island Sound, was conducted collaboratively by New York Department of Environmental Conservation (NYDEC), Connecticut Department of Environment and Energy (CTDEEP), Long Island University, Post Campus (LIU), and members on New York's (NY) whelk fishing industry from 2011 – 2018. Biological data was collected from 685 channeled and knobbed whelk samples collected by CTDEEP Long Island Sound trawl survey (n=414), NYDEC Peconic Bay trawl and Long Island Sound trap surveys (n=66) and NY whelk fishermen (n=205). Researchers at LIU collected and determined maturity for 137 whelks from Great South Bay on Long Island's south shore. Size at maturity for female whelks was determined by examining the relationship of ovary and nidamental weight versus SL and SW. Minimum size of maturity for female whelks was determined by examining the size where this relationship becomes exponential. This study found the minimum size of maturity for female channeled and knobbed whelks is 5 1/2" SL and 3" SW. This size did not vary temporally or spatially. This information is being used to establish a minimum size limit. For additional information, please contact **Kim McKown** at NYDEC.

DELAWARE – Age, growth, and maturity of the knobbed whelk were examined by Rich Wong from 2005-current, Delaware Division of Fish and Wildlife (DDFW), Department of Natural Resources and Environmental Control. Over 5,000 specimens have been examined for age, growth, or reproductive development. Initial ageing was described by opercular striations, with ageing of statoliths starting in 2010. Maturation/ovary development was assessed by macroscopic descriptions of whole gonads. A more definitive examination of oocyte development is currently being described by histology. No fishery-independent surveys exist, preventing formal quantitative population modeling of the State's whelk stocks (knobbed and channeled whelks). Key results included male and female Von Bertalanffy growth parameters and female size at maturity ogives. Yield-per-recruit analyses have been explored for the knobbed whelk. The main takeaway for management was that the onset of female maturity occurs sharply at 5" SL, and that by 5.5 to 6", the vast majority of females contain oocytes at late stages of development. These findings are being verified by histology. The Delaware MLS for the knobbed whelk is: 5" SL, 3" SW for knobbed whelk; and 6" SL, 3 1/8" SW for channeled whelk. The whelk dredge season is closed from June 16 to January 14. For additional information, please contact **Rich Wong** at DDFW.

MARYLAND/VIRGINIA – A biological assessment examining temporal and spatial variations in growth and reproductive parameters of channeled whelk in the mid-Atlantic was conducted by Robert Fisher and Dave Rudders from 2009 – 2011. Channeled whelk were sampled from three near-shore commercial harvest areas in Maryland and Virginia: Ocean City, Maryland (OC); Eastern Shore of Virginia (ES); and Virginia Beach, Virginia (VB). Biological

information collected for all whole whelks included: total weight, SL, SW, sex, GSI, yield, age (statolith), and growth. Channeled whelk populations from ES and VB had unimodal length-frequency distribution with a single peak at a SL less than the current MLS for those regions. However, channeled whelk populations from OC had a bimodal distribution with the smaller peak at a SL less than the MLS for that region and the larger peak at a SL greater than the MLS. The SL at 50% maturity varied by sex and sampling location. Males reached maturity at a smaller mean size in ES and VB than in OC, but size at maturation for females was similar between OC and ES with a smaller mean size in VB. Recruitment for the fishery was estimated to occur at ~6 years for VB and ~7-8 years for ES and OC. Under current MLS for each sampling location, females had a low probability (1 – 15%) of being sexually mature. Results indicate that current MLS are inappropriate for sustainable management of the channeled whelk resource. Size at maturity as estimated here indicates that immature female whelks are removed by the fishery under current MLS regulations, potentially impacting recruitment success and ultimately subjecting the whelk population to overexploitation. Given the life history information generated for channeled whelk fishery managers have a basis to re-evaluate fishery management strategies for this species to ensure the sustainability and productivity of the fishery and the resource. For additional information please reference: **Fisher 2015b**; **Fisher and Rudders 2017**.

