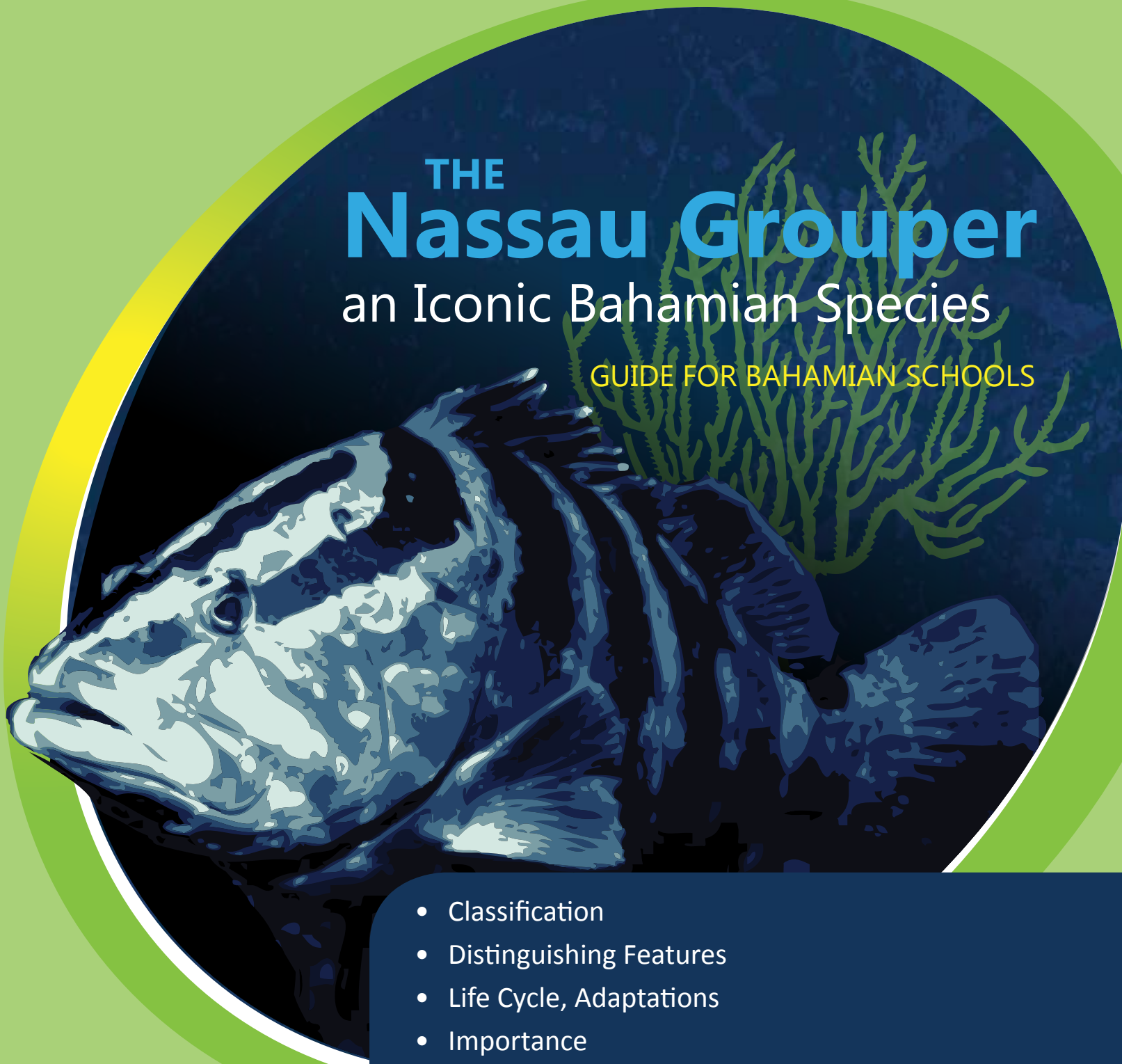
THE Nassau Grouper

an Iconic Bahamian Species

GUIDE FOR BAHAMIAN SCHOOLS

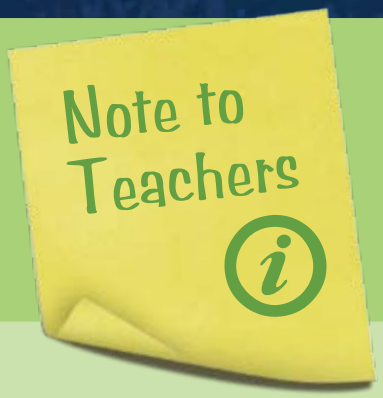


- Classification
- Distinguishing Features
- Life Cycle, Adaptations
- Importance
- Threats, Conservation and Management
- Classroom Activities

A Publication of The
Bahamas **R**eef **E**nvironment
Educational **F**oundation
www.breef.org

The Bahamas Reef Environment Educational Foundation (BREEF) is a Bahamian non-profit foundation established in 1993. Our mission is to promote the conservation of the Bahamian marine environment that sustains our way of life. BREEF informs the public about our marine environment and the threats to our oceans and coral reefs, motivating people to get involved with protecting our critical resources.

BREEF is committed to educating people about the marine environment and the role that it plays in our tourism and fishing industries, and in providing food, recreation and shoreline protection for us all. This important learning tool, developed by BREEF with funding from the Lyford Cay Foundation, is designed for use in Bahamian classrooms. It will help to provide enriching, engaging classroom experiences for science students throughout The Bahamas.



The Nassau grouper is the most important commercial fin fish species in the Bahamas. The species, however, has been overfished throughout the region and is considered an endangered species throughout its range. The Bahamas is considered to be one of the few regions in which fish populations are considered to be 'relatively' healthy.

Nassau grouper are vulnerable to overfishing because during the winter months they form large groups called spawning aggregations or 'schools' in order to reproduce. These aggregations form at predictable times and locations and are therefore an easy target for fishers. Catching the fish at this time threatens the survival of the species and thus the livelihood of the people who depend on them. The aggregations are the only opportunities for these iconic fish to reproduce.

To help sustain the Bahamian Nassau grouper fishery, protection of Nassau grouper spawning aggregations began in 1998 with seasonal closures during the winter months. During the closed season the capture or sale of Nassau grouper is prohibited. This conservation measure will help to ensure that there is a plentiful supply of this fish for the enjoyment of future generations of Bahamians.

