



**WESTERN ATLANTIC  
CORAL REEF  
HEALTH & RESILIENCE  
CARDS**



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**Living Oceans  
Foundation**

Andrew Bruckner, 2010

*The Western Atlantic Health and Resilience Cards* provide photographic examples of the dominant habitat features and biological indicators of coral reef condition, health and resilience to future perturbations. Representative examples of benthic substrates types, indicators of coral health, algal functional groups, dominant sessile invertebrates, large, motile invertebrates, and herbivorous and predatory fishes are presented, with emphasis on major functional groups regulating coral diversity, abundance and condition. This is not intended as a taxonomic ID guide.

**Resilience** is the ability of the reef community to maintain or restore structure and function and remain in an equivalent 'phase' as before an unusual disturbance. The most critical attributes of resilience for monitoring programs are compiled in this guide. A typical protocol involves an assessment of replicate belt transects in multiple reef environments to characterize 1) the diversity, abundance, size structure cover and condition of corals, 2) the abundance/cover of other associated and competing benthic organisms, including "pest" species; 3) fish diversity, abundance and size for the key functional groups (avoiding many of the small blennies, gobies, wrasses, juveniles and non-reef species, and focusing on large herbivores, piscivores, invertebrate feeders, and detritivores); 4) abundance of motile macroinvertebrates that feed on algae and invertebrates, especially corallivores; 5) habitat quality and substrate condition (biomass and cover of five functional algal groups, turf, CCA, macroalgae, erect corallines and cyanobacteria; amount of rubble, pavement and sediment); 6) coral condition (prevalence of disease and corallivores, broken corals, levels of recruitment); and 7) evidence of human disturbance such as levels and types of fishing, runoff, and coastal development. In addition to the bioindicators shown here, physical attributes of the reef (shading, canopy layers, reef slope, presence of deep water), historic and current water temperatures, currents, wave exposure, other environmental measures, and external factors like connectivity help maintain high resilience in coral reefs.

**Cover illustrations:** Attributes of resilient reefs. **Top left:** Healthy *Acropora* reef with staghorn coral (foreground), elkhorn coral and branching gorgonians. **Top right:** Massive coral community with low levels of macroalgae and healthy *Diadema antillarum* urchin populations. **Middle left:** School of herbivorous blue tangs feeding on algae. **Middle right:** Fairy basslet, a key ornamental coral reef species harvested for the aquarium trade. **Lower left:** Green moray, an important predator. **Lower right:** Resting school of blue striped grunts and white grunts. **Bottom left:** Tiger grouper among flower coral (*Eusmilia fastigiata*) and large-cup star coral (*Montastraea cavernosa*).



# Substrate Condition



coral-dominated; little macroalgae  
rubble & CCA



fleshy macroalgae



fleshy macroalgae & sediment



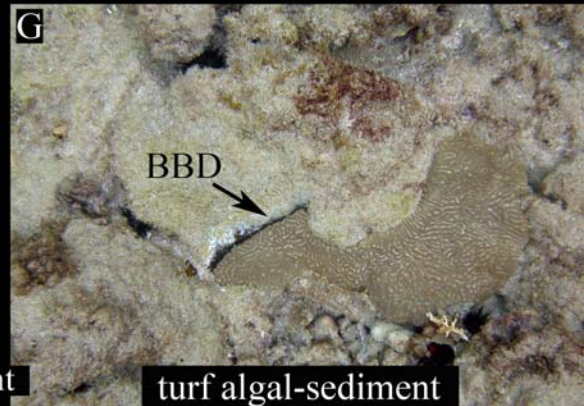
rubble & cyanobacteria



crustose macroalgae



crustose coralline algal (CCA) pavement



turf algal-sediment

**Substrate types.** **A. Coral-dominated:** High cover *Acropora cervicornis* (staghorn coral), *Montastraea faveolata* (mountainous star coral) and branching gorgonians; little macroalgae. **B. Fleshy Macroalgae:** High cover and biomass of *Dictyota*, *Halimeda* and other fleshy and calcareous macroalgal taxa. **C. Macroalgal Hardground:** Moderate cover of macroalgae and patches of red crustose-coralline algae (CCA) adjacent to a sand patch. **D. Rubble:** Unstabilized coral rubble colonized by cyanobacteria. **Inset: Rubble** colonized by CCA. **E. Crustose Macroalgae-Dominated:** Substrate and dead massive corals colonized by brown crustose algae *Peyssonnelia* sp. **F. CCA Pavement:** Colonized by crustose coralline algae (CCA). CCA is diseased (arrows: margin of disease lesion). **G. Turf Algal Sediment:** Dense turf algae with trapped sediments. Encrusting brain coral (*Diploria clivosa*) has black band disease (BBD)

**Coral Condition.** **A.** Overturned *Acropora palmata* (elkhorn coral) with abrasions and broken branches. **B.** *A. palmata* fragment fused to the reef with multiple protobranches. **C.** *Agaricia agaricites* (lettuce coral) recruit on coralline algal colonized pavement. **D.** Dead *A. palmata* colony, in growth position, colonized by macroalgae. **E.** Overgrowth of *Diploria strigosa* brain coral by the zoanthid *Palythoa caribaeorum*. **F.** *A. palmata* branch with new mortality (no algal colonization), recent mortality (fine turf algae, 2-7 days old) and old mortality (months old; eroded corallites, dense turf algae). **G.** *D. strigosa* with recently abraded and eroded skeletal structures from stoplight parrotfish predation. **H.** New and recent tissue loss on *M. annularis* (lobate star coral). **I.** Bleached brain coral (*D. strigosa*) with black band disease (BBD). Bleached live tissue (BL), new mortality (ND), recent mortality (RD; green, algal colonized) and old mortality (*Lobophora* macroalgae). **J.** Bleached colony of *M. faveolata* without any tissue loss.