POPULATION INFORMATION

MASSACHUSETTS STOCK ASSESSMENT – Nelson et al. 2018 from Massachusetts Division of Marine Fisheries (MADMF) conducted a stock assessment for channeled whelk in Nantucket Sound, from which most of the MA whelk (>70%) landings originate. The assessment used data collected through 2016 and included life history information (maturity and growth studies), fishery-independent indices of relative abundance generated by MADMF bottom trawl survey, and fishery-dependent data including landings and effort data reported by harvesters and length frequency data from commercial at-sea sampling. Multiple data-limited stock assessment methods were used in the assessment and results compared. The models used in the assessment were Catch Maximum Sustainable Yield (MSY), Depletion-Based Stock Reduction Analysis, Non-equilibrium Biomass Dynamics Model, Delury Model, Catch Curve Analysis, Statistical Catch-At-Age Model, Yield Per Recruit, Spawning Biomass Per Recruit, and Stochastic Projections. Results from model runs indicated that the Nantucket Sound channeled whelk stock was overfished and overfishing was occurring in all cases. Past harvest of channeled whelk had already depleted the resource at the time of the assessment. In order to rebuild the stock adequate spawning stock protection is needed as well as a reduction in fishery removals. Additional analysis estimated it would take 10 years to rebuild the stock if annual landings were capped at 255,000 pounds, 15 years with annual landings of 595,000, and 20 years with annual landings of 760,000. These estimates assume there is sufficient spawning stock left in the population. If the stock can be rebuilt to the biomass at maximum sustainable yield (BMSY) levels and have continued protection of spawning stock, then annual harvest levels between 1.2 and 1.6 million pounds are likely sustainable. For additional information, please reference: **Nelson et al. 2018.**

RHODE ISLAND STOCK ASSESSMENT – An initial stock assessment of the Rhode Island whelk and fishery was performed by Gibson (2010) using a biomass dynamic model (BDM) and an overfishing reference point of fishing mortality at maximum sustainable yield (FMSY = 0.33) was calculated. The BDM clearly showed that whelk abundance is strongly influenced by fishing mortality rate (F). High F rates above the FMSY =0.33 level result in low biomass; high whelk abundance occurs when the F is less than FMSY . Based on the available data at that time, it was concluded that FMSY =0.33 was an appropriate overfishing reference point and a fishing mortality rate target equal to 75% of FMSY (F=0.25) would provide a buffer between the overfishing threshold. Based on this initial stock assessment, F rate was at or below this level, indicating that overfishing was not occurring. Also, biomass was estimated to be near the BMSY reference level, so an overfished condition was not likely (Gibson 2010). The whelk

stock assessment was updated in 2014 to include data through 2013 and resulted in re-estimation of FMSY =0.40. As with the initial stock assessment, high fishing mortality rates above FMSY =0.40 resulted in low biomass; high whelk abundance occurred when the F was less than FMSY. The updated target F rate was 0.30. F had risen and was now estimated to be at or above FMSY, so overfishing was likely. Biomass remained at or above BMSY, however projections indicated that biomass would fall below BMSY if overfishing continued. The whelk stock assessment was updated again in 2017 to include data through 2016 and resulted in re-estimation of FMSY =0.53. As with the previous assessments, high fishing mortality rates above FMSY =0.53 result in low biomass; high whelk abundance occurs when the F is less than FMSY. The updated target F rate is 0.39. F has risen and is now estimated to be at or above FMSY, so overfishing is likely. Biomass is now below BMSY and projections indicate that biomass will continue to fall if overfishing continues (Gibson 2017). For Additional information, please reference: **Angell 2020**.

POPULATION GENETIC STRUCTURE – An assessment on the population genetic structure of channeled whelk along the US Atlantic coast was conducted by Askin et. al in 2020. Channeled whelk were sampled from ten commercial resource areas across the species' range from Massachusetts – South Carolina, with fine-scale sampling in the mid-Atlantic region. This assessment utilized single-nucleotide polymorphisms (SNPs) to estimate genetic diversity and delineate population genetic structures of the regions. The data revealed the presence of seven genetically distinct populations along the US Atlantic coast: 1) Buzzards Bay, Massachusetts; 2) Rhode Island; 3) "mid-Atlantic 1" (Ocean City, Maryland; Eastern Shore, Virginia; Light Tower, Virginia); 4) "mid-Atlantic 2" (Virginia Beach); 5) Pamlico Sound, North Carolina; 6) Wilmington, North Carolina; 7) Charleston, South Carolina. This study revealed complex population genetic structure and varying levels of genetic divergence. Additional sampling in between Maryland and Rhode Island is needed to address population genetic structure between the mid-Atlantic and New England on a finer scale. For additional information please reference: **Askin et. al 2020.**

