Cownose Rays in the Chesapeake Bay: What do we know?

October 22, 2015

National Aquarium

Baltimore, MD

Photo credit: Becky Gregory/Flickr

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

Chesapeake Bay Program

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Acknowledgements

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

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Executive Summary

On October 22, 2015, the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team hosted a scientific workshop in Baltimore, MD on cownose rays in the Chesapeake Bay. Scientists presented their research results and discussed the related implications with fishery managers of the Executive Committee of the Sustainable Fisheries Goal Implementation Team. The objectives of the workshop were to discuss the state of knowledge on cownose rays in the Chesapeake Bay and how to determine the status of the population to inform any future fishery management.

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

Topic	Research Summary	Implications

Age, Growth and Reproduction	- Cownose rays are a K-selected species characterized by:
	  o Late maturity – Males mature at 6-7 years; Females at 7-8 years
	  o Long gestation periods – 11 months
	  o Low reproductive potential – 1 pup per mature female per year
	- Maximum life span is at least 21 years.
	- Average disc width at maturity is about 85 cm for males and females.
	- Females give birth once a year. Right after giving birth, mating occurs and females become pregnant again.
	  o Over a lifetime, a female cownose ray can produce a maximum of 15 pups.
	- Juvenile cownose rays (ages 2-4) are rarely observed in Chesapeake Bay studies. This may indicate that juveniles do not use the Chesapeake Bay habitat until they reach maturity.
		- K-selected characteristics make cownose rays susceptible to overfishing.
		- When a female is removed from Chesapeake Bay, a new recruit is also removed from the population due to the almost year-round gestation of mature females.
		- Unknown juvenile habitat use and migrations is a gap in understanding the full life history.
		- More research is needed to better understand habitat use and movements of males throughout their life history.

Population Dynamics	- Migrating schools of mature cownose rays enter the Chesapeake Bay in May each year to pup and to mate. o Mature females entering the Bay are near the end of their gestation period and give birth in June-July. Mating occurs soon after birth. - Males leave the Bay in June-July right after mating occurs. Research indicates that males may spend some time in offshore waters. More information is needed on male	- After July, mature males are no longer present in the Chesapeake Bay, so all fishing gear interactions in late summer are with females. - Research is underway to determine if individual cownose rays return to the same tributaries within the Chesapeake Bay to pup and mate each year.

	movements when they leave the Bay. - Females remain in shallow-water habitats in the Bay until mid-October. o Males and females migrate south together to their overwintering grounds off the Florida coast. - Unknown population size for the East Coast and Chesapeake Bay populations. - The cownose rays that use the Chesapeake Bay each summer are part of a larger cownose ray population along the U.S. East Coast. This population is distinct from cownose rays in the Gulf of Mexico. - Cownose ray populations have a very low intrinsic rate of population increase (minimal population growth from year to year).	- Cannot determine stock status or population trends without population estimates or abundance indices, respectively. - Cownose ray schooling behavior, especially large migratory schools along the coast, can affect aerial population estimates and influence public perception of an assumed prolific population. - Low rates of population increase suggest cownose ray populations are susceptible to overfishing.

Diet	- Cownose rays are opportunistic feeders.
	- Recent diet studies in Chesapeake Bay show that dominant prey items include softshell clams, macoma clams and razor clams. Oysters and hard clams were not a significant part of their diet.
	  o Diet composition is site-specific. Cownose rays sampled near on-bottom aquaculture areas had a higher percentage of oysters and/or hard clams.
	- Their mouths and jaws are designed to crush shellfish, but predation is limited by the bite force and jaw gape size.
		- Diet composition of individual cownose rays can depend on the sampling location and method.
		  - Fishery independent samples tend to minimize the loss of stomach content (due to regurgitation) and more accurately represent natural prey items.
		- Ongoing research includes development of genetic techniques to identify partially digested materials found in diet samples that were previously unidentifiable.

Shellfish Industry Interactions	- Historical and recent concerns of cownose ray predation on valuable shellfish resources are prevalent in the Chesapeake Bay region, especially in Virginia. - Although recent diet studies have shown that oysters and clams were not found to be significant portions of their diets, localized and intensive feeding on oysters or clams can occur.	- Ray-shellfish interactions can be a localized threat to shellfish restoration and aquaculture operations. These interactions need to be addressed. - Protection of smaller shellfish could help mitigate the threat of cownose ray

	o It takes more energy for cownose rays to feed on clustered oysters (i.e. spat-on-shell) than on single oysters. o Cownose ray predation is limited by bite force and gape size, so larger shellfish may be less susceptible to predation. - Researchers and industry in Virginia have been working to test various cownose ray predation deterrent devices.	predation. - Cownose ray predation deterrents can be costly. Some deterrents proved to be ineffective against cownose ray predation.
Fishing Pressure	• Cownose rays generally interact with shallow water gear types (e.g. pound nets, haul seines). • Cownose rays are caught in Chesapeake Bay as commercial bycatch and are targeted for recreational fishing (bowhunting). o Subsidized commercial bycatch in Virginia from 2007-2014. - Potential gear interactions in offshore areas could include trawls, gill nets, and other gears.	- Unknown fishing effort and mortality. Some landings data available for commercial bycatch in Virginia. - Not possible to differentiate male and female cownose rays from the surface. - Rays that are caught recreationally are not being used.
Marketing	- VIMS Advisory Services staff affiliated with Virginia Sea Grant worked with industry to launch a comprehensive marketing effort over the past several years for cownose ray product. Efforts included exploring domestic and foreign markets as well as working with local chefs and seafood buyers. - 30-34% of cownose ray flesh is usable for human consumption. - The irregular shape makes cownose rays time-consuming and expensive to process. - Venomous spines make them hard to handle. - To date, continued marketing efforts are not feasible due to low demand and high processing cost.	- Low demand and unsuccessful long-term marketing efforts seem to indicate that a commercial fishery is not feasible at this time. - If cownose ray did become a high value fishery with increased demand in the future, there is potential for overfishing. - A reduction fishery for cownose rays is not an effective solution for shellfish predation concerns.

