Purpose and Scope

In order to inform the Region’s consultation activities regarding the recently listed Nassau grouper, this document consolidates and interprets information obtained through the recent listing process and collected through collaboration with state, federal (Southeast Fisheries Science Center [SEFSC]), and university partners. This collection of information provides Section 7 assistance, and identifies early conservation/recovery concepts to be considered during consultation. The contents are intended to summarize best available information as well as facilitate integration of conservation/recovery considerations into our routine consultation practices. A large quantity of data was synthesized in the production of this document and as such it should be considered a job aid and used as general guidance only.

Section 7 Considerations

Following the June 2016 Nassau grouper listing under the Endangered Species Act (ESA), we began considering what types of federal actions could have the potential to affect the species. This analysis considered Nassau grouper distribution and habitat use within its range based on the various life stages of the species. We relied on the 2013 Biological Report and collected additional information from various state, university, and federal agencies, as presented below, to ensure the most recent data available was incorporated (Hill and Sadovy de Mitcheson 2013).

Range for consultation purposes: How common is the species and where is the species found? Based on data from our FWC, university, and NOAA partners

All data, to date, suggest that Nassau grouper are absent from the waters surrounding most of the continental United States. The exception is Florida where a small number of larger juveniles and adults (293 individuals) have been recorded in surveys and others reported in fisheries (see supporting data for details). No larval Nassau grouper or juveniles smaller than 19cm fork length (FL) have been collected or observed in Florida waters. To settle from the plankton and successfully recruit, Nassau grouper require specific nursery habitats coupled with currents to transport larvae; these areas are limited to the Florida Reef Tract. However, it should be noted that sampling along shoreline habitats of the Florida Keys where smaller juveniles might be expected to occur has been limited, to date. Ichthyoplankton surveys have not collected Nassau grouper. Adults have been captured at offshore reef outcroppings north of the Florida Reef Tract; these fish likely moved in as large juveniles or adults. Based on the information detailed later in this document, we evaluated the range and distribution of Nassau grouper to ensure that our section 7 consultation practices consistently and accurately consider where the species may be present. Please refer to the SERO Section 7 Mapper for more detailed information on the recommended Nassau grouper consultation areas: [ESA Section 7 Mapper web app viewer](https://www.serowebappviewer.noaa.gov).
Southeast Florida, North of Government Cut

- General coastal construction projects occurring in the southeastern United States, with the exception of those in the Florida Keys (including the Dry Tortugas and Biscayne Bay to Government Cut), will have no effect on the species due to the absence of Nassau grouper in these nearshore locations. The general absence of Nassau grouper outside of the Florida Keys is well documented by the lack of records in Florida Fish and Wildlife Conservation Commission’s, Fisheries Independent Monitoring data as well as various surveys conducted by the National Marine Fisheries Service’s SEFSC. Specifically, we do not believe Nassau grouper will be present in waters on the north side of the Florida Keys (north of Hwy 1), the Gulf of Mexico, and coastal locations along the Atlantic coast north of Government Cut.

- Adults and large juvenile Nassau grouper may be present at offshore (> 3 miles) reef outcroppings north of Government Cut to Cape Canaveral, FL. Nassau grouper are captured incidentally in the snapper-grouper fishery by both commercial and recreational fishers using handlines (NMFS 2016).

- The general absence of Nassau grouper in nearshore areas outside of the Florida Keys is well documented by the lack of records in Florida Fish and Wildlife Conservation Commission’s, Fisheries Independent Monitoring data as well as various surveys conducted by the National Marine Fisheries Service’s SEFSC.

Government Cut to Florida Keys and Dry Tortugas

- Adult and large juvenile Nassau grouper may be present in waters surrounding the Dry Tortugas and on the south side (south of U.S. Hwy 1) of the Florida Keys, including Biscayne Bay to Government Cut. In this area, consultations should carefully evaluate the habitat preferences for these life stages in determining whether Nassau grouper may be present in affected areas. Nassau grouper are not expected to present on the north side of the Florida Keys (north of U.S. Hwy 1). Please refer to the Section 7 Mapper for more information on the recommended consultation area for Nassau grouper in this area.

- The likelihood of encountering small juveniles and larval Nassau grouper is extremely unlikely to occur in the nearshore areas of the Florida Keys including Biscayne Bay to Government Cut. While benthic survey may identify appropriate habitat for larvae to settle in the nearshore/lagoon area, no Nassau grouper smaller than 19 cm FL has been collected or observed in Florida waters.

