UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT COURT OF FLORIDA
Miami Division

Case No.: 1:16-cv-23017-DPG

SOUTHERN ALLIANCE FOR CLEAN ENERGY
TROPICAL AUDUBON SOCIETY INCORPORATED,
and FRIENDS OF THE EVERGLADES, INC.,

Plaintiffs,

v.

FLORIDA POWER & LIGHT COMPANY,

Defendant.

EXPERT REPORT OF JAMES FOURQUREAN, Ph.D. (Miami)

I have been retained by the Plaintiffs in this matter to offer expert testimony. Pursuant to Fed. R. Civ. P. 26(a)(2)(B), the following is my written report. I have attached a C.V. with my qualifications and publications as Attachment 1 to the report. A list of all other cases in which, during the previous 4 years, I have testified as an expert at trial or by deposition is attached as Attachment 2. I am being paid an hourly rate of $175 for my work in this case.

My opinions are based on the data on seagrass distribution, nutrient availability and water quality of both surface water and groundwater available to me as of May 14, 2018. I will continue to search for new data to inform my opinions as set forth below.

OPINIONS

1. The seagrass beds of Biscayne Bay and the rest of south Florida require very low nutrient loading to survive. In essence, seagrasses are killed and replaced by fast-growing, noxious seaweed if nutrient delivery is increased. Nutrient delivery can be increased either by increasing the concentration of nutrients in discharges, OR by increasing the volume of water containing nutrients, even at very low concentrations that would pass drinking water quality standards over a long period of time.

All plants, including seagrasses, require light, water, and mineral nutrients, such as phosphorus and nitrogen, to grow. The required supply of nutrients for any plant population to grow is a function of the plants relative growth rate. Plants that grow quickly require high rates of nutrient supply, while plants that grow more slowly require a lower rate of supply. As a consequence, rapidly-growing plants are found where nutrient supplies are high, and slow-growing plants where nutrient supplies are low. High nutrient supplies are not necessarily bad for slow-growing plants, but at high nutrient supply rates fast growing plants can overgrow and shade out the slow growers.

In general, the size of a plant is a good indicator of its relative growth rate, with smaller plants having higher growth rates. In seagrass beds in Biscayne Bay, the fastest growing plants are the single-celled algae that live either in the water, in the sediments, or attached to hard surfaces, such as seagrass leaves. Filamentous algae that grow on surfaces grow slightly slower, followed by more complex macroalgaes, like the fleshy and calcareous seaweeds. Seagrasses grow even slower. Different species of seagrass have different growth rates and nutrient requirements. The narrow-bladed species widgeon grass (*Ruppia maritima*) and shoal weed (*Halodule wrightii*) grow faster than the spaghetti-like manatee grass (*Syringodium filiforme*) which in turn has a faster growth rate, and therefore higher nutrient requirements, than turtle grass (*Thalassia testudinum*). It quite common in south Florida, that nutrient supplies can be so low as to constrain the growth of even the slowest growing species (Fourqurean and Rutten 2003).

Evidence to support the relationship between growth rate and nutrient requirement come from both the distribution of seagrasses around natural nutrient “hot spots” in south Florida (Powell et al 1991) and from fertilization experiments (Armitage et al 2011, Ferdie and Fourqurean 2004). For example, the natural state of eastern Florida Bay is very low nutrient availability. However, on some of the mangrove islands in Florida Bay, there are large colonies of wading birds that hunt for food around the bay (Figure 1). Those birds roost and nest on the islands, and bring food home to feed their young. Both adults and young defecate on the islands, causing natural point sources of nutrient supplies around these small islands. In response to this point source, nutrient availability is very high within a few meters of the islands and decreases with distance away from the mangrove shoreline. In response to this gradient, there are concentric halos of different plants growing on the bottom. Closest to the island where nutrient pollution is greatest, there is only a coating of microalgae covering the sediments. Further away from the island there is a macroalgae zone, followed by a halo of dense widgeon grass, a halo of dense shoal weed, then a zone of mixed shoal grass and dense turtle grass. Farther away still, outside the zone of influence of nutrients from the bird colony, turtle grass declines in density to very sparse coverage.