CURRENT MANAGEMENT REGULATIONS

Current management regulations among whelk-producing states were reviewed during the working group. The type and amount of information gathered on effort and reporting in the channeled whelk varies by state (Table 2). Currently, not all whelk landings are reported by species, dealer reporting is not mandatory among all states, gear type is not always reported, and not every state conducts biological sampling (Table 2). The minimum legal size is not consistent among states, with some states lacking any kind of size regulation (Table 3). There is also some debate on which measurement is the most effective, and in some instances limited information provided to industry on how to properly measure whelk when harvested (although see **video tutorial from MA**). Most state have permit requirements; however, it varies depending whether it is species or gear specific, limited or open entry, and who can hold permits and how those permits can be transferred (Table 4). Additionally, the pot limits, fishing season, bycatch requirements, recreational fishing regulations, and under-sized harvest rules differ by state as well (Table 4). Collection (and monitoring of) landings data is not consistently collected among whelk-producing states. Moreover, there is insufficient information on type of gear used, average landings (lbs.), and recent landings trends. (Table 5). Pots are the primary gear used in the majority of states, with knobbed and channeled whelk being the primary species landed (Table 5).

FUTURE MANAGEMENT CONSIDERATIONS

DECISIONS FOR BEST MANAGEMENT PRACTICES – At the conclusion of the working group meetings there was a unanimous agreement that all states should implement mandatory commercial whelk fishery reporting requirements, including species and gear-specific landings and effort information. License and/or permit

	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA
Does your state collect landings statistics for whelk?	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Are whelk landings reported by species?	Yes	Yes	Sometimes	Yes	Sometimes	Yes	Yes	Sometimes	No	No	No
Is harvester reporting mandatory?	Yes	Yes, c.o.	Yes, c.o.	Yes, c.o.	Yes, b.o.	Yes	Yes	Yes	Yes, c.o.	Yes, c.o.	Yes, c.o.
Is dealer reporting mandatory?	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes
What year did reporting begin?	2000 – fisherman catch reports, 2005 – SAFIS	2006– SAFIS	2016	2011 – foodfish, lobster, crab, 2018 – permit holders	N/A	1976 – annual, 1998 – monthly	1994	1993	1978	1978	1989
What is the scale of temporal resolution?	Day	Day	Day	Day	N/A	Day	Day	Day	Day	Day	Trip
What is the scale of spatial resolution?	State Statistical Reporting Area	State Shellfish Harvest Area	State Waters Area Codes	NMFS State Sub Area	N/A	State Level Water Bodies	N/A	NMFS State Area or State Water Area	State Shellfish Growing Areas	State Near Shore General Trawl Zones, Hand Shellfish Ground	State Level Defined Zones
Is gear type reported?	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Limited	Yes	Yes	Yes
Are units of effort reported?	Yes	Yes	Yes	Yes	N/A	Yes	Trip	Limited	Trip	Yes	Yes
Does the state conduct biological sampling?	Yes - SW	Yes – (2012) SL, SW, SH	No	Yes - SL, SW, SH, weight (limited)	No	No	No	No	Yes - SL, SW, SH (optional), weight (optional)	No	No

Table 2. Summary of reporting by state. State abbreviations are: Massachusetts (MA), Rhode Island (RI), Connecticut (CT), New York (NY), New Jersey (NJ), Delaware (DE), Maryland (MD), Virginia (VA), North Carolina (NC), South Carolina (SC), and Georgia (GA). Notes: c.o. = "commercial only", b.o. = "bycatch only", SAFIS = "standard Atlantic fisheries information system", NMFS = "National Marine Fisheries Service".

requirements for commercial harvest of whelk are also necessary to effectively monitor and manage whelk fisheries (Table 2). Additionally, state-run monitoring programs to collect fisheries independent data will help eliminate knowledge gaps surrounding the biology of channeled whelk in different resource areas. Key data needs identified through this working group include understanding the SL, SW, age, age at sexual maturity, growth, and size at sexual maturity for whelk across the species range as well as the population connectivity between resources. States needing a framework for biological assessments can follow examples set by states that have already completed biological assessments. While it may be too early to identify if regional or state management in necessary, providing guidance on additional data needs for all states with an active channeled whelk fishery will help unify efforts and provide a baseline standard for data collection. After the knowledge gaps are filled, additional meetings will be needed to provide more detailed steps for management recommendations.