Recommendations from the Researchers

- Conduct outreach to address the misconceptions about cownose rays in the Chesapeake Bay and throughout their range along the East Coast. Promote coordinated messaging across the region to communicate that:
    - Cownose rays are a highly migratory species along the Atlantic Coast that enter estuaries like the Chesapeake Bay for pupping and mating each year.
    - Cownose rays are not invasive.
    - Cownose rays are not a species of skate.
    - Cownose rays are a slow-growing, slow to mature, and low fecundity species.
- Explore the possibility of working with commercial and recreational fisheries to develop citizen science efforts to support cownose ray research.
- Better characterize and quantify all sources of fishing mortality (commercial bycatch and discards, recreational effort and discards) for cownose rays in the Chesapeake Bay waters and throughout their range along the Atlantic Coast.
- Continue working with the shellfish industry to develop effective cownose ray predation deterrents and mitigating devices. Consider recent research on cownose ray predation limitation (jaw gape size ad bite force) for larger shellfish.
- Prioritize and support continued cownose ray research to address information gaps, including remaining life history questions and estimates of population size and abundance indices.
- Based on the range and movement of cownose rays along the Atlantic Coast, discuss cownose ray research and management at relevant fishery management forums and agencies on the U.S. East Coast.

Introduction

Cownose rays have been and continue to be a species of public interest in the Chesapeake Bay. Historically, cownose rays have been seen as a threat to valuable shellfish species in the Chesapeake Bay and along the US East Coast. This concern continues today, especially as shellfish aquaculture and restoration efforts are increasing. In 2006, the Virginia Sea Grant Marine Advisory Program hosted a workshop to discuss these concerns and share information to help guide efforts moving forward (Fisher 2009). Since then, stakeholders in Virginia have explored the potential harvest of cownose rays and related seafood marketing efforts as a possible way to reduce the cownose ray population to protect shellfish resources.

Currently, cownose rays are not managed in the Chesapeake Bay, nor are they managed in other areas along the US East Coast.

Over the past decade, a number of research studies have been conducted to begin to address the many questions about cownose rays in the Chesapeake Bay, and elsewhere in their range. These studies on the life history and population dynamics of the cownose ray provide insights on their time spent in the Chesapeake Bay and resulting interactions with the fishing industry.

Recently, media has drawn attention to recreational bow-hunting tournaments targeting cownose rays in the Chesapeake Bay. These tournaments have been criticized for their controversial methods of killing the rays and the unknown effects on the cownose ray population.

At the June 2015 meeting of the Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team, the idea of a cownose ray workshop was proposed during the public comment session. The Team's Executive Committee supported moving forward with a workshop as an opportunity to convene cownose ray researchers to discuss the latest science and determine what is known about the Chesapeake Bay cownose ray population to inform future management discussions.

The Sustainable Fisheries Goal Implementation Team is a diverse group of managers, scientists and fishery stakeholders from across the Chesapeake Bay working to connect science to management decisions that cross jurisdictional boundaries. The Team's Executive Committee is chaired by the NOAA Chesapeake Bay Office and is comprised of fishery managers from the Maryland Department of Natural Resources, the Potomac River Fisheries Commission, the District Department of the Environment, the Virginia Marine Resources Commission and the Atlantic States Marine Fisheries Commission.

This report summarizes the research, discussion and recommendations from the workshop and includes references to the related scientific publications and reports.

Workshop Goal

Conduct a scientific workshop to characterize what is known about the life history and population dynamics of cownose rays in the Chesapeake Bay as well as fishing effort and ecosystem interactions. Identify a mechanism to determine the stock status of Atlantic cownose rays (*Rhinoptera bonasus*) in the Chesapeake Bay to inform future fishery management.

Workshop Participants

The workshop was based on content presented by cownose ray researchers and scientists. The Sustainable Fisheries Goal Team Executive Committee engaged in discussion with the scientists and provided insight into management questions and concerns. The workshop was open to the public and included time for public comment at the end of the workshop agenda. A full list of workshop attendees including the public is listed in Appendix C on page 28.

Scientific experts and researchers:

- Lyndell Bade, Colby College; formerly East Carolina University
- Tobey Curtis, National Oceanic and Atmospheric Administration
- Drew Ferrier, Hood College
- Bob Fisher, Virginia Institute of Marine Science, Marine Advisory Services
- Dean Grubbs, Florida State University Coastal and Marine Laboratory
- Tom Ihde, ERT, Inc. for the National Oceanic and Atmospheric Administration
- Jan McDowell, Virginia Institute of Marine Science, Department of Fisheries Science
- Matt Ogburn, Smithsonian Environmental Research Center
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Sustainable Fisheries Goal Team Executive Committee:

- Bob Beal, Atlantic States Marine Fisheries Commission
- Lynn Fegley, Maryland Department of Natural Resources (Fishery Manager)
- Marty Gary, Potomac River Fisheries Commission (Fishery Manager)
- Bryan King, District Department of the Environment (Fishery Manager; not in attendance)
- Rob O'Reilly, Virginia Marine Resources Commission (Fishery Manager)
- Peyton Robertson, National Oceanic and Atmospheric Administration (Chair)
- Bruce Vogt, National Oceanic and Atmospheric Administration

Life History

Overview of Age, Growth, Reproduction and Diet

Bob Fisher, Virginia Institute of Marine Science, Marine Advisory Services

Presentation Link

Research publications

Fisher, R.A. 2010. Revised 2012. Life history, trophic ecology, & prey handling by cownose ray, *Rhinoptera bonasus*, from Chesapeake Bay. Final Report to NOAA Chesapeake Bay Office for (NA07NMF4570324) Grant No. 713031. Link

Fisher, R.A., G.C. Call and R.D. Grubbs. 2013. Age, Growth, and Reproductive Biology of Cownose Rays in Chesapeake Bay. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science 5: 224-235. DOI: 10.1080/19425120.2013.812587

Fisher, R.A., G.C. Call and J.R. McDowell. 2014. Reproductive variations in cownose rays (*Rhinoptera bonasus*) from Chesapeake Bay. Environmental Biology of Fishes 97(9): 1031-1038. DOI: 10.1007/s10641-014-0297-9

Cownose rays (*Rhinoptera bonasus*) are a species of cartilaginous fish that, along with sharks, skates and other ray species comprise the elasmobranchs. Cownose rays are characterized by late maturity (males 6-7 years; females 7-8 years); long gestation (11 months); and low fecundity (1 pup per mature female per year). Cownose ray predators include cobia and nearshore shark species such as sandbar and dusky sharks as well as humans.