U.S. Caribbean

- All life stages of Nassau grouper may be present throughout Puerto Rico and the U.S. Virgin Islands (i.e., the U.S. Caribbean). Again, habitat associations for the various life stages should be
considered in determining whether the species may be present in the area affected by proposed actions.

Considerations for Projects Located in Florida Keys

Projects (e.g., general construction) occurring in all waters on the south side of the Florida Keys to Government Cut may have the potential to affect the species, with the following clarification and limitations:

- The presence of post-settlement and early-juvenile Nassau grouper in the nearshore coastal areas is unknown. Adult Nassau grouper along the east coast of Florida are likely a result of larval immigration from the Caribbean via the Florida Current. Nassau grouper larvae (2-3cm TL) settle in the lagoon area with coarse calcareous substrate, numerous sponges, and stony corals (primarily Porites spp.) affixed with macroalgae (Laurencia spp.). These small fish lived within the coral/macroalgae clumps patchily distributed at 2-3m depths. This habitat provides both cover and prey for these very small fish. To reduce the risk of mortality, these post-settlement fish, like most coral reef fish, do not emigrate from settlement habitat except during ontogenetic habitat shifts. After 4 – 5 months of living within the macroalgae clumps, the early juveniles emerge and are found adjacent to these alga-covered coral clumps within the lagoon area. Early juveniles are not expected to be in seagrass habitats. To settle from the plankton and successfully recruit, Nassau grouper require specific nursery habitats coupled with currents to transport larvae. While Nassau grouper nursery habitat occurs in the Florida Keys, NMFS is not aware of any record of a Nassau grouper smaller than 19cm FL despite numerous surveys including those for ichthyoplankton near the western boundary of the Florida Current and in the passes between the Keys. It is possible that the Florida Current is carrying Nassau grouper into the Florida Reef Tract and the larvae are settling in the lagoon area on the windward side of the Florida Keys. However small individuals have not been observed despite survey and coupled with the large area of the Florida Reef Tract, NMFS has determined that adverse effects on post-settlement and early juveniles would be extremely unlikely to occur and a NLAA determination is appropriate.

- While larger juveniles (19cm FL and larger) do occur off the Florida Keys, NMFS does not expect any Nassau grouper of this size to be present on soft habitat (mud/sand areas with no coral or rock). “No effect” determinations by the action agency are appropriate for projects occurring over soft bottom habitat.

- Nassau grouper (19cm FL and larger) could occur over corals, reefs, and other hardbottom habitat, including channels and canals cut through the limestone hardbottom found throughout the Florida Keys. In this instance, a “no effect” determination CANNOT be supported as the species may be present and a “may affect” determination will be made; subsequent analysis to
analyze the potential effects of the project based on its stressor(s) is necessary. Additional information to assist with that analysis is provided below.

- Nassau grouper, like other grouper species, are closely associated with structure and utilize these areas for cover. Therefore, they may be found in areas with docks and seawalls even if hardbottom is absent. Again, additional information to assist with the analysis is provided below.

Common Routes of Effect to Consider for Projects Occurring in Waters on the South Side (South of Hwy 1) in the Florida Keys and in Waters Surrounding the Dry Tortugas

If a project will occur near corals, reefs, hard bottom, or shoreline structures, the biologist should consider the following list of potential stressors and their effects. The biologist should also include the accompanying rationale to justify a determination that effects are extremely unlikely to occur or insignificant, as applicable and appropriate. Exceptions beyond routine small scale projects for which this rationale may not be appropriate could include: large scale projects such as marinas that have a longer construction duration, fishing piers that could result in the incidental capture of Nassau grouper, port expansion projects that may require significant impacts to hard-bottom habitat, consultation on fishery management plans that could result in the incidental bycatch of Nassau grouper in otherwise legal federal fisheries, and activities that could result in significant impacts to hard bottom habitats used by Nassau grouper.

- PHYSICAL INJURY FROM EQUIPMENT - Nassau grouper have the potential to be physically injured or killed by interactions with construction equipment and pile installation. However, we believe this is extremely unlikely to occur because this species is mobile and expected to move away from active construction equipment.