This booklet was developed by BREEF to support the learner outcomes of the Science and Social Science curricula in The Bahamas. The information can be utilized to teach Environmental Biology units such as Biodiversity, Interdependence between Species and the Environment, Endangered Species, Protected Areas, Conservation and Environmental Stewardship and, Fisheries Management. Discussion questions denoted by  have been included throughout.

For more information about Nassau grouper and marine ecology resources visit our website at www.breef.org. Book classroom presentations or coastal field trips, at 327-9000 or breef@breef.org.

We look forward to your feedback so that we can better serve your marine education needs and promote environmental stewardship to all.

Introduction

The Nassau grouper is an important marine species native to the Bahamas and the Caribbean region. Concerns about the status of this natural resource and the impact of its decline on the culture and socioeconomic environment of the Bahamas have led to the implementation of conservation and fishery management strategies designed to prevent collapse of this important fishery.

Many Bahamians rely on grouper for employment, to generate revenue for the dive and tourism industries and as an important food source. It is therefore, essential that adequate measures are put in place and enforced for effective management of this species.

Nassau Grouper - Classification/Taxonomy

The Classification system is designed to describe and group living things making them easier to appreciate and study. There are six basic levels in the classification system. They are:

Kingdom	Phylum	Class	Order	Family	Genus	Species

Organisms are grouped according to their characteristics. The largest grouping is the kingdom. Organisms in the same kingdom share the some basic features but can be very different in appearance.

As one moves through the classification levels, from kingdom to species, the organisms in each group have more features in common. The smallest group is called the species. Organisms of the same species are so alike that they are able to successfully reproduce and produce fertile offspring.

The Nassau grouper can be classified as follows:

Kingdom	**Animal** – multicellular organisms that ingest their food
Phylum	**Chordata (Vertebrates)** – animals with backbones
Class	**Actinopterygii** – fish with fins that consist of a web of skin supported by bony spines
Order	**Perciformes** – dorsal fins divided into two parts i.e. spiny at the front and soft at the back
Family	**Serranidae** – all groupers and seabasses
Genus	***Epinephelus***
Species	***striatus***

The common name of an organism can vary from place to place. Therefore to avoid confusion, each organism is given an internationally recognized scientific name. An organism's scientific name is derived from its genus and species. This is called the Binomial System of Nomenclature i.e. naming species

Binomial = Bi (Two) + Nom (Names)

Common Name	***Scientific Name***
Nassau grouper	***Epinephelus striatus***
Queen Conch	***Strombus gigas***
Spiny Lobster	***Panulirus argus***

In a scientific name the genus begins with a CAPITAL LETTER and the species with a lower case letter. These are then either underlined or written in italics.

Importance of the Nassau Grouper

The Nassau grouper is an important reef inhabitant throughout the Caribbean region.

- The health of the reef is dependent on the delicate balance between corals, algae (seaweed), herbivores, carnivores and detritivores. As a higher level predator, Nassau grouper help control the population of other reef organisms helping to maintain the ecological balance.

- It is an important food fish, and is therefore an important part of Bahamian culture.

Diet

Juvenile Nassau grouper: small crustaceans, small fish

Adult Nassau grouper: shrimp, crabs, octopus, a variety of reef fish

'Boil fish' is traditionally made with Nassau grouper. How can the Bahamian public continue to enjoy this dish during the closed season? *Boil fish can be made with other fish species such as red snapper and hog fish. Bahamians can also be encouraged to try lionfish as an alternative. Eating lionfish would also help to reduce the numbers of this harmful invasive species.*

- The fishing industry contributes approximately $85-90M annually to the economy, with sales of Nassau grouper contributing approx $1.5M. Nassau grouper is fished commercially and recreationally by hand line, fish pots (traps), and Hawaiian sling and spear.

Fishers need to be able to continue to make a livelihood during closed seasons. What can we do to support them? *Purchase other species of fish during the closed season such as snappers. Support the establishment and respect the boundaries of Marine Protected Areas (MPAs). Create other job opportunities.*

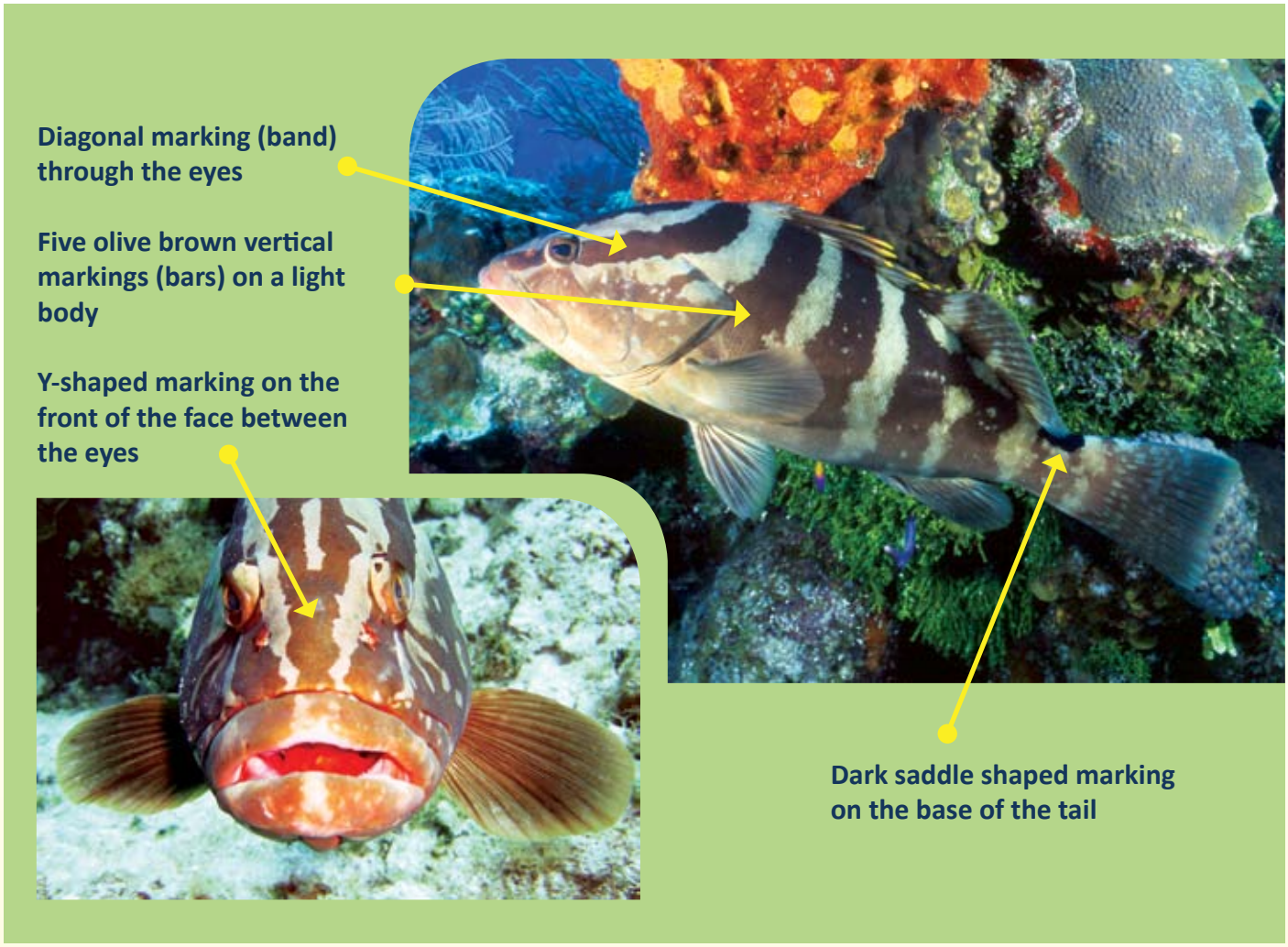
- Divers and snorkelers from around the world visit The Bahamas. The opportunity to encounter endangered species like Nassau grouper, sharks and sea turtles in the wild adds value to our tourism product.

