

State of the Sound Symposium



**Proceedings of the Symposium:
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Port Royal Sound Foundation
Okatie, South Carolina
via Zoom**

Port Royal Sound Foundation,
with support from:

Spring Island Trust

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South Carolina Department of Natural Resources

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About the Port Royal Sound Foundation Research Symposium

The Port Royal Sound Foundation's mission is to preserve the Port Royal Sound for the environmental, cultural, and economic well-being of our area. We strive to be the leading authority and advocate for the Port Royal Sound, providing and supporting education, research, and conservation initiatives to preserve it.

Research is vital to understand what we know about the Port Royal Sound, what questions are left to be answered, and how to prioritize future research. Many estuaries that have been extensively studied are already damaged or polluted. Research on the Port Royal Sound has historically lacked long-term, consistent data on a variety of topics. In order to avoid the fate of other damaged estuaries, it is critical to be proactive and invest in understanding and protecting the Sound.

The Port Royal Sound Foundation's research symposium provides a platform for researchers to share their work with other scientists, local leaders, and community members. Convening researchers in this way facilitates conversations between people with similar areas of interest and encourages collaboration between scientific entities doing work on the Port Royal Sound. It also engages the public to understand what work is being done in their backyard and why it matters.

The 1st annual Port Royal Sound Foundation research symposium was held on February 11, 2022. Moderated by Dr. Chris Marsh, the State of the Sound Symposium hosted 11 area experts from SC Department of Natural Resources and University of South Carolina Beaufort who discussed what knowledge currently exists about the ecology of the Port Royal Sound. A series of short talks covered an array of topics including crustaceans, fish, underwater soundscapes, dolphins, shorebirds, water quality, geology, and land use. A roundtable discussion followed that explored how future research can help us better understand and protect this incredible resource in the heart of the Lowcountry.



State of the Sound Symposium

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REPORT AVAILABILITY

Electronic copies of this report may be downloaded from the Port Royal Sound Foundation's website at: <https://portroyalsoundfoundation.org/> .

Hard copies may be available from the following address:
Port Royal Sound Foundation
310 Okatie Highway
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Videos of select presentations can be found at:
https://www.youtube.com/playlist?list=PLAv_68a8MqnvXUf6ggGXXkefjMS4_E5E.

COVER

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Table of Contents

Welcome and Introduction	5
(Chris Marsh)	
Geology of the Port Royal Sound	6
(Will Doar)	
Port Royal Sound Watershed and Land Use	7
(Andrew Tweel)	
Environmental and Habitat Quality of Port Royal Sound	8
(Denise Sanger)	
Long-term Trends in SCDHEC Water Quality Data	9
(Eric Montie)	
Importance of Port Royal Sound to Statewide Oyster Reef Landscape	10
(Peter Kingsley-Smith)	
Health of Crustacean Populations in Port Royal Sound	11
(Michael Kendrick)	
Analysis of Port Royal Sound Fish Communities	12
(Elizabeth Bullard)	
Underwater Soundscapes	13
(Eric Montie)	
Trends in Recreational Fish Populations	14
(Joseph Ballenger)	
Food Web Lessons from Mariculture of Red Drum	15
(Erin Levesque)	
Lowcountry Dolphin Monitoring Project	16
(Alyssa Marian)	
Port Royal Sound as Critical Shorebird Habitat	17
(Felicia Sanders)	
Roundtable Discussion and Conclusion	18

Welcome and Introduction

Dr. Chris Marsh
Executive Director, Spring Island Trust

When scientists seek to understand how a natural system works, they look at the different levels of scale that are observed. Our first four researchers provide a large-scale view of the Port Royal Sound and patterns of change that have been observed in its watershed.

Scientists often use the term ecological services to explain how a healthy natural environment creates a healthy human environment. Port Royal Sound oysters, crustaceans, and marine fish provide important economic benefits for our local communities, while also serving as indicators to the Sound's health. The next four presentations provide information on these important groups of marine life.

