



Sharks and Rays 101: A Virtual Program Connecting Families with Estuary Research

ACTIVITIES AND
PROGRAM MODELS

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ABSTRACT

Virtual programming presents new opportunities to connect learners with aquarium ambassador animals, communicate science, and foster appreciation of coastal habitats. Educators can share additional resources, such as video footage and researcher presentations, that would otherwise be unavailable to aquarium guests viewing exhibits. Starting in the summer of 2020, the University of Georgia Marine Education Center and Aquarium (MECA) hosted new virtual public programs, including a Sharks and Rays 101 webinar. This webinar was offered twice; in summer 2020 it had 46 attendees, including 17 children and 29 adults, and in spring 2021 it had 25 attendees, including 6 children and 19 adults. The webinar used a place-based approach, introducing local elasmobranch species and shark nursery research conducted in Georgia estuaries. Estuaries are important nursery habitats for many shark species and areas where individuals recreationally fishing may interact with elasmobranchs. Activities included a virtual visit featuring a stingray and skate, participant polls, Q & A with a researcher, and interpreting maps from shark surveys. The program was evaluated with a voluntary survey and pre- and post-tests. Surveys indicated that future webinars, including those for adults, could increase engagement by incorporating videos of ambassador animals, polls, and limiting slide presentation length. An accompanying classroom activity was developed to extend learning after the webinar, utilizing a recording of the live event. This paper describes the webinar, shares the classroom activity, and suggests modifications that may be used by other educators to virtually teach about shark nurseries in estuaries.

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This paper describes a virtual family public program hosted by University of Georgia Marine Education Center and Aquarium (MECA), using elasmobranch ambassadors to teach about estuary research and conservation. In the summer of 2020, MECA transitioned to virtual public programming as a safety precaution during the COVID-19 pandemic. While challenging, the shift to a virtual format presented MECA educators with a new opportunity to tie together the live animal encounters on exhibit with research about those animals' habitats. Aquariums offer a venue for communicating research with a mixed-age audience because families constitute a large portion of aquarium visitors, and the social dynamics within these groups contribute to the learning of both the children and adults involved (Briseño-Garzón, Anderson & Anderson 2007).

There are a variety of virtual formats available, including webinars (Mitchell, Culbertson & Sutton 2015), live webcams of exhibits in zoos and aquariums (Jarret 2021), and even longer-format interactive virtual camps (Kast et al 2021). Animal webcams provide the opportunity for real-time remote observation of animals (Jarret 2021) but do not typically include interaction from the viewer. In contrast, webinars incorporate interactivity, typically with audience questions or comments for a knowledgeable presenter (Mitchell, Culbertson & Sutton 2015). Some online educational programs expand interactivity to include group work, learner presentations, and artistic creations (Kast et al 2021).

In contrast to the virtual camp led by Kast et al (2021) whose audience was youth only; virtual family public programs bring together both child and adult public participants. Due to the safety precautions needed for online public programming with mixed ages, MECA chose to use a videoconferencing software platform, Zoom Webinar, that can host larger groups and limits participants' ability to share their video compared to other platforms such as Zoom Meetings. To eliminate confusion around the term, "Zoom Webinar" will be used when discussing the specific software choice used by MECA, and "webinar" to refer to any live online educational presentation.

Webinars have been a venue for scientists to share their research with the public (Mitchell, Culbertson & Sutton 2015), and the use of this format for communicating science continued to increase during the COVID-19 pandemic (Meyer et al 2021). Webinars allow people to participate from a wider geographic area and can remove financial barriers to attending (Mitchell, Culbertson & Sutton 2015). However, access to the internet can limit accessibility, and the lecture format can be challenging for maintaining audience interest (Mitchell, Culbertson & Sutton 2015; Robideau & Matthes 2021). Using visual aids is recommended as a best practice to increase engagement in webinars; however, many of the existing suggestions are about improving presentation slides (Mitchell, Culbertson & Sutton 2015; Robideau & Matthes 2021). Aquarium educators, however, are used to teaching without slide presentations and can contribute to expanding the type of visuals used in webinars, such as incorporating the interpretation of live video footage at aquarium exhibits.