REFERENCE POINTS FOR FUTURE MANAGEMENT – VMRC suggested listing the pros and cons of each MLS measurement (SL, SH, SW) for use by individual states. DDFW agreed that not one measurement fits all states, however providing a description of each measurement could be useful for individual states. MDDNR voiced concern that some sort of understanding is needed surrounding the harvesting of channeled whelk before they have a chance to reproduce. Recently, MADMF enacted a long-term program for incremental adjustments to MLS, with a final MLS target of L_{50}. MAMDF stated L_{50} is not the optimum management strategy, however it was

	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA
Minimum Length Size Regulation	N/A	5-3/8" prior to July 2020	N/A	N/A	5"	6"	6"	5-1/2"	N/A	4-1/2"	N/A
Minimum Width Size Regulation	~3-5/16"	3" prior to July 2020	N/A	N/A	N/A	3-3/8"	3-3/8"	N/A	N/A	N/A	N/A
Minimum Height Size Regulation	N/A	2-1/4" as of July 2020	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Any Undersize Tolerance?	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Do you specify how to measure?	Yes, by defining gauge dimension and how to measure shell with gauge.	Yes, by defining shell height and how to measure shell with gauge.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3. Summary of size regulations by state. State abbreviations: Massachusetts (MA), Rhode Island (RI), Connecticut (CT), New York (NY), New Jersey (NJ), Delaware (DE), Maryland (MD), Virginia (VA), North Carolina (NC), South Carolina (SC), and Georgia (GA).

necessary to provide some level of reproduction prior to exploitation to enhance recruitment to the channeled whelk fishery. DDFW enacted a step-wise increase in MLS for the knobbed whelk fishery. In addition to the MLS adjustment, effort was tightly controlled by DDFW. The cut back in effort eventually allowed for the MLS to be reduced and ultimately provided some stability to the knobbed whelk fishery in Delaware. All states agreed that identifying the exploitation rate through mandatory reporting, landings information, and biological assessments (fisheries independent and dependent data) is necessary for understanding the long-term acceptable harvest rates for the channeled whelk fishery.

INDUSTRY CONSIDERATIONS – VIMS referred to the biological assessment that revealed a MLS at L_{50} was not appropriate for preventing collapse of the channeled whelk resource in the Mid-Atlantic. VIMS stressed that if best management practices (BMPs) revolve around MLS, it is unrealistic for industry to adhere to. As a reference, if Virginia jumps to a MLS of 6" industry would collapse because the resource at that size class is not there. Ideally BMPs would be focused around the biology of channeled whelk, with incremental adjustments of MLS being an initial step. In reality, management agencies have to adjust for the current status of the channeled whelk fishery in their respective states. The working group highlighted the need for collaborative efforts between industry and management agencies and stressed the inclusion of industry members in conversations moving forward. All states agreed that the economic success of the channeled whelk fishery is dependent upon the biological constraints of channeled whelk (slow growth, late maturation, direct development, reduced dispersal). It was also discussed that in the process of altering management regulations, it is important to consider how changes in MLS, gear type, or other harvest regulations will affect the channeled whelk resource economically. To better understand how management changes would impact industry, additional data are needed on indicators that are dominant in industry production decisions (e.g. price by size class or fishing trip costs).

CONCLUDING REMARKS

A more comprehensive look at the channeled whelk resource is needed to better assess how the channeled whelk resource differs among states along the Atlantic coast. ASMFC concluded that channeled whelk would not be considered a species managed by their group because channeled whelk are not a highly-migratory species. Additionally, ASMFC stated that more fisheries independent and dependent data are needed before making any sort of regional or multi-state decisions on management strategies. While several life history studies have

	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA
Permit Required	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Species or Gear Specific	Gear	Species	Gear	Species	N/A	Gear	Species	Both	N/A	Gear	Both
Non-resident Permit Holders	Yes	No	Yes	Yes	N/A	No	Yes	Yes	No	No	Yes
Open or Limited Entry	Limited	Both	Open	Limited	Limited	Open	Limited	Both	N/A	Open	Open
Permit Transfers Allowed	Yes	Yes	N/A	Yes	Yes	N/A	Yes	Yes	Yes	N/A	N/A
Transferability Restrictions	Yes	Yes	N/A	N/A	No	N/A	Yes	Yes	Yes	N/A	N/A
Multiple Licenses on a Vessel	No	2	N/A	Yes	No	N/A	Yes	2	No	No	N/A
Whelk Pot Limit	200	300	None	None	None	None	None	200	None	N/A	N/A
Whelk Fishing Season	Yes	No	No	No	No	Yes - Dredge	No	Yes - Dredge	No	Yes - Trawl	Yes - Trawl
Daily Trip Limit	Yes, for otter trawls and hand-harvest only	Yes	No	No	No	No	No	Yes	No	No	No
Whelk Bycatch in other Fisheries	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Whelk Bycatch Permit Required	No	No	No	No	No	No	No	No	No	No	Yes
Harvest Under-sized Whelk from other State*	No	No	N/A	N/A	No	N/A	No	Yes	Yes	Yes	No
Recreational Regulation	Yes	Yes	No	No	No	Yes	No	No	Yes	No	No
New Management Rules	Yes - a scheduled gauge increase	No	Yes - changes in minimum size and gear marking	Yes - changes in minimum size and gear marking	No	No	Yes - limited entry	No	No	No	No

