# The Development Process and Methods for the Coastal Georgia Report Card


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April 2021

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### *A general overview*

Ecosystem health assessments have become more common in recent years, and report cards are being produced by a variety of groups from small, community–based organizations to large partnerships. Ecological report cards provide a numeric grade or letter that is similar to a school report card, and are considered a public friendly way to provide a timely and geographically detailed assessment of ecosystems or rivers.

As environmental monitoring has been conducted in Coastal Georgia for over 20 years, there is a need to communicate the data collected. Synthesizing and integrating the data into a document that is accessible to the general public and specific groups in the coastal zone informs the community of the health of their local waterways. However, not all the information that is generated by this process can fit into a public-friendly report card. The following pages describe in detail the methods and scoring procedures used to develop the Coastal Georgia report card.

A number of steps were taken in the development of the report card. First a workshop was conducted with several divisions within the Georgia Department of Natural Resources (DNR): the Coastal Resources Division, Wildlife Resources Division, and Environmental Protection Division.

The main goals of this workshop were to determine preferred indicators and potential data sources for those indicators as well as mockup the draft report card and discuss potential content of the report card. After the workshop, numerous conference calls and phone meetings occurred to finalize the indicators, determine sub-regions and sampling sites, establish thresholds, review data analysis and report card scores, and design and produce content for the report card.

In 2020, the values and threats to Coastal Georgia were revisited and indicator importance and relevance were reviewed. This led to the addition of three new indicators: dissolved oxygen, bald eagles, and spotted seatrout. The two indicators covering right whales (population and calves) were removed from the report card scoring. The indicators were reorganized into four indices: water quality, fisheries, birds, and sea turtles.

Coastal Georgia health in 2020 is defined as the progress of three water quality indicators (enterococcus, fecal coliform, and dissolved oxygen), four fisheries indicators (red drum, blue crabs, shrimp, and spotted seatrout), three bird indicators (wood storks, American oystercatchers, and bald eagles) and two sea turtle indicators (sea turtle hatching and sea turtle nesting) toward scientifically derived thresholds or goals. Each of these groups of indicators are averaged into indices: the water quality, fisheries, bird, and sea turtle indices. The four indices are combined into the Coastal Georgia Ecological Health Score.

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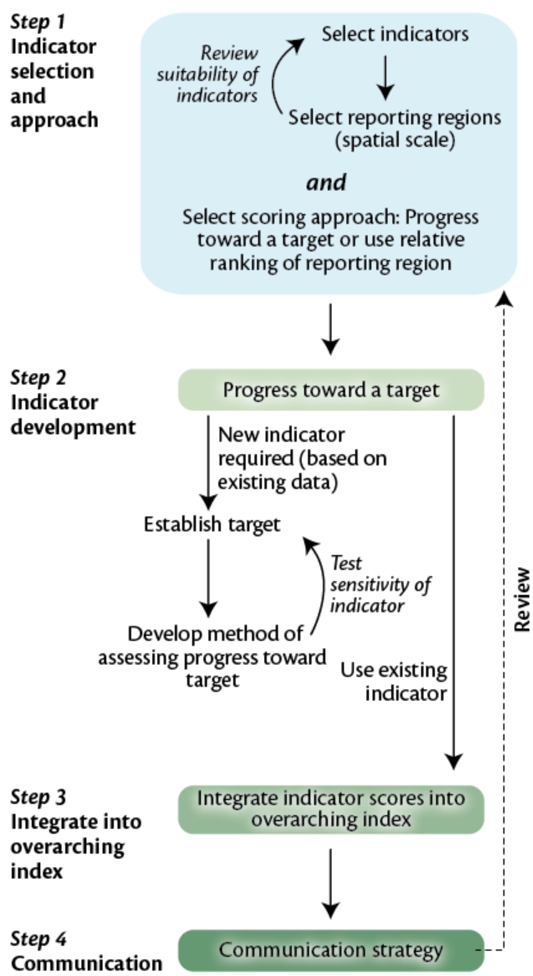
## Introduction

Ecological report cards are considered a public friendly way to provide a timely and geographically detailed assessment of ecosystems or rivers. Report cards provide a numeric grade or letter that is similar to a school report card, delivering quick and understandable results to a broad audience. One key aspect of report cards is that they integrate and synthesize diverse data sources and types. Over the last ten years, report cards have gained popularity as a communication tool in the United States (Chesapeake Bay, Gulf of Mexico, Mississippi River, San Francisco Bay, Willamette River) as well as several international areas (Great Barrier Reef, Australia; Chilika Lake, India; Orinoco River, Colombia).

Existing ecological data collected by government and local community groups mainly from Georgia DNR provide an excellent platform to develop an annual report card that acts to synthesize, interpret, and disseminate this information. Ultimately, the partners of the Coastal Resources Division plan to use this process to improve community and management awareness and understanding of the status of the environment of Coastal Georgia. The primary objectives of this project are to collate data, review indicators, and synthesize both to effectively report the health of Coastal Georgia.

## Determining indicators

The figure at right illustrates the process that occurs when producing a report card. There are four main steps: 1) Indicator selection and approach, which includes assessing currently available data as well as the "ideal" datasets, 2) Indicator development, which includes developing targets or thresholds (discussed more in the next section) for each indicator, 3) Integrating indicators into an overarching index, and 4) Communicating the results through a report card product. Fundamentally, all report cards should be based on indicators and indices that are scientifically defendable, preferably peer-reviewed, and transparent. The data and methods underlying the report card should be understandable and clear to all audiences, should they want to drill down from the overall grade to individual metrics that make up indicators or indices.

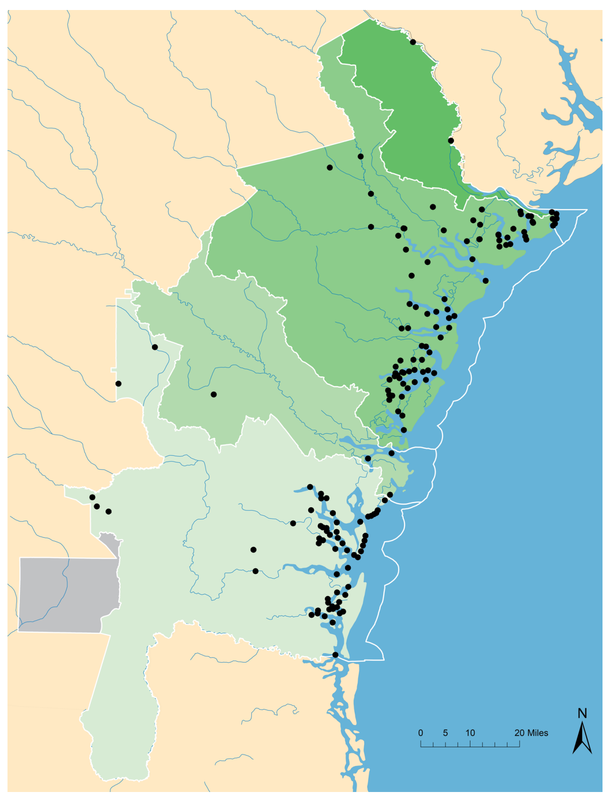


For the Coastal Georgia report card, a workshop of local experts was convened at the beginning of the project, and one of the main goals of the workshop was to determine potential indicators for the report card (image at right). The workshop started with a full list of available data, such as water quality data, human health data, as well as data of fisheries and many groups of wildlife. As the discussions continued, an ideal list of indicators that could be included was collated. From there, the spatial and temporal resolutions of the indicators were determined to ensure that there was sufficient coverage of data for use in the analysis. For example, human health parameters, such as enterococcus and fecal coliform, are collected at least once a month, year round. These are robust annual datasets that can definitely be incorporated into the report card. Conversely, water clarity data had low spatial and temporal resolution, so was noted as one that could be incorporated into the report card in the future, if monitoring began in more sampling locations.

In August 2020, a process began to revise and update the report card. Virtual workshops were held in November 2020 and all the indicators were reviewed and revisited. During this process new indicators were added and a few original indicators were removed.

## Data sources

The majority of the data in the report card were collected by the Georgia DNR Coastal Resources, Environmental Protection, and Wildlife Resources Divisions.