- TEMPORARY LOSS OF FORAGE OR REFUGE HABITAT - Nassau grouper may temporarily be unable to use the project area as forage or refuge habitat due to avoidance related to construction noise and/or physical exclusion from the area via turbidity curtains or disturbance. We believe these types of effects would be insignificant, based on the typical small footprint and short duration associated with most projects. Additionally, Nassau grouper (at the sizes that would be found in the action areas) are highly mobile organisms and provided similar habitat is nearby, we expect these adjacent sites could provide similar short-term refuge or forage habitat.

- LONG TERM HABITAT ALTERATIONS - Larger juvenile and adult Nassau grouper (>19cm FL) use a variety of hardbottom habitats. While the listing rule characterized habitat loss as a low risk to species survival and distribution, habitat loss may affect species recovery. Projects resulting in the removal or modification of reef or hardbottom habitat may affect Nassau grouper by displacing them from these specific habitats. However, we believe any effects from most small scale removals or modifications of reef or hardbottom habitat will be insignificant provided there is other habitat in close proximity to the project site that can serve a similar habitat function for Nassau grouper. Projects removing or altering larger areas of habitat will require further considerations and analyses. Activities that have significant or large scale direct or indirect impacts to reef or hard bottom habitat may result in adverse effects to the species
through the modification or loss of habitat. Long term/permanent impacts to reef or hardbottom habitat should be considered in assessing potential for adverse effects to the species.

- **NOISE** - Effects to ESA-listed animals as a result of noise created by construction activities can physically injure animals in the affected areas or change animal behavior in the affected areas. Injurious effects can occur in two ways. First, immediate adverse effects can occur to listed species if a single noise event exceeds the threshold for direct physical injury. Second, effects can result from prolonged exposure to noise levels that exceed the daily cumulative exposure threshold for the animals, and these can constitute adverse effects if animals are exposed to the noise levels for sufficient periods. Behavioral effects can be adverse if such effects interfere with the animal movement, feeding, resting, or reproduction, for example. Our evaluation of effects to listed species as a result of noise created by construction activities is based on the analysis prepared in support of the Opinion for SAJ-82.\(^1\) The biologist should conduct a noise analysis to evaluate effects to ESA-listed fish identified by NMFS and whether the effects are NLAA or LAA.

- **TURBIDITY** - Project construction could increase turbidity that may adversely affect Nassau grouper. To control and reduce turbidity, the applicant will generally be required to use turbidity curtains, which will be installed prior to and remain in place throughout all in-water construction. Turbidity curtains will remain in place post-construction until turbidity and siltation subsides. Given the short duration and this best management practice associated with typical projects it is likely there will be no effect from turbidity. No effect determinations do not need to be discussed in consultations drafted by NMFS.

- **VESSEL TRAFFIC** – Vessel traffic/boat strikes are not a concern for Nassau grouper as they are demersal (bottom-dwelling) fish\(^2\) that associate with hardbottom. We believe that their association with rocky bottoms and coral reefs coupled with their demersal life history lead to a “No Effect” determination. No effect determinations do not need to be discussed in consultations drafted by NMFS.

**Consideration for Projects within the U.S. Caribbean**

Based on the assumption stated above that all life stages of Nassau grouper are likely present in the U.S. Caribbean, action agencies, and subsequently NMFS, must consider possible impacts to multiple life stages of Nassau grouper from a variety of in-water projects that are likely to occur in the Caribbean. UNLIKE THE FLORIDA KEYS, all size classes may occur in project areas of the U.S. Caribbean. This becomes especially important in considering noise analyses for which there are different thresholds for smaller fish (those <2g) versus larger fish (>2g). NMFS is uncertain about how individual projects may affect the species and therefore effects will need to be considered on a project-by-project basis. Considerations should include time of year (to determine life stages that may be present), habitat types in the vicinity of the project, scale of the project, and then potential routes of effects.