Migrating schools of cownose rays enter the Chesapeake Bay in May (when water temperature is about 17 degrees Celsius) and leave by mid-October. They are mostly observed in the Bay when aggregated in shallow water to forage or when mating. Cownose rays that use the Bay are only a fraction of a larger Western Atlantic population of cownose rays along the US East Coast.

Public perception has been divided among those who consider cownose rays as a threat (get rid of them), seafood (eat them), and elasmobranch species (protect them). Problems historically associated with cownose rays include:

- Feeding on valuable shellfish species along the Atlantic Coast, thus threatening valuable shellfish aquaculture and restoration efforts.
- Destruction of submerged aquatic vegetation when foraging.
- Interference with fisheries due to gear damage, feeding on catch and injury to humans. Cownose rays typically interact with shallow-water gear (haul seine, pound nets) and will consume anything collected in that gear type. They have venomous barbs that make them difficult to handle and can cause injury to humans.
- Public perception of the species is influenced by media coverage.

After the 2006 Virginia workshop on cownose ray predation on shellfish, efforts began to explore the potential feasibility of cownose ray harvest in Virginia. Potential positive outcomes from a cownose ray fishery could include possibly reducing predation pressure on valuable shellfish and serving as a source of income. Potential negative outcomes from a cownose ray fishery could include the potential of overexploitation due to the ray's slow growth and low fecundity, seafood marketing challenges and processing costs for cownose ray products.

Age and Growth

Males reach sexual maturity between 6-7 years and females reach sexual maturity between 7-8 years. At maturity, both males and females have an average disc width of about 85-86 cm. Males grow faster than females, but they reach a smaller maximum size than females. Female maturity was largely determined by the diameter of the largest ova or by observed pregnancy. Male maturity was determined using multiple criteria including the presence of sperm and calcification of the claspers (used for mating).

The oldest cownose ray observed in the Chesapeake Bay was a 21-year old female. The age and size distribution of cownose rays collected show a lack of immature rays (approximately ages 2-4) in Virginia waters. This indicates that these "teenage" cownose rays may not use the Chesapeake Bay habitats in the summer like the young-of-the-year and mature rays do.

Reproduction

When female cownose rays enter the Chesapeake Bay in May, they are three quarters of the way through their gestation period. Shortly after females give birth in June or July, mating occurs between mature females and males. After mating occurs, males leave the Bay and go to other summer habitats along the US East Coast, with females remaining in the Bay until September-October.

Generally, female cownose rays can only be pregnant with one pup at a time, resulting in the low fecundity (reproductive capacity) of one pup born per mature female per year. If a female in late stages of pregnancy becomes overly stressed, she may abort her pup. There is a common misconception that individual cownose rays can produce multiple pups per year, which is typically not the case. Other species of rays, such as the bluntnose and butterfly rays, can give birth to multiple pups each year.

Diet

Diet study results can depend on where and how the cownose rays were sampled. Fishery-dependent sampling results in a higher percentage of fish found in the ray stomach samples. This is due to cownose rays feeding on fish also captured in the fishing gear (i.e. haul seines or pound nets). Fishery-independent sampling provides better insight the natural prey species and diet composition of cownose rays. For Fisher's study in the Chesapeake Bay, fishery-independent stomach sampling showed bivalves and small crustaceans as dominant prey items in the diet. Of the bivalves, most were softshell clams. Only 2% were Eastern oyster and 3% were hard clams.

Diet composition is also site-specific. Cownose rays sampled near on-bottom aquaculture areas had a higher percentage of oysters and/or hard calms in their stomachs than those sampled in other areas. Cownose rays are highly opportunistic predators, and so will feed on oysters if other prey is not available.

The mouth, jaws and teeth of cownose rays are made for crushing shellfish, but they can be limited by their jaw gape size and crushing force. This makes it difficult for the rays to feed on larger shellfish. It takes more time and energy for cownose ray to feed on spat-on-shell clustered oysters vs. single oysters, but they are able to break down and feed on clustered oysters. Spat-on-shell may mitigate some predation, but will not eliminate the possibility of predation.

Comments/Discussion

- Cownose rays do not preferentially feed on commercially-important bivalves like oysters and hard clams in the Chesapeake Bay.

- Cownose rays are creative at finding food sources. Management needs assistance to figure out how to adapt to cownose ray interactions with shellfish. The oyster industry is still concerned that cownose rays can decimate their oysters.
    - Cownose rays are able figure out and bypass predation deterrent devices. In past experiments, they have breached magnetized devices, bubble fences and shell overlays. (Fisher and Stroud 2006; Mann et al. 2014)
    - More research and testing are needed on additional predation deterrent devices for the shellfish industry.
    - Cownose rays are a part of the ecosystem, and interactions with the shellfish industry will continue to occur.
- When a female is removed from the population, a new recruit is removed as well since mature females are pregnant for most of their time in the Chesapeake Bay.

Feeding Mechanics and a Historical Perspective on Cownose Ray Concerns

Dean Grubbs, Florida State University Coastal and Marine Lab

Presentation Link

Research publications

Fisher, R.A., G.C. Call and R.D. Grubbs. 2011. Cownose Ray (*Rhinoptera bonasus*) Predation Relative to Bivalve Ontogeny. Journal of Shellfish Research 30(1): 187-196. DOI: http://dx.DOI.org/10.2983/035.030.0126

Kolmann, M.A., D.R. Huber, P.J. Motta and R.D. Grubbs. 2015. Feeding biomechanics of the cownose ray, Rhinoptera bonasus, over ontogeny. Journal of Anatomy 227(3): 341-351. DOI: 10.1111/joa.12342

Cownose rays have been observed in the Chesapeake Bay for centuries and were recorded as early as John Smith in 1608. Historic observations cited high abundance and predation on shellfish associated with cownose rays. A common misconception is that cownose rays are invasive in the Chesapeake Bay, but they are a native species to the U.S. East Coast.

