# The importance of Fish Presence to Coral Health

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Many of the public comments on the RMA N-164 (MPA network) focused on a need to understand the connection between fish presence and coral health. Many studies have concluded that coral health depends on the presence, abundance and composition of fish and not just herbivores. Coral health requires ecosystem balance including the whole food web including grazers, spongivores, macro-invertebrate feeders, and large and medium piscivores (Hunt and Sharp 2014; Rowler & Yule 2010). Fish provide nutrition that promotes coral growth and clean the substrate to promote coral settlement, attachment, and survival. Fish grazers reduce cover of macroalgae and sponges that directly compete with coral for space, and reduce coral exposure to deadly dissolved organic carbon (DOC) that kills coral. Fishes clean diseased coral tissue and remove coral predators that consume and kill coral. Even large predators like sharks and jacks play critical roles (Rohwer and Youle 2010; Williams et al. 2014).

Herbivore fishes provide key services that mediate competition between corals and macroalgae, reduce macroalgal abundance and cover, and increases the presence of crustose coralline algae (CCA) that is a preferred substrate for coral settlement (Burkepile & Hay 2008). Fish presence increases coral growth and recruitment, decreases coral mortality (Steneck 1988, Hughes et al. 2007, Burkepile & Hay 2008), and intensifies herbivory on macroalgal populations (Miller & Hay, 1998, Hughes et al. 2007, Mumby & Steneck 2008). Fish grazing is now more important in the Caribbean to partially mitigate the loss of grazing by the sea urchin, *Diadema antillarum*, following its massive die-off in the Caribbean in 1983 (Lessios 1988; Edmunds & Carpenter 2001).

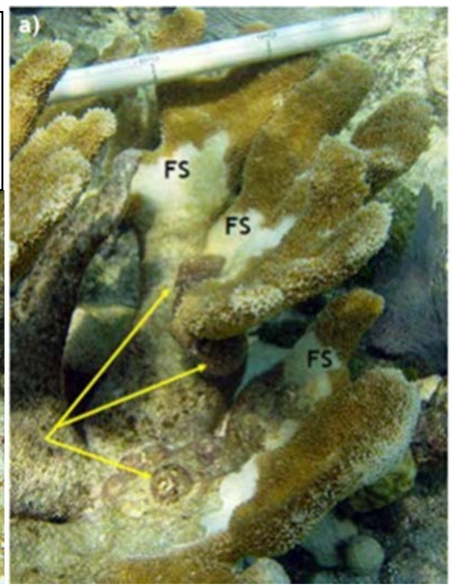
Coral growth rates, skeletal accretion and surface area expansion of coral were greater with the presence of resident schools of grunts (Meyer, et al. 1983, Meyer and Schultz 1985). Algal grazing rates were approximately three times higher in areas with resident grunts than structurally similar areas without resident schooling grunts (Shants et al., *in review*, cited in Hunt and Sharp 2014). Sites with fish schools contained double the amount of beneficial CCA cover and half of the turf algal sediment compared to sites without fishes present. The growth rates of transplanted *A. cervicornis* colonies were 150% higher at sites with fish schools.

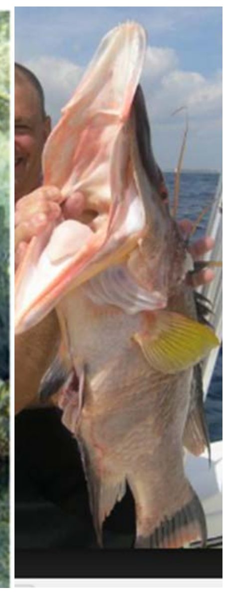
Raymundo et al. 2009 surveyed reefs across the central Philippines, including well-managed marine protected areas (MPAs), and found that disease prevalence was significantly negatively correlated with fish taxonomic diversity. MPAs had significantly higher fish diversity and less disease than unprotected areas. They further hypothesized that Chaetodontidae are major vectors of coral disease by virtue of their trophic specialization on hard corals and their ecological release in overfished areas, particularly outside MPAs. Lamb et al. (2015) examined the utility of no-take marine reserves as tools for mitigating diseases that affect reef-building corals. We found that sites located within reserves had fourfold reductions in coral disease prevalence compared to non-reserve sites ( 80,466 corals surveyed). Lamb et al (2016) showed that one year after a severe tropical cyclone, corals inside reserves had sevenfold lower levels of disease than those in non-reserves. Similarly, disease prevalence was threefold lower on reserve reefs following chronic exposure to terrestrial run-off from a degraded river catchment, when exposure duration was below the long-term site average.