Table 4. Summary of regulations by state. State abbreviations: Massachusetts (MA), Rhode Island (RI), Connecticut (CT), New York (NY), New Jersey (NJ), Delaware (DE), Maryland (MD), Virginia (VA), North Carolina (NC), South Carolina (SC), and Georgia (GA). *Can a fishermen harvest under-sized whelk that were caught in other states?

provided valuable biological information on channeled whelk, fisheries dependent and independent data are still widely deficient across the Atlantic coast. It was stated that regional management could provide the push needed for regulatory consistency based on life history measures, population dynamics, and fishery patterns; however, a greater effort in data collection (effort, landings, gear type, species caught) is first needed within states to provide consistency. Given the momentum from this workshop, the channeled whelk working group will meet again in Spring 2022 to continue conversations on the development of best management practices for the channeled whelk fishery. Those practices should serve as guidelines for agencies to develop regulations that compliment neighboring states when applicable. Several states have offered to organize this spring meeting to amend this living document to meet that goal.

There were concerns among states about the timeline to develop a fisheries management plan and the length of time until implementation. Stock assessments can take considerable time and effort (3+ years) to gather and synthesize data into a consistent format. States involved identified defining units across jurisdictional boundaries using genetics, size and maturity, and other productivity metrics as the next steps moving forward. For genetic analyses, additional channeled whelk tissue sampling should focus on the gaps between Maryland and Rhode Island and between Rhode Island and Massachusetts, which could provide a more fine-scale delineation of the

	MA	RI	CT	NY	NJ	DE	MD	VA	NC	SC	GA
Whelk Species Landed	Channeled and Knobbed	Channeled and Knobbed	Channeled and Knobbed	Channeled and Knobbed	Channeled and Knobbed	Channeled and Knobbed	Channeled and Knobbed	Channeled, Knobbed, and Lightning	Channeled, Knobbed, and Lightning	Channeled, Knobbed, and Lightning	Channeled, Knobbed, and Lightning
Primary Species	Channeled	Channeled	Channeled	Channeled	Knobbed	Knobbed	Channeled	Channeled	N/A	Knobbed	Knobbed
Gear Used	Pots, Trawls, Dredge, Hand	Pots, Trawls, Dredge, Hand	Pots, Trawls, Dredge, Hand, Hook and Line	Pots, Trawls, Dredge, Hand, Hook and Line	Pots, Trawls, Dredge	Pots and Dredge	Pots and Trawls	Pots and Dredge	Pots, Trawls, Dredge, Hand, Gill net	Trawls, Hand, Bycatch	Pots, Trawls, Hand
Primary Gear	Pots	Pots	Pots	Pots	Pots	Dredge	Pots	Pots	Pots	Bycatch	Pots Bycatch
Average Landings (lbs.) from 2015 - 2019	1,400,000	482,626	274,711	468,557	161,000 combined species	554,000 combined species	16,400	594,791 combined species	174,561	less than 1700	less than 2000
Recent Landing Trends	Declining	Declining	No trend	Increasing	No trend	No trend	Increasing	Declining	Declining	Stable	Declining

Table 5. Summary of landing data by state. State abbreviations: Massachusetts (MA), Rhode Island (RI), Connecticut (CT), New York (NY), New Jersey (NJ), Delaware (DE), Maryland (MD), Virginia (VA), North Carolina (NC), South Carolina (SC), and Georgia (GA).

population structure within the New England region and between New England and the mid-Atlantic regions. Additional sampling of channeled whelk for biological assessments should also extend to offshore areas (federal waters) where channeled whelk resources are targeted by commercial fisheries. Once sufficient data have been collected, individual states can perform stock assessments.