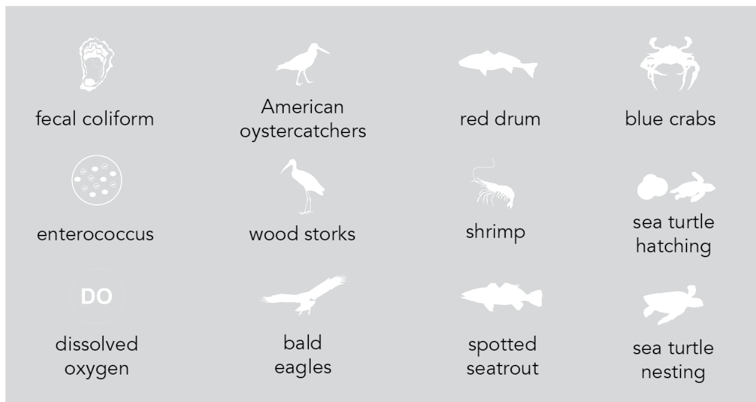

## Sampling site and sub-region determination

Sampling site locations were already determined in this case because of previous years of monitoring data at sampling sites in Coastal Georgia. The only necessary step was to confirm that there were enough sampling sites within each watershed and to determine sub-region areas. Sub-region areas are usually determined based on geographic features (such as geology or land use) or hydrology (such as drainage basin size). For example, if there is an upstream portion, a mixing portion, and a "receiving waters" portion, those could be the three sub-regions. Remember that all sub-regions need to have enough sampling sites to be scientifically rigorous.

The sub-regions for this report card were determined based on five watersheds in the 11 counties that make up the coastal region. The watersheds from north to south are the Savannah, Ogeechee, Altamaha, St. Mary's/Satilla, and Suwanee. There was only sufficient sampling site coverage within the Ogeechee and St. Mary's/Satilla watersheds, and only for the water quality indicators. Data coverage for the water quality, fisheries, bird, and sea turtle indicators could not be separated by sub-region because of the type of data collected, and because much of this data applies on a larger scale than at a sample site location. All of the data used in the report card was scored for overall coastal Georgia without being separated by sub-regions. Overall, there is adequate sampling resolution throughout the coastal zone, with those indicators with less than ideal sampling discussed in detail in the following sections.

## Indicator relevance

The indicators in this report card help answer the question "How healthy is coastal Georgia?" Each indicator measures a different parameter of the environment that affects organisms that live in the ecosystems of the coastal zone (image at right).




Enterococcus is a key indicator of human health in coastal Georgia. Bacteria occur naturally in both fresh and salt water. Bacteria are also commonly found in the intestines of humans and other warm-blooded animals. Most are harmless to humans and animals, but some are pathogenic and can cause illness in swimmers. Pathogens can come from the feces of many animals, including wildlife and pets, or from humans, through leaking septic systems and broken sewer lines. Testing for all pathogens is difficult, so testing for the presence of indicator bacteria is typical. Indicator bacteria, such as enterococcus, are present in large numbers, so they are easy to find and relatively inexpensive to monitor. This indicator is not harmful itself, but can come from similar sources as pathogens. The presence of enterococcus suggests that harmful pathogens may also be present. During significant rainfalls, there is an increased risk for elevated and unsafe bacteria in natural waters. Enterococcus is used as an indicator of human health in brackish and salt water.

Fecal coliform in shellfish harvest areas is a crucial indicator of human health. Bacteria occur naturally in both fresh and salt water. Bacteria are also commonly found in the intestines of humans and other warm-blooded animals. Most are harmless to humans and animals, but some are pathogenic and can cause illness if they are present in shellfish that are consumed by humans. Pathogens can come from the feces of many animals, including wildlife and pets, or from humans, through leaking septic systems and broken sewer lines. This indicator is not harmful itself, but can come from similar sources as pathogens. The presence of fecal coliform in shellfish harvest areas suggests that harmful pathogens may also be present.

Dissolved oxygen (DO) is a key indicator of ecosystem health. Nearly all aquatic animals need adequate DO in the water to survive, even aquatic plants can be harmed if the water around their roots is low in DO. Low dissolved oxygen levels can also cause changes in water chemistry that may trigger the release of nutrients from sediments into the water column. Low DO is often a result of eutrophication-excess nutrients in the water fuel algal blooms, and when the algae die and decompose, the decomposition process depletes DO.

Blue crabs are a key indicator of the health of fisheries in coastal Georgia. Blue crabs are an important living resource in the coastal zone. They are both a predator and prey in the food web. They use oyster beds and shallow water areas to mate and molt. Fishing for blue crabs in Georgia is a recreational and commercial pastime.

Red drum is a major indicator of the health of fisheries in coastal Georgia. Red drum is an important living resource in the coastal zone. Red drum is a key top predator and uses areas in coastal Georgia as an important spawning and nursery habitat. This organism makes up a popular commercial and recreational fishery.

Spotted seatrout are an important indicator of the health of fisheries in coastal Georgia. Spotted seatrout are a key living resource in the coastal zone because they are an important predator and use the coastal area as an important nursery habitat. This organism makes up a popular commercial and recreational fishery.

Shrimp are an important indicator of the health of fisheries in coastal Georgia. Shrimp are a key living resource in the coastal zone because they are one of the main prey species for predators.

Birds are important indicators to determine wildlife health in coastal Georgia. Wood stork productivity, American oystercatcher replacement rate, and bald eagles are three important indicators for bird species that nest along the coast.

Sea turtles are an important indicator to evaluate wildlife health in coastal Georgia. Sea turtle nesting and sea turtle hatching are two indicators that give representative information on the health of these animals along the coast.

## Indicator thresholds and scoring

The indicators that had enough spatial and temporal resolution to use in the 2020 report card were enterococcus, fecal coliform, dissolved oxygen, blue crab, red drum, spotted seatrout, shrimp, wood stork productivity, American Oystercatcher replacement rate, bald eagles, sea turtle nesting, and sea turtle hatching.

Once these indicators were identified, targets or thresholds for each indicator were developed. Establishing targets for each indicator can be done by developing thresholds or using management goals. A threshold ideally indicates a tipping point where current knowledge predicts an abrupt change in an aspect or some aspects of ecosystem condition. Thus, from the perspective of choosing meaningful, health-related thresholds, this must be the point beyond which prolonged exposure to unhealthful conditions actually elicits a negative response. For example, prolonged exposure to dissolved oxygen concentrations below criteria thresholds elicits a negative response in aquatic systems by either compromising the biotic functions of an organism (reduced reproduction) or causing death.

More generally, however, thresholds represent an agreed-upon value or range indicating that an ecosystem is moving away from a desired state and toward an undesirable endpoint. Recognizing that many managed ecosystems have multiple and broad-scale stressors, another perspective is to define a threshold as representing the level of impairment that an environment can sustain before resulting in significant (or perhaps irreversible) damage.

When selecting thresholds, it is important to recognize that there are many already available, and more than likely, there are thresholds available for the indicator that is chosen. A good place to start looking for existing thresholds and goals is in other report card methods or scientific reports and publications.

One way to develop threshold values, if none exist, is to relate them to management goals, and these goals can be used to guide the selection of appropriate indicators. Even with the definition of agreed-upon thresholds, there is still the question of how best to use these threshold values in a management context. Recognizing this challenge, thresholds can still be effectively used to track ecosystem change and define achievable management goals. As long as threshold values are clearly defined and justified, they can be updated in light of new research or management goals and, therefore, can provide an important focus for the discussion and implementation of ecosystem management. Alternatively, if stressors are correctly identified and habitats appropriately classified, there should be multiple attributes (indicators) of the biological community that discriminate in predictable and significant ways between the least and most impaired habitat conditions. Reference communities can then be characterized using these data, which in turn can be used to develop threshold values.

In order to determine thresholds for coastal Georgia, a comprehensive literature review was conducted. Within the literature review, both local and regional studies and reports were examined. Numerous meetings to review threshold determination and analysis were held with staff from Georgia DNR, Coastal Resources Division, Environmental Protection Division, and Wildlife Division. State-wide standards are preferred for use as thresholds, but for most indicators the state did not have an established standard or threshold. For water quality indicators, federal and state thresholds were available. The fisheries indicators had thresholds based on long-term averages. The bird and sea turtle indicators had thresholds based on the literature review, trends data, and expert recommendations. For each indicator, a different threshold, or multiple thresholds, were determined where appropriate.