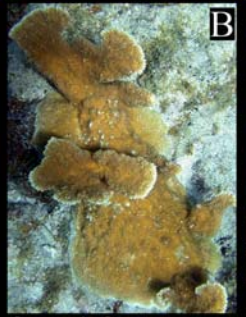
**Algae & Cyanobacteria.** Algae are divided into four groups based on morphology. **Crustose coralline algae (CCA):** Unpalatable encrusting calcified algae; indicator of coral recruitment. **Calcareous macroalgae:** Erect, calcified species, unpalatable; contribute to reef sediments. **Turf algae:** Fine, filamentous species; primary food source for herbivores; can become dense, trap sediments & prevent coral recruitment. **Macroalgae:** Fleshy algae vulnerable to grazing; at high biomass & cover capable of overgrowing corals. **A.** *M. annularis* (star coral) skeleton with CCA, *Dictyota* & red filamentous algae. **B.** Gelatinous red macroalgae & cyanobacteria (green tufts). **C.** *Caulerpa*, chemically defended fleshy macroalgae. **D.** CCA with encrusting brown macroalgae *Lobophora* & erect coralline algae *Halimeda*. **E.** *Stephanocoenia intersepta* blushing star coral with disease. A band of recently dead skeleton separates live tissue & green turf algae. **F.** Dense red turf algae on *M. annularis*. **G.** Bleached *Porites* finger coral. Dead branches in foreground colonized by turf algae. **Inset:** *M. annularis* with filamentous algal tufts from a damselfish algal lawn. **H.** Cyanobacteria on *P. porites*. **Upper inset:** Turf algae & cyanobacteria. **Lower inset:** Sea plume (*Pseudopterogorgia*) overgrown by cyanobacteria. **I.** CCA, turf algae & *Dictyota* on coral skeleton.