- Studies have indicated that some grouper species are predators of the lionfish. Lionfish are a venomous invasive marine species with few natural predators. They compete with native fish like snappers and groupers for food, threatening their survival. Maintaining healthy grouper populations may help to control lionfish populations.

An invasive species is a non-native (alien) species that can cause harm to the economy, the environment or to human health.

Distinguishing Features of the Nassau Grouper

There are many different types of grouper in Bahamian waters: These include: Tiger grouper, Black grouper, Rock Hind, Goliath grouper (Jewfish), Yellowfin grouper, Yellowmouth grouper, and Coneys, each with specific distinguishing features. Although groupers are similar in appearance, the Nassau grouper can be easily recognized by:



Groupers can change color to blend in with their habitat. In fact, Nassau grouper exhibit four color patterns while breeding. However they can always be distinguished from other groupers by the dark saddle-shaped marking on the base of the tail. For identification purposes all other grouper caught during the Nassau grouper closed season must be landed with the head on and the skin intact.

The government has declared that all grouper caught during the closed season must have its head and tail on and skin intact. Why is this rule necessary? *Since other grouper species can be caught during the Nassau grouper closed season. Nassau grouper are easily distinguished by the black saddle shaped marking on the base of the tail.*

Geographical Distribution

Despite its name, the Nassau grouper has been historically found throughout the western Atlantic Ocean, Gulf of Mexico and the Caribbean Sea, including Bermuda, Florida and The Bahamas. However today many of these populations are in decline.

Source: Woods Hole Oceanographic Institution website: http://www.whoi.edu
Illustration by Jack Cook/WHOI Graphic Services

Habitat & Life Cycle

Nassau grouper occupy a variety of habitats during their life cycle. Although adult grouper are usually solitary animals, during the full moons of November to March they migrate over long distances, grouping together in large numbers to breed. A school of breeding fish is called a spawning aggregation. Historically aggregations had tens of thousands of fish, but today these numbers have dwindled significantly.

Other fish, including snappers (mutton fish, lane snappers, etc.) and other species of grouper, and bonefish also aggregate to spawn. They sometimes use the same spawning sites, but may do so at different times of year.

Spawning Behaviour

Nassau grouper change color when they breed. During the day, they may exhibit their normal coloration. However, at dusk, just before spawning, four distinct color phases are visible in a spawning aggregation. These are:

- **Normal** – typical coloration of a Nassau grouper.
- **Bicolor** – occurs in both males and females during the late afternoon. These have a dark back and a light-coloured belly.
- **White belly** - females in the normal color phase but with white abdomens swollen with ova (eggs).
- **Dark** – seen in courting and spawning fish, the entire body is dark. These are probably females that are ready to spawn.

Spawning occurs around sunset. At this time the fish perform courtship rituals, releasing sperm and eggs in the water. Eggs are fertilized externally (in the water) and hatch within 23-40 hours. The larvae float in the water column for 35-70 days, after which they settle into nursery areas, such as mangrove creeks and sea grass beds. After a year, the juveniles generally move to shallow reefs where they remain for up to four years when they usually move to deeper reefs. Most Nassau grouper are sexually mature by the time they are seven years old.

How does the reproductive behavior of Nassau grouper make the species vulnerable to overfishing?

- Nassau grouper are slow to mature, they start at four to five years (3.8-4 lbs). Approximately 75% of the population is sexually mature at seven pounds. They also reproduce seasonally, i.e. only during the winter months. These factors result in few offspring and populations that can be easily overfished. In contrast, lionfish are sexually mature at one year and reproduce year round.
- Nassau grouper gather in large numbers (historically 1000s, currently 100s) to spawn at predictable times and locations making them an easy target for fishers.
- Fishing on a spawning aggregation results in the harvest of breeding fish that may not have yet had a chance to release their gametes (sperm and eggs).
- The fish travel long distances, over 100 miles, to reach an aggregation site. Therefore harvesting fish at an aggregation site depletes not only local fish populations but also populations far away since fish are unable to return to their home reefs.
- Fishing activity at a spawning site may disrupt breeding activity.
- Currently (2014), the minimum size limit for harvesting Nassau grouper in The Bahamas is three pounds (approx. 17" length), yet recent science indicates that they are not sexually mature before they weigh at least five pounds. As a result, some groupers are legally caught as juveniles, before they have had a chance to reproduce.