Fertilization experiments have confirmed that a change in nutrient supply first leads to a change in the density, and then the species composition, of seagrass beds in south Florida (Fourqurean et al 1995). In Florida Bay, fertilizing sparse turtle grass beds with phosphorus first results in an increase in the density of turtle grass; however, once shoal grass becomes established in the fertilized patches, it rapidly displaces the turtle grass (Figure 2). Less controlled experiments illustrate how the seagrass beds of the Florida Keys changed as the Keys became developed. Early developments relied on cesspools or septic tanks for wastewater "treatment." Neither provide nutrient removal in the rocky limestone substrate of the Keys. Thus, wastewater and stormwater nutrients emanating from the shoreline development resulted in the growth of lush seagrass beds immediately off shore of Key Largo (Figure 3). This observation could be interpreted as a "good" thing because seagrass growth and coverage expanded. However, data from other observations and experiments temper this optimism.

A model has been developed to illustrate how normally low-nutrient seagrass beds of south Florida will change as nutrient availability changes (Fourqurean and Rutten 2003, Figure 4). The model shows that seagrass beds composed of abundant turtle grass, the slowest-growing species, become lush with increased nutrient conditions. But, as nutrient supply continues to increase, the species composition gradually changes as faster-growing species replace the slower-growing ones. At the highest nutrient levels, seagrasses are replaced by seaweeds and microalgae, Loss of the seagrass community will result in a dramatic change in community structure and function. Animal species dependent on seagrass for food and shelter (e.g., speckled trout, redfish, bonefish and tarpon) are replaced by less desirable species (e.g., jellyfish). The model predicts that the relative abundance of benthic plants at a site is an indicator of the current rate of nutrient supply. Changes in the relative abundance from slow-growing to fast-growing species at any site indicates an increase in nutrient supply.

2. The seagrasses along the coastline of the Cooling Canal System (CCS) existed for thousands of years in a nutrient-limited state, which means any addition of new nutrients changes the balance of these ecosystems. Increased nutrients harm the ecosystem by increasing the rates of primary production by marine plants. Increase in growth rates means that faster-growing, noxious marine plants, like macroalgae (seaweeds) and microscopic algae and photosynthetic bacteria, overgrow and outcompete seagrasses and corals for light, leading to the losses of corals and seagrasses.

The density and species composition of the seagrasses of southern Biscayne Bay are controlled by the availability of phosphorus. The water column in southern Biscayne Bay has very low concentrations of dissolved phosphorus, and the grand mean TN:TP ratios (ie, the ration of moles of nitrogen to the moles of phosphorus) of the water in southern Biscayne Bay average 177.9 (Caccia and Boyer 2005). When TN:TP of oceanic water is above 16 it indicates that the availability of phosphorus limits the growth of plankton (Redfield 1958). Seagrasses are more complex than phytoplankton, so that the critical ratio determining whether N or P limits plant growth for seagrasses is 30 (Fourqurean and Rutten 20013). The N:P of Turtle Grass (*Thalassia testudinum*) collected in the vicinity of Turkey Point was 88.6 in 2013, a clear indication of phosphorus limitation (Dewsbury, 2014). Fertilization experiments (Armitage et al 2011, Ferdie and Fourqurean 2004) clearly show that phosphorus fertilization of turtle grass with N:P > 80 first leads to an increase in density of turtle grass, then a replacement of turtle grass by faster-growing seagrasses, followed by a loss of seagrasses as P loading continues.

3. Around the world, there are many nutrients that can limit noxious plant growth, but most often, the nutrients that limit this growth are either nitrogen or phosphorus. In south Biscayne Bay, phosphorus is limiting to phytoplankton and macroalgae. This means that addition of phosphorus will upset the ecological balance of seagrass beds as has been exhibited in Northern Biscayne By and Florida Bay. Upsetting the balance of populations of aquatic flora and fauna by nutrient addition is a violation of Florida surface water quality standards.

As set forth in F.A.C. 62-302.520(48)(b), Nutrients, "In no case shall nutrient concentrations of a body of water be altered so as to cause an imbalance in natural populations of aquatic flora or fauna." Although there are numeric nutrient criteria for Biscayne Bay, F.A.C. 62-302.532(h), the narrative criterion still applies. F.A.C. 62-302(48)(a) states, "Man-induced nutrient enrichment (total nitrogen or total phosphorus) shall be considered degradation in relation to the provisions of Rules 62-302.300, 62-302.700, and 62-4.242, F.A.C." Because Biscayne Bay is Outstanding Florida Waters under 62-302.700, man-induced nutrient enrichment from the FPL CCS is considered degradation, which is prohibited.