Aerial population surveys were conducted in the Chesapeake Bay in 1988, and a study by Blaylock (1993) estimated a population size of between 4 and 9 million rays in the Bay. One school of rays alone was estimated to be over 5 million individuals (Blaylock 1989). Very high levels of variance and uncertainty are associated with these estimates.

Over the past several decades, the Virginia oyster industry has engaged in many discussions on how to reduce cownose ray populations to protect shellfish species. The 2006 Workshop in Virginia focused primarily on these cownose ray interactions with shellfish.

The recent cownose ray diet work in the Chesapeake Bay (Fisher 2010) shows that small, soft shell clams and crustaceans make up most of their diets. Higher predation on oysters and hard clams were observed in cownose rays that were sampled on bottom aquaculture sites, but oysters were still only 5% of the diet at those sites.

The mouth, teeth and jaws of cownose rays are designed to crush shellfish for consumption. Shell depth is the limiting factor for what cownose rays can feed on. Oysters with a shell depth of 10-22mm have the highest probability of being consumed. Cownose rays tend to ignore the very small shellfish, and the jaw gape of cownose rays limits their ability to consume oysters with a shell depth greater than 26mm. Bite force could also be a limiting factor for oysters with a shell depth greater than 22mm. The maximum bite force of a cownose ray is about 500 Newton's, and 600-800 Newton's of force are required to fracture a shell with a 22mm depth. (Fisher, Call & Grubbs 2011)

Comments/Discussion

- Need to better convey how cownose ray diet varies spatially and temporally, and how that affects the utility of the information from diet studies.
    - The Eastern oyster is consistently a relatively small component of the diet despite the location in which they are captured and the sampling methodology.
- Are the unidentifiable "other" diet contents significant?
    - Research is moving toward being able to better identify a higher percentage of stomach contents.

Genetic Technique to Identify Shellfish Prey Items in Diet

Lyndell Bade, Colby College; formerly Eastern Carolina University

Presentation Link

Research publication

Bade, L.M., C.N. Balakrishnan, E.M. Pilgrim, S.B. McRae and J.L. Luczkovich. 2014. A genetic technique to identify the diet of cownose rays, *Rhinoptera bonasus*: analysis of shellfish prey items from North Carolina and Virginia. Environmental Biology of Fishes 97(9): 999-1012. DOI: 10.1007/s10641-014-0290-3

Visual diet analyses can result in a high percentage of unidentifiable and unknown prey types in stomach samples. Research focused on developing genetic techniques to help investigate cownose ray diets with a focus on shellfish prey, including the Eastern oyster, hard clam and softshell clams.

For Bade et al.'s study, Cownose rays were collected using a variety of fishery-independent and fishery-dependent methods from a site in Virginia waters and sites in North Carolina waters. Stomach samples were first analyzed visually, resulting in a high percentage of unknown tissue.

In order to identify the species comprising the unknown stomach contents, DNA primers were developed for each shellfish species of interest. PCR tests were then used with the DNA primers to check the unknown tissue for presence of those shellfish species. 215 samples of unknown stomach samples were tested from 33 cownose ray individuals. 45 stomach samples tested positive for one or more of the tested species. The three species that were found from Virginia cownose ray stomachs were stout tagelus clams (razor clams), Baltic macoma clams and softshell clams. The Eastern oyster and hard clams were not present in the stomachs.

This genetic methodology can be applied to future diet studies to determine if specific shellfish species are present in stomach content samples. It can also be used to test samples from digestive tracts (stomachs and spiral valves). The methodology can be expanded to include more shellfish and crustacean species.

Comments/Discussion

- Matt Ogburn (SERC): The Smithsonian Environmental Research Center is developing a database of DNA for fish and invertebrate species that can be used to identify species in future diet studies. This genetic database will allow for species identification (through DNA sequencing) in stomach material that cannot be visually identified.
- New genetic techniques, such as DNA sequencing, that are developed can be applied to future diet studies to analyze unidentifiable stomach and spiral valve samples.

Wrap-Up Discussion on Life History and Diet Studies

- Fishery managers note that there seems to be a major difference between watermen's observations of cownose rays decimating oyster bars and the results of these diet studies.
    - The signatures of cownose ray consumption are seen on oyster bars, so predation on oysters is happening. Need to emphasize the opportunistic feeding nature of cownose rays. They will consume oysters if given the opportunity, although it seems that they do prefer other prey species (i.e. softshell clams).
    - It takes a lot more energy for cownose rays to feed on spat-on-shell oysters than single oysters and other prey items.
- Managers want to know what effect cownose ray predation is having on the oyster population as a whole.
- Is there any threat to blue crabs from cownose ray predation?
    - Not really. Mud crabs are consumed by the rays, but blue crabs are fast and difficult to catch.

Population Dynamics

Population Changes: Do the reports match the biology?

Dean Grubbs, Florida State University Coastal and Marine Lab

Presentation Link

Research publication

Grubbs R.D., J.K. Carlson, J.G. Romine, T.H. Curtis, W.D. McElroy, C.T. McCandless, C.F. Cotton, J.A. Musick. 2016. Critical assessment and ramifications of a purported marine trophic cascade. Scientific Reports 6:20970. Link

There is substantial uncertainty around cownose ray population changes over time. A paper by Myers et al. in 2007 claims that decreases in shark populations have led to increases in cownose ray populations, which have in turn led to the collapse of shellfish stocks along the U.S. East Coast. Myers et al. (2007) used data from state fishery-independent surveys and estimated a very high intrinsic rate of population growth for cownose rays .The surveys they used, however, have very small sample sizes. Also, some oyster and shellfish collapses occurred in areas where there are no cownose rays, indicating that those collapses were not caused by cownose ray predation.