---


\(^2\) Some demersal fish are susceptible to vessel traffic; for example, Atlantic sturgeon that inhabit navigation channels.
These routes of effects may include but are not limited to:

- Physical injury from equipment.
- Loss of forage or refuge habitat – Habitats used by small Nassau grouper include a variety of microhabitats (Laurencia spp. mats, queen conch shells, tilefish mounds) and more traditional habitats (coral, mangroves, hard bottom) (Hill and Sadovy de Mitcheson 2013). However large-scale projects that have direct or indirect impacts to reef or barbottom habitat can have potential effects to adults. In locations where small juveniles may occur, loss of seagrass and mangroves may also have potential effects to the species’ nursery areas. In the U.S. Caribbean, activities with permanent impacts to the nearshore seagrass and mangrove habitat should be assessed for potential adverse effects to newly settled and juvenile life stages.
- Behavioral or physical injury from noise.
- Accidental bycatch.

**Potential Work Window To Avoid Effects of Noise to Small (<2g) Recent Recruits**

- Construction open windows to avoid impacts to newly recruited juveniles - proposed actions should occur between July 7 – December 11 to avoid noise impacts to small (<2g) Nassau grouper. While applicants are not required to conduct work within this window projects conducted outside of this period would consider potential impacts of noise to these small (<2g) juvenile Nassau grouper.
- This work window is based on the following:
  - Assuming (1) aggregations form at the same sites every year from November – February, (2) eggs hatch as larvae 23-40 hours post fertilization, and (3) larvae are planktonic for up to 70 days but typically recruit to demersal habitat around 40 days at an average size of 2.5cm (25mm), then the latest that a young 2.5cm (25mm) new recruit would show up in the action area would be February 28th + 2 days (to hatch) + 70 days planktonic then recruit (conservative, worst case scenario) = May 11.
  - Estimated growth rate is 0.57mm/d (this assumes the growth rate for slightly larger fish applies to this size class),
  - A 2g fish is approximately 57mm, therefore the recruit at 25mm needs to grow 32mm in order to reach a TL of 57mm (size at recruitment to 57mm to reach a weight of 2g; or a total of 32mm (57mm – 25mm = 32mm).
  - With a growth rate of 0.57mm/day it would take 56.2 days for the recruit to grow 32mm (32mm/0.57mm/d = 56.2).
  - Therefore with a spawn date of February 28 + 2 days (to hatch) + 70 days planktonic then recruit + 56.2 days for the recruit to grow to 2g = July 7.
  - Next, the date a new recruit from the next year class could enter the action area would be December 11 (earliest recruit would be November 1 + 1 day to hatch + 40 days to recruit on conservative side = December 11).
  - So between July 7 - December 11 (roughly 5 months) Nassau grouper less than 2g should not be present in the nearshore habitat.
  - Noise Abatement Methods may be available and can be assessed for effectiveness.
Conservation and Recovery Considerations

One of the goals of PRD is to promote conservation and recovery of ESA listed species. Section 7 consultations and the related engagement with action agencies (and applicants) provide an opportunity to help achieve these goals. While the most serious threats to Nassau grouper is removal by fishing at spawning aggregations and inadequate law enforcement (which are beyond the scope of the routine consultations addressed by this document, except perhaps FMP consultations), other threats contribute to the status of this species. Possible issues to consider during consultation include, but are not limited to:

- Loss of any of the habitats utilized by groupers during various life stages may influence their distribution, abundance, and survival, including alterations or destruction of nearshore nursery areas, including mangroves and seagrasses, and degradation of hardbottom habitat. Therefore, consulting biologists should not only work to avoid and minimize potential project impacts to Nassau grouper habitat during consultation with action agencies, but encourage proactive conservation actions that could help improve or protect habitat through conservation recommendations whenever possible.

- Where applicable and practicable, staff should seek the cooperation and assistance of action agencies and applicants in helping with public outreach concerning the plight of the species. This may include, but is not limited to, helping communicate (e.g., signage) the importance of minimizing human impacts to habitats used by the Nassau grouper (and other protected species!), compliance with existing regulations including no take and seasonal/areal closures, and promoting responsible fishing practices (e.g., use of circle hooks when fishing in areas where this species may be captured and safely returning this species to the water if captured).

Background Information

This section presents information to help familiarize you with the species to understand its basic biology, life history, ecology, and habitat use. This information was used in combination with the listing rule, and the Biological Report, to guide development of the Section 7 framework.

Listing Information

- Listed as threatened on June 29, 2016 (81 FR 42268), effective July 29, 2016.
- Critical Habitat has not been designated.

Species Description

- Adult appearance (Figure 1): Dark band on top of head from upper jaw through each eye and then curving to meet its corresponding band above eye (i.e., tuning fork pattern); 5 dark vertical bars; black saddle on the caudal peduncle; and, numerous black spots below/behind each eye.
- Juveniles exhibit a color pattern similar to adults.