### Enterococcus

The enterococcus threshold was determined using US EPA's Beach Action Value. Beach Action Values (BAVs) are considered conservative, precautionary tools that can be used as a single sample maximum to issue health advisories at beaches. The BAV for enterococcus is 70 CFUs (colony forming units) at the health risk of 1 in 28 persons. For each enterococcus sample, the measurement was compared to the threshold on a pass/fail basis. When enterococcus was >70 CFUs, it equaled a failing score, where as if enterococcus was ≤70 CFUs, it equaled a passing score.

### Fecal coliform

The fecal coliform threshold was determined using the US Food and Drug Administration's National Shellfish Sanitation Program (NSSP). According to the NSSP the fecal coliform median or geometric mean MPN or MF (mTEC) of the water sample results shall not exceed 14 per 100 ml, and not more than 10% of the samples shall exceed an MPN or MF (mTEC) of 43 MPN per 100 ml. Each sampling site in the oyster harvesting areas of coastal Georgia was used for this analysis. Each sample is compared to the 43 MPN threshold. When fecal coliform was >43 MPN, it equaled a failing score, where as if fecal coliform was <=43 MPN, it equaled a passing score. After all of the samples were scored, then these scores for each site were averaged to come up with the attainment score. If the attainment is >=90%, then the overall score for that site is 100%. If the attainment is <90%, then the overall score is 0%. This scoring method was used to incorporate the criteria stipulation that the fecal coliform shall not be above 43 MPN in more than 10 percent of the values. The geometric mean fecal coliform value was then calculated for each sampling site over the entire year. Each geometric mean was compared to the 14 MPN threshold. When fecal coliform was >14 MPN, it equaled a failing score, where as if fecal coliform was ≤14 MPN, it equaled a passing score. As long as both scores (for thresholds of 43 MPN and 14 MPN) pass, the sampling site gets a passing score. If one or both of the scores fail, the sampling site gets a failing score.

### Dissolved oxygen

Dissolved oxygen (DO) data used was from sites east of Route 17 and Interstate 95. The time period examined was summer, from June 1 to October 31. The DO thresholds are multiple thresholds based on professional judgement by scientists working on DO at Georgia CRD. The thresholds are 3 mg/l and 5 mg/l. The threshold 5 mg/l was set as the A+ or 100% score. The threshold 3 mg/l was set as a high F or the 19% score. Based on these points, the equation of the line was determined which was used to calculate the scores. The equation is $y = 40.5x - 102.5$. Each dissolved oxygen sample was plugged into the equation to calculate the scores.

### Blue crabs

The blue crab threshold was determined using historical data in coastal Georgia. The blue crab long-term geometric mean was calculated for the previous 20 years, from 2001−2020. This value of 0.92906 was compared to the 2020 blue crab geometric mean and then multiplied by 100 to put the value on a 100-point scale. Every year, the long-term geometric mean changes to be using the most recent 20 years of data.

### Red drum

The red drum threshold was determined using historical data in coastal Georgia. The red drum long-term geometric mean was calculated from 2003−2020. This value of 0.834 was compared to the 2020 red drum geometric mean and then multiplied by 100 to put the value on a 100-point scale. Every year, the long-term geometric mean changes to use the most recent 20 years of data.

### Spotted seatrout

The spotted seatrout threshold was determined using historical data in coastal Georgia. The spotted seatrout long-term geometric mean was calculated from 2009−2020. This value of 0.4707 was compared to the 2020 spotted seatrout geometric mean and then multiplied by 100 to put the value on a 100-point scale. Every year, the long-term geometric mean changes to be using the most recent 20 years of data.

### Shrimp

The shrimp threshold was determined using historical data in coastal Georgia. The shrimp long-term geometric mean was calculated from 2001−2020. This value of 2.525 was compared to the 2020 shrimp geometric mean and then multiplied by 100 to put the value on a 100-point scale. Every year, the long-term geometric mean changes to be using the most recent 20 years of data.

### Wood stork productivity

The wood stork productivity thresholds are multiple thresholds determined based on the regional productivity range of 1.5 chicks per nest per year and conversations with experts in coastal Georgia. The regional productivity range was set as the lower end of the "B" score and equal interval scoring was used to determine the rest of the threshold levels. The thresholds are as follows: A = >2.0, B = 2.0−1.5, C = 1.5−1.0, D = 1.0−0.5, and F = 0.5−0. The average chicks fledged per nest for entire coastal Georgia per year was compared to the thresholds to calculate an overall score. The equations in Table 1 were used to calculate the score.

**Table 1: Wood stork indicator thresholds and equations.**

| Wood Stork (chicks per nest) | Score | Equation |
|---|---|---|
| >2.0 | 100-80 | $y=38x+3$ |
| 1.5 – 2.0 | 79-60 | $y=38x+3$ |
| 1.0 – 1.5 | 59-40 | $y=40x$ |
| 0.5 – 1 | 39-20 | $y=40x$ |
| 0 – 0.5 | 19-0 | $y=40x$ |

### American oystercatcher replacement rate

The American oystercatcher replacement rate thresholds are multiple thresholds determined based on the replacement rate of 0.32 and conversations with experts in coastal Georgia. The replacement rate was set as the lower end of the "B" score and interval scoring was used to determine the rest of the threshold levels. The thresholds are as follows: A = >0.5, B = 0.5−0.32, C = 0.32−0.2, D = 0.2−0.1, and F = 0.1−0. The average chicks fledged per nest for entire coastal Georgia per year was compared to the thresholds to calculate an overall score. The equations in Table 2 were used to calculate the score.

**Table 2: American oystercatcher indicator thresholds and equations.**

| American oystercatcher (chicks fledged per nest) | Score | Equation |
|---|---|---|
| >0.5 | 100-80 | y=105.56x+26.222 |
| 0.32 – 0.5 | 79-60 | y=105.56x+26.222 |
| 0.2 – 0.32 | 59-40 | y=166.67x+6.6667 |
| 0.1 – 0.2 | 39-20 | y=200x |
| 0 – 0.1 | 19-0 | y=200x+(0.000000000000003) |

### Bald eagles

Bald eagles are scored using four metrics. They are, 1) the number of occupied territories, 2) three-year nest success rate, 3) number of young fledged per occupied territory, and 4) number of young fledged per successful nest. 2015 was the first season in which the number of nests statewide first exceeded 200, and that has remained the case every year since. Therefore, the six-year period from 2015–2020 is being used as the starting point for calculating the rolling three-year nest success rate metric. The four metrics are equally averaged together to the overall bald eagle score. The data and thresholds were provided by Bob Sargent (Wildlife Resources Division, DNR). The thresholds and equations used are in the tables below.

**Table 3: Number of eagle occupied territories metric thresholds and equations.**

| Change in number of occupied territories | Grade | Score | Equation |
|---|---|---|---|
| >5 | A | 100-80 | y=4.75x+55.25 |
| 1 – 4 | B | 79-60 | y=4.75x+55.25 |
| 0 | C | 59-40 | y=10.5x+49.5 |
| -1 – -4 | D | 39-20 | y = 5x+44 |
| > -5 | F | 19-0 | y = 5x+44 |

**Table 4: Three-year average nest success metric thresholds and equations.**

| Percent of successful nests over recent three year period | Grade | Score | Equation |
|---|---|---|---|
| >80% | A | 100-80 | y=x |
| 75 – 79% | B | 79-60 | y=3.8x-221.2 |
| 70 – 74% | C | 59-40 | y=4x-236 |
| 65 – 69% | D | 39-20 | y=5x-305 |
| <65% | F | 19-0 | y=0.3077x |

**Table 5: Eagle young fledged per occupied territory metric thresholds and equations.**

| Young fledged per territory | Grade | Score | Equation |
|---|---|---|---|
| >1.3 | A | 100-80 | y=190x-168 |
| 1.2 – 1.3 | B | 79-60 | y=10x+48 |
| 1.0 – 1.1 | C | 59-40 | y=190x-150 |
| 0.8 – 0.9 | D | 39-20 | y=10x+30 |
| <0.8 | F | 19-0 | y=190x-132 |

**Table 6: Eagle young fledged per successful nest metric thresholds and equations.**

| Young fledged per successful nest | Grade | Score | Equation |
|---|---|---|---|
| >1.6 | A | 100-80 | y = 200x-240 |
| 1.50 – 1.59 | B | 79-60 | y = 200x-240 |
| 1.40 – 1.49 | C | 59-40 | y = 200x-240 |
| 1.30 – 1.39 | D | 39-20 | y = 200x-240 |
| <1.3 | F | 19-0 | y = 200x-240 |

### Sea turtle nesting trends

The sea turtle nesting trends thresholds are multiple thresholds determined based on the National Marine Fisheries Service and US Fish and Wildlife Service recovery goal for loggerhead nesting in Georgia. The recovery goal is a 2% increase over a 50-year period to achieve a total of 2,800 nests. The recovery goal was set as the lower end of the "B" score and equal interval scoring was used to determine the rest of the threshold levels. The thresholds are as follows: A = >2% increase, B = 1−2% increase, C = 0−1% increase, D = 0−1% decrease, and F = >1% decrease. The sea turtle nesting trends value for entire coastal Georgia per year was compared to the thresholds to calculate an overall score. The equations in Table 7 were used to calculate the score.