Live animals are a key component of marine education at aquariums and generate interest among the public to attend programming (Ballantyne et al. 2007; Briseño-Garzón, Anderson & Anderson 2007). Tapping into this public interest for animal ambassadors presents an opportunity for marine educators to simultaneously foster ocean literacy beyond that species. One approach is to invite a researcher to present how the featured animals interact with their marine habitat, sharing relevant findings for the public to make informed decisions about using coastal areas.

The Sharks and Rays 101 public program hosted by MECA provides an example of how webinars can be a tool to teach about conservation by combining both virtual interactions with live animals and research presentations within a place-based framework. Place-based education draws on the lived experiences of learners to foster care and understanding of local areas (Smith 2002). Sharks and Rays 101 applies this approach by introducing animal ambassador species specifically found in the South Atlantic Bight, the section of coastal water stretching from Cape Hatteras, North Carolina, to Cape Canaveral, Florida. These highlighted species live in shared coastal waters that the attendees use for recreational activities such as swimming and fishing. The research presented was conducted in this area, as well.

INSTRUCTIONAL CONTEXT

Sharks and Rays 101 was offered twice, in summer 2020 and spring 2021, serving 71 total participants. Forty-six people attended the 2020 webinar, including 29 adults and 17 children ranging in age from 4 to 17 years old. In 2021, 25 people attended including 19 adults and 6 children, 8 to 14 years old. The webinar was open to all ages but was designed and marketed for people 10 years old or older. Safety precautions were taken due to the mixed-age audience in a virtual setting, including removing the option for participants to chat with each other, not allowing participants to share video or audio, and requiring that all program participants under 18 years old be supervised by an adult at their location for the duration of the class. A recording was also taken of the live Sharks and Rays 101 webinar, which was close-captioned, and posted for additional public viewing on the UGA Marine Extension and Georgia Sea Grant YouTube page (Supplemental File 1). A classroom activity, “Shark Nursery Study” for sixth-grade students that pairs with the recorded virtual Sharks and Rays 101 program (Supplemental File 2) is also shared here. Formal classroom educators should be aware that evaluation of the efficacy of the activity was conducted with a public, mixed-age audience in an informal learning format.

VIRTUAL LOGISTICS AND EQUIPMENT

The program described was presented using the Zoom Webinar video-conferencing platform. Two educators and a moderator led the program. As shown in [Figure 1](#), one educator taught from the aquarium, using a phone on a gimbal and headphones. The other educator taught from their office using a computer with a Logitech webcam. Pre-registration was required but was kept open until the start of the program. The moderator welcomed the group and monitored the chat and Q & A box. Moderators for virtual public programs included undergraduate interns that could work from a remote location and still gain experience in marine education.



Figure 1 Equipment set up for the Sharks and Rays 101 virtual public program.

Figure notes: The public program was filmed from an iPhone SE cellphone. The grey device holding the phone is called a gimbal and was used to hold the video image steady, allowing the educator to move around the tanks and behind the scenes while filming. Phone headphones with a built-in microphone were used for both the audio input and output. When narrating the slide presentation, the educator sat at a rolling cart with the gimbal set up on a small tripod. A computer was available as a backup device but was not needed in this program.

INSTRUCTIONAL CONTENT

Elasmobranchs, the animal group that includes sharks, rays, and skates, were chosen as the focus for this virtual public program because they are a taxon that typically generates interest and attention from the public ([Ferry & Shiffman 2014](#)). It is estimated that one-fourth of all shark and ray species in the world are threatened with the possibility of extinction, which could impact ecological balance in many locations due to their influence on the food web ([Dulvy 2014](#)).

While shark finning and overfishing are well-known conservation challenges, habitat degradation from coastal development and pollution is another driving force in elasmobranch decline ([Dulvy 2014](#)). Estuaries, ecosystems where fresh and saltwater mix, are an important coastal habitat to conserve in the South Atlantic Bight, partly because of their role as nursery habitats for elasmobranchs. Nursery habitats are areas that increase the survivability of young (or sub-adult) sharks due to abundant food resources, protection from predators, or a combination of both ([McCandless et al 2007](#)).