Figure 1. Adult Nassau grouper on a reef. Photo credit: S.K. Bolden.
• Maximum weight: 55lbs (25kg).
• Maximum length: 4ft (122cm).

Range (based on literature and historical accounts)
• Bermuda and Florida (USA), throughout the Bahamas and Caribbean Sea (Figure 2).
  o Florida Range: Cape Canaveral south through the Florida Keys westward to the Tortugas and Pulley’s Ridge. It is fairly uncommon in Florida, with mixed accounts historical abundance.
  o Considered rare in the Gulf of Mexico
• Primary determinants of distribution in Nassau grouper are not known although water clarity, habitat, and benthos appear to be important. The mean depth range of the Nassau grouper (0-130m) may be influenced more by the availability of suitable habitat than by food resources, since diet is highly varied and more a function of body size than of water depth.
• Occurs in tropical/subtropical waters (~24°C - 30°C, but can vary); generally shallow water, but may be found in depths to 130m; can tolerate practical salinity of 15 for a few days, but prefer 30 or greater.
• Patchy abundance throughout the range of a species is common due to variability of habitat quality/quantity and/or exploitation level.

Distribution (based on life history)
• Within Florida, the reef tract is essential for Nassau grouper recruitment.
  o The Florida Reef Tract extends from St. Lucie Inlet in Martin County to the Dry Tortugas with the most prolific reef development seaward of the Florida Keys. It is a near continuous offshore reef structure that stretches in a barrier-like formation for some 360 linear miles.
  o The Florida Reef Tract is a complex progression of continuous reef habitat from inshore (shoreline/intertidal zone to lagoon to back reef to patch reefs to reef flat to reef crest) to offshore built upon older carbonate structures that provides the necessary habitats and topographical complexity for the Nassau grouper to complete its growth from post-settlement to adult.
• Because there is no known spawning within Florida waters, immigrating Nassau grouper larvae would require transport from the Caribbean through the Gulf Stream.
  o East of the Florida Reef Tract is the Straits of Florida that separates the south Florida shelf from the Bahamas Bank. The Florida Current, a strong surface current originating in the South Atlantic and Caribbean, dominates the Straits of Florida. The Florida Current links with the Gulf of Mexico Loop Current and the Yucatan Current off peninsular Florida, becoming the Gulf Stream System offshore of the southeastern U.S. The Florida Current transports warm water from the Caribbean, resulting in the presence of West Indian biota in the Florida Keys.
The distribution of Nassau grouper, within the range, varies based on habitat and depth as previously discussed. Some areas within the confirmed range of Nassau grouper do not provide essential nearshore nursery habitats, however adults may occupy adjacent offshore hardbottom areas.

Figure 2. Confirmed range of Nassau grouper currently includes Bermuda, Florida (USA), the Bahamas, and Caribbean Sea (Acero and Garzón-Ferreira 1991; Cervigón 1991; Heemstra and Randall 1993; Smith 1971).

Summary of Survey Results by Area

Continental U.S.

- Florida Keys (south of landmass) and Dry Tortugas
  - FWC has tagged 14 animals in waters off the Florida Keys and Dry Tortugas from 2008 to 2016. The animals ranged in size from 27 to 78.7cm TL.
  - 291 animals have been recorded during FWC/NOAA/National Park Service/UM-RSMAS in-water surveys from Biscayne Bay, through the Florida Keys and Dry Tortugas. Survey period is 1999 – 2014; however no sampling occurred in 2013 or 2015, and 2016 data are being processed. Nassau grouper observed ranged in size from 19.5 to 91cm FL in average depths ranging from 1.3 to 85.25m.
    - Habitat types where Nassau grouper were observed included: continuous reef high relief, continuous reef low relief, isolated patch low relief, isolated patch medium relief, isolated patch high relief, spur and groove low relief, and spur and groove high relief habitats.
    - All surveys were conducted on the south side of the Florida Keys, and only in reef habitat.
    - The smallest Nassau grouper that FWC has recorded in the Florida Keys was at a site called Coral Gardens; FWC has observed many “juveniles” Nassau grouper here all at a length in the upper 20cm range or larger. Coral Gardens is described by FWC as a nearshore site with many patch reefs.
    - FWC has a seining program with monthly survey at ten sites in the middle keys with no
reports of Nassau grouper. This gear type (seine) is not likely to capture Nassau grouper.