One of the themes of this symposium is why long-term monitoring is critical to protecting the Port Royal Sound for future generations. The final four presentations describe monitoring programs of recreational fish, dolphins, and shorebirds, and the information that can be gained from these kinds of studies.

At the conclusion of the symposium, a roundtable discussion among the speakers explores what still needs to be learned about the Port Royal Sound in order to protect it.

Geology of Port Royal Sound

Dr. Will Doar

Senior Geologist of Coastal Plain at SCDNR Geological Survey

The geology of the Port Royal Sound dates back hundreds of millions of years. The Appalachians formed ~320 million years ago (ma) during the convergence of tectonic plates, and ~180 ma the Atlantic Ocean opened as plates diverged. Over millions of years, sediment coming from the Appalachians settled in the Atlantic Ocean and built the modern Atlantic coast. As sea level rose during the Eocene, Oligocene, and Miocene (5.3-55.8 ma) additional sediment and nutrients were deposited in the area. During the Pliocene and Pleistocene, there were significant fluctuations in sea level rise and fall, which formed “terraces” that mirror the modern beach system in the Lowcountry. These are recognizable as a salt marsh behind a beach face, which is an unusual formation. On a shorter timescale, local relative sea level rise is notable for changing upland species to salt tolerant species and increasing local erosion as waves act on the upland.

Port Royal Sound Watershed and Land Use

Dr. Andrew Tweel

Environmental Scientist at Marine Resources Division of SCDNR

The Port Royal Sound Watershed reaches 70 miles inland, covers parts of 5 counties, and has low freshwater input and high salinity relative to other South Carolina estuaries. It can be approximately divided along I-95 into an upper and lower watershed. Ninety nine percent of the entire watershed's coastal wetlands are found in the lower portion, with approximately sixty percent of the lower watershed being submerged at some point, either as wetland or open water habitats. Land use between the upper and lower watersheds varies greatly, with most agriculture and forestry occurring in the upper watershed, and much higher levels of urbanization in the lower watershed, particularly in the rapidly growing Beaufort/Port Royal, Bluffton, and Hilton Head areas. Development creates more impervious surfaces and often reduces forested land area, both of which increase the volume and rate of stormwater runoff. This also results in reduced groundwater recharge and evapotranspiration. Stormwater runoff may also carry contaminants such as fecal coliform, fertilizers and pesticides, tire wear particles, oil, and more, which can be washed into the estuary. Stormwater ponds are a best management practice intended to slow runoff and counter some of these effects, and there are 1,900 ponds in the lower watershed that make up 5 square miles of new surface water. As stormwater enters the estuary, small tidal creeks are often the primary interface between upland and coastal systems, and the first to take in runoff from the land.

Environmental and Habitat Quality of Port Royal Sound

Dr. Denise Sanger

ACE Basin National Estuarine Research Reserve Research Coordinator and

Ecosystems Scientist at Marine Resources Division of SCDNR

In the lower Port Royal Sound Watershed, habitat types can generally be divided into open water (>100 m wide), large tidal creeks (10-100 m wide), small tidal creeks, and salt marsh. The South Carolina Estuarine and Coastal Assessment Program (SCECAP) has sampled 156 open water and 123 large tidal creek sites in the lower watershed since 1999. Environmental quality assessments from these sites include water quality (dissolved oxygen; pH; salinity; nutrients such as nitrogen and phosphorus; chlorophyll a; fecal coliforms), sediment quality (chemical contaminants, total organic carbon, and toxicity), and biological quality (macrobenthic organisms). All these metrics—given a rating of poor, fair, or good—are combined to determine an overall habitat assessment. Analysis from 2010-2020 shows that while habitat quality in open water is 100% good, large tidal creeks are approximately 75% good, with some poor and fair—a pattern present in the water, sediment, and biological quality metrics. In the 1999-2009 timeframe, large tidal creeks had approximately 15% fair and 0% poor habitat quality, which increased to approximately 20% fair and 3% poor habitat quality in the 2010-2020 timeframe. Overall, more impaired water quality is seen in tidal creeks due to a closer connection to the land, and water quality in tidal creeks has been declining over the previous two decades. Fortunately, the Port Royal Sound has not reached the tipping point of broader impairment and open water habitats are not yet being noticeably impacted by contamination from runoff.