Fish Spawning Aggregation (FSA)

Spawn = eggs of an aquatic animal
+
Aggregation = a collection or grouping (schooling)

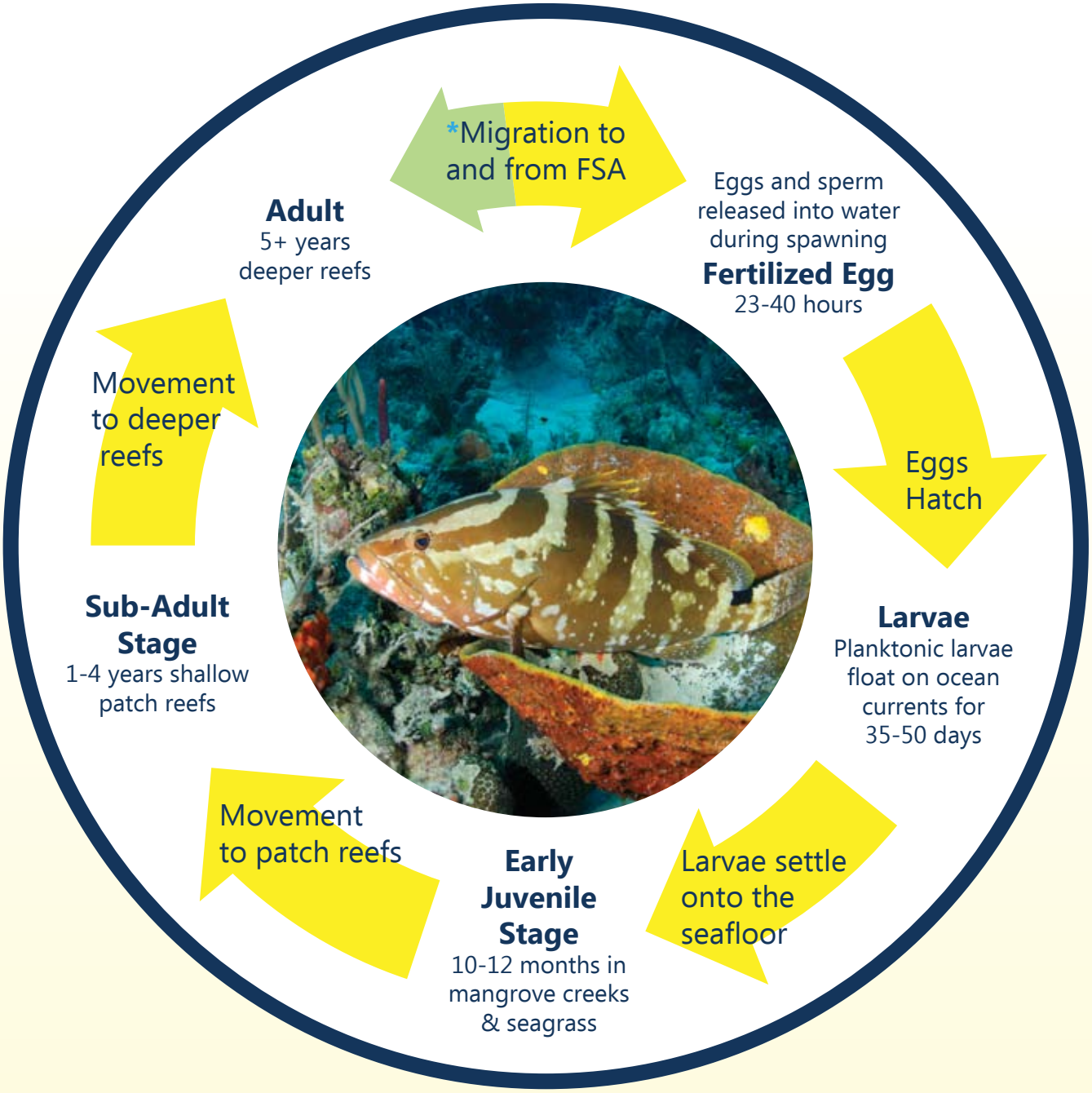
Why do closed seasons correspond with the reproductive seasons of organisms? *This ensures that the species is allowed to reproduce successfully, ensuring replenishment of our marine resources and safe guarding livelihoods.*

Nassau Grouper Factoids:

- **Nassau grouper start to mature at 4-5 years old (19" length). 75% of the population matures by 22".**
- **Spawning sites are also called 'grouper holes'.**
- **Nassau groupers may swim over 100 miles from their home reef to reach a spawning aggregation site.**
- **They return to their home reef after spawning.**
- **They may live for 20+ years.**
- **Nassau grouper swallow their prey whole.**
- **Nassau grouper have been reported to eat lionfish which have very few natural predators in this region. A healthy Nassau grouper population may help to reduce the numbers of harmful invasive species.**
- **Like many reef fish Nassau groupers can change sex from female to male.**

Life Cycle of the Nassau Grouper

Epinephelus striatus



Fish Adaptations

Adaptations are physical features, behaviours and physiological characteristics that allow an organism to survive in its environment. For example, fish are adapted to life in water. They have fins for swimming and gills to extract oxygen.

This grunt was removed whole from the Nassau grouper's stomach

The Nassau grouper is a solitary, bottom dwelling, carnivorous predator that feeds on a wide variety of fish, such as grunts, and parrotfish. They also feed on invertebrates such as crabs, octopus, and crawfish. They are ambush predators, waiting in reef crevices for unsuspecting prey which they engulf whole with strong suction. A Nassau grouper can swallow prey half its length.

The physical adaptations of a Nassau grouper are consistent with those of a carnivore: the muscular body and rounded tail, allows them to maneuver easily and to swim with short bursts of speed. Body stripes and the ability to change color allow them to camouflage so that they are less visible to prey and predators.

Physical adaptations of fish include:

- Body shape - *the flattened shape of a ray indicates that it is a bottom dweller, while the streamlined shape of barracuda indicates that it can swim fast.*
- Mouth size – *a small mouth indicates an herbivorous fish (surgeonfish); a large mouth indicates a carnivore (grouper).*
- Tooth size/shape – *carnivores often have large pointed teeth (barracuda) while herbivores have small or fused beak-like teeth (parrotfish).*
- Color pattern – *bright colors warn of potential danger (lionfish – venomous), whilst predators are often silvery or camouflage to conceal them from prey (barracuda).*
- Tail shape – *a forked tail indicates a fast swimmer (marlin), whilst a tapered tail belongs to the slowest (eel).*
- Distinctive markings – *spots and stripes break up the body shape to confuse predators.*
- Lateral lines – *detect vibrations/movement in water.*

Behavioral adaptations can be inherited or learned. They are strategies that allow organisms to survive in their environment by helping them to feed, avoid predation, respond to environmental changes and to reproduce.