**Table 7: Sea turtle nesting trends indicator thresholds and equation.**

| Sea turtle nesting trends | Score | Equation |
|---|---|---|
| 2 | 100 | y=25x+50 |
| 1 | 75 | y=25x+50 |
| 0 | 50 | y=25x+50 |
| -1 | 25 | y=25x+50 |
| -2 | 0 | y=25x+50 |

### Sea turtle hatching success

The sea turtle hatching success thresholds are multiple thresholds determined based on the National Marine Fisheries Service and US Fish and Wildlife Service recovery goal for loggerhead hatching in Georgia. The thresholds are as follows: A = >70%, B = 60−69%, C = 50−59%, D = 40−49%, and F = 30−39%. The sea turtle hatching success value for entire coastal Georgia per year was compared to the thresholds to calculate an overall score. The equations in Table 8 were used to calculate the score.

**Table 8: Sea turtle hatching success indicator thresholds and equation.**

| Sea turtle hatching success | Score | Equation |
|---|---|---|
| >70% | 100-80 | y=x+10 |
| 60 – 69% | 79-60 | y=2.1111x-66.667 |
| 50 – 59% | 59-40 | y=2x-60 |
| 40 – 49% | 39-20 | y=2x-60 |
| 30 – 39% | 19-0 | y=2x-60 |

## Overall Scoring and Grades

Once thresholds have been identified, data are scored using either a pass/fail or multiple threshold method. Ideally, multiple thresholds are used to provide some gradation of results from poor to excellent, rather than just pass or fail, but this may not be appropriate for all indicators.

A pass/fail scoring method is a simple method used to calculate indicator scores based on whether or not an ecologically relevant threshold was met. The process outlined below uses enterococcus as an example, and results are scored on a scale of 0 to 100%, where the higher percentage values represent more healthy conditions (see figure below).

1. Sort data by station

| Station Name | Date | Enterococcus (MPN) |
|---|---|---|
| REIMOLDS PASTURE | 4/24/14 | 63 |
| REIMOLDS PASTURE | 5/7/14 | 38 |
| REIMOLDS PASTURE | 6/18/14 | 83 |
| REIMOLDS PASTURE | 7/9/14 | 3 |
| REIMOLDS PASTURE | 8/6/14 | 15 |
| REIMOLDS PASTURE | 9/25/14 | 51 |
| REIMOLDS PASTURE | 10/15/14 | 140 |
| REIMOLDS PASTURE | 10/23/14 | 12 |
| SEA ISLAND NORTH | 4/1/14 | 2 |
| SEA ISLAND NORTH | 5/13/14 | 510 |
| SEA ISLAND NORTH | 5/20/14 | 10 |
| SEA ISLAND NORTH | 6/24/14 | 2 |
| SEA ISLAND NORTH | 7/22/14 | 2 |
| SEA ISLAND NORTH | 8/12/14 | 2 |
| SEA ISLAND NORTH | 9/9/14 | 10 |
| SEA ISLAND NORTH | 10/7/14 | 5 |

2. Calculate the score for each data point Ex: If total nitrogen >0.3 $mg \cdot l^{-1}$, then Score = Pass (or 100)

| Station Name | Date | Enterococcus (MPN) | Threshold (MPN) | Score |
|---|---|---|---|---|
| REIMOLDS PASTURE | 4/24/14 | 63 | 70 | 100 |
| REIMOLDS PASTURE | 5/7/14 | 38 | 70 | 100 |
| REIMOLDS PASTURE | 6/18/14 | 83 | 70 | 0 |
| REIMOLDS PASTURE | 7/9/14 | 3 | 70 | 100 |
| REIMOLDS PASTURE | 8/6/14 | 15 | 70 | 100 |
| REIMOLDS PASTURE | 9/25/14 | 51 | 70 | 100 |
| REIMOLDS PASTURE | 10/15/14 | 140 | 70 | 0 |
| REIMOLDS PASTURE | 10/23/14 | 12 | 70 | 100 |
| SEA ISLAND NORTH | 4/1/14 | 2 | 70 | 100 |
| SEA ISLAND NORTH | 5/13/14 | 510 | 70 | 0 |
| SEA ISLAND NORTH | 5/20/14 | 10 | 70 | 100 |
| SEA ISLAND NORTH | 6/24/14 | 2 | 70 | 100 |
| SEA ISLAND NORTH | 7/22/14 | 2 | 70 | 100 |
| SEA ISLAND NORTH | 8/12/14 | 2 | 70 | 100 |
| SEA ISLAND NORTH | 9/9/14 | 10 | 70 | 100 |
| SEA ISLAND NORTH | 10/7/14 | 5 | 70 | 100 |

3. Calculate the station score by averaging the scores for each data point in that station.

| Station Name | Date | Enterococcus (MPN) | Threshold (MPN) | Score | Station Score |
|---|---|---|---|---|---|
| REIMOLDS PASTURE | 4/24/14 | 63 | 70 | 100 | 75 |
| REIMOLDS PASTURE | 5/7/14 | 38 | 70 | 100 | |
| REIMOLDS PASTURE | 6/18/14 | 83 | 70 | 0 | |
| REIMOLDS PASTURE | 7/9/14 | 3 | 70 | 100 | |
| REIMOLDS PASTURE | 8/6/14 | 15 | 70 | 100 | |
| REIMOLDS PASTURE | 9/25/14 | 51 | 70 | 100 | |
| REIMOLDS PASTURE | 10/15/14 | 140 | 70 | 0 | |
| REIMOLDS PASTURE | 10/23/14 | 12 | 70 | 100 | |

4. Calculate the overall score by averaging all station scores.

| Station Name | Station Score | Overall Score |
|---|---|---|
| REIMOLDS PASTURE | 75 | 91 |
| SEA ISLAND NORTH | 88 | |
| BRADLEY (OSSABAW) | 100 | |
| Contentment Bluff Sandbar | 100 | |
| Dallas Bluff Sandbar | 100 | |
| KINGS FERRY | 25 | |
| SKIDAWAY NARROWS | 75 | |
| SOUTH OSSABAW | 100 | |
| TYBEE ISLAND SOUTH | 98 | |
| TYBEE ISLAND MIDDLE | 100 | |
| TYBEE ISLAND NORTH | 98 | |
| Tybee Island Polk St | 91 | |
| TYBEE ISLAND STRAND | 96 | |
| BLYTHE ISLAND REG PARK | 100 | |
| Jekyll Clam Creek | 79 | |
| CONVENTION CENTER | 98 | |
| JEKYLL NORTH AT DEXTER LANE | 100 | |
| 4H CAMP (JEKYLL) | 98 | |
| ST. ANDREWS PICNIC AREA | 71 | |
| SOUTH DUNES (JEKYLL) | 100 | |
| CAPT. WYLLY NEAR BEACHVIEW | 100 | |
| SEA ISLAND SOUTH | 100 | |
| 5th ST. CROSSOVER (SSI) | 92 | |
| EAST BEACH OLD COAST GUARD | 92 | |
| MASSENGALE (SSI) | 94 | |
| 12 ST. GOULDS INLET (SSI) | 100 | |
| ST. SIMONS ISL LIGHTHOUSE | 89 | |

For coastal Georgia, all water quality indicators have multiple thresholds except for enterococcus, all fisheries indicators have pass/fail thresholds, all bird indicators have multiple thresholds, and all sea turtle indicators have multiple thresholds. By using multiple thresholds when they are available, indicators can be assessed with greater precision than using a pass/fail method (see table below).

| | Multiple Thresholds | | Grade | % Score |
|---|---|---|---|---|
| Measured indicator value | 5 | Pristine condition | | |
| | | ● | A | 80–100 |
| | 4 | | | |
| | | ● | B | 60–<80 |
| | 3 | | | |
| | | ● | C | 40–<60 |
| | 2 | | | |
| | | ● | D | 20–<40 |
| | 1 | | | |
| | | ● | F | <20 |
| | 0 | Impaired condition | | |

Once each indicator is compared to a pass/fail or multiple threshold scale, assigned a score, and averaged into a station score if applicable, a grade can be assigned. For the fisheries and wildlife indicators, the grading scale follows a 20-point grade scale of 0–100%, with equal interval breaks (see table at right).