Long-term Trends in SCDHEC Water Quality Data

Dr. Eric Montie

Associate Professor of Biology and Director of Marine Sensory & Neurobiology Lab at USCB

Salinity and fecal coliform have been sampled in the May River and other Beaufort County estuaries from 1999-2017 to understand what factors influence their levels and to compare estuaries throughout Beaufort County to determine which have undergone the most degradation in that time. Data from 11 shellfish monitoring stations along the May River show temporal, geographical, environmental, and human influences on salinity and fecal coliform. The headwaters are more sensitive to freshwater input, and data shows lower salinity and higher fecal coliform levels closer to the headwaters, sometimes above the level at which SCDHEC restricts shellfish harvesting. Historically, salinity has decreased and fecal coliform has increased at most sites, corresponding with a 13% increase in residential land and an 11.5% decrease in forested land. The exception to this pattern is nearest to the coast, where it is theorized that sea level rise causes sea water intrusion, which increases salinity levels. As climate change increases El Niño events, increased rainfall and stormwater runoff may lead to lower salinity and higher fecal coliform levels. Additionally, increasing populations means more impervious surfaces, loss of forested land, and the potential for more septic failures, which also decrease salinity and increase fecal coliform. As such, it is crucial to address the loss of forested land, which decreases transpiration and rainfall interception, both of which slow the amount and rate of stormwater runoff.

Importance of Port Royal Sound to Statewide Oyster Reef

Landscape

Dr. Peter Kingsley-Smith

Shellfish Scientist at Marine Resources Division of SCDNR

Oyster reefs provide many ecosystem services, including provisioning shellfish stocks for recreational and commercial fisheries, culturally significant Lowcountry oyster roasts, supporting habitat and prey needs of American Oystercatchers, maintaining estuarine salt marshes by protecting shorelines from wave energy, and more. Unmanned Aerial Vehicle (UAV) imagery has determined that 46% of South Carolina's 5,017 acres of oyster reefs occur in the Port Royal Sound. In the larval stage, oysters preferentially settle on the shells of previous generations of oysters. Building artificial reefs using old oyster shells, oyster castles, repurposed crab traps, and manufactured wire-reefs offers new substrate for settlement. The South Carolina Oyster Demographic Assessment (SCODA) generates data on oyster size-frequency, density, recruitment and mortality along the South Carolina coast. The Port Royal Sound has a 5.5% mean mortality rate, compared to a 7% statewide mean mortality. This may be because the Port Royal Sound's ocean-dominated system makes oysters less susceptible to salinity fluctuations that can cause major die-offs. The Port Royal Sound's mean oyster size of 26.5 mm is close to the state's average. New research on diseases impacting oyster health in the Port Royal Sound began in summer 2021. Overall, maintaining the health and abundance of oysters is critical in the Port Royal Sound, which accounts for 37% of SCDNR shellfish management areas, 27% of state shellfish grounds, and 40% of total state harvest by weight from 2004-2020.

Health of Crustacean Populations in Port Royal Sound

Dr. Michael Kendrick

Crustacean Scientist at Marine Resources Division of SCDNR

While many crustaceans inhabit the Port Royal Sound, blue crab and white shrimp are significant for their economic importance, generating over \$13 million annually, and ecological importance in the salt marsh food web. Crab potting and estuarine trawl surveys have been conducted in the Port Royal Sound for over three decades. Trawl survey results reveal that the number of mature blue crabs in the Port Royal Sound is relatively similar to other South Carolina estuaries, but that fewer immature blue crabs are caught. This may indicate a sampling bias or potentially a higher survival rate of smaller size classes, reducing the need for high numbers of immature crabs to support an adult population. Data is also being collected on parasites that impact shrimp health, including those that are trophically-transmitted with skates and rays being the final host. Future research seeks to fill knowledge gaps in blue crab population and recruitment patterns and how species interactions may affect shrimp parasites.