Identifying nurseries for different shark species helps elasmobranch conservation by recognizing habitats needing protection ([NMFS 2006](#)). To achieve this, NOAA Fisheries coordinates the COASTAL Atlantic States Shark Pupping and Nursery (COASTPAN) Survey. Through this

cooperative effort for better understanding and improved shark conservation, Georgia estuaries have been identified as nursery habitats for several shark species, including Atlantic sharpnose shark (*Rhizoprionodon terraenovae*), bonnethead (*Sphyrna tiburo*), blacktip shark (*Carcharhinus limbatus*), and sandbar shark (*Carcharhinus plumbeus*) (Belcher 2008).

The shark science segment of Sharks and Rays 101 was based on research conducted by the Georgia Department of Natural Resources in collaboration with COASTPAN. Educators in other states may also be able to connect with COASTPAN researchers in their area, as surveys occur along the entire east coast of the United States and similar GULFSPAN nursery surveys are conducted along the Gulf coast (NOAA 2017). State natural resource management agencies are another useful resource for finding local elasmobranch nursery information.

One of the ways that both tourists and residents in the South Atlantic Bight are likely to interact firsthand with sharks and rays is through recreational fishing within or near the estuary. Therefore, this program also shared information from the NOAA Office of Sustainable Fisheries (2020) about minimizing harm to elasmobranchs during catch and release angling. Sharks and Rays 101 included a virtual visit with an Atlantic stingray (*Dasyatis sabina*), as this species is commonly caught inshore by recreational anglers and is one of the most common elasmobranch species caught as bycatch in Georgia’s shrimp fishery (Belcher & Jennings 2009). Two other species exhibited at the aquarium served as animal ambassadors during the program, including clearnose skates (*Raja eglanteria*), and Atlantic guitarfish (*Pseudobatos lentiginosus*).

LESSON OUTLINE

This hour-long webinar used a series of short segments, as shown in Table 1, to present instructional content in various ways. Educators utilized slide presentations, a visit to aquarium exhibits, a Q & A with a shark researcher, and a virtual walk behind the scenes to see skate eggs and juveniles. Animals are not always active when filming live, so pre-recorded videos of the fish were also shown. Participants were encouraged to ask questions and participate in polls throughout. In addition, participants were encouraged to draw what they saw in the tanks to focus their observations. Five of the Ocean Literacy Principles (NOAA 2021) were incorporated into the program (Table1).

TIMING	ACTIVITY	CONCEPTS COVERED	OLP
30 min	Educators log on in a practice session to test audio and visuals.	N/A	N/A
5 min	Polls, using maps and photos on PowerPoint (PPT) to locate a sense of place relative to the world’s ocean	Understanding participant’s prior knowledge, connecting how the ocean impacts inland and coastal attendees	# 1 # 3
15 min	Virtual stingrays and skate visits at aquarium exhibits, sketches, polls, pre-recorded video of skate eggs and juveniles, film behind the scenes	Adaptations, local species, common characteristics of elasmobranchs, practicing observations	# 5
10 min	Humans and elasmobranch interactions, PPT with global and local information, Showing fishing gear with best practices	Extinction and endangered species, fishing regulations, best practices for recreational fishing in inshore waters	# 6
15 min	PPT presentation from shark researcher, sharing maps and graphs, attendees interpret the data visuals using the chat box to respond	Identifying nursery habitats, role of science in informing conservation, importance of estuaries, interpreting graphical and spatial information	# 5 # 7
10 min	Q & A with researcher		
5 min	Wrap up & exit polls	What did we learn?	

Table 1 Sharks and Rays 101 Lesson Outline. Note the right column indicates where Ocean Literacy Principles, OLP, were incorporated.

RESULTS

PARTICIPANT ENGAGEMENT

While educators teaching Sharks and Rays 101 could not see or hear participants, attendees’ engagement was gauged with responses from the chat box, polls, and Q & A. Attendees participated in polls more than any other options for interacting virtually. During the live

program, 18 of the 19 adult attendees answered at least one poll. Twelve attendees wrote in the chat box at least once, and six of those attendees asked at least one question. Most questions were asked during the visits to the elasmobranch exhibits, and a few were asked to clarify information shown on the maps during the research section. No questions were asked during the fishing section. Educators encouraged attendees to draw what they saw during the virtual exhibit visit and invited adults to share their drawings as sample work, one of which is included in Figure 2.