# Coral Condition



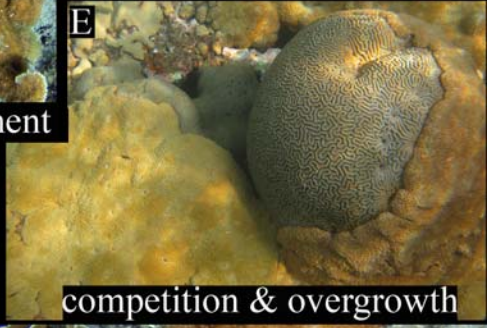
overturned coral



fused fragment



coral recruit



competition & overgrowth



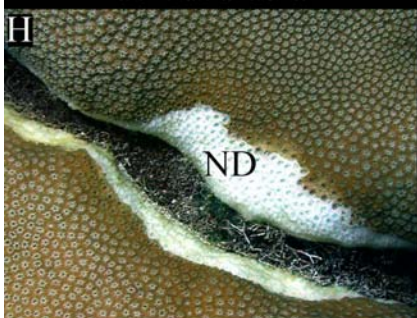
standing dead coral



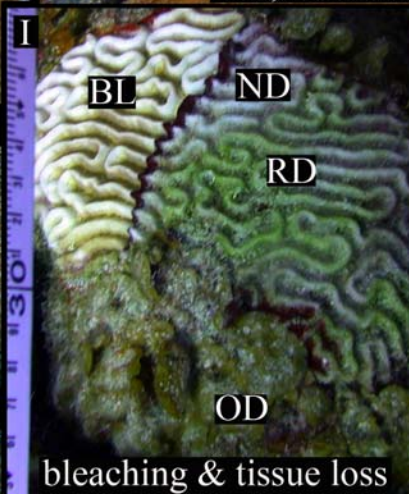
new, recent & old tissue loss



abraded coral



recent tissue loss



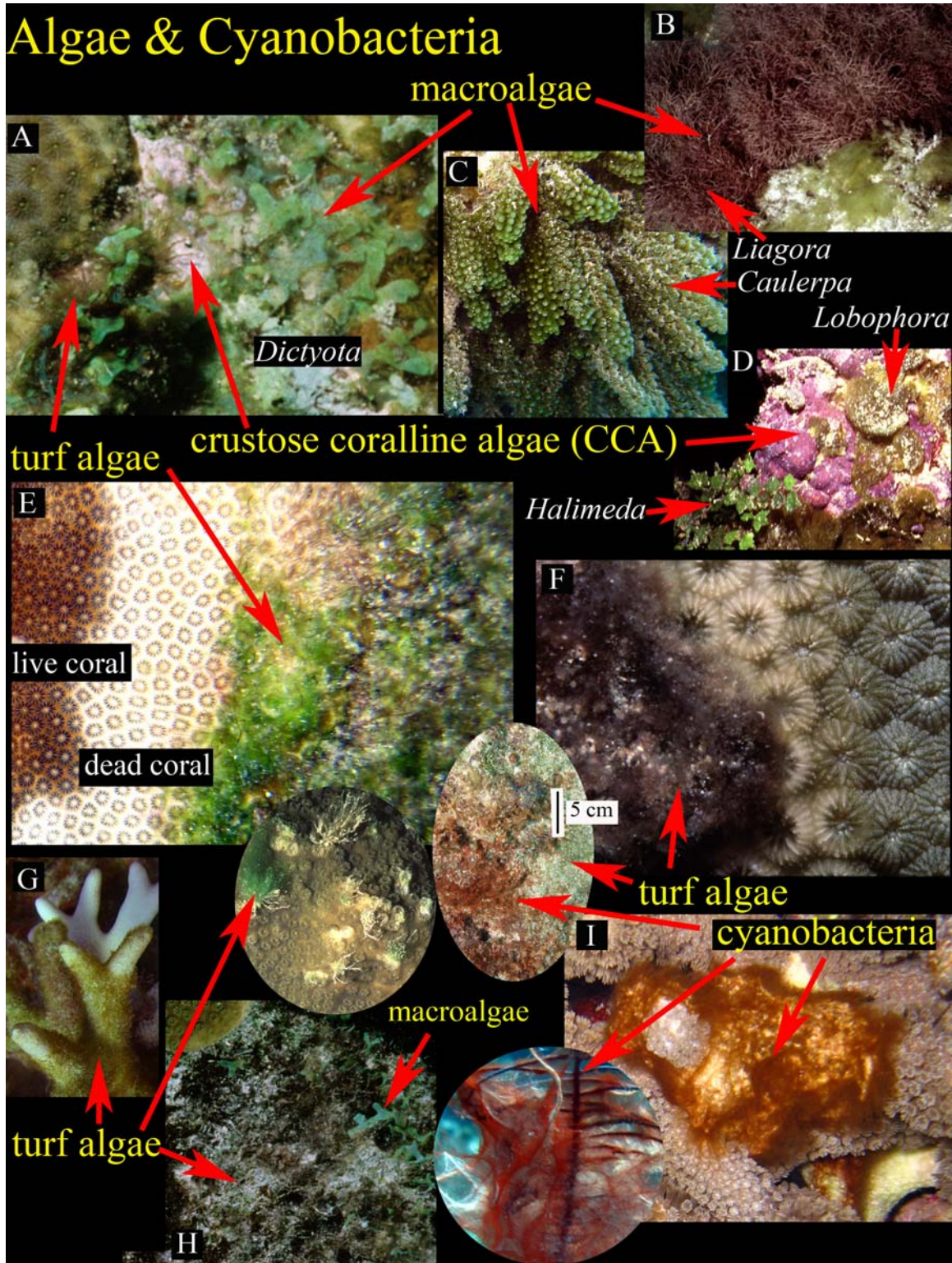
bleaching & tissue loss



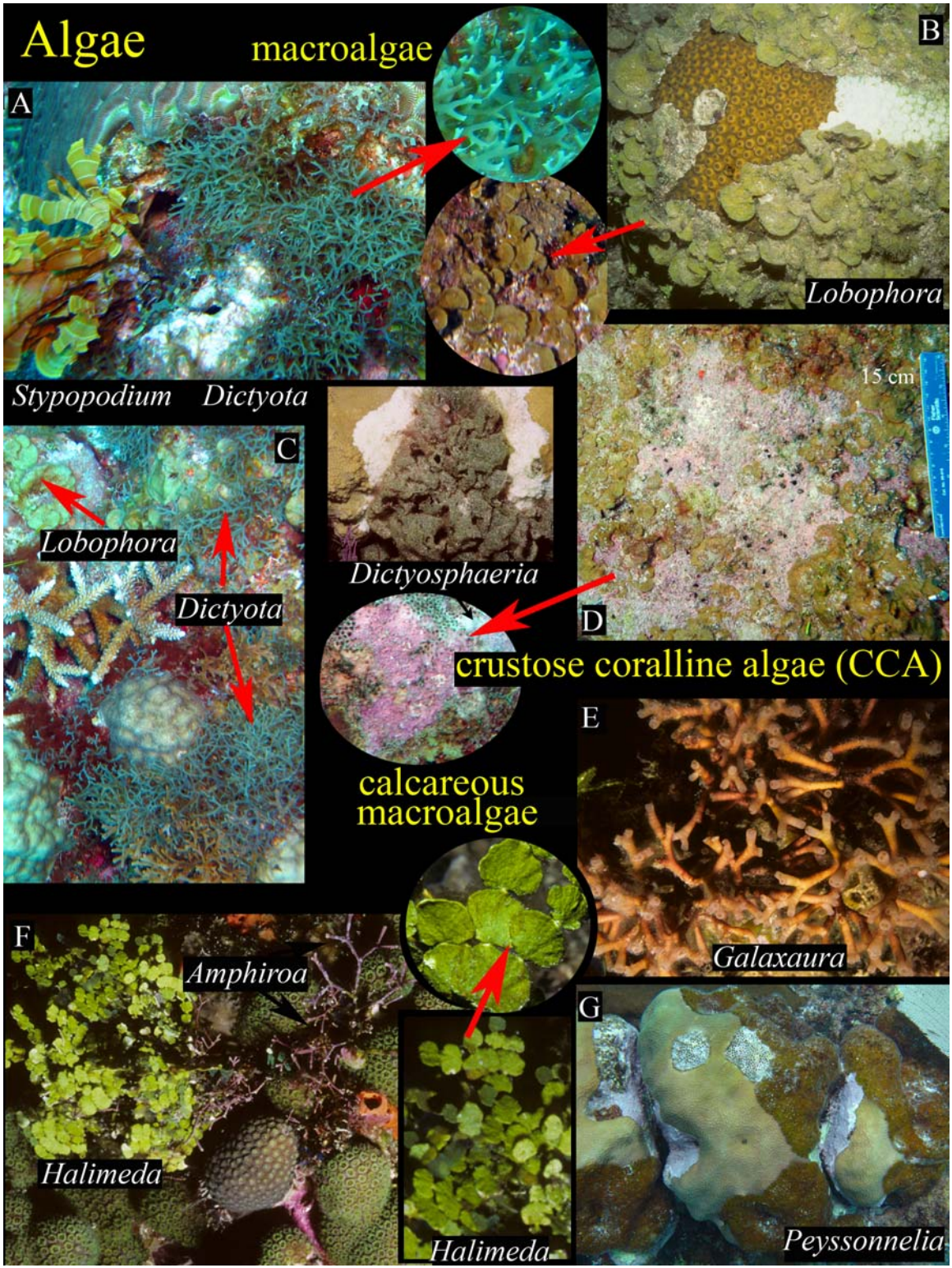
bleaching



# Algae & Cyanobacteria







**Algae.** **A.** Dead *D. strigosa* with macroalgae (*Styopodium* and *Dictyota*). **B.** *Montastraea cavernosa* (large-cup star coral) being overgrown by *Lobophora*. **C.** Reef substrate with staghorn coral (*A. cervicornis*), mustard hill coral (*Porites astreoides*), CCA, & macroalgae (*Dictyota* and *Lobophora*). **Inset:** *Dictyosphaeria*, a green macroalgae. **D.** Pavement colonized by CCA & *Lobophora*. **E.** Erect calcified red macroalgae *Galaxaura*. **F.** Green calcareous macroalgae *Halimeda* & red calcareous macroalgae *Amphiroa* on *Madracis decactis* coral. **G.