In discussion of most appropriate stock assessment models, many agreed that surplus production and/or age-based model approaches are best suited to whelk assessments. Another option discussed was the relatively new data limited methods (Depletion-based Stock Reduction Analysis or Depletion Corrected Average Catch) that are increasing in popularity specifically for circumstances similar to data poor channeled whelk fishery. The traffic-light approach using indicators on population status and fishery performance across historical years to compare to current year to gauge success of fishery could be another option to consider. Additionally, it would be beneficial to identify the harvest level and price per pound or total revenue that at a minimum would allow for harvest of mature individuals and provide economic stability for the channeled whelk fishing industry. All states agreed that addressing the truncated size structure of individuals, eliminating illegal, unregulated and undersized fishing, and reducing the number of depleted stocks should be a major focus of long-term goals for this fishery. Efforts should also focus on gaining trust from industry members to increase monitoring and reporting of qualitative and quantitative fishery-dependent data.

Future success of the channeled whelk fishery will require collaboration between management agencies and industry members, with long-term sustainable harvest requiring reduced landings for the foreseeable future. The average time from spawning to recruitment for channeled whelk is 7-9 years. Many fishermen involved may not necessarily see benefits of these conservation measures in their careers. The real challenge will be trying to convince fishermen to ignore the short-term economic gain for the long-term conservation effort. The working group sees this as a living document to be used for facilitating conversations between scientists, state agencies, and industry members. As scientists we strive to better understand industry perspective and identify needs and concerns related to the channeled whelk fishery and we encourage feedback from this document to better align our biological research needs with industry needs.

ACRONYMS AND ABBREVIATIONS

A_{50} – Estimated age at 50% maturity

ASMFC – Atlantic States Marine Fisheries Commission - **http://www.asmfc.org/**

B – Biomass.

BMSY – Biomass at maximum sustainable yield.

BMPs – Best management practices (to reduce over-fishing, rebuild stocks, and maintain sustainable harvest).

CTDEEP – Connecticut Department of Energy and Environmental Protection - **https://portal.ct.gov/DEEP**

DDFW – Delaware Division of Fish and Wildlife - **https://dnrec.alpha.delaware.gov/fish-wildlife/**

F – Fishing Mortality Rate.

FMSY – Fishing Mortality at maximum sustainable yield.

GADNR – Georgia Department of Natural Resources - **https://gadnr.org/**

L_{50} – Estimated size at 50% maturity.

MAMDF – Massachusetts Division of Marine Fisheries - **https://www.mass.gov/orgs/division-of-marine-fisheries**

MDDNR – Maryland Department of Natural Resources - **https://dnr.maryland.gov**

MLS - Minimum Legal Size.

NCDMF – North Carolina Division of Marine Fisheries - **https://deq.nc.gov/about/divisions/marine-fisheries/**

NJDEP – New Jersey Department of Environmental Protection - **https://www.nj.gov/dep/**

NYDEC – New York Department of Environmental Conservation - **https://www.dec.ny.gov/**

RIDEM – Rhode Island Department of Environmental Management - **http://www.dem.ri.gov/**

SCDNR – South Carolina Department of Natural Resources - **https://www.dnr.sc.gov/**

SH – Shell Height; maximum straight-line distance measured across the shell parallel to shell length.

SL – Shell Length; spire apex to edge of siphonal canal.

SW – Shell Width; maximum straight-line distance measured across shell perpendicular to shell length with opercular opening flat on surface.

VIMS – Virginia Institute of Marine Science - **https://www.vims.edu/**

VMRC – Virginia Marine Resource Commission - **https://www.mrc.virginia.gov/**

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ACKNOWLEDGEMENTS

Funding for this project was provided by VIMS Marine Advisory Program and Virginia Sea Grant. We would like to thank all members of the working group for their collaboration and contributions in developing this document. Formatting and design assistance of this document was provided by Jay Clark and Madeleine Jepsen of Virginia Sea Grant.

Additional copies of this publication are available from:

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Virginia Institute of Marine Science
MARINE ADVISORY PROGRAM

P.O. Box 1346 | Gloucester Point, VA 23062
Phone: 804.684.7164
Website:
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This work is a result of research sponsored in part by NOAA Office of Sea Grant, U.S.

Department of Commerce, under Grant No. NA180AR4170083 to the Virginia Sea Grant Program. The views expressed herein do not necessarily reflect the views of any of those organizations.

Sea Grant Virginia

COVER PHOTO BY ROBERT FISHER

VIMS MARINE RESOURCE REPORT NO. 2021-7 | VSG-21-5