For the enterococcus and fecal coliform indicators, the grading scale follows a 10-point grade scale (<60% = F, 60-70% = D, etc.) with uneven interval breaks (see table at right). This scoring scale is different since bacteria and contaminant indicators are directly related to human health and warrant a stricter grading scale. In order to incorporate the human health index into the other two indices, the scores are converted from a 10-point to 20-point scale.

Final grades are equally divided to provide a clearer picture of health (see figure below). Following the typical school grading

| Score (%) | Grade | Description |
|---|---|---|
| ≥0 to <20 | F | Very poor |
| ≥20 to <25 | D– | Poor |
| ≥25 to <35 | D | Poor |
| ≥35 to <40 | D+ | Poor |
| ≥40 to <45 | C– | Moderately Poor |
| ≥45 to <55 | C | Moderate |
| ≥55 to <60 | C+ | Moderate |
| ≥60 to <65 | B– | Moderately Good |
| ≥65 to <75 | B | Moderately Good |
| ≥75 to <80 | B+ | Moderately Good |
| ≥80 to <85 | A– | Good |
| ≥85 to <95 | A | Good |
| ≥95 to <100 | A+ | Good |
| =100 | A+ | Very Good |

| Score | Narrative |
|---|---|
| 100 | Excellent |
| 90.00–<100 | Good |
| 80.00–<90 | Moderate |
| 70.00–<80 | Moderately Poor |
| 60.00–<70 | Poor |
| <60 | Very Poor |

scale overall (<60% = F, 60-70% = D, etc.) would result in consistently failing grades, which does not provide information about small improvements or declines in ecosystem health. The equally divided grading scale and multiple thresholds allow evaluation of small changes in ecosystem health, even at the very poor, poor, and moderately poor ranges.

**A** ≥80—100%
All human health, fisheries, and wildlife indicators meet desired levels. Indicators in these locations tend to be very good, most often leading to preferred habitat conditions.

**B** ≥60—<80%
Most human health, fisheries, and wildlife indicators meet desired levels. Indicators in these locations tend to be good, often leading to acceptable habitat conditions.

**C** ≥40—<60%
There is a mix of good and poor levels of human health, fisheries, and wildlife indicators. Indicators in these locations tend to be fair, leading to sufficient habitat conditions.

**D** ≥20—<40%
Some or few human health, fisheries, and wildlife indicators meet desired levels. Indicators in these locations tend to be poor, often leading to degraded habitat conditions.

**F** 0—<20%
Very few or no human health, fisheries, and wildlife indicators meet desired levels. Indicators in these locations tend to be very poor, most often leading to unacceptable habitat conditions.

Final indicators, thresholds, time periods, location, and protocol are listed in Table 9.

**Table 9: All indicators and thresholds.**

| Indicator | Threshold | Time period | Location | Protocol |
|---|---|---|---|---|
| Enterococcus | 70 CFUs | Entire year | Beach sampling sites (CRD) | US EPA's Beach Action Value |
| Fecal coliform | 43MPN and 14MPN | Entire year | Shellfish area sites (CRD & EPD) | National Shellfish Sanitation Program |
| Dissolved oxygen | 5 mg/l and 3 mg/l | June – October | Coastal areas east of Rt-17 and I-95 | GA DNR |
| Blue crabs | long-term geometric mean over most recent 20 years | (March – April) | Coastal trawls | GA DNR |
| Red drum | long-term geometric mean over most recent 20 years | (June – August) | Coastal trawls | GA DNR |
| Spotted seatrout | long-term geometric mean over most recent 20 years | | Coastal trawls | GA DNR |
| Shrimp | long-term geometric mean over most recent 20 years | Entire year | Coastal trawls | GA DNR |
| Wood stork productivity | >2.0, 2.0-1.5, 1.5-1.0, 1.0-0.5, 0.5-0 | Entire year | Beach nest locations | 1.5 chicks per nest, regional productivity range |
| American oystercatcher | >0.5, 0.5-0.32, 0.32-0.2, 0.2-0.1, 0.1-0 | Entire year | Beach nest locations | replacement rate of 0.32 |

| | | | | |
|---|---|---|---|---|
| Bald eagles | See tables 3-6. | Entire year | Nest locations | GA DNR, WRD |
| Sea turtle nesting trends | >2% increase, 1%-2% increase, 0-1% increase, 0-1% decrease, >1% decrease | Entire year | Beach nest locations | National Marine Fisheries Service and US Fish and Wildlife Service recovery goal = 2% increase over 50yr |
| Sea turtle hatching success | >70%, 60%-69%, 50%-59%, 40%-49%, 30%-39% | Entire year | Beach nest locations | National Marine Fisheries Service and US Fish and Wildlife Service recovery goal |

## Quality Assurance/Quality Control

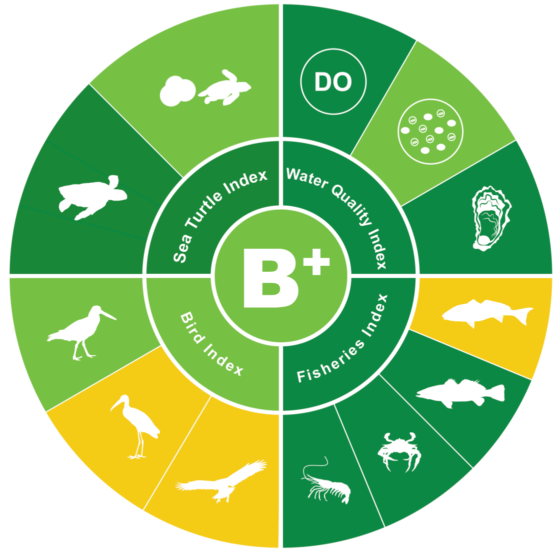
Raw data QA/QC

Data spreadsheets are provided to the analysts from the Georgia Department of Natural Resources. These data include all sampling points for all indicators, as well as weather and field notes. The first step is to check over the data for any outliers or flagged data. This is done by graphing the data over time and by sampling site. This is the time that flagged data is noted and correspondence with the data entry person and/or the field monitor is conducted to determine if there was an equipment malfunction or a collection error. Graphing each indicator by site helps to see related patterns in the data. If one site is inconsistent with other sites, such as an increasing value while all other sites are decreasing, it is an indication of suspect data. If the data are then checked and confirmed as correct, this could be a "hotspot" and should be followed up by the organization to determine the problem.

Data analysis QA/QC

After data were analyzed, a second person re-checks the data. All numbers are compared to original spreadsheets to make sure there are not any errors transferring data. All calculations are also checked, to make sure equations have been entered in correctly, and applied to the correct cells in the Excel spreadsheet. The current dataset is small enough to check every indicator and every calculation. As datasets become larger and more complex, a subset of data is checked. This is done by comparing the current year's indicator score to last year's indicator score. If the score is different by 33% (or a pre-determined amount) between one year and the next, those data are flagged and checked for accuracy. Having proper quality assurance and quality control methods is vital to maintaining the integrity of the data.