** Brown crustose coralline algae *Peyssonnelia* overgrowing *M. annularis*.

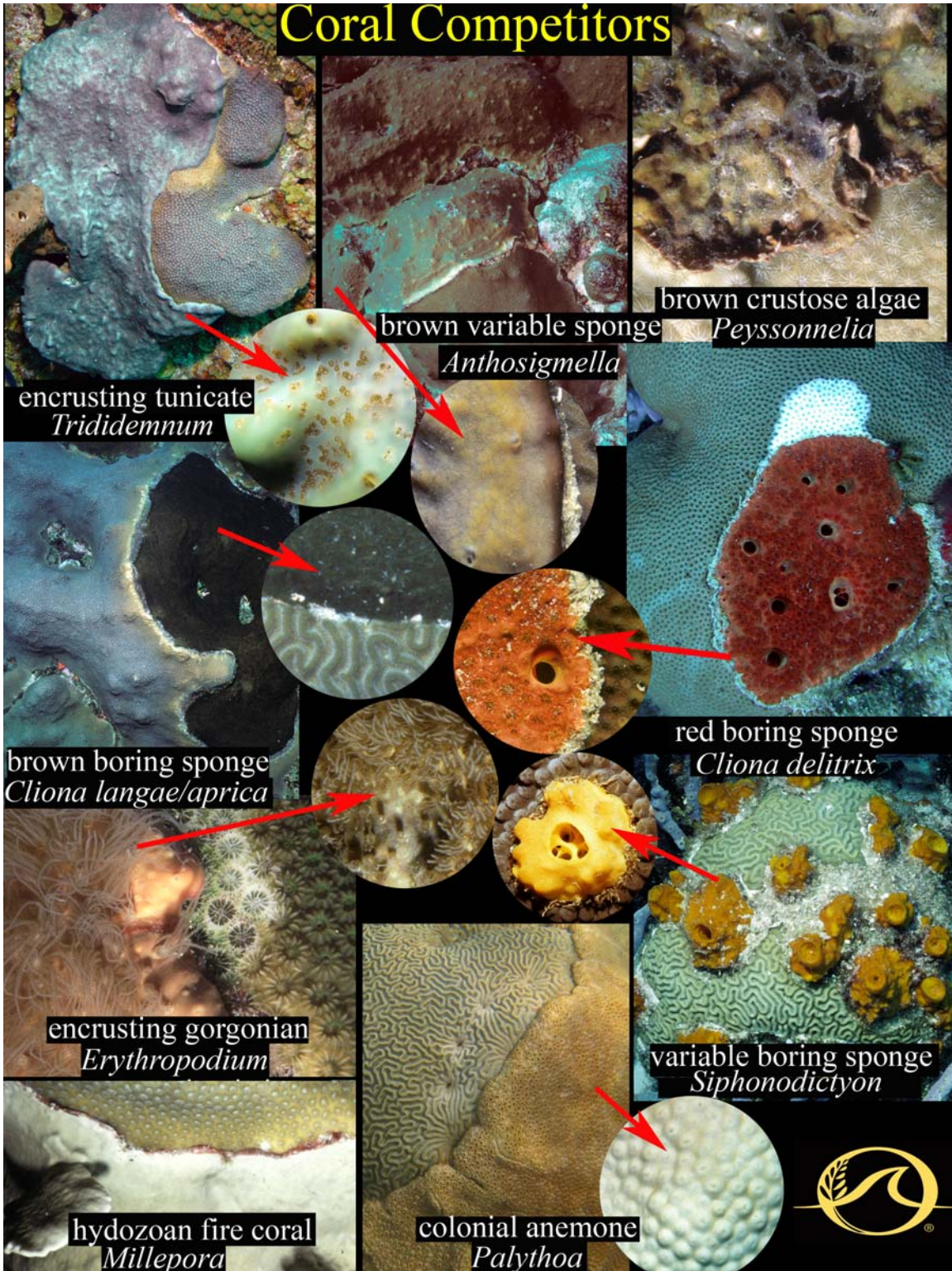
**Coral competitors.** **A.** *Trididemnum solidum* a colonial tunicate that overgrows most species of corals. **B.** The brown variable sponge, *Anthosigmella varians*, a leathery sponge that overgrows corals. **C.** The brown crustose algae *Peyssonnelia* forms overlapping plates that slowly overgrow coral and other substrates. **D& E.** Two examples of *Cliona* sponges that bioerode and kill corals. The brown boring sponge is on *M. faveolata* and the red boring sponge is on *Siderastrea siderea*, starlet coral. **F.** The encrusting gorgonian *Erythropodium caribaeorum* overgrowing *M. faveolata*. **G.** A boring sponge *Siphonodictyon coralliphagum* on *D. strigosa*. **H.** The hydrozoan coral *Millepora complanata* overgrowing *M. annularis* lobate star coral. **I.** The colonial anemone, *Palythoa caribaeorum* overgrowing a brain coral, *D. strigosa*.