Recent analyses to better understand the growth of cownose ray populations (Grubbs et al. 2016) show that these high estimates of population growth rates may not by biologically possible. Estimates of age-specific survival of cownose rays in the Chesapeake Bay are not high enough to support these high population growth rates from Myers et al. 2007. Based on a conservative approach with 5 growth models (Grubbs et al. 2016), the intrinsic rate of population growth for cownose rays is estimated to be extremely low with a median rate of increase of 0.008 (range of -0.018 to 0.032 per year). This means that the population could be growing minimally from year to year, or it could even be slightly decreasing. Based on comparison to the growth rates of shark species, cownose rays may be more susceptible to overfishing than large coastal shark species.

Comments/Discussion

- There is a need for population surveys to monitor the cownose ray population over time. Aerial surveys could be effective because cownose rays swim near the surface. There is no baseline population size for cownose rays at this time.
- What signs would we see if the population was in danger of collapse?
    - Due to the schooling behavior of cownose rays, we may not recognize the warning signs of a low population in time.

Genetic Variation of Cownose Ray Populations

Jan McDowell, Virginia Institute of Marine Science, Dept. of Fisheries Science

Presentation Link

Research publications

Carney, S.I., D.M. McVeigh, J.B. Moss, M.D. Ferrier, and J.F. Morrissey. In review. Preliminary investigation of mitochondrial genetic variation in the cownose ray *Rhinoptera bonasus* from the

Chesapeake Bay and Gulf of Mexico. Submitted to the Journal of Fish Biology.

Fisher, R.A and J.R. McDowell. 2014. Discrimination of Cownose Ray, *Rhinoptera bonasus*, Stocks Based on Microsatellite DNA Markers. Final Report to NOAA Chesapeake Bay Office for (NA11NMF4570215) Link

Genetic Variation across the Cownose Rays' Range

(Research conducted from 2011-2013)

The cownose ray *Rhinoptera bonasus* is the only species of *Rhinopteridae* that occurs along the U.S. East Coast and Gulf of Mexico. Cownose rays are found from southern New England down to Brazil, including in the Gulf of Mexico, and possibly western Africa. Cownose rays in the Western Atlantic (US East Coast) use one of two known nursery and breeding grounds: Chesapeake Bay and Delaware Bay. The Gulf of Mexico is used for the same purpose by cownose rays that live in the Gulf and Caribbean Sea.

Genetic analyses using mitochondrial DNA sequencing were applied to cownose ray samples collected along the U.S. East Coast and the Gulf of Mexico (Fisher & McDowell 2014). Results show three distinct groups, which could indicate a historical separation between the Gulf of Mexico and U.S. East Coast cownose ray populations. Samples collected from Brazil and Colombia were also analyzed and showed that the cownose rays off of South America are genetically distinct from the Chesapeake Bay and Gulf of Mexico populations. (Fisher & McDowell 2014)

Microsatellite markers in *Rhinoptera bonasus* showed that there were no significant differences among U.S. East Coast samples from New Jersey, Virginia and North Carolina. This may indicate a single cownose ray stock along the U.S. East Coast. (Fisher & McDowell 2014)

Genetic Variation between the Chesapeake Bay and Gulf of Mexico

(Research conducted 2011-2015)

Similar genetic analyses using mitochondrial DNA sequencing were applied to 175 samples collected from the Patuxent River in Mechanicsville, MD; St. George Island, MD; Reedville, VA; and Tampa, FL. Results show that populations at each location have different levels of genetic variation. Within the Chesapeake Bay, different groups of cownose rays may use different areas of the Bay upon their return to forage, pup and mate each year. This could indicate some level of female philopatry, where females return to the same areas within the Bay each year to mate. This may indicate that females using the same area are related to one another.

Overall Conclusions

The Gulf of Mexico and Chesapeake Bay represent genetically distinct stocks of *Rhinoptera bonasus*. Research suggests that more than one species may be present in the Gulf of Mexico, but the multiple species do overlap in space and time. *Rhinoptera bonasus* found in Colombia and Brazil seem to be a third distinct stock. Female cownose rays may return to the same location to pup and breed each year. More research and analyses are needed to confirm these hypotheses.

Tracking Cownose Ray Movement

Pop-up Satellite Archival Tags

Bob Fisher, Virginia Institute of Marine Science, Marine Advisory Services

Presentation Link

Research publication

Omori, K.L. 2015. Developing Methodologies for Studying Elasmobranchs and Other Data-Poor Species. Master's thesis. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point. Link

Researchers at the Virginia Institute of Marine Science (VIMS) are using pop-up satellite archival tags (PSATs) to study the movement and migration patterns of cownose rays. PSATs are programmed to release from the animal after 90-180 days and transmit the stored data to satellites. PSATs measure temperature, depth and light levels. VIMS researchers tagged cownose rays in the summers of 2011 and 2013. 16 PSATs have been deployed on cownose rays to date. 5 have reported successfully, 9 released early and 2 tags were non-reporting.

Data from tagged females shows them exiting the Bay in September and migrating down the U.S. East Coast to their overwintering grounds off the Florida coast by December. The movement and migration patterns of immature cownose rays are still unknown.

It is largely unknown where males go after mating and leaving the Chesapeake Bay mid-summer. By August, only female cownose rays remain in the Bay. PSAT data from a tagged male in July-August shows deep dives occurring each night, which could only occur in areas of the outer continental shelf. Tag data has shown some male individuals moving into deeper, offshore waters and even heading north along the U.S. East Coast for the rest of the summer. They then head back down the East Coast in October to the same overwintering grounds as the females off the Florida coast.

PSAT tags are not as effective for smaller scale movements within the Chesapeake Bay. They are more effective for studying the longer migration patterns along the U.S. East Coast.

Acoustic Telemetry

Matt Ogburn, Smithsonian Environmental Research Center

Presentation Link

Researchers at the Smithsonian Environmental Research Center are currently using acoustic telemetry to study the movements of cownose rays, which will help inform the scale for any future fisheries management (tributary scale? Baywide? Coastwide?). Acoustic telemetry can detect small-scale movements of cownose rays within the Chesapeake Bay.