Examples are:

- Social behaviours – *solitary, schooling, colonial, territorial*
- Predation strategy – *ambush, pack hunting, trapping*
- Survival strategy – *swimming speed, burrowing*
- Period of activity – *nocturnal, diurnal*
- Locomotion – *motile, sessile, migratory*
- Courtship display – *color changes, swimming patterns*

Physiological adaptations are metabolic responses to an organism's environment that ensure its survival. Examples include the ability to withstand hypoxic (low oxygen) conditions or temperature extremes, and the production of venom to capture prey or as a defense mechanism. Bioluminescence often seen in deep-sea fish can attract mates or attract prey. Organisms also utilize a variety of reproductive strategies to increase the survival of offspring: egg guarding, live birth, hermaphroditism, ability to change sex, synchronous release of gametes, and production of vast numbers of offspring.

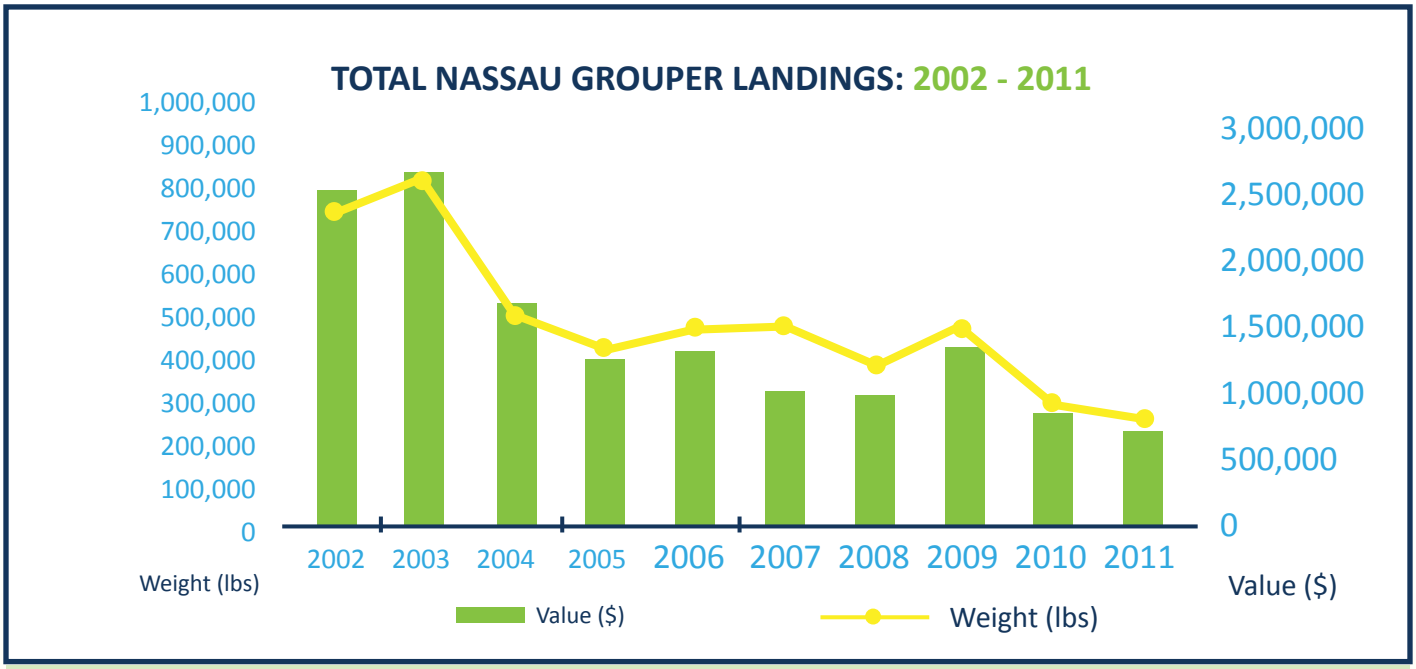
Which of the reproductive strategies mentioned do Nassau grouper employ and what is the advantage of this to the species? *Synchronous release of gametes – Nassau grouper aggregate to spawn. During courtship males and females release eggs and sperm at the same time. This increases the probability that the eggs will be fertilized. Since Nassau grouper are unable to care for their young, the more offspring that they produce, the greater the chance that some of them will survive to adulthood.*

The Nassau Grouper Fishery in The Bahamas

Due to population declines throughout its range the Nassau grouper is considered an endangered species. The Bahamas is one of the few places in which this species is still harvested on a commercial scale. The Department of Marine Resources collects fishery landings data, and in 1994 started to distinguish between landings of Nassau grouper and other grouper species. Between the years of 1994-1997, seven hundred to 1.1 million pounds of Nassau grouper were reported to be landed annually. Monthly landings data shows that much of the annual catch was harvested from spawning aggregations during the winter months of December to February.

In 1998 site specific closures (Andros and Long Island) were implemented with countrywide closed seasons beginning in 2004. Fisheries landings for Nassau grouper from 2004 onward therefore reflect Nassau grouper harvested during the open season. Landings data show a decline in the amount of fish landed on an annual basis. This decline may be due to the implementation of the closed season since what was previously the most productive time of year for landings is now closed. The data may also reflect changes in fishing effort but raises concerns about the sustainability of the fishery. Current surveys of spawning sites have documented population declines and poaching activity.

Are the last remaining Nassau grouper fisheries sustainable? In 2009 the Department Marine Resources partnered with scientists to explore this issue. 280 fishermen from throughout The Bahamas were interviewed to record their views on the status of the fishery and its future.



Nassau grouper landing by value ($) and weight (lbs.) 2002-2011
Source: The Department of Marine Resources

The interviews revealed that most of the fishers were concerned about the status of the Nassau grouper fishery. They expressed concerns about overfishing, the capture of small-sized fish, the use of compressors, poaching and the lack of monitoring and enforcement of the closed season. According to the fishers, the landings of Nassau grouper have been declining since the 1900's before season closures began. This trend is reflected in the fisheries data which shows that although the Nassau grouper landings have been declining steadily, the total fisheries landings have not been declining to the same extent. Given these findings, the study concludes that The Bahamas' Nassau grouper fishery may be fully to over-exploited. The study gives the following recommendations for the management of sustainable fishery: continuation of the annual closed season, improved monitoring control and surveillance during the open and closed seasons at a minimum, along with protection of spawning grounds within MPAs, continued data collection and assessment of Nassau grouper populations.