**Sessile Invertebrates.** **A.** The sea plume *Psuedopteroergorgia* (gorgonian) **B.** Corky sea finger (*Briareum asbestinum*). **C.** Common sea fan, *Gorgonia ventalina*. **D.** Black corals (order Antipatharia) in the genus *Antipathes*. **E.** Colonial anemone (zoanthid) *Zoanthus pulchellus* on *M. annularis* star coral. **F.** Giant Caribbean sea anemone, *Condylactis gigantea*. **G.** Orange cup coral *Tubastraea coccinea* (scleractinian coral). **H-L.** Dominant growth forms of sponges: vase, rope, ball, tube and barrel sponges.

**Motile invertebrates.** **A.** The herbivorous long-spined sea urchin *Diadema antillarum*. **B & C.** Caribbean spiny lobster (*Panulirus argus*) and spotted lobster (*P. guttatus*); gastropod predators. **D.** Cushion sea star *Oreaster reticulatus*, an important carnivore in grassbeds, often sold dried as a curio. **E.** Rock boring urchins, *Echinometra*. *E. lucunter* often found in shallow reef flat areas while *E. viridis* occurs throughout the reef and may bioerode corals at high densities. **F & G.** Sea cucumbers, *Astichopus multifidus* and *Isostichopus badionotus*, are important detritivores found in sandy areas between reefs. **H.** Tulip snail, *Fasciolaria tulipa* preys on other gastropods. **I- J.** Large crabs including *Mythrax spinosissimus* spider crabs and *Carpilius corallinus* coral crabs feed on mollusks, crustaceans and other invertebrates. **K.** Octopus, a commercially exploited predator that feeds primarily on mollusks. **L.** The herbivorous queen conch, *Strombus gigas* are found in grassbeds, sandflats and reef areas and are overharvested in many places. **I. & J.** Trumpet triton (*Charonia variegata*) and king helmet snail (*Cassis tuberosa*) feed primarily on echinoderms, and are heavily targeted for the shell trade.



# Coral Competitors



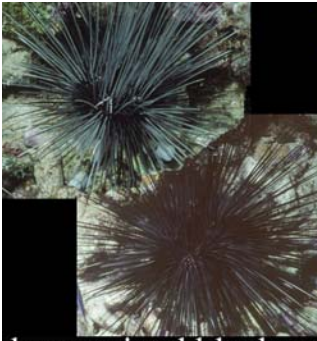


# Sessile Invertebrates

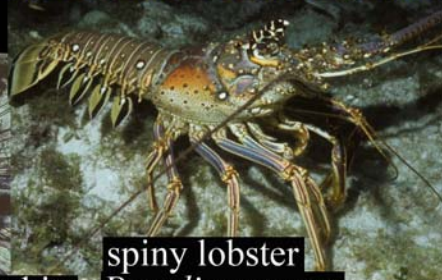




# Motile Invertebrates



long-spined black urchin  
*Diadema antillarum*



spiny lobster  
*Panulirus argus*



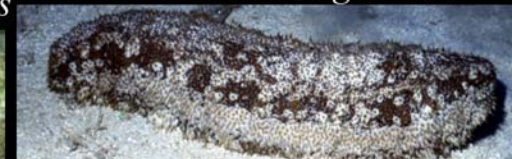
spotted lobster  
*Panulirus guttatus*



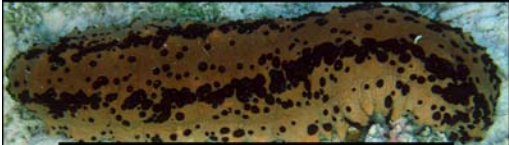
cushion seastar  
*Oreaster reticulatus*