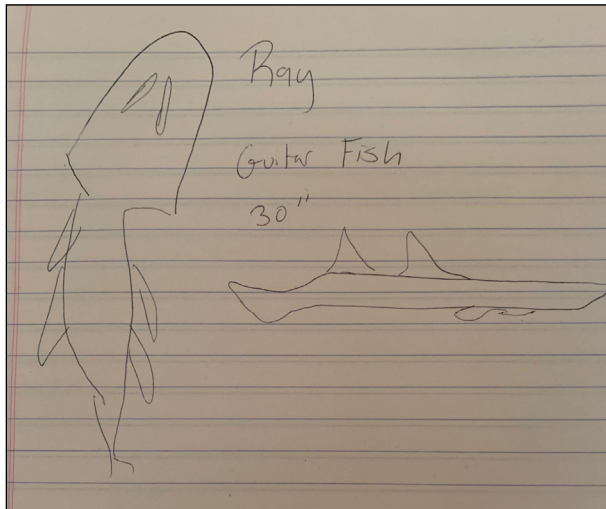


Figure 2 Guitarfish drawing.

Figure notes: Sample work from the Sharks and Rays 101 public program showing a drawing of an Atlantic guitarfish by an adult attendee drawn during a virtual exhibit visit.

PROGRAM EVALUATION

Qualtrics was used to administer a voluntary pre- and post-test. All 19 adults who registered for the Spring 2021 Sharks and Rays 101 program were emailed before the event with an invitation to participate in the pre-test and then emailed a post-test after the webinar. There were 10 pre-tests and 11 post-tests returned, with 6 respondents completing both. The Qualtrics link with the post-test also included a survey to gather feedback on the program and assess if the program was successful in increasing participants' emotional connection to Georgia estuaries, awareness of conservation actions, and intention to apply what they learned. The evaluation instruments are provided in Supplementary File 3.

The average post-test score increased from 75% to 92%. Of the 10 participants who took the pre-test, most knew the ocean influences weather and climate, that there is just one world ocean, and that the ocean is largely unexplored. In addition, eleven participants returned surveys where they wrote what they learned in their own words. Responses included remarks on shark and ray diversity, anatomy, habitats, interpreting data and making observations. All survey respondents strongly or somewhat agreed that the program was fun for them and that they learned why it is important to protect coastal habitats and actions they can take to protect sharks and rays. Family groups indicated the program was a bonding experience and supported concepts their children were learning in school. Only four respondents reported that they had already felt strongly connected to the Georgia coast before the program, while nine indicated that they felt more strongly connected to the Georgia coast after attending. Seeing live animals, particularly the skate eggs, was the most listed favorite activity and the least favorite was the PowerPoint lecture.

DISCUSSION

CHALLENGES WITH VIRTUAL PUBLIC PROGRAMMING

Filming and teaching virtually from the aquarium presented audio and visual challenges due to dim lighting, running pumps, and high ceilings. Moving from tank to tank also presented challenges for video quality. During the first test of this program in July 2020 the educator filmed using just a cell phone held by hand, so it is possible to offer similar virtual lessons with minimal equipment. Because MECA was offering a high volume of virtual programming, it was worth the investment to purchase additional filming equipment and software to improve the audiovisual quality of the virtual programs, including a Zoom Webinar 500 license, Rode wireless lapel mics, selfie light, gimbal, and Logitech webcam.

During onsite intergenerational public programs, it is also easier to provide differentiated simultaneous learning experiences for a wide age range. Puppets and coloring sheets may be made available for the youngest visitors while adults are engaged in asking questions. A virtual setting makes it harder to offer these different activities simultaneously. Encouraging sketching during the program during Q & A periods was an attempt at replicating this to some degree.

Zoom videoconferencing did not offer closed captioning at the time of this program. Recordings of the program were later uploaded to YouTube, where closed captioning was added to make it accessible for the hard of hearing or deaf viewers. In addition, attendees that needed closed captioning could request it for the live event ahead of time and MECA would arrange for transcription services called communication access real-time translation (CART).