Passive acoustic telemetry technology utilizes a transmitter (VEMCO acoustic tag) that transmits a signal to passive receivers stationed at various locations. For this study, the transmitter is surgically implanted in individual cownose rays, and each transmitter has a distinctive code to identify individual rays. The transmitters have a battery life of 2-6 years.

To date, 47 cownose rays have been tagged. The rays were tagged and released in both Maryland and Virginia tributaries. The rays have been detected within the Chesapeake Bay and at many locations along the East Coast. Similar to the PSAT data, one tagged male left the Bay in July moved north, and then returned to the overwintering grounds in Florida with the females. Most tagged rays have been detected in Chesapeake Bay in summer, along the southeast US coast in spring and fall, and off of Florida between Cape Canaveral and Miami during winter.

Data on their movement in future summers will provide insight into their movements within the Chesapeake Bay and determine if individuals return to the same locations in Chesapeake Bay tributaries each year. Tagged young of the year rays will help identify juvenile habitat, which is currently unknown.

Comments/Discussion

- It is important to determine where immature "teenage" cownose rays go during the summer in order to understand the full life history. Continuing to track cownose ray movement will help collect this information.
- Further research and additional tagging depends on funding availability.

Fishing Effort and Marketing

Bob Fisher, Virginia Institute of Marine Science, Marine Advisory Services

Presentation Link

Related Publications

Fisher, R. (ed). 2009. Regional Workshop on Cownose Ray Issues Identifying Research and Extension Needs, Yorktown, VA, June 1-2, 2006. Virginia Sea Grant-09-06. VIMS Marine Resource Report 2009-06. Link

Fisher, R.A. 2012. Product Development for Cownose Ray. Final Report Submitted to the Virginia Marine Resources Commission. VIMS Marine Resource Report No. 2012-5. VSG-12-08. Link

Cownose rays generally interact with shallow water gear types (e.g. pound nets, haul seines), and are caught in the Chesapeake Bay as commercial bycatch. They are also targeted in recreational fishing tournaments (bowhunting). Fishing effort and mortality are not quantified, with the exception of landings data for 2007-2014 subsidized bycatch in Virginia. Cownose rays are not currently managed by jurisdictions in the Chesapeake Bay or along the US East Coast.

After the 2006 Virginia cownose ray workshop, Virginia explored the feasibility of cownose ray harvest as a potential predation control method to protect shellfish. From 2007-2014, the Virginia Marine Resources Commission subsidized commercial bycatch in order to provide cownose rays for product development. The Virginia Marine Products Board worked with the Virginia Institute of Marine Science, the Virginia Marine Resources Commission, seafood processors and the fishing industry to launch a comprehensive investigation into potential cownose ray seafood products and promotion to support markets for those products, which were marketed as the “Chesapeake Bay Ray.”

Approximately 30-34% of the cownose ray is edible and with 66-70% waste. Products explored for human consumption included whole wings, fillets and loins, liver oil and cartilage. The approximate cost to produce a vacuum-packed ray (fillet or steak) was $1.26 per pound. Analyses of ray meat shelf life and nutritional value were conducted for these consumable products. Other cownose ray products were explored, including bait for the Virginia whelk (conch) fishery, fertilizer, dog food and leather (made from the ray skin).

Marketing efforts included education and outreach components such as cooking demonstrations, recipe publications, media interactions and working with over 50 chefs. Efforts also included a public tasting where 89% of the over 200 participants rated the product highly. The product was also sampled at trade shows both domestically and internationally, including engaging with Asian markets and buyers.

Marketing challenges included a short harvest season making it difficult to provide a year-round supply, as well as a lack of familiarity among chefs on how to prepare and use the ray product. Overall, low demand from seafood distributors, retailers, chefs and consumers and the labor-intensive, expensive processing of the ray’s irregular shape present significant marketing challenges for cownose ray products.

Comments/Discussion

- If cownose rays become a high value fishery, the species could become depleted quickly.
    - When a female cownose ray is harvested in the Bay, a recruit is also removed from the population since the females are always pregnant while in the Bay.
    - It is not possible to distinguish male and females from the surface of the water.
- Need to collect information on cownose ray fishing mortality. Currently, there is a lack of information on the levels of recreational harvest and commercial bycatch (with the exception of Virginia's landings data for 2007-2014 subsidized bycatch).
- Potential gear interactions in offshore areas could include trawls, gill nets, and other gears.
- It seems that interest in bowhunting is growing. Cownose rays that are harvested in these tournaments are not used for any products and carcasses are being discarded either on land or in the water.
    - Wanton waste laws do exist in Maryland and Virginia, but they are mostly for terrestrial game species.
- If a managed fishery ever developed in the Chesapeake Bay, It would most likely be a bycatch fishery. Coastal sharks are managed as bycatch fisheries with a bycatch harvest cap.

Considerations Moving Forward

Discussion-Workshop Participants

How can we mitigate cownose ray interactions with valuable shellfish species?

- The cownose ray is and will continue to be an issue for the shellfish industry. It is important to emphasize the opportunistic feeding nature of rays.
- Bob Fisher (VIMS) hopes to continue and build on past efforts to research predation deterrents and mitigation devices for the shellfish industry in Virginia.
    - Can we improve predation deterrence by identifying times and places where cownose rays are most likely to impact the oyster industry?
- Bruce Vogt (NOAA) asked about possible mitigation techniques. Could floats or cages be used for aquaculture?
    - Bob Fisher (VIMS) pointed out that it is very labor intensive to containerize shellfish.

How can we determine the population status of cownose rays?

- Scientists agree that abundance indices need to be developed and should include data from the broader U.S. East Coast in addition to Chesapeake Bay-specific data. Cownose rays that use the Chesapeake Bay are part of the larger US East Coast population.
    - The workshop report will include a list of potential cownose ray population data sources from along the Atlantic Coast.
    - Fishery managers emphasized the need for a fishery-independent abundance index.
    - Lack of funding and resources is a limiting factor in developing these indices and conducting additional research on cownose rays.
- Need to collect information on fishing mortality of cownose rays.
    - Peyton Robertson (NOAA) suggested that the jurisdictions begin requiring registration of bowhunting tournaments in order to quantify the fishing effort and harvest of rays from these tournaments.
    - Bob Fisher (VIMS) and Rob O'Reilly (VMRC) emphasized that it will be important to collect data from all sectors and gear types that interact with cownose rays, not just bowhunters.