- The FWC collaborator queried several divers in the group if they recall observing Nassau grouper smaller than 19.5cm in the Florida Keys and none of them can recall such an event. Several of these people have thousands of dives each in the Florida Keys.
- There are limited data for nearshore non-reef areas where action areas may occur.
- Two extensive surveys were conducted for ichthyoplankton at the western edge of the Florida Current; one surveys used light traps and the other nets. While both surveys collected Serranids, neither collected *E. striatus*.

- **Florida Bay - area on the north side of the upper Florida Keys that is encompassed within the Everglades National Park boundary.**
  - Surveys by FWC’s Fisheries Independent Monitoring program reports only a single Nassau grouper record. The gears utilized for this survey (otter trawls, 21.3 meter haul seines, and purse seines) are not likely to capture Nassau grouper over hardbottom habitat but would be appropriate for catching juveniles in the lagoon area.
  - The **FWC Unified Florida Coral Reef Tract Map** identifies many areas around the Florida Keys and the Marquesas as hardbottom habitat including large areas immediately north of the Middle Keys.
  - Numerous studies have documented abundant red algae (*Laurencia* spp.) and sponges, corals, and other crevice-structures in these hard bottom areas, which are also near patch reefs and deeper contiguous reef tracts.
  - Available information indicates the species is not common; however, habitat to support each of its ontogenetic stages is prevalent, suggesting the potential of the area for supporting a recovering population.

- **Florida Keys to Government Cut (Biscayne Bay)**

- **Government Cut (Miami Dade County) Florida to Cape Hatteras, North Carolina**
  - No animals have been recorded during in-water surveys off the coast of Florida from Government Cut in Miami to St. Lucie Inlet in Martin County. This data is limited, surveying has only occurred from 2012-2015 (2016 data not yet available).
  - NOAA SEFSC conducts annual surveys in the Atlantic from Florida to North Carolina. Since the inception of this program in 1990, only 1 adult Nassau grouper has been observed. This individual was recorded by video on 8/16/13 in 52 meters of water off the coast of Jacksonville, FL. Given there is only this one record it is our opinion that this was a seasonal wanderer that ventured outside of the known geographic range of this species, and it does not represent a true range expansion.
  - The SEFSC generally surveys hard bottom areas at depths starting around 50ft and out to about 350ft depth. The closest to shore the SEFSC surveys is approximately 3.5 miles at depths of 45 ft (at the shallowest point). While juvenile and adult Nassau grouper could occupy habitat at this depth, the SEFSC has not surveyed near shore sea grass or algae habitats within 3.5 miles of shore.
  - Both commercial and recreational fishers have captured Nassau grouper from reef outcroppings offshore (> 3 miles) between Cape Canaveral and the Florida Keys (NMFS
2016).

- Spawning Locations
  - There are currently no known spawning aggregations within Florida waters, but it is possible they occur. While a few larger juvenile-sized Nassau grouper have been observed in Florida waters, no information is available to determine their origin. Pair spawning of Nassau grouper has not been recorded. It is likely that recruits spawned in the Caribbean are the source for the Nassau grouper within Florida waters.

U.S. Caribbean (Puerto Rico and the U.S. Virgin Islands)
- At least two Nassau grouper aggregation sites have disappeared.
- A newly identified small aggregation near Puerto Rico at Bajo de Sico may be a reconstitution of a former aggregation.
- Grammanik Bank, located south of St. Thomas, U.S. Virgin Islands, has shown a number of Nassau grouper aggregating during the reproductive season.
- Multiple life stages are assumed to be present based on the presence of these two spawning aggregations.

Caribbean – not within jurisdiction of ESA, but provided for informational purposes
- Bahamas - all life stages present and common, numerous spawning sites are known.
- Cayman Islands – all life stages present and common, numerous spawning sites are known.
- Belize – all life stages present and common, numerous spawning sites are known.
- Mexico – fishing pressure in the 1990’s caused many aggregations to collapse and three remaining aggregations are known to remain.
- Bermuda – previously abundant with numerous spawning sites, commercial fishing greatly reduced abundance where aggregation sites no longer form; presence of small individuals has recently increased.
- Cuba – data are few and difficult to validate, numerous spawning sites are reported to occur.