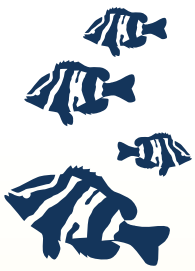
Protection and Management

In 1996 and again in 2003, the Nassau grouper was placed on the International Union for Conservation of Nature (IUCN) Red List for species at a high risk of global extinction. The species has been assessed as endangered because it is estimated that its population has declined by 60% in the last 30 years.

Regionally, over a third of the Nassau grouper spawning aggregations have disappeared. It is considered to be commercially extinct in Florida, Bermuda, Puerto Rico and the Virgin Islands. In Bermuda, grouper landings declined 15-fold over a six year period, and in Cuba, of the spawning aggregations identified in 1884, only one exists today. To date, recovery at an extinct site has never been recorded. In The Bahamas, there is strong concern over the status of our Nassau grouper populations as significant population declines have been recorded for all studied aggregations with several no longer occurring at times when they had formed in the past.

Threats

Organisms are constantly faced with threats both natural and human-induced that affect their survival and ability to reproduce. Through natural selection, they are adapted to cope with naturally occurring threats to their survival including disease, predation, natural disasters and competition between species. However, due to advances in technology and increased human population pressure, humans have added stressors that have resulted in population declines and extinctions. Human actions that have resulted in declines in Nassau grouper populations include:



Fishing on spawning aggregations

Nassau grouper gather in large numbers to spawn at predictable times and locations. This behaviour makes them particularly vulnerable to overfishing because:

a. fishing on a spawning aggregation removes fish that may not have had an opportunity to reproduce.
b. fishing on an aggregation in one area can deplete fish populations in other areas.
c. fishing activity may disrupt spawning behaviour.

Fishing during the closed season

The closed season occurs during the winter months of December to February, corresponding with the main months of breeding period for the Nassau grouper. Catching the fish at this time of year reduces the number of sexually mature fish in the population.

Harvest of juveniles

Bahamian Fisheries Regulations prohibit the harvest of grouper weighing less than three pounds. Catching undersized/immature grouper before they are sexually mature and can breed, threatens populations for the future.

Habitat loss

Nassau grouper inhabit mangrove creeks as juveniles and coral reefs as adults. Both of these ecosystems are being negatively impacted by habitat destruction for coastal development, e.g. dredging, pollution, climate change and by the presence of invasive species.

Pollution

Pollution and run-off of sediment and nutrients (fertilizers, sewage etc.) from the land decreases water clarity and encourage the growth of seaweed that prevents coral growth. Coral reefs, the habitat of adult Nassau grouper, need clear sun-lit water to thrive.

Invasive species

Invasive species are non-native species that can harm the environment by reducing native biodiversity. The lionfish is a threat to grouper populations. Lionfish are carnivorous, venomous fish. Their diet is similar to that of commercially important fish species such as the Nassau grouper and snappers. Lionfish therefore compete with groupers for prey.

Management of the Nassau Grouper Fishery

In response to the decline of Nassau grouper stocks, a variety of conservation mechanisms have been implemented both regionally and locally.

- **Closed seasons** – fishing is prohibited or limited during a specified period that coincides with the breeding season. In The Bahamas, the Government declares the closed season at its discretion. Unlike the crawfish season, the Nassau grouper closed season has not yet (2013) been fixed in legislation. BREEF and other conservation partners support the strengthening of laws regarding the closed season to include annual fixed dates so that fishers, restaurants and the general public can make adequate preparations. Until this occurs, timely closure advisories should be issued. In The Bahamas, site-specific, seasonal closures of spawning aggregation sites began with the 1998/99 breeding seasons which progressed to country-wide seasonal closures in 2004 to make enforcement more feasible. Special protection is also usually given to the High Cay, Andros, spawning aggregation site.

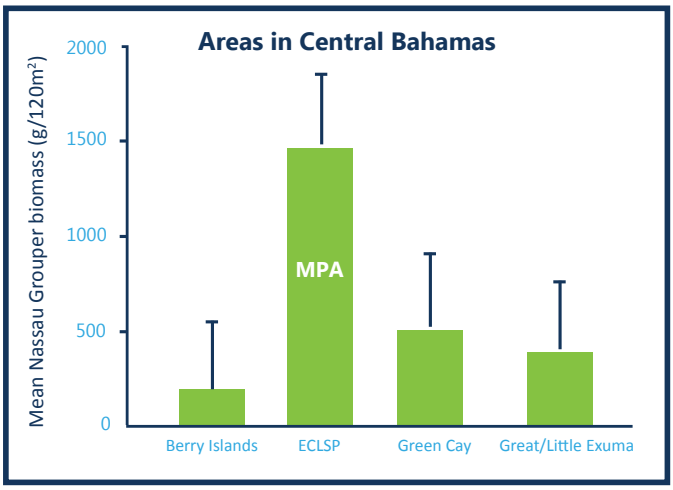
Bahamas Country-wide closed seasons to date:

Jan 1 - 31 2004
Dec 16 2004 - Feb 16 2005
Dec 13 2005 - Feb 14 2006
Dec 1 2006 – Feb 28 2007
Dec 15 2007 - Feb 28 2008
Dec 1 2008 – Feb 28 2009
Jan 1-Feb 28 2010
Dec 1 2010 - Feb 28 -2011
Dec 1 2011 - Feb 29 -2012
Dec 1 2012 - Feb 28 -2013
Dec 1 2013 - Feb 28 2014

What other regulations are needed to ensure that the closed season is not violated? *BREEF and other NGOs advocate for the sale (by fishers, restaurants etc.) of Nassau grouper to be prohibited during the closed season. Marine Protected Areas should be established which protect known spawning sites. These sites can be effectively monitored by defense force officers, park wardens and fisheries officers.*

Do you think that there should be a closed season for any other species, if so, why? *Varied, opinions - based on concepts learned. Although closed seasons reduce fishing pressure, in other regions they have proven to be ineffective if they are established after populations have declined below critical levels. Another factor that must be considered is the timing of closed seasons. For example, a closed season for conch would coincide with the closed season for crawfish. If two fisheries are closed at the same time, this can negatively impact the livelihood of fishers and the economy. Other methods that may be considered for protection of marine species are: establishment of Marine Protected Areas and reducing or eliminating export of a particular marine product to reduce the demand for harvest and therefore protecting our food security.*

- **Establishment of a Bahamian network Marine Protected Areas (MPA)**
these act as replenishment zones and should include all habitats essential for the Nassau grouper life cycle – mangrove creeks, seagrass beds, shallow reefs, deeper reefs, and spawning aggregation sites. Studies indicate that the Nassau grouper population is far greater in the Exuma Cays Land and Sea Park (ECLSP) which has been a no-take zone (all fishing is prohibited) since 1986. Additionally, a network of MPAs is being established throughout The Bahamas to provide fishery replenishment zones: e.g. South Berry Islands Marine Reserve, The Exuma (Jewfish Cays) Marine Reserve, No Name Cay Marine Reserve. Through the Bahamas 2020 Declaration, the Government of The Bahamas has committed to effectively conserve at least 20% of the near-shore marine environment across country by 2020.