Analysis of Port Royal Sound Fish Communities

Elizabeth Bullard

Graduate Student at College of Charleston

The Port Royal Sound hosts euryhaline finfish species, meaning those that can tolerate a wide range of salinities. The Sound serves as a breeding and nursery ground for both permanent and temporary residents, including recreationally important species like red drum, spotted seatrout, southern flounder, sheepshead, and black drum. Diversity of finfish species is an indicator of a healthy and productive ecosystem. This research aims to quantify seasonality of species diversity (i.e., alpha and beta diversity), presence of ecosystem health indicator species, and spatial differences in community dynamics for the Port Royal Sound. Future research seeks to understand the cause of observed community dynamics and increase the temporal data of finfish monitoring in the Port Royal Sound. By continuing sampling efforts overtime temporal changes can be tracked to note changes seen on a more long-term scale.

Underwater Soundscapes

Dr. Eric Montie

Associate Professor of Biology and Director of Marine Sensory & Neurobiology Lab at USCB

Soundscapes are a new approach to understanding marine life by observing biological, geophysical, and anthropogenic noise. The Estuarine Soundscape Observatory Network in the Southeast (ESONS) strives to measure the health of estuaries by recording the diversity and abundance of marine life at a high temporal resolution—healthy estuaries are loud with biological noise. In the May River, major contributors to the estuarine soundscape are snapping shrimp, finfish, bottlenose dolphins, and vessel noise. Research beginning in 2012 has revealed that biological sounds follow seasonal, lunar, day/night, and tidal cycles, and are impacted by water temperature. Also, there are correlations between fish calling and juvenile appearance and abundance. Future research seeks to understand how climate variability affects courtship calls, which may impact reproduction and year class strength.

Trends in Recreational Fish Populations

Dr. Joseph Ballenger

Estuarine Finfish and Sharks Scientist at Marine Resources Division of SCDNR

In the Port Royal Sound, longline, trammel net, and estuarine trawl surveys are used to collect information on recreational fish population trends in order to make science-based management decisions. Longline surveys take place at the entrances of estuaries and nearshore waters, targeting adult red drum and coastal sharks. Most commonly caught are Atlantic sharpnose sharks and red drum, but 42 species have been encountered since 2007. This survey indicates that red drum populations increased from 2010-2015, then declined through today, which is similar to coast-wide trends. Trammel net surveys target lower estuary, salt-marsh edge, and oyster reef habitats. In the Port Royal Sound, 69 species have been encountered since 2010. Spotted sea trout show high susceptibility to environmental conditions, while southern flounder and red drum show overall declining patterns. Red drum are tagged and have a recapture rate of 27.5%, compared to the typical 5% recapture rate for marine and freshwater fish. This high recapture rate may be attributed to high fishing pressure and/or low population sizes in the area. The estuarine trawl survey typically targets small size species with over 120 species recorded since monitoring began in 2011, including ones not typically recorded in other surveys, like weakfish. The combination of all these surveys provides an important snapshot of finfish and coastal sharks and a long-term data series to detect ecological change in the Port Royal Sound.

Food Web Lessons from Mariculture of Red Drum

Erin Levesque

Fishery Biologist at Marine Resources Division of SCDNR

Red drum are raised at the Waddell Mariculture Center in production ponds that are filled with water from the Colleton River. Filters are used to allow phytoplankton and zooplankton into the ponds to serve as the base of the food chain, while excluding other fish and invertebrates that may act as either predators or competitors in the systems. The conditions of these closed-system ponds are monitored through phytoplankton, zooplankton, and water quality assessments. Red drum larvae are produced in stocked tanks from genotyped adult fish before being released into the production ponds. To mimic the annual timing of reproduction in nature, red drum grow in the ponds from late August to November, initially relying on rotifers for food and transitioning to copepods as they get larger. Once the fish reach 30-50 mm, they can be safely harvested and released along the South Carolina coast. The hatchery contribution to red drum populations in the Sound can be determined by genetically differentiating between wild and stocked fish. Studies on these pond-raised red drum show that the survival of juveniles is not limited by temperature or prey availability, but growth in ponds stocked later in the season is slower than those stocked early. Understanding the physical and biological parameters on survival and growth of red drum contributes to protecting this important species.