Life History/Ecology/Habitat Use

Biological Characteristics
- Slow-growing.
- Long lived (~29 years).
- Naturally occur at low density across large spatial scale.
- Generation time (the interval between the birth of an individual and the subsequent birth of its first offspring) is estimated at 9-10 years.
- Data from scales and otoliths indicate that fish reach sexual maturity in approximately 4-7 years. Both male and female Nassau grouper typically mature at 4–5 years of age and at lengths between 40 and 45cm SL (44 and 50cm TL).
- Reproductive period is brief (days) as fish aggregate to spawn at transient, site-specific locations during consecutive full moons in the winter; there are no records of pair spawning.
Diet

- Larval and pelagic juvenile Nassau grouper feed on a variety of plankton, including pteropods, amphipods, and copepods.
- Demersal juveniles occur in nearshore benthic habitats (i.e. mangroves, seagrasses, and macroalgal clumps) and feed mainly on crustaceans.
- Late juveniles/subadults occur on hard bottom and reefs and feed mainly on benthic invertebrates and fish.
- Adult Nassau grouper are unspecialized, bottom-dwelling, ambush-suction predators. Numerous studies describe adult Nassau grouper as piscivores.
- Piscivores are generally diurnal to coincide with activity period of their prey. There are limited data regarding Nassau grouper foraging period. Nassau grouper may take advantage of the reduced light levels at dawn and dusk combined with the increased number of prey during changeover between diurnal and nocturnal fishes to forage as a means to reduce high energy costs associated with large fish abusing prey.

Habitat Use by Size Class

Table 1. Size, habitat, and notes associated with each life stage

<table>
<thead>
<tr>
<th>Life stage</th>
<th>Size</th>
<th>Habitat</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egg</td>
<td>N/A</td>
<td>Eggs are planktonic within the oceanic environment</td>
<td>Eggs hatch as larvae 23-40 hours post fertilization</td>
</tr>
<tr>
<td>Larvae</td>
<td>&lt;2.5cm TL</td>
<td>Larvae are planktonic within the oceanic environment</td>
<td>Larvae are planktonic for up to 70 days but typically recruit to demersal habitat around 40 days at an average size of 2.5cm.</td>
</tr>
<tr>
<td>Post-settlement and early juveniles</td>
<td>2.5 – 15cm TL</td>
<td>Recruit (2-3cm TL) to coral clumps (primarily Porites spp.) covered by masses of macroalgae (Laurencia spp.) in shallow nearshore waters. With growth (at about 8cm TL) move from within the macroalge to outside/adjacent coral/algae clumps. Have also been found in several microhabitats including empty queen conch shells, debris adjacent to seagrass, and rubble mounds. Begin shifting to reef habitats including solution holes, ledges, and natural/artificial patch reefs around 12-15 cm.</td>
<td>Several studies indicate coral clumps with attached macroalgae as being the most important settlement habitat. Usually in coarse calcareous sand areas as the stony corals provide attachment sites for the red algae as direct holdfast attachment is inhibited. Density of recruits within algae can be up to 8, become more solitary as they move from within algae to adjacent areas. Also a shift towards deeper water as size increases.</td>
</tr>
<tr>
<td>Juveniles</td>
<td>15 – 50cm TL</td>
<td>Inshore patch reefs, both natural and artificial, at smaller length (15 – 30cm TL) s then transitioning to forereef habitat around 30-35cm TL. Transition to progressively deeper water banks and offshore reefs with increased size.</td>
<td>Generally solitary in specific habitats for extended periods.</td>
</tr>
<tr>
<td>Adults</td>
<td>&gt;50cm</td>
<td>High relief corals and rocky substrates in</td>
<td>• Relatively sedentary,</td>
</tr>
<tr>
<td>Life stage</td>
<td>Size</td>
<td>Habitat</td>
<td>Notes</td>
</tr>
<tr>
<td>------------</td>
<td>------</td>
<td>---------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>TL</td>
<td>clear water from the shore to depths of 130 m. Occupy crevices, caves, solution holes, and ledges in these habitats.</td>
<td>• correlation between size and depth, • movements generally diurnal</td>
</tr>
</tbody>
</table>