The Bahamas is expanding its network of Marine Protected Areas. How does this support our fishing industry? *Effective MPAs protect fish species within their boundaries, increasing fish populations which then repopulate adjacent fishing grounds. Fish within reserves can successfully reproduce, seeding adjacent fishing areas with larvae. Marine Reserves protect critical habitat that is essential to the survival of important fishery resources such as conch, grouper and crawfish.*

- **Size limits** – regulations limit the harvest of juveniles (less than 3 pounds).

- **Fishing bans** – Since 1990 there has been a complete ban on the fishing of Nassau grouper in US federal waters.

- **Protection of specific spawning sites during the closed season –** some sites in Belize have been protected since 2002. During the Bahamian closed season, special protection is given for the High Cay, Andros spawning aggregation site which is designated as a 'Protected Area'. All fishing is prohibited in this area for the full duration closed season. However, due to challenges in enforcement, an MPA at this location is more feasible.

- **Scientific Research** – more research is needed so that the information can be used to guide policy. Some of the questions that scientists would like to answer are:

Can aggregations that have disappeared reform in new areas or again in the same area?

Are fish in different regions in The Bahamas spawning at the same time?

Do individual fish spawn more than once per season?

Do individuals reproduce each year and if so, do they always go to the same site?

What is the minimum number of fish required at an aggregation site for spawning to occur?

What are the characteristics of the best habitat types for juvenile Nassau grouper?

What is the status of Nassau grouper stocks throughout The Bahamas?

Where do larvae spawned at a particular site go?

Additional conservation measures that should considered:

- Community consultation and education programmes.
- Inclusion of aggregation sites within the boundaries of Marine Protected Areas.
- Increasing the minimum harvestable size from 3+lbs to 5+ lbs, which is closer to the average size of sexually mature Nassau grouper.
- BREEF does not support the export of Nassau grouper. This will help to ensure that the fish is available for local consumption.
- Enforcement of existing seasonal closures.
- Legislation for a fixed closed season.
- Complete prohibition of the sale of Nassau grouper during the closed season.
- Address the problem of illegal poaching in Bahamian waters.

Why is an annual closed season with legislated fixed dates important?
To provide permanent protection for Nassau grouper during its breeding season. To reduce confusion regarding the dates of the closed season. With advanced knowledge of the closed season dates the fishing community, seafood processors and consumers can prepare just as they do for crawfish.

Case Study

The Grouper Moon Project & the Cayman Islands Example

The Cayman Islands support the largest known aggregation of Nassau grouper in the world. After its discovery on the west end of Little Cayman in 2001, Reef Environmental Education Foundation (REEF)* and the Cayman Islands Department of Environment (CIDOE) launched a groundbreaking research and education program, known as the Grouper Moon Project, to study the aggregation. After two years of significant harvest at the Little Cayman site, the Cayman Islands government issued an 8-year ban in 2003 on fishing for Nassau grouper at all current and remnant aggregation sites.

REEF and CIDOE have coordinated annual efforts to monitor and study the Little Cayman aggregation, as well as several remnant aggregations on Cayman Brac and Grand Cayman. The Grouper Moon Project research has grown in scope to include an ambitious acoustic tagging project, juvenile habitat research, genetic studies, multi-species investigations, and a drifter project to understand how currents and other oceanographic conditions affect grouper larvae recruitment. This intensive research has indicated that the policy actions are indeed working. At the end of 2011, based on findings to date, the Cayman Islands Marine Conservation Board extended the protections for an additional eight years, and a broader package of harvest rules aimed to maximize long-term Nassau grouper conservation is currently under review. These include a closed, no-take season on Nassau grouper from November – April, a slot size limit allowing take of individuals between 16” – 24”, and a daily bag limit of 4 fish per person per day. In addition, due to the extensive use of spawning sites by dozens of other fish species, it has been recommended that these important places be closed to harvest year-round. While this is a clear manifestation of project success, the Cayman government knows that it’s imperative to document continued recovery of the species, and promote sustained support for Nassau grouper conservation in the Caymans and elsewhere.

Grouper Moon Education Program

To ensure long-term success and effective conservation of Nassau grouper, REEF and CIDOE have conducted extensive outreach through news media, public service announcements, printed material, and documentaries. With support from Disney Worldwide Conservation Fund beginning in 2011, REEF began working on the creation and implementation of an education program designed for elementary and high school students. The curriculum focuses on bringing the Nassau grouper into Caribbean elementary and high school classrooms through lesson plans and live-feed webcasts that connect students in their classrooms with scientists in the field. These unique and exciting live webcasts utilize state-of-the-art underwater video technology, allowing students to engage with Grouper Moon scientists and virtually experience what it's like swimming among the thousands of Nassau grouper that gather on the west end of Little Cayman during winter full moons.

For further information about the Grouper Moon Project, visit www.REEF.org/groupermoonproject. To learn more about the Cayman Islands Department of Environment, visit www.doe.ky.

*REEF is a US-based, non-profit organization, it's mission is to conserve marine ecosystems by educating, enlisting, and enabling divers and other marine enthusiasts to become active ocean stewards and citizen scientists. While similar in name, REEF and BREEF are not affiliated. However, BREEF collaborates with the Grouper Moon Project partners on education and outreach efforts focused on Nassau grouper spawning aggregations.

AQUACULTURE— Fish farming is this a feasible solution?

Aquaculture is the rearing of aquatic organisms in a controlled environment. Today 40% of the fish eaten in the US is farm raised. Can aquaculture play a role in helping to conserve our local fisheries?

Aquaculture can pose many challenges. The success of farming aquatic organisms depends on several factors including the type of organism (native vs. non-native species, herbivore vs. carnivore), source of feed, cost of equipment, and impact on the environment. Aquaculture facilities can impact the environment through habitat destruction, pollution, intentional/unintentional release of non-native species. While the potential for supplying seafood through fish farming is great, measures to conserve wild populations must be implemented to protect our culture, livelihoods and natural heritage.