Pawlik et al. 2016 concluded that sponge grazers were important for coral health because they reduced sponge competition and exposure to DOCs. Dixson et al 2014 showed that both coral and fish larvae were repelled by chemical cues from fished, seaweed dominated reefs but were attracted to cues from coral-dominated areas where fishing was prohibited.

Major predators that consume Florida corals include corallivorous snails, fireworms, butterflyfishes, damselfishes (Kaufman 1977, Hixon and Brostoff 1983, Cantano et al. 2014), and corallivorous parrotfish. The corallivorous snail (*Coralliophila abbreviate*) is a threat to *Acropora* coral as a predator and disease vector (Williams & Miller 2005). Most predatory species that benefit coral are targeted by fishing. Spiny lobster are keystone predators that preferentially eat mollusks (Cox et al 1997) including coral eating snails (Johnson and Miller 2007), but are largely extirpated on SE Florida reefs for much of the year. Absence of lobster allows predatory mollusks to increase in size and abundance (Estes et al. 1989) and can significantly change the composition of benthic habitats (Robles, 1996). While spiny lobster predation is concentrated on small snails, medium and large snails are preferred food for invertebrate feeding fish including hogfish, grunt, porgy, triggerfish, trunkfish, puffers, and porcupine fish that are able to crush mollusk shells with their jaws or pharyngeal teeth (Randall 1967).

Corallivorous snail feeding scars (FS) account for ~30% of overall Elkhorn coral Acropora palmata tissue loss. Miller 2016, SEFSC ecosystem review.



Hogfish specialize in eating mollusks and were recently listed as overfished and undergoing overfishing by Florida Fish and Wildlife Commission (FWC) and the South Atlantic Fishery Management Council (SAFMC).


Fireworm predation

Figure shows fireworm eating a growing tip of Staghorn coral, *Acropora cervicornis,* and two dead tips from earlier predation. Fireworm predation affected up to half of both wild and outplanted colonies. Source: M. Miller 2016, SEFSC Ecosystem review.

Threespot damselfish coral predation.

Territorial damselfish will kill large areas of live coral tissue to create algal gardens (Hixon and Brostoff 1983, Cantano et al. 2014).

There is no science to support the assumptions that coral health is decoupled from fish presence or that MPAs would not be effective in SE Florida.  Sustainable fishery productivity requires a healthy ecosystem with sufficient primary productivity and a balance of prey and predator species.  MPA networks are an ecosystem-based approach to management that complements traditional fishery management approaches to ensure persistence of coral reef ecosystems.

In 2006 Elkhorn and Staghorn *Acropora* corals were listed as threatened under the Endangered Species Act.  In 2015 the *Acropora* recovery plan was published by the National Marine Fisheries Service (2015). It included using MPAs as a recovery strategy.  Five additional Atlantic corals, including major reef building corals, were listed as threatened in 2015.

**References**


Raymundoa, Laurie J., Andrew R. Halford, Aileen P. Maypa, and Alexander M. Kerra.  2009. Functionally diverse reef-fish communities ameliorate coral disease.  PNAS 106 (40) 17067-17070.

Burkepile DE & ME Hay.  2008. Herbivore species richness and feeding complementarity affect community structure and function on a coral reef. Proc Nat. Academy of Science of the United States of America 105: 16201-6.