LESSONS LEARNED FOR IMPROVING WEBINARS

Most survey respondents listed videos of animal ambassadors as their favorite part of the program. With only six paired pre- and post-tests, there were not enough survey respondents to generalize program evaluation findings. However, there were 71 total attendees, and the educators' observations of participant engagement provided them lessons learned to improve their future webinars, as listed in Table 2. For instance, educators received the greatest number of questions during segments with live videos of animals, indicating that this visual was also engaging for those adults that attended the program but did not return an evaluation.

Table 2 Lesson Learned for Webinars from Sharks and Rays 101. Note that there are existing published rubrics of best practices for webinars, including for STEM classroom programs (Mitchell, Culbertson & Sutton, 2015) and for extension audiences (Robideau & Matthes, 2021). The Sharks and Rays 101 educators found that their successes occurred when they followed these practices most closely. These guides, listed in the citations, may be useful to other presenters.

LESSONS LEARNED FOR FUTURE WEBINARS		
SUCCESSFUL ASPECTS	FUTURE CHANGES	EVALUATION
<ul style="list-style-type: none"> • Short, pre-recorded videos • Real-time video of aquarium exhibits • Polls and drawings • Q & A throughout • Participants sharing their experiences • Rehearsing • A moderator who is not teaching • Prompting participants to interpret the graphs with one scaffolded question at a time 	<ul style="list-style-type: none"> • Reduce content covered to allow more interaction time • Shorten to an hour • During the research presentation alternate between slides and the researcher shown full screen without slides, talking with props such as biofacts or gear • Pre-record videos of research in action • Invite educators to join researchers in the field/lab to take videos for later use 	<ul style="list-style-type: none"> • Use a shorter pre/post-test across all programs offered for larger sample • Partnering with a graduate student or education researcher to conduct evaluations can benefit busy aquarium teams • In addition to content knowledge, questions could be asked about intent to take conservation action

The educators tried to incorporate best practices for webinars as outlined by Mitchell, Culbertson & Sutton (2015) and Robideau & Matthes (2021), such as switching presentation modes regularly, adding time for audience reflection, stopping for Q & A throughout, and encouraging audience participation in applying skills actively at home. However, this format took more time than a lecture, and toward the end, the program was less interactive and did not switch presentation modes as often due to timing. Participants' least favorite part was having two slide presentations at the end. Removing the fishing section would shorten the slides.

Information on actions anglers can take to protect sharks is still beneficial, however, as almost half of the respondents had fished before, but few test respondents knew which hook minimizes damage to elasmobranchs during catch and release. Narrowing the scope of the webinar would make it easier to incorporate more effective virtual learning while staying under an hour. Therefore, in the future, Sharks and Rays 101 educators will offer a series of more focused webinars, such as a separate event specifically for anglers.

SHARING COASTPAN SCIENCE WITH AQUARIUM VISITORS POST-PANDEMIC

Sharks and Rays 101 was for families of mixed ages, however, only 2 of the 19 adults in the spring 2021 event attended with children, compared to 24 of the 29 adults that attended with children during the same webinar offered in summer 2020. This matched a larger pattern within the MECA virtual public programs of family attendance decreasing later in the pandemic while adult attendance remained high. As MECA reopened to in-person programming, virtual family programs have not continued, both due to limitations on staff time and audience interest.

Children as young as 4 years old and up to 17 years participated in the first Sharks and Rays 101, indicating an interest among family audiences in learning about estuarine research. While the virtual format may not continue to be the best mode for this audience at MECA, these authors are considering how to continue incorporating shark research into onsite programs, such as using portions from the attached “Shark Nursery Study” as a station during existing family festivals at the aquarium or as a rainy-day camp activity.

Webinars for adult audiences are likely to remain, however. While adult learners have different needs than children (Lambert et al 2014), even adult learners in the Sharks and Rays 101 program preferred live animals and interactive components over lectures. This is consistent with the call for active learning (Freeman et al 2014), including when using webinars (Lieser, Taff, & Murphy-Hagan 2018). Therefore, future webinars communicating science for adults would benefit from incorporating strategies aquariums use in their interactive virtual programs, such as videos of animal ambassadors, polling, and encouraging participants to do an activity at home, facilitated virtually in real-time. Hybrid programs could also be used, such as a COASTSPAN researcher presenting remotely via webinar, followed by educators leading in-person fishing, fish dissections, aquarium tours, or assisting with research, if possible.