rock boring urchins  
*Echinometra lucunter*



furry sea cucumber  
*Astichopus*



three-rowed sea cucumber  
*Isostichopus*



*E. viridis*



tulip snail  
*Fasciolaria tulipa*



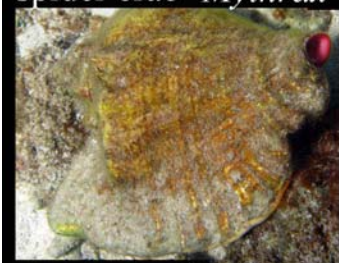
spider crab  
*Mythrax*



coral crab  
*Carpilius corallinus*



*Octopus sp.*



queen conch  
*Strombus gigas*



trumpet triton  
*Charonia variegata*



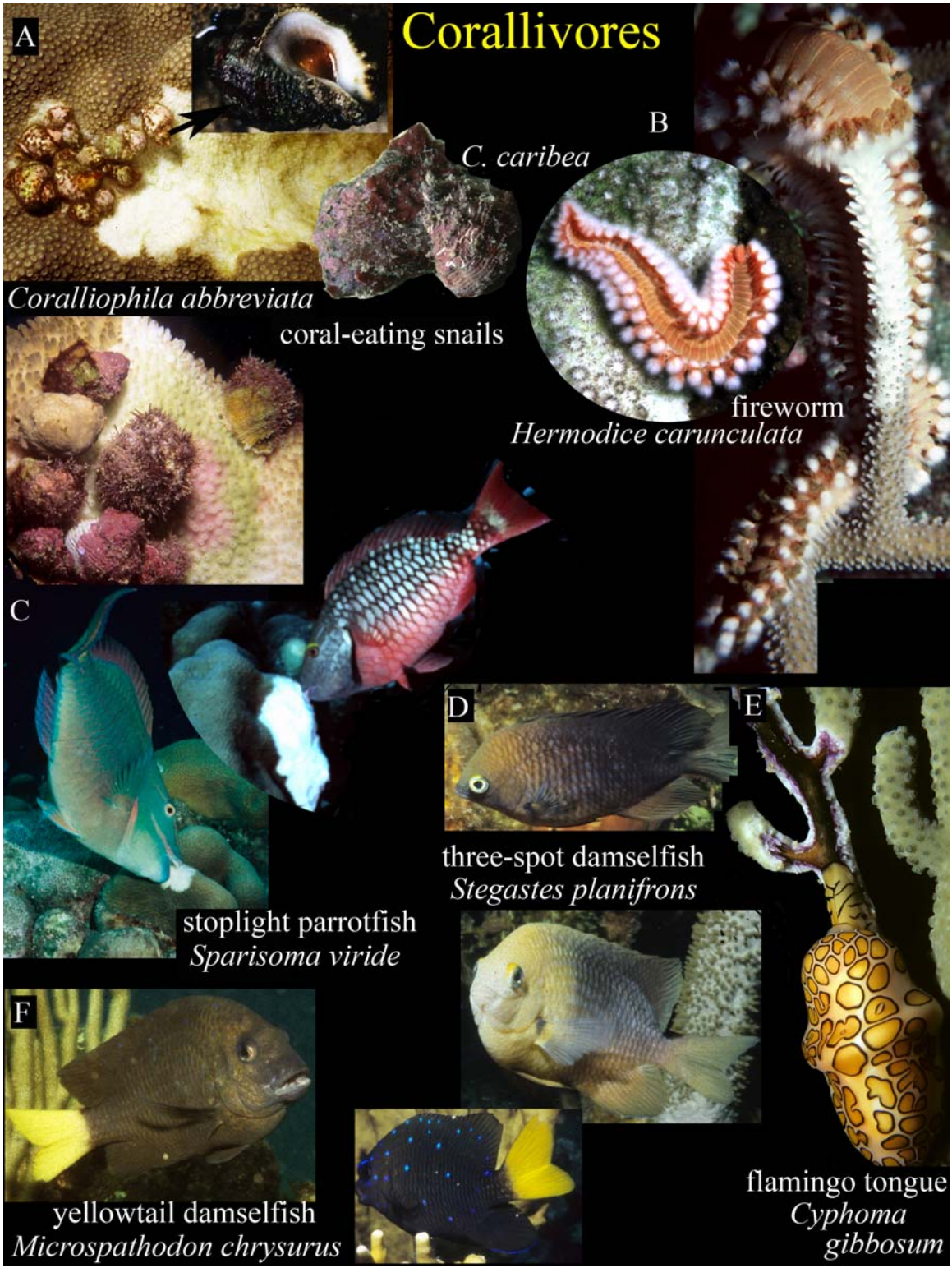
helmet snail  
*Cassis tuberosa*

**Corallivores:** **A.** The coral eating gastropod *Coralliophila abbreviata* on *M. faveolata* (top) and *A. palmata*. The underside, showing the orange operculum; smaller, less common species, found primarily on gorgonians, *C. caribea*. **B.** Polychaete fireworm *Hermodice carunculata* feeding on staghorn coral. **C.** A terminal phase male (TP, blue green) and initial phase (IP, red and black) stoplight parrotfish *Sparisoma viride* feeding on *M. annularis*. **D & F.** Damselishes that bite live coral. Yellowtail damselfish, *Microspathodon chrysurus* forms territories around *A. palmata* and creates circular lesions on live tissue. Adult (left) and juvenile (right). Three-spot damselfish, *Stegastes planifrons* forms algal lawns on most coral species. **E.** The flamingo tongue gastropod, *Cyphoma gibbosum* preys on branching and encrusting gorgonians and sea fans.

**Herbivores.** The two dominant taxa of fish that feed on algae are acanthurids (surgeonfishes) and parrotfishes. Acanthurids are browsers that usually feed in large schools, inhibiting the growth of filamentous and fleshy turf algae. **Blue tangs** feed on algae without ingesting sediment. **Doctorfishes** and ocean **surgeonfishes** consume detritus and sediment when grazing on algae. Of 14 species of parrotfishes, the most common large-bodied parrotfish are shown. Parrotfish teeth are fused into powerful beaks capable of scraping and excavating the reef's structure when feeding on algae; nearly 75% of the gut contents in some species is calcium carbonate, which is ground into fine sediment. **Redband** and **yellowtail parrotfishes** are primarily grazers, ingesting minimal sediment. **Princess** and **striped parrotfishes** are scrapers. **Stoplight parrotfish** are excavators that feed frequently on live coral. **Blue, midnight, rainbow** and **queen parrotfishes** are excavators and scrapers. Coloration of juveniles (not shown), initial phase (IP) females and terminal phase (TP) males differs. These fishes are often caught in gill nets and fish traps, and by spearfishing, but should be protected from fishing.