Cox, C, JH Hunt, WG Lyons, GE Davis.  1997.  Nocturnal foraging of the Caribbean spiny lobster (*Panulirus argus*) on offshore reefs of Florida, USA. Mar. Fishwater Res. 48: 671-679.

Dixon, DL, DA Abrego and ME Hay.  2014.  Chemically mediated behavior of recruiting corals and fishes: A tipping point that may limit reef recovery.  Science 345: 892-897.

Estes, JA, DO Duggins, GB Rathbun.  1989. The ecology of extinctions in kelp forest communities.  Conservation Biology 3(3): 252-263.

Hixon, M & W Brostoff.   1983. Damselfish as keystone species in reverse – intermediate disturbance and diversity of reef algae.  Science 220: 511-513.

Hughes et al. 2007. Phase shifts, herbivory, and resilience of coral reefs to climate change.  Current biology 17: 360-5.

Hunt and Sharp 2014.  Developing a comprehensive strategy for coral restoration for Florida.  Final Report.  FWC. 90 pp.

Johnson, L. and MW Miller. 2007.  Variation in life-history traits of the corallivorous gastropod Coralliophila abbreviate on three coral hosts.  Marine Biology 150: 1215-1225.

Kaufman, LKB.  1977.  The threespot damselfish: Effects on benthic biota of Caribbean coral reefs.  Third International Coral Reef Symposium 1: 559-564.

Lamb, JH, DH Williamson, GR Russ, and BL Willis. 2015. Protected areas mitigate disease of reef-building corals by reducing damage from fishing. Ecology 96: 2555-2567.

Lamb, JH, AS Wenger, MJ Devlin, DM Ceccarelli, DH Williamson, and BL Willis. 2016. Reserves as tools for alleviating impacts of marine disease. Phil. Trans. R. Soc. 371: 20150210.

Mumby, PJ & RS Steneck. 2008. Coral reef management and conservation in light of rapidly evolving ecological paradigms. Trends in Ecol and Evol 23: 555-63.

Meyer J.L., Schultz E.T., Helfman G.S. 1983. Fish schools: An asset to corals. Science 220(4601): 1047-1049.

Meyer J.L. and E.T. Schultz. 1985. Migrating haemulid fishes as a source of nutrients and organic matter on coral reefs. Limnol. Oceanogr. 30: 146-156.

National Marine Fisheries Service. 2015. Recovery Plan for Elkhorn Coral (*Acropora palmate*) and Staghorn Coral (*A. cervicornis*). Prepared by the *Acropora* Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland.

Pawlik, J.R. et al. 2016. A vicious circle? Altered carbon and nutrient cycling may explain the low resilience of Caribbean coral reefs. BioScience Advance Access .7 pp.

Raymundoa, Laurie J., Andrew R. Halford, Aileen P. Maypa, and Alexander M. Kerra. 2009. Functionally diverse reef-fish communities ameliorate coral disease. PNAS 106 (40) 17067-17070.

Randall, J.E. 1967. Food habitats of reef fishes of the West Indies. Studies in Tropical Oceanograpy 5: 665-847.

Robles, C. 1996. Turf battles in the tidal zone. Natural History 1996(7): 24-27.

Rohwer, F and M. Youle. 2010. Coral reefs in the microbial seas. Plaid Press. USA, 201 pp.

Steneck, R. 1988. Hervivory on coral reefs: a synthesis *Proc 6$^{th}$ Int Coral Reef Symp 1: 37-49.*

Sutherland, KP and KB Ritchie. 2004. White pox disease of the Caribbean elkhorn coral, *Acropora palmata*. In Coral Health and Disease. E. Rosenberg and Y. Loya (eds). Springer-Verlag, Berlin 289-300.

Williams, DE & MW Miller. 2005. Coral disease outbreak: pattern, prevalence and transmission in *Acropora cervicornis* 301: 119-128.