## New indicators added in 2020



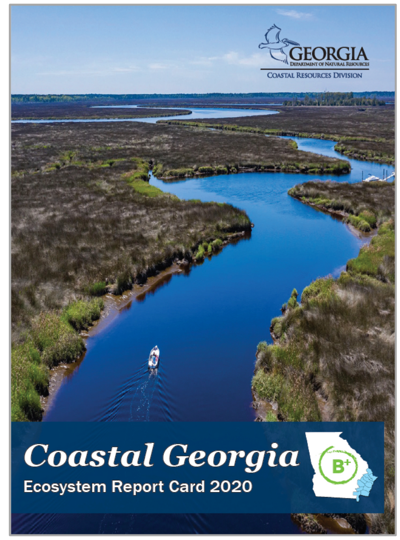

For the past five years, two human health indicators, three fisheries indicators, and six wildlife indicators have been averaged into three indices and then averaged into an overall Coastal Georgia ecosystem health score. In 2020, the values and threats to Coastal Georgia were revisited and indicator importance and relevance were reviewed. This led to the addition of three new indicators: dissolved oxygen, bald eagles, and spotted seatrout. The two indicators covering right whales (population and calves) were removed from the report card scoring. While right whale are important species, their population viability is influenced by much more than the time they spend in Georgia waters. The indicators were reorganized into four indices, water quality, fisheries, birds, and sea turtles. Despite the change in methodology, the scores calculated back to 2014 show similar results as the previous indicators used in past report cards.

## Combining indicators into indices

Overarching indices give a much better integrated assessment (and therefore representative score) of an ecosystem's health than can be achieved using a single metric. These indices comprise multiple metrics that are ranked according to a threshold value and then averaged together. Multi-metric health indices have become commonplace in resource and ecosystem management. The majority of these indices focus on stream macroinvertebrates and fish, but more recently, indices have been developed using various water quality and biotic parameters. There are many parameters that can be included, and all need to be properly evaluated in terms of what they add to the robustness of the indices. Robustness refers to the ability of the indicator or index to perform well under a range of conditions. Although more simplistic indices may lack relevant parameters or the spatial and temporal resolution that make indices more robust or effective for regional comparisons, very complex indices may have indicators that do not necessarily contribute much to the robustness of the index. Hence, the main objective is to select the appropriate type and number of indicators that, when combined in an index, give a robust and accurate representation of an ecosystem's health and are understandable to the majority of users.

In coastal Georgia, four indices were developed to help synthesize the data and obtain an overall score of the health of the coast. The four indices are a Water Quality Index, a Fisheries Index, a Bird Index, and a Sea Turtle Index. The water quality indicators are enterococcus, fecal coliform, and dissolved oxygen. The fisheries indicators are red drum, blue crab, spotted seatrout, and shrimp. The bird indicators are wood storks, American oystercatchers, and bald eagles. The sea turtle indicators are sea turtle hatching, and sea turtle nesting. These four indices combined create the overall coastal Georgia health score.

## Communication through a report card




Ecological report cards, much like school report cards, provide performance–driven numeric grades or letters that represent the relative ecological health of a geographic region or component of the ecosystem. They are an important tool for integrating diverse data types into simple scores that can be communicated to decision makers and the general public. In other words, large and often complex amounts of information can be made understandable to a broad audience.

Ecological report cards enhance research, monitoring, and management in several ways. For the research community, they can lead to new insights through integration schemes that reveal patterns not immediately apparent, help to design a conceptual framework to integrate scientific understanding and environmental values, and help to develop scaling approaches that allow for comparison in time. Within monitoring realms, report cards justify continued monitoring by providing timely and relevant feedback to managers and can have the added benefit of accelerating data analyses. For management, they provide accountability by measuring the success of restoration efforts and identifying impaired regions or issues of ecological concern. This catalyzes improvements in ecosystem health through the development of peer pressure among local communities. Report cards also can guide restoration efforts by creating a targeting scheme for resource allocation.

Ecosystem health assessments have become more common in recent years, and report cards are being produced by a variety of groups from small, community–based organizations to large partnerships. Although methods, presentation, and content of report cards vary, the underlying premise is the same: to build community awareness and raise the profile of health impairment issues and restoration efforts.

Some common elements of report cards include

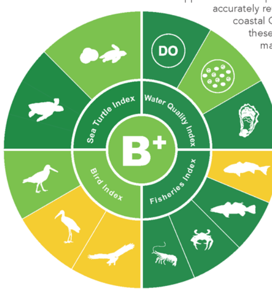
1. A map of the watershed or region
2. A grade stamp
3. The year of the report card
4. A summary of the key features (e.g., ecosystem types, recreation activities)
5. A “What You Can Do” section

For the Coastal Georgia report card numerous meetings were conducted to plan the content, layout, and design of the documents. Many iterations of the report card occurred as the document evolved into its final state. The report card provides background information on the coast, impacts to the ecosystems, discussion about the purpose of creating a report card, details about what the public can do to protect the health of the coast, and activities Georgia DNR is doing were included in the report card document, in addition to the methods, scores, and grades. This report card provides a synthesis of monitoring data being collected in coastal Georgia in a visually appealing and engaging manner (see image above). The Coastal Georgia report card includes the five basic elements listed above. In addition, more detailed discussion of some of the indicators in the report card is included.

# Moderately good ecosystem health

## Overall health

Overall, Coastal Georgia received a B+, a moderately good score (77%). The highest scoring indicators were blue crab, spotted seatrout, and sea turtle nesting, and all had perfect scores (100%). This year's report card makes some changes in the indicators used to grade the ecosystem's overall health. These changes removed right whales as an indicator species and added spotted seatrout and bald eagles. The changes reflect a more holistic approach to the report card with the goal of more accurately reflecting the overall health of coastal Georgia. You can learn more about these changes and why they were made further inside this report card.




**Scoring Legend**

- A ≥80–100% good
- B ≥60–<80% moderately good
- C ≥40–<60% moderate
- D ≥20–<40% poor
- F 0–<20% very poor

## Grading scale

- **A ≥80–100%** All water quality, fisheries, bird, and sea turtle indicators meet desired levels. Indicators in these locations tend to be very good, most often leading to preferred habitat conditions.
- **B ≥60–<80%** Most water quality, fisheries, bird, and sea turtle indicators meet desired levels. Indicators in these locations tend to be good, often leading to acceptable habitat conditions.
- **C ≥40–<60%** There is a mix of good and poor levels of water quality, fisheries, bird, and sea turtle indicators. Indicators in these locations tend to be fair, leading to sufficient habitat conditions.
- **D ≥20–<40%** Few water quality, fisheries, bird, and sea turtle indicators meet desired levels. Indicators in these locations tend to be poor, often leading to degraded habitat conditions.
- **F 0–<20%** Very few or no water quality, fisheries, bird, and sea turtle indicators meet desired levels. Indicators in these locations tend to be very poor, most often leading to unacceptable habitat conditions.

| 90% | 72% | 90% | 92% | 40% | 100% |
|---|---|---|---|---|---|
| fecal coliform | enterococcus | dissolved oxygen | shrimp | red drum | blue crabs |

# Indexes highlights

## Fisheries index

**The fisheries index** scored 83%, an A-, in 2020. Overall, fisheries indicators are good, which means that sustainable fishing practices are used, and the coastal environment is able to support most commercial and recreational species. Blue crab, spotted seatrout, and shrimp all had good scores. Red drum had a moderate score of 40%. While the reason for this is still being studied, population changes like this may be due to environmental factors such as salinity or temperature.

*A spotted seatrout caught by recreational fisherman Mike Smith. Recreational fishing licenses can be purchased at GoOutdoorsGeorgia.com. Provided photo.*

## Water quality index

**The water quality index** scored 84%, an A-, in 2020. Overall, water quality indicators are good, meaning that it is generally safe to swim and to eat local shellfish, and that there are oxygen levels that support fish and other species. Dissolved oxygen and fecal coliform had good scores, and enterococcus had a moderately good score.

## Bird index

**The bird index** scored 61%, a B-, in 2020. Overall, bird indicators are moderately good. American oystercatchers had a moderately good score. Bald eagles and wood storks had moderate scores. The lower wood stork score was most likely due to repeated storms affecting one colony right as they were establishing their nests and in the early egg-laying stage. Overall, wood stork populations are being maintained, American oystercatcher nesting is healthy, and bald eagle nest success is moderate.