RECOMMENDATIONS FOR REPLICATING AND MODIFYING SHARKS AND RAYS 101

Informal educators at other facilities may find this lesson useful for replicating similar public programs at their sites. This shark and ray program was based on connecting attendees to the Georgia coast. Due to similarities in habitat and species, however, the activity sheet and recorded webinar will likely be relevant for educators elsewhere within the South Atlantic Bight. Aquariums and marine education centers in other locations could offer similar format programs but change the specific elasmobranch species highlighted to those found in their area or exhibited at their facilities. Connecting with researchers involved in COASTPAN and GULFSPAN surveys could also highlight local nursery research for educators on the east or Gulf coasts of the United States.

For informal educators who teach on the coast but not in an aquarium setting, field teaching offers opportunities to share similar information about the ecological importance of nursery habitats within estuaries for elasmobranch conservation. Program participants have encountered sharks and rays during MECA field programs that involve fishing, seining, or trawling activities.

Classroom educators can use the “Shark Nursery Study” activity sheet linked in the supplementary files with their students. In this activity, students dive deeper into the research methods described in the webinar by processing a paper shark as if they were participating in the COASTPAN survey. “Shark Nursery Study” is designed to be functional as a stand-alone activity, although it can be paired with all or part of the Sharks and Rays 101 recording.

CONCLUSIONS

The Sharks and Rays 101 public program connected family and adult audiences with estuaries in Georgia through a virtual program that combined live elasmobranch encounters and a presentation from a shark scientist. The virtual format was conducive to incorporating research materials such as graphs and maps, and virtual visits to aquarium exhibits added visual interest and opportunities for active learning. Therefore, as aquariums return to in-person programming, there is value in continuing to offer some virtual programs as a tool for connecting adult visitor groups with marine research, although families may prefer onsite programs if available.

Similar virtual programs could be offered by other educators using elasmobranchs in their aquarium exhibits or teaching collections. Videos of the animals were survey respondents’ favorite part of the webinar. Due to the popularity of this visual, marine educators who learned how to use videoconferencing to show live animals during the COVID-19 pandemic may want to consider using this new skill set to partner with researchers in future webinars. Specifically, researchers involved in COASTPAN and GULFSPAN surveys could be a useful resource for other marine educators wanting to teach about nursery habitats. The existing recordings from public programs offered during the COVID-19 pandemic may also be a useful free resource for classroom educators. The Sharks and Rays 101 recording and a classroom activity sheet “Shark Nursery Study” are included here for others to use.

ADDITIONAL FILES

The additional files for this article can be found as follows:

- **Supplementary File 1.** Recording of the live Sharks and Rays 101 public program.
URL: <https://youtu.be/j3B7KPPVBr0>
- **Supplementary File 2.** Shark Nursery Study Activity Sheet for sixth-grade classrooms.
DOI: <https://doi.org/10.5334/cjme.72.s1>
- **Supplementary File 3.** Program evaluation materials.
DOI: <https://doi.org/10.5334/cjme.72.s2>

ETHICS AND CONSENT

We applied for and were granted an exemption under category 2 by the Institutional Review Board for research with human subjects at Miami University, reference number 03837e. Only adult participants were surveyed, and it was made clear that participants did not have to complete the survey to participate in the public program. Kayla Clark communicated verbally and in writing to public attendees that her role was both the public programs coordinator for UGA Marine Extension and Georgia Sea Grant teaching the class, and as a graduate student with Miami University, researching the effectiveness of the lesson.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS

Kayla Clark co-developed and co-taught this lesson, administered the pre/post-tests, and coordinated the testing of the activity during a live public program. She drafted the article manuscript. For the Shark Nursery Study activity sheet linked in supplementary file 2 she drew the illustrations and wrote the directions.

Devin Dumont co-developed and co-taught this lesson. He provided the maps, graphs, and tables used in the activity sheet and slide presentations based on data from his master's thesis. The shark study activity sheet is also based on his research methods, as part of the Georgia Department of Natural Resources survey to identify shark nurseries with funding from COASTSPAN. He wrote the nursery content for the article and reviewed and edited the manuscript.

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