Could researchers work with bowhunters to support future research efforts?

- Drew Ferrier (Hood College) suggested a citizen science effort would be possible. It could be a tagging effort or an effort to perform biopsies and obtain tissue samples.
- Lyndell Bade (Colby College), Drew Ferrier (Hood College) and Bob Fisher (VIMS) have all worked with bowhunters previously to obtain cownose rays samples for their research.

Will the marketing efforts in Virginia continue?

- Due to lack of demand and high processing costs, the subsidized bycatch and related marketing efforts for cownose rays in Virginia will not continue as of now.
- Economically, cownose ray products are not profitable at this time and there is no market to support a fishery.
- The subsidized commercial bycatch landings in Virginia have decreased since peaking in 2008.

How do we communicate information from the workshop to the public and address any misconceptions about cownose rays?

- The translation and communication of this scientific information to stakeholders and decision-makers will be critical moving forward.
- Dean Grubbs (FSU) stated that once we communicate to the public and industry about the common misconceptions, some people may change their actions. The false narrative of "Save the Bay, Eat a Ray" has been the message for a long time now.
- Peyton Robertson (NOAA) pointed out that since the 2006 workshop in Virginia, there has been a lot of new research and knowledge.
- Public outreach needs to include specific messaging about dispelling myths about cownose rays.

Do cownose rays have negative impacts on seagrass habitat?

- Based on Bob Fisher's (VIMS) recent discussions with J.J. Orth at VIMS about this topic, cownose ray destruction of SAV beds no longer seems to be a major issue. Cownose rays may have had more interaction with SAV beds in the past when both softshell clams and SAV were more abundant, since softshell clams are a favored prey item and are associated with SAV habitats.
- Traces of SAV were still found in the stomach samples from the recent diet studies.
- It is possible that cownose ray feeding in soft sediments and grass beds can have positive ecosystem effects by aerating the bottom and bringing up worms and other species. Fish may follow the rays and eat these small prey items, and the aeration might also help with softshell clam settlement or other ecosystem processes.

What are the current conversations within the jurisdictional management agencies?

Virginia (Rob O'Reilly – Chief of Fisheries Management, VMRC)

The Virginia Marine Resources Commission had previously discussed a proposal that would ban bowhunting of all ray and skate species in Virginia waters. At this workshop, Dean Grubbs (FSU) informed the workshop participants that only the cownose ray has near-surface swimming behavior that would make it accessible to bowhunters. In addition, the workshop participants noted the importance of recognizing that mortality to rays is not confined to one specific gear type.

These facts have altered the advice that VMRC staff will provide to its Commission, in January 2016, concerning bowhunting of cownose ray. The VMRC staff will initially contact and register bowhunting clubs and promote non-wasteful hunting practices, while requesting tallies of cownose ray. There may need to be a regulation that specifies these requirements. In addition to bowhunting tournaments, mortality from commercial bycatch and discards needs to be taken into account. The VMRC will inform commercial harvesters via its website and Commercial Fishing Newsletter of the need for enumeration of these by-catch mortalities. In January 2016, staff will provide information to the Commission to help inform their discussions and to begin to address misinformation about cownose rays.

It will be extremely challenging to change behavior of any user group, since the perception of rays as a threat has been influencing industry decisions for many years. Explaining the findings of the recent diet studies will be very important. We need to explain these results in terms of effects on the resource, as in: what impact is cownose ray predation having on shellfish populations overall?

Potomac River Fisheries Commission (Marty Gary – Executive Secretary, PRFC)

It would be beneficial to start this process of collecting data on fishing effort, perhaps through free permits or another mechanism to obtain data from the tournaments. This issue will be brought to the Potomac River Fisheries Commission's Finfish Advisory Committee and to the full Commission for discussion on potential actions moving forward.

Maryland (Lynn Fegley – Deputy Director, Fisheries Service, MD DNR)

In Maryland, the Department of Natural Resources does not have direct authority to manage cownose rays, which means that Maryland does not currently have authority to require the registration of cownose ray tournaments, although this could be done on a voluntary basis as part of a pilot program.

Maryland has a couple of avenues to acquire direct authority to implement a management program for cownose rays, both of which require information which is currently unavailable including population status and fishing levels relative to population health. One avenue is to declare the species "In Need of Conservation" – this regulatory action would require the State to demonstrate that the species may become threatened in the foreseeable future and that the species has a limited or declining population. A second means for comprehensive management would be to develop a Fishery Management Plan (FMP) for cownose rays. An FMP has several statutory requirements for included information such as the condition of the fishery relative to current and historic populations. Limited data on cownose ray populations, fishing levels, fishing effort, etc. render each of these options problematic at this time.

Maryland could use its authority on recreational gear to create some limits on types of gear to be used in the harvest of cownose rays. It is unknown if fishing levels are currently to high relative to the coastal population and using limited authority to manage certain gears would not solve a biological problem because it is unknown how many animals are killed by differing recreational and commercial fishing gears. Overall, Maryland's objective is to manage the biological sustainability of the resource.

Recommendations from the Researchers

The workshop scientists developed the following list of recommendations based on their research and discussions from the workshop.