## Sea turtle index

**The sea turtle index** scored a 80%, an A-, in 2020. Overall, sea turtle indicators are good. Sea turtle nesting is good, while sea turtle hatching is moderately good. Sea turtle management is promoting populations and maintaining excellent nesting.

*Sea turtle nesting season is May to mid-August, and females typically nest on the same beach annually. DNR photo by Adam Mackinnon.*

| 100% | 66% | 59% | 57% | 60% | 100% |
|---|---|---|---|---|---|
| spotted seatrout | American oystercatchers | wood storks | bald eagles | sea turtle hatching | sea turtle nesting |

# New indicators and methods for 2020

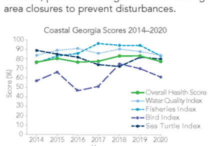
For the past five years, two human health indicators, three fisheries indicators, and six wildlife indicators have been averaged into three indices and then averaged into an overall Coastal Georgia ecosystem health score. In 2020, the values and threats to Coastal Georgia were revisited and the importance and relevance of indicators was reviewed. This led to the addition of three new indicators: dissolved oxygen, bald eagles, and spotted seatrout. The two indicators covering right whales (population and calves) were removed from the report card scoring.

While the right whale is an important species, its population viability is influenced by much more than the time they spend in Georgia waters. The indicators were reorganized into four indices: water quality, fisheries, birds, and sea turtles. Despite the change in methodology, the scores from 2014 to 2019 were recalculated and showed similar results as past report cards.

## Report card scores from 2014–2020

In Coastal Georgia, report card scores vary from year-to-year. By tracking health over time, we can evaluate changes in the environment and prioritize management and restoration. For example, DNR actively manages wood stork and American oystercatcher populations by habitat creation, predator management and nesting area closures to prevent disturbances.

| Indicator | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|
| fecal coliform | 92% | 92% | 92% | 80% | 90% | 98% | 90% |
| enterococcus | 82% | 91% | 94% | 94% | 96% | 78% | 72% |
| dissolved oxygen | 79% | 85% | 87% | 84% | 84% | 87% | 90% |
| shrimp | 100% | 100% | 96% | 84% | 84% | 75% | 92% |
| red drum | 83% | 69% | 100% | 100% | 91% | 100% | 40% |
| blue crabs | 22% | 62% | 47% | 100% | 100% | 100% | 100% |
| spotted seatrout | 99% | 100% | 100% | 100% | 100% | 100% | 100% |
| American oystercatchers | 47% | 61% | 28% | 13% | 78% | 78% | 66% |
| wood storks | 67% | 70% | 64% | 84% | 81% | 78% | 59% |
| bald eagles | NA | 66% | 46% | 57% | 62% | 51% | 57% |
| sea turtle hatching | 77% | 69% | 64% | 47% | 44% | 64% | 60% |
| sea turtle nesting | 100% | 100% | 100% | 100% | 100% | 100% | 100% |




*Conditions in Coastal Georgia have been relatively good over the last seven years.*

## Importance of a report card

Environmental report cards are powerful tools used around the world to describe ecosystem status, increase public awareness, and inform and influence decision makers to act to improve the health of a watershed. Developing rigorous, quantitative assessments provides accountability that is beneficial to support environmental protection efforts. A five-step process is used to develop report cards.


# Coastal Georgia is a gem of biodiversity and natural wonders

Marshes, wetlands, and barrier islands make up the diverse habitats of Coastal Georgia. The region is rich in abundant wildlife like sea turtles, fishes, shellfish, birds, and mammals. Recreational opportunities abound, such as boating, fishing, bird watching, kayaking, and swimming. Protecting the ecosystems and their inhabitants helps support not only recreational opportunities, but also the local economy, seafood industry and tourism.

*Coastal wetlands, like salt marshes, filter pollutants as water runs downstream, which improves water quality for species in the estuary, like marine mammals. DNR photo.*

*Maintaining a healthy coastal ecosystem is an important way to support recreational uses, such as kayaking, and commercial uses, like fishing and ecotourism. DNR photos.*

# Report card highlights in 2020

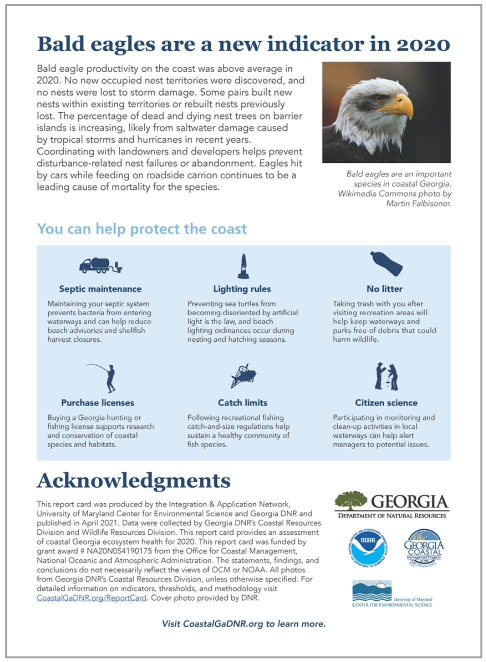
*Wood storks are an important indicator species because they depend on varying wetland types to successfully nest and raise young. DNR photo by Tim Keyes.*

## Wood stork

Wood storks received a moderate score of 59% in 2020. While populations fluctuate annually, environmental factors such as food and habitat availability throughout their range can influence their success.

## Spotted seatrout

Spotted seatrout received a good score of 100% in 2020. This indicator was added in 2020 to help give a more holistic view of fisheries health in coastal Georgia. Seatrout are a relevant indicator because they spend a majority of their lifecycle in multiple habitats within Georgia estuaries.



## Bald eagles are a new indicator in 2020

Bald eagle productivity on the coast was above average in 2020. No new occupied nest territories were discovered, and no nests were lost to storm damage. Some pairs built new nests within existing territories or rebuilt nests previously lost. The percentage of dead and dying nest trees on barrier islands is increasing, likely from saltwater damage caused by tropical storms and hurricanes in recent years. Coordinating with landowners and developers helps prevent disturbance-related nest failures or abandonment. Eagles hit by cars while feeding on roadside carrion continues to be a leading cause of mortality for the species.

*Bald eagles are an important species in coastal Georgia. Wikimedia Commons photo by Martin Falbisoner.*

### You can help protect the coast

**Septic maintenance**
Maintaining your septic system prevents bacteria from entering waterways and can help reduce beach advisories and shellfish harvest closures.

**Lighting rules**
Preventing sea turtles from becoming disoriented by artificial light is the law, and beach lighting ordinances occur during nesting and hatching seasons.

**No litter**
Taking trash with you after visiting recreation areas will help keep waterways and parks free of debris that could harm wildlife.

**Purchase licenses**
Buying a Georgia hunting or fishing license supports research and conservation of coastal species and habitats.

**Catch limits**
Following recreational fishing catch-and-size regulations help sustain a healthy community of fish species.

**Citizen science**
Participating in monitoring and clean-up activities in local waterways can help alert managers to potential issues.

## Acknowledgments

This report card was produced by the Integration & Application Network, University of Maryland Center for Environmental Science and Georgia DNR and published in April 2021. Data were collected by Georgia DNR's Coastal Resources Division and Wildlife Resources Division. This report card provides an assessment of coastal Georgia ecosystem health for 2020. This report card was funded by grant award # NA20N0S4190175 from the Office for Coastal Management, National Oceanic and Atmospheric Administration. The statements, findings, and conclusions do not necessarily reflect the views of OCM or NOAA. All photos from Georgia DNR's Coastal Resources Division, unless otherwise specified. For detailed information on indicators, thresholds, and methodology visit CoastalGaDNR.org/ReportCard. Cover photo provided by DNR.

*Visit CoastalGaDNR.org to learn more.*

## Conclusions

The scores and grades were synthesized into a public-friendly document that can inform and engage its readers. Furthermore, the resulting report card is a tangible output of the efforts of the Georgia Department of Natural Resource's three divisions: Coastal Resources Division, Environmental Protection Division, and Wildlife Division, which is important for their continued support in the management of the coast.