Lowcountry Dolphin Monitoring Project

Alyssa Marian

Lab Manager and Research Technician for Marine Sensory & Neurobiology Lab at USCB

Historically, visual surveys, telemetry, and drones have all been used to gather information on dolphin communities. The relatively new practice of passive acoustic monitoring, while it cannot determine exact species counts, allows for greater temporal coverage, records of social and foraging behavior below the surface, and data on spatial distribution. Acoustic monitoring in the May River is used to detect echolocation (most common), burst pulses, and whistles from dolphins. Long-term monitoring reveals that more vocalizations occur closer to the mouth of the river, and are highest in the winter and lowest in the summer. Visual surveys supplement acoustic monitoring to help understand why these patterns are detected. By identifying individuals, we learn that the May River has a small year-round resident population and a slightly larger seasonal resident population, but most dolphins are non-residents. Interestingly, there are fewest dolphins present in the fall and winter—the loudest seasons. This is possibly because there is less prey in winter, which is concentrated at the mouth of the river, so dolphins congregate there and rely on echolocation while hunting. Visual surveys have also provided information on the extensive home range of resident dolphins. There is much more to learn from acoustics, including the link between prey and abundance, determining core use areas, and analyzing the impacts of anthropogenic noise.

Port Royal Sound as Critical Shorebird Habitat

Felicia Sanders

Shorebird Project Manager at SCDNR

Shorebirds are a staple of South Carolina beaches and estuaries. There are 52 species of shorebirds in North America, 2/3 of which nest in the arctic or boreal habitat up north. Whimbrel are known to nest in tundra shores of Canada and Alaska and spend winters on the northern coast of South America. As they return to the north from South America, many stop along the South Carolina-Georgia coast for approximately 35 days to fatten up and prepare to fly north. It was recently discovered that Deveaux Bank at the mouth of the North Edisto serves as a nocturnal roost for whimbrel, the largest known nocturnal roost for the species. At least 20,000 roosting whimbrel were counted there during peak northward migration, which is 1/2 the eastern population of whimbrel and 1/4 the entire North American population. Preliminary data from GPS trackers provides insight into where these birds go during the day, and some individuals are known to come down to the Port Royal Sound to forage, returning to the same location every day. Further information on the habits of whimbrel will increase understanding and protection for this important species, and encourage future research on shorebird populations.

Roundtable Discussion and Conclusion

While current knowledge suggests that the Port Royal Sound is a healthy system, many unanswered questions and potential threats are still necessary to be addressed. Researchers shared their thoughts on what these questions and future priorities need to be, both based on their own field of expertise and a bigger picture of the Port Royal Sound.

On a large scale, many agreed that more long-term studies are needed to understand the effects of the rapid development taking place in the Port Royal Sound. Extensive development raises concerns about stormwater runoff and the health of salt marshes. Other human activities, like shellfish harvesting, require further research to determine how to establish a sustainable relationship with the ecosystem.

Separate from direct human impacts, other researchers seek to understand the intricacies of the estuarine food web, changes to productivity, and marine animal life cycles. Larger stressors that also require greater focus are the impacts coming from the uplands, as well as the current rate of relative sea level rise.

While we are fortunate that our efforts are currently focused on preserving the Port Royal Sound, rather than restoring it, there is much more work to be done to understand and protect this system. State and local support makes the biggest difference to start, maintain, and expand essential long-term monitoring programs to address these questions and concerns.