- Conduct outreach to address the misconceptions about cownose rays in the Chesapeake Bay and throughout their range along the East Coast. Promote coordinated messaging across the region to communicate that:
    - Cownose rays are a highly migratory species along the Atlantic Coast that enter estuaries like the Chesapeake Bay for pupping and mating each year.
    - Cownose rays are not invasive.
    - Cownose rays are not a species of skate.
    - Cownose rays are a slow-growing, slow to mature, and low fecundity species.
- Explore the possibility of working with commercial and recreational fisheries to develop citizen science efforts to support cownose ray research.
- Better characterize and quantify all sources of fishing mortality (commercial bycatch and discards, recreational effort and discards) for cownose rays in the Chesapeake Bay waters and throughout their range along the Atlantic Coast.
- Continue working with the shellfish industry to develop effective cownose ray predation deterrents and mitigating devices. Consider recent research on cownose ray predation limitation (jaw gape size ad bite force) for larger shellfish.
- Prioritize and support continued cownose ray research to address information gaps, including remaining life history questions and estimates of population size and abundance indices.
- Based on the range and movement of cownose rays along the Atlantic Coast, discuss cownose ray research and management at relevant fishery management forums and agencies on the U.S. East Coast.

Appendix A. References

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Appendix B. Workshop Agenda and List of Attendees

Cownose Rays in the Chesapeake Bay: What do we know?

Thursday, October 22nd, 2015

National Aquarium, Baltimore, MD

Workshop Goal: *Characterize what is known about the life history and population dynamics of cownose rays in the Chesapeake Bay as well as fishing effort and ecosystem interactions. Identify a mechanism to determine the stock status of Atlantic cownose rays (Rhinoptera bonasus) in the Chesapeake Bay to inform future fishery management.*

This is a scientific workshop bringing together experts to discuss the latest research and the broader context of what we know about cownose rays in the Chesapeake Bay. Time is allotted for brief public comment. Written public comments can be submitted for inclusion in the final workshop report. There are no policy decisions being made at this workshop.

8:30am **Light Breakfast (provided for workshop participants and organizers)**

9:00am **Welcome from the National Aquarium and Sustainable Fisheries Goal Implementation Team (Chair, Peyton Robertson-NOAA)**

- Introductions
- Workshop Context
- Review workshop agenda and objectives

9:30-11:00am **Life History: Age, Growth, Reproduction and Diet**

- Overview - Bob Fisher (VIMS)
  - Historical concern of shellfish predation and prey preference – Dean Grubbs (FSU)
  - Diet Study: New Genetic Technique – Lyndell Bade (formerly ECU)
- Discussion
  - Predation on oysters, soft and razor clams
  - Vital Rates/Demographics: Fecundity, age of maturity, longevity

11:00-12:20pm **Population Dynamics**

- Background on Population Change Over Time – Dean Grubbs (FSU)
- Tagging and Acoustic Telemetry Research – Matt Ogburn (SERC)

and Bob Fisher (VIMS)
- Genetic Diversity – Jan McDowell (VIMS)
- Discussion
  - Population connectivity
    - How are individuals using habitat in the Bay?
    - Are there specific places individuals return to?
  - Question of population size

12:20-1:00pm **Lunch (provided for workshop participants and organizers)**

1:00-1:30pm **Fishing Effort Summary**
- Marketing and Current Fishing Activities – Bob Fisher (VIMS)
- Discussion
  - What data exist on catch of cownose rays?

1:30pm **Discussion: Where do we go from here?**
- What science questions are most important for management? How can we answer those questions?
- What datasets/indices currently exist?
- How can we determine the status of cownose rays in the Chesapeake Bay?
- Scientific considerations for management?

3:30-3:50pm **Public Comment**

3:50-4:00pm **Wrap-Up and Recommendations**

Post-workshop:
A workshop report will document the proceedings and serve as the most recent collective scientific input on cownose rays in the Chesapeake Bay. Include a literature and data review.

Thank you!
- ✓ Workshop participants
- ✓ Chesapeake Bay Program's Sustainable Fisheries Goal Implementation Team
- ✓ National Aquarium, especially Laura Bankey
- ✓ NOAA Chesapeake Bay Office
- ✓ Sonja Fordham

Appendix C. List of Attendees

Scientific experts and researchers:

Lyndell Bade	Colby College; formerly East Carolina University
Tobey Curtis	National Oceanic and Atmospheric Administration
Drew Ferrier	Hood College
Bob Fisher	Virginia Institute of Marine Science, Marine Advisory Services
Dean Grubbs	Florida State University Coastal and Marine Laboratory
Tom Ihde	ERT, Inc. for the National Oceanic and Atmospheric Administration
Jan McDowell	Virginia Institute of Marine Science, Department of Fisheries Science
Matt Ogburn	Smithsonian Environmental Research Center
Howard Townsend	National Oceanic and Atmospheric Administration

Sustainable Fisheries Goal Team Executive Committee

Bob Beal	Atlantic States Marine Fisheries Commission
Lynn Fegley	Maryland Department of Natural Resources (Fishery Manager)
Marty Gary	Potomac River Fisheries Commission (Fishery Manager)
Bryan King	District Department of the Environment (Fishery Manager; not in attendance)
Rob O'Reilly	Virginia Marine Resources Commission
Peyton Robertson	National Oceanic and Atmospheric Administration
Bruce Vogt	National Oceanic and Atmospheric Administration

Workshop Staff

Laura Bankey	National Aquarium
Emilie Franke	ERT, Inc. for the National Oceanic and Atmospheric Administration (report lead)
Kara Skipper	Chesapeake Research Consortium

Agency Staff and Sustainable Fisheries Goal Team Members

Rob Aguilar	Smithsonian Environmental Research Center
Simon Brown	Maryland Department of Natural Resources
Nancy Butowski	Maryland Department of Natural Resources
Bill Goldsborough	Chesapeake Bay Foundation
Mike Luisi	Maryland Department of Natural Resources
Sarah Widman	Maryland Department of Natural Resources

Public Observers (*provided verbal public comments)

Howard Edelstein	Fish Feel
Mary Finelli*	Fish Feel
Sonja Fordham*	Shark Advocates International
Emily Hovermale	Humane Society of the United States
Kathryn Kullberg*	Humane Society of the United States (public comment on workshop webpage)
Jack Cover	National Aquarium
Alan Henningsen	National Aquarium
Jennie Janssen	National Aquarium
Andrew Pulver	National Aquarium
Brent Whitaker	National Aquarium

Appendix D. Available Population Data for the Atlantic Coast

Workshop scientists are compiling information on available cownose ray population data from along the U.S. East Coast. This information will be added to this report in mid-2016.