The process of producing the report card, from the initial workshop to the final stages of the report card, was made possible by the collective efforts of the Georgia Department of Natural Resources Coastal Resources Division, Environmental Protection Division, Wildlife Division, and the Integration & Application Network, UMCES. This effort cannot be understated in regards to finishing the product on time, so that the report card is relevant and topical when released.

In future report cards, with increased sampling sites and new indicators measured, the integrity and quality of the data will increase and provide guidance for management actions.

## Web Resources

Coastal Resources Division
http://coastalgadnr.org/

Wildlife Resources Division
http://georgiawildlife.org/

Environmental Protection Division
http://georgiaepd.org/

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## Appendix A

Past indicators or indicators that were explored but not used in the report card.

### Fish consumption advisories

Fish consumption advisory data is an important indicator of human health. Throughout coastal Georgia key fish species that are commonly eaten by humans are tested for heavy metals and other dangerous chemicals. The primary metals found in fish in coastal Georgia are mercury and arsenic, which, when present at high levels are unsafe for human consumption. Heavy metals can enter fish through the food chain, as small fish eat plants or benthic organisms that may have taken up metals from contaminated soils or water. When larger fish eat the smaller fish, the amount of metals accumulated in the tissues of the large fish, which are then caught and eaten by humans. Fish consumption advisories are based on the amount of heavy metals that are at low enough concentrations in fish to still be safe for humans to consume. Fish consumption advisory data was removed in 2016 due to the data not being updated frequently.

The fish consumption advisories threshold was determined using the Georgia DNR Environmental Protection Division's State Guidelines for Eating Fish from Georgia Waters. The thresholds used are the different levels of the advisories themselves. There are four categories fish consumption can fall into, No restriction, 1 Meal per Week, 1 Meal per Month, and Do Not Eat. These categories are based on specific levels of arsenic and mercury found in fish tissues of the sampled fish. For each sampled fish, the arsenic and mercury were compared to the categories they fall into, and then each of these categories was assigned an appropriate score. Samples with No Restriction, were given a 100% score. Samples with 1 Meal per Week and 1 Meal per Month were given a 66.7% and 33.3% scores, respectively. Samples with Do Not Eat were given a 0% score.

### Right whales

Right whales are an important indicator to examine wildlife health in coastal Georgia. Right whale calf production index and right whale population growth rate are two indicators used to evaluate the health of this species in the waters of coastal Georgia. The right whale indicators were removed in 2020 due to inconsistencies with data collection, and the location of this species being mainly outside coastal Georgia.

#### Right whale population growth rate

The right whale population growth rate thresholds are multiple thresholds determined based on recommendations from the National Marine Fisheries Service. The thresholds are as follows: A = ≥3.5%, B = 2.5−3.49%, C = 1.5−2.49%, D = 0.5−1.49%, and F = <0.5%. The right whale population growth rate value for entire coastal Georgia for 2011 was compared to the thresholds to calculate an overall score. For right whales, the most recent data available is from 2011.

#### Right whale calf production index

The right whale calf production index thresholds are multiple thresholds determined based on recommendations from the National Marine Fisheries Service. The thresholds are as follows: A = ≥0.075, B = 0.05−0.075, C = 0.025−0.05, D = 0.0125−0.025, and F = <0.0125. The right whale calf production index value for entire coastal Georgia for 2011 was compared to the thresholds to calculate an overall score. For right whales, the most recent data available is from 2011.

### Nutrients

Nutrients are essential to the health and diversity of estuaries. However, excessive nutrients in water systems can lead to harmful algal blooms, which may negatively affect the health of humans and other animals. The primary nutrients of concern are nitrogen and phosphorus. Both are required for plants and animals to grow; however, when in excess, they can cause serious problems. When nitrogen and phosphorus are present in excess, algae overgrowth may occur, resulting in an algal bloom that eventually dies and decays. The decomposition process depletes dissolved oxygen, which can lead to very low dissolved oxygen levels and subsequent fish kills. Lower algae levels promote cleaner, clearer water, more available habitat, and fewer harmful algal bloom effects.

### Total phosphorus

The total phosphorus (TP) threshold was determined based on the Florida Department of Environmental Protection's Numeric Nutrient Criteria (62-302.532 Estuary-Specific Numeric Interpretations of the Narrative Nutrient Criterion). The Numeric Nutrient Criteria separates different areas throughout Florida and gives a specific criterion for each region. The furthest north threshold in Florida, which is the St. Mary's River/Amelia River region, Lower St. Mary's is 0.045 mg/l. For each total phosphorus reading, the measurement was compared to the threshold on a pass/fail basis. When TP was >0.045 mg/l, it equaled a failing score, where as if TP was ≤0.045 mg/l, it equaled a passing score. While TP was analyzed and scored during the development of the report card, it was not included in the overall report card. This is due to difficulties coming to consensus on water quality data and thresholds in coastal Georgia.

### Dissolved inorganic nitrogen

The dissolved inorganic nitrogen (DIN) thresholds are multiple thresholds based on the US EPA's National Coastal Condition Assessment. The thresholds are <0.1 mg/l, 0.1−0.5 mg/l and >0.5 mg/l. Each dissolved inorganic nitrogen sample was compared to these thresholds to calculate the scores. When the DIN value was <0.1 mg/l, it equaled a 100% score. When the DIN value was between 0.1 mg/l and 0.5 mg/l, it equaled a 50% score. When the DIN value was >0.5 mg/l, it equaled a 0% score. While DIN was analyzed and scored during the development of the report card, it was not included in the overall report card. This is due to difficulties coming to consensus on water quality data and thresholds in coastal Georgia.

### Chlorophyll a

Chlorophyll is a key indicator of estuary health. It is the green pigment that allows plants to convert sunlight into organic compounds during photosynthesis. Of the several kinds of chlorophyll, chlorophyll *a* is the predominant type found in microalgae (phytoplankton) in fresh and saltwater ecosystems. Therefore, chlorophyll *a* is used as a measure of phytoplankton biomass, which is controlled by factors such as water temperature and light and nutrient availability. Phytoplankton serve as a base of the food web in many estuaries. However, too much phytoplankton leads to large algal blooms that can reduce water clarity. Additionally, once an algal bloom dies, the algae cells sink to deeper water, where they decay and deplete waters of oxygen. Lower algae levels promote cleaner, clearer water, more available habitat, and fewer harmful algal bloom effects.

The chlorophyll *a* thresholds are multiple thresholds based on the US EPA's National Coastal Condition Assessment. The thresholds are <5 µg/l, 5−20µg/l and >20 µg/l. Each chlorophyll *a* sample was compared to these thresholds to calculate the scores. When the chlorophyll *a* value was <5 µg/l, it equaled a 100% score. When the chlorophyll *a* value was between 5 µg/l and 20 µg/l, it equaled a 50% score. When the chlorophyll *a* value was >20µg/l, it equaled a 0% score. While chlorophyll *a* was analyzed and scored during the development of the report card, it was not included in the overall report card. This is due to difficulties coming to consensus on water quality data and thresholds in coastal Georgia.

### Water clarity

Water clarity is an important water quality indicator to determine ecosystem health. Water clarity is a measure of how much light penetrates through the water column. It is dependent upon the amount of suspended particles (e.g., sediment and plankton) and colored organic matter present. Clear water is critical for the growth and survival of aquatic grasses, as well as fish, crabs, and other aquatic organisms. However, clear water should not be confused with the color of the water. Black water systems, for example, have highly colored water, but that is a natural phenomenon and is not an indication of eutrophication. Poor water clarity is usually caused by a combination of excess suspended sediments from runoff from the land and the growth of phytoplankton, which is fueled by nutrients.

The water clarity thresholds are multiple thresholds based on a University of Georgia report of Recommended Indicators of Estuarine Water Quality for Georgia by Joan E. Sheldon and Merryl Alber. The thresholds are >0.5 m, 0.5−0.3 m and <0.3 m. Each water clarity sample was compared to these thresholds to calculate the scores. When the water clarity value was >0.5 m, it equaled a 100% score. When the water clarity value was between 0.5 m and 0.3 m, it equaled a 50% score. When the water clarity value was <0.3 m, it equaled a 0% score. While water clarity was analyzed and scored during the development of the report card, it was not included in the overall report card. This is due to difficulties coming to consensus on water quality data and thresholds in coastal Georgia.