Pros

- **Reduces fishing pressure on wild fish/conch stocks.**
- **Creates jobs, revenue and provides opportunities for local investment.**
- **It increases scientific knowledge e.g. understanding of the life cycle, of the resource so that we can make informed decisions about their management.**
- **Farm raised organisms can potentially be released into the wild to boost wild stocks. However, this has not been successful because the farm raised species often lack the natural behaviours which help them to survive in the wild e.g. predator evasion.**

Cons

- **Construction of aquaculture facilities often impact natural nursery habitats such as wetlands.**
- **Farming of carnivorous species such as Nassau grouper would impact wild fish populations because fish are harvested from the wild to feed the farmed fish.**
- **Increases the risk of disease transmission and parasites from farmed to wild populations.**
- **By-products of the industry such as, chemicals used to treat parasites, excess nutrients in feed and waste often causes water pollution.**
- **Fish farms may threaten the livelihood of fishers.**
- **Farms are susceptible to weather, predators and disease so measures must be taken to counteract these which are often expensive.**
- **Species chosen for aquaculture are often hardy species that can grow and reproduce quickly. When they are non-native to a particular region, these characteristics can make them particularly damaging invasive species.**
- **Costs are often high.**

A. Fish adaptations – Design a fish

Background information: students should understand how the physical adaptations of fish allow them to survive in their environment.

Materials: paper/card, colored pencils
Task: Challenge each student to create an ID card for their own newly discovered fish species.

INSTRUCTIONS TO STUDENTS:

1. On the front of the card make a drawing of your fish showing its physical adaptations and write its imaginary scientific name and common names.
2. Write a paragraph on the back of the card explaining where the fish lives and the adaptations that your fish has that helps it to survive in its chosen habitat.
3. Students should use the cards to tell their classmates about their newly discovered species.
4. Display cards in the classroom.

B. Fishing for the Future - Fishing Simulation Activity

Time: 30 minutes

OVERVIEW

In this fishing simulation activity, students will model several consecutive seasons of a Nassau grouper commercial fishery. They will explore how fishing technology, population growth, and sustainable practices impact fish catch and fisheries management. As students progress through the fishing seasons they are likely to overfish their oceans and will have to migrate to other oceans to meet their basic needs. Most groups will eventually create a total crash of fish stocks in all the oceans. This demonstration will clearly indicate the benefits of sustainable fishing practices.

Objectives: Students will:

1. Model the factors that can result in overfishing.
2. Discuss social, environmental and economic impacts of overfishing.
3. Identify sustainable fishing practices.

Materials: hard candy e.g. M&Ms (two 14-ounce bags for up to 30 students), one cup per student, one straw per student, one small bowl per group, one spoon per group, stopwatch

BEFORE YOU BEGIN

Divide the class into groups of up to 5 students. Put 30 candies in each bowl. Select one student in each group to act as a moderator i.e. to record catches, identify students who were unable to catch their quota and to add additional candies to the bowl after each round.

INSTRUCTIONS

1. Explain the game rules:
    - Each student is a fisher whose livelihood depends on catching fish.
    - The candies represent fish in the ocean.
    - Each fisher must catch at least 2 fish in each round to survive (i.e. one for personal consumption and the other for sale). The greater the number of fish caught the greater the earnings of the fisher.
    - When the fishing season opens for each round, students must follow instructions given for fishing i.e. fisheries regulations.
    - Fishing is not permitted between rounds (closed season).
    - When the season closes after each round, the remaining fish in each bowl represents the breeding population.
    - One new fish will be added to the bowl at the end of each round for every fish that is left in the ocean.

2. Give each group: a bowl (ocean) with 30 Candies (fish) and have them name their ocean.

3. Give each student a straw (fishing rod) and cup (fishing vessel) in which they must place the fish that they catch.

ROUND 1

Fisheries Regulations – Students have 20 seconds to fish. Students should use the straw to fish while holding their hands behind their backs. Fishing during the closed season will result in disqualification.

At the end of each round:

- Have each fisher count his/her catch (candies in cup) and record their catch (fisher's log).
- Calculate the number of fish caught in each round i.e. Number of fish in cup minus the number of fish caught the previous season.
- Calculate the value of the catch, using a rate of $50 per fish i.e. 50 multiplied by the number of fish caught.
- Record the number of fish that remain in the bowl.
- After each round, fishers who do not catch a minimum of two fish must sit out for the following round, after which they may return to the game.
- The moderator should add one new fish for every fish left in the bowl (ocean).

ROUND 2

Fisheries Regulations – Students have 20 seconds to fish. The remaining students should hold the straw in their hands to fish; [this represents new technology such as a faster vessel or fish-finding sonar. The successful fishers were able to purchase these with the profits of the previous fishing season]. Fishing during the closed season will result in disqualification.

ROUND 3

After the second fishing season, give the most successful fisher in each group a spoon to use instead of a straw. This represents inequity in the fishing industry in which some fishers utilize more advanced fishing technology such as, electric fishing reels. Continue the game for round three.

ROUND 4

If students have depleted their oceans, allow them to invade other oceans. Do not tell them that that they can do this beforehand. Fishers may either go as a group to one ocean or disperse to several oceans.

SAMPLE FISHER'S LOG

Season	Number of Fish in Cup	Number of Fish Caught	Value of Catch @ $50 per Fish	Number of Fish left in the Ocean
1				
2				
3				

Additional Rounds - Repeat fishing, recording, and replenishment of fish stocks until either sustainable fishing is achieved or until all or most groups deplete their stocks.

Discussion Questions

Use the following sample questions to help students to reflect about the activity and how it simulates real world fishery issues.

- **How did you feel when you realize that you had depleted your fish stock?**
- **How did you feel when other fishers joined your group?**
- **How does this activity relate to real oceans and fishery issues?**
- **What happens to a resource when you have infinite population growth, growing technology and a finite resource?**
- **To whom do the fish in the ocean belong?**
- **How do the actions of consumers and fishers impact the resource?**
- **Who is responsible for taking care of the resource?**
- **Introduce and discuss the concept of sustainability using the following definition: "Meeting the needs of the present without compromising the ability of future generations to meet their own needs."**
- **Ask why sustainability may be an important goal for a society and what might be difficult about realizing this goal?**
- **What actions can we take to ensure a sustainable Nassau grouper fishery?**

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