**Reproduction**

- Spawning aggregation sites (Figure 3) are transient and site-specific forming between November and February around the full moon when water temperatures around 25°C – 26°C. All known reproductive activity occurs within these aggregations.
- Adults move from resident reefs as spawning time approaches to established spawning areas. Distances traveled are highly variable depending on distance to aggregation site. Some fish move only a few kilometers, but some individuals are known to travel up to several hundred kilometers to the aggregation site. Limited observations indicate: 1) fish move in groups numbering between 25 and 500; 2) movement is parallel to the coast or along the shelf edge; 3) movements are synchronous, and 4) individuals return to their home reef after spawning.
- Spawning aggregation sites have been found to occur near the edge of insular platforms, as little as 50 m from the shore, nearby a drop-off into deeper water across a wide (6-60m) depth range and diversity of substrate types. Sites are characteristically small, highly circumscribed areas, measuring several hundred meters in diameter, with soft corals, sponges, stony coral outcrops, and sandy depressions.
- The general spawning behavior consists of courtship among four distinct color phases concluding with a rapid vertical rush lead by a female followed by numerous males releasing eggs and sperm into the water column well above the substrate near sunset.
- Size and number of spawning aggregations have decreased over time (Figure 3). Based on the size and number of current spawning aggregations the Nassau grouper population appears to be just a fraction of its historical size. Recent evidence suggests that spawning is occurring at what may be reconstituted or novel spawning sites in Puerto Rico and U.S. Virgin Islands.
- The following figure (Figure 3) denotes the location of historic and current spawning aggregations.
Figure 3. Nassau grouper spawning aggregations locations both historically (a) and as of about 2007 (b) according to available information; not all sites have been validated. Inset shows full geographic range, main concentrations (shaded) and extended areas (dashed lines). Each closed circle represents 1, or occasionally 2, reported site(s). Open circles are “probable” sites. (Sources: Sadovy and Eklund 1999; Sala et al. 2001; Smith 1972; Whaylen et al. 2004); Belize Spawning Aggregation Working Group, unpublished data; R. Claro, unpublished data; E. Sala, unpublished data, as presented in De Mitcheson et al. (2008).
Summary of Threats

The most serious threats to Nassau grouper are fishing at spawning aggregations and inadequate law enforcement. In addition a variety of other threats have been identified as also impacting the status of this species including: 1) negative pressures on growth rate/productivity and spatial structure/connectivity, as well as effectiveness of foreign regulations; and 2) potential impacts from artificial selection, insufficient abundance levels and diversity, commercial harvest, and effectiveness of state and territory regulations. Additional detail is provided in the listing rule.

Major loss of any of the habitats utilized by groupers during various life stages is likely to influence their abundance and survival. While habitat loss was categorized as a low risk threat during the listing process, it influences survival and recovery and deserves consideration when analyzing proposed project impacts.

Perhaps the greatest habitat losses influencing grouper populations arise from alterations or destruction of nearshore nursery areas, including mangroves and seagrasses, and by the declining state of coral reef systems (Dahlgren and Eggleston 2001; Gardner et al. 2003; Semmens et al. 2007)

- Changes in water temperature experienced by early life stages of Nassau grouper may have profound effects on their food consumption, development and growth rate, and these factors may play a significant role in the annual fluctuations in the survival of this species (Ellis et al. 1997). This may be compounded by the fact that these early life stages already experience high mortality rates due primarily to predation (Choat 2012) and disease susceptibility (Harikrishnan et al. 2011).
- Sea temperature may also affect adult grouper directly by affecting metabolism, reproduction, growth and behavior (Colin 1992; Watanabe et al. 1995).
- Other environmental stressors that are likely to affect grouper survival directly include predicted climate related changes in ocean chemistry (e.g. ocean acidification) (Cheung et al. 2013; Semmens et al. 2007; Young et al. 2006).

To date, very little research has been done examining the impacts of environmental stressors on the different life stages of Nassau grouper.

Supporting Materials

For more information, visit [Nassau grouper](#)

The [Recovery Outline and Biological Report](#) are available for download.
Literature Cited


Semmens, B. X., and coauthors. 2007. Charting a course for Nassau grouper recovery in the Caribbean: What we've learned and what we still need to know. Pages 607-609 in 60th Gulf and Caribbean Fisheries Institute, Punta Cana, Dominican Republic.