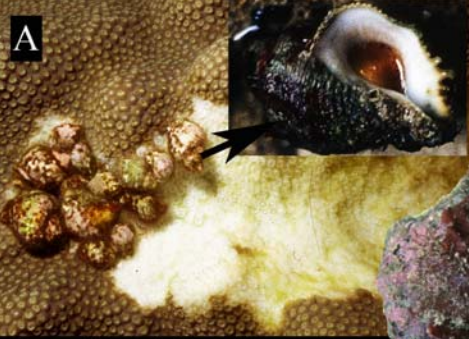
**Invertebrate Feeders: Butterflyfish and Angelfish.** Five of the seven Caribbean butterflyfishes are shown. All of these eat hard and soft corals and zoanthids, tunicates, and other invertebrates. **Four-eye butterflyfish:** gorgonians; **banded butterflyfish:** polychaetes; **reef and spot-fin butterflyfishes:** tubeworms, hydroids and crustaceans; **longsnout butterflyfish:** tubeworms. **Atlantic spadefish** feed on bottom dwelling invertebrates, preferring sponges, zoanthids, gorgonians, polychaetes and tunicates. Six common angelfishes are shown. **Rock beauty, queen and blue angelfishes** eat sponges almost exclusively, while **French and gray angelfishes** feed on sponges, soft corals, tunicates and many other invertebrates. Juvenile angelfishes often act as cleaners, feeding on parasites, but algae also forms an important part of their diet.





# Corallivores

A



*Coralliophila abbreviata*

coral-eating snails

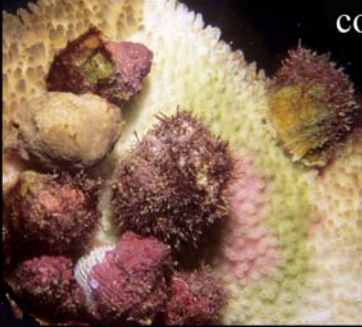
*C. caribea*

B



fireworm

*Hermodice carunculata*



C



stoplight parrotfish  
*Sparisoma viride*

D



three-spot damselfish  
*Stegastes planifrons*

E



flamingo tongue  
*Cyphoma gibbosum*

F



yellowtail damselfish  
*Microspathodon chrysurus*





Surgeonfishes



doctorfish



blue tang



ocean surgeonfish



queen parrotfish



striped parrotfish



yellowtail parrotfish

Herbivores



princess parrotfish



blue parrotfish



rainbow parrotfish



midnight parrotfish



stoplight parrotfish



redband parrotfish

Parrotfishes

TP

TP

IP

IP

TP

TP

IP

IP

TP

IP



# Invertebrate Feeders: Butterflyfish & Angelfish



four-eye butterflyfish



banded butterflyfish



reef butterflyfish



Atlantic spadefish



longsnout butterflyfish



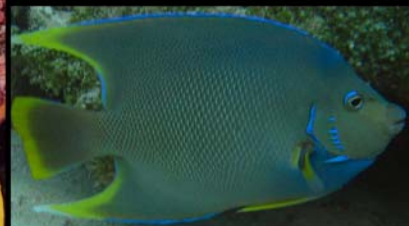
spot-fin butterflyfish



queen angelfish



rock beauty



blue angelfish



French angelfish



juvenile French angelfish



gray angelfish

**Invertebrate feeders:** Shrimps, crabs, lobsters and hard-shelled molluscs are the most commonly eaten invertebrates. **Hogfish, queen triggerfish** and **jolthead porgies** are important predators of *Diadema*, *Echinometra* and other urchins, but also eat molluscs. Juvenile Spanish hogfish act as cleaner fish. **Filefish, pufferfish, boxfish** and related fishes have powerful mouths with beak-like jaws for breaking gastropod and hermit crab shells, and removing tube worms from coral heads; they may help control corallivorous snail populations. **Grunts** form resting schools on the reef and associated habitats and make nightly migrations to distant habitats to feed on polychaetes, crustaceans, gastropods (black, Spanish and caesar grunt) and other small invertebrates.

**Reef Predators I: Snapper** and **grouper** are the dominant predators on unimpacted reefs, and they are often the first fish to disappear due to fishing. **Snapper** in the genus *Lutjanus* (except Cubera snapper, a piscivore) feed primarily on crustaceans and small fishes. Some species feed throughout the day, while others form resting schools in day, feeding at night; some move between grassbeds, mangroves, sandflats and reefs. **Yellowtail snapper** feed above the substrate at night on crabs, worms, shrimp, small fishes and gastropods. **Groupers** are ambush hunters that feed during the day, dusk and dawn. The genus *Mycteroperca* prefers fish, especially grunts and parrotfishes, while the genus *Epinephilus* prefers lobsters, large crabs and shrimp but will also eat cephalopods, pufferfish, boxfish, wrasse, goatfish, damselfish and other small fishes. Nassau and tiger groupers will eat the invasive lionfish.

**Reef Predators II:** Fish eating species include roving predators such as **sharks, jacks, moray eels and barracuda**. **Moray eels** are mostly nocturnal and crepuscular feeders (except the spotted moray) seeking prey concealed in holes. **Jacks** form hunting packs, moving through the reef to splinter schools of grunts, silversides and other fishes. **Scorpionfish and lizard fish** are ambush predators that wait for their prey in concealed places. While most **sharks** are fish eaters, **rays** are primarily invertebrate feeders. Rays feed primarily in soft bottom areas on bivalve and gastropods mollusks including queen conch.



# Invertebrate Feeders

# Boxfish

## Hogfish



hogfish



blue scrawled filefish



honeycomb cowfish



spotted trunkfish



Spanish hogfish



whitespotted filefish

## Filefish

## Pufferfish



spotted burrfish

## Grunts

## Triggerfish



queen triggerfish



balloonfish



bluestriped grunt



gray triggerfish



sailors choice



French grunt



black margate



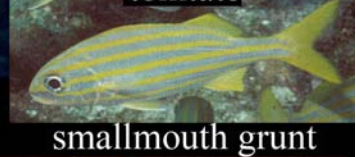
tomtate



jolthead pogy



porkfish



smallmouth grunt



Spanish grunt



# Reef Predators

## Snapper



gray snapper



cubera snapper



schoolmaster snapper



dog snapper



yellowtail snapper



mutton snapper



red hind



rock hind



coney



graysby



yellowmouth grouper



gag grouper



yellowfin grouper



tiger grouper



black grouper



Nassau grouper



# Reef Predators



spotted moray eel

## Eels



green moray eel

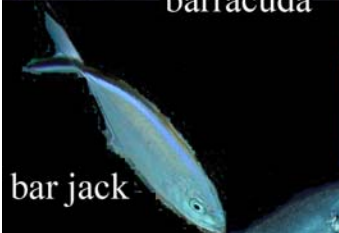
## Ambush predators



barracuda



scorpionfish



bar jack



crevalle jack



lizardfish

## Jacks



horse-eye jack

## Mackerel



cero



nurse shark

black jack

## Sharks



lemon shark

# Invertebrate Feeders

## Rays



yellow stingray



southern stingray



spotted eagle ray



# Scientific Names of Fishes

## Acanthurids

Doctorfish- *Acanthurus chirurgus*

Blue tang- *A. coeruleus*

Surgeonfish- *A. bahianus*

## Scarid Parrotfish

Rainbow- *Scarus guacamaia*

Blue- *S. coeruleus*

Midnight- *S. coelestinus*

Princess- *S. taeniopterus*

Queen- *S. vetula*

Striped- *S. iserti*

## Sparisomid Parrotfish

Stoplight- *Sparisoma viride*

Redband- *S. aurofrenatum*

Yellowtail- *S. rubripinne*

## Butterflyfishes & Angelfishes

Four-eye butterflyfish- *Chaetodon capistratus*

Banded butterflyfish- *C. striatus*

Spot-fin butterflyfish- *C. ocellatus*

Reef butterflyfish- *C. sedentarius*

Longsnout butterflyfish- *C. aculeatus*

Atlantic spadefish- *Chaetodipterus faber*

Queen Angelfish- *Holacanthus ciliaris*

Blue Angelfish- *H. bermudensis*

French Angelfish- *Pomacanthus paru*

Gray Angelfish- *P. arcuatus*

Rock Beauty- *Holacanthus tricolor*

## Invertebrate Feeders

Hogfish- *Lachnolaimus maximus*

Spanish hogfish- *Bodianus rufus*

Blue scrawled filefish- *Aluterus scriptus*

White spotted filefish- *Cantherhines macrocerus*

Honeycomb Cowfish- *Acanthostracion polygona*

Spotted trunkfish- *Lactophrys bicaudalis*

Spotted burrfish- *Chilomycterus atinga*

Balloonfish- *Diodon holacanthus*

Queen triggerfish- *Balistes vetula*

Ocean triggerfish- *Canthidermis sufflamen*

Porkfish- *Anisotremus virginicus*

Black margate- *A. surinamensis*

Sailors choice- *Haemulon parra*

Blue-striped grunt- *H. sciurus*

French grunt- *H. flavolineatum*

Smallmouth grunt- *H. chrysargyreum*

Tomtate- *H. aurolineatum*

Spanish grunt- *H. macrostomum*

## Predators

Cubera snapper- *L. cyanopterus*

Gray snapper- *Lutjanus griseus*

Mutton snapper- *L. analis*

Dog snapper- *L. jocu*

Schoolmaster snapper- *L. apodus*

Yellowtail snapper- *Ocyurus chrysurus*

Red hind- *Epinephelus guttatus*

Rock hind- *E. adscensionis*

Nassau grouper- *E. striatus*

Coney- *Cephalopholis fulvus*

Graysby- *C. cruentatus*

Black grouper- *Mycteroperca bonaci*

Gag- *M. microlepis*

Tiger grouper- *M. tigris*

Yellowfin grouper- *M. venenosa*

Yellowmouth grouper- *M. interstitialis*

Spotted moray eel- *Gymnothorax moringa*

Green moray eel- *G. funebris*

Barracuda- *Sphyraena barracuda*

Bar jack- *Caranx ruber*

Black jack- *C. lugubris*

Horse-eye jack- *C. latus*

Crevalle jack- *C. hippos*

Scorpionfish- *Scorpaena plumieri*

Lizardfish- *Synodus intermedius*

Cero- *Scomberomorus regalis*

Yellow stingray- *Urolophus jamaicensis*

Spotted eagle ray- *Aetobatus narinari*

Southern stingray- *Dasyatis americana*

**Back cover:** Examples of direct pressures that degrade the resilience of coral reefs. Fishing, one of the top threats includes the use of fish traps and gill nets (**top left**), seine nets (**top right**) and spearfishing (**center**). Fishers often deploy traps from small wooden boats (**center left**) in channels between the reef, but they also land on the reef (**center right**) and cause damage and breakage to corals especially during storms. Fish catch from speargun (**middle**) and fish trap (**lower left**) include many juveniles, low value herbivores and omnivores, and ecologically important t herbivores. High levels of turbidity and sedimentation (**lower left**) affects light levels reaching the reef and can lead to smothering of corals and other sessile organisms. Corals and other organisms are collected for ornamental purposes as curios (**lower center right**: Trumpet triton, helmet snail, queen conch and coral skeletons) and for aquaria (**lower right**: Bleached, killed coral skeletons for sale in Florida). Recent queen conch “middens” in Curacao. Three large piles of conch shells are higher than the individual in the foreground (**bottom left**). The lionfish (*Pterois volitans*) recently invaded the Atlantic and has spread throughout the wider Caribbean; photo from Belize (**bottom right**).

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