4. Current seagrass species composition and abundance data collected by ongoing seagrass monitoring programs show that Turtle Grass biomass offshore from the CCS is unusually dense compared to other areas in southern Biscayne Bay, likely as a consequence of increased P availability in the region.

Seagrass density data collected around Turkey Point in the late 1960's-early 1970's describe a system with very sparse turtle grass interspersed with a few dense patches more than a few hundred meters offshore (Zieman 1972). In addition, long-time fisherman report that the dense Turtle Grass flats they fished further offshore near the Arsenicker Keys in the early 1970's are now devoid of seagrasses, likely because of continued P addition. In my opinion, there is an imbalance in the seagrass meadows of southern Biscayne Bay in the vicinity of the CCS, likely caused by increased P discharged from the CCS. A a preliminary review of seagrass abundance (% cover) data collected in Biscayne Bay since the mid 1980's and statements from keen observers responsible for these and other monitoring programs suggest seagrasses in the nearshore vicinity of the CCS and TP facility are denser than elsewhere in Biscayne bay. I will be collecting and analyzing any and all data not available to me at this time to better understand these preliminary statement and observations.

5. The nearshore seagrass beds are incredibly efficient at removing P from the water column and storing P at vanishingly small concentrations. In fact, even 30 feet from large point-sources of P in Florida Bay, it is not possible to measure increases in P concentrations in the water column because it has all been captured by the seagrass communities This P capture causes increased plant growth and ecosystem imbalances. This imbalance first leads to an actual increase in the abundance of seagrass, but rapidly it causes a change in species composition, first to faster-growing seagrasses, then to seaweeds, then to microscopic algae.

6. Groundwater discharges along the coast of southern Biscyane Bay contain elevated concentrations of phosphorus, so that any process that causes groundwater discharge to the local seagrasses will supply the limiting nutrient that upsets the balance of the ecosystem.

P concentrations in the deeper canals offshore of the CCS and in caves offshore of Turkey Point are 10-20 times higher than the median concentrations (0.03 μM) of inorganic phosphorus in Biscayne Bay waters (Caccia and Boyer 2005).

7. The geology underlying the CCS and the adjacent seagrass meadows is based on limestone, which is made of calcium carbonate minerals. Calcium carbonate minerals strongly absorb orthophosphate onto their surfaces. But, respiration by plants, animals and bacteria dissolve calcium carbonate minerals, releasing the orthophosphate absorbed to the surfaces. During normal conditions, south Florida ecosystems are incredibly efficient at holding on to captured phosphorus– so much so that the impacts caused by adding P to seagrass beds in south Florida for even short periods can still be measured 30 years after the P additions. On the other hand, bacteria cause added N captured by south Florida ecosystems to be rapidly transformed and removed from those ecosystems. Bacterial processes transform oxidized inorganic nitrogen species and organic nitrogen into ammonium. Other bacterial processes lead to the loss of inorganic nitrogen (ammonium, nitrate and nitrites) from the system as nirous oxide and dinitrogen gas. These facts result in P additions causing permanent and cumulative imbalances in nearshore marine waters of the Keys while N additions cause imbalances that can be corrected by the cessation of N addition.

Inorganic phosphorus strongly sorbs onto limestone minerals, retarding the transport of phosphorus through the limestone aquifer. However, the binding of phosphate to those minerals is a function of both the salinity of the groundwater (Price et al 2010) as well as the oxidation state of that groundwater (Flower et al 2017a) . Both large increases and decreases in the salinity can desorb the phosphate, and make it mobile in the groundwater The seawater of Biscayne Bay and the fresh groundwater of the Biscayne Aquafer are both supersaturated with respect to limestone minerals, and therefore they will not liberate phosphate immobilized on limestone in the groundwater, but calcite will dissolve, and phosphorus will be released, where these two waters mix (Wigley and Plummer 1976). Hence, mixing of saltwater and freshwater in the aquifer can liberate phosphorus and transport it to the surface. This phenomenon explains the plant biomass and productivity increases along the coast of south Florida where brackish groundwater discharges (Price et al 2006). Further, injection of salty groundwater into freshwater aquifers through saltwater intrusion drives phosphorus release from that bedrock (Flower et al 2017b).

When saline and fresh groundwater mix in south Florida sources mix, they create a brackish water solution that dissolves calcium carbonate minerals, releasing orthophosphate stored on the surfaces of the limestone particles.

When this P-laden water reaches the surface, it will be captured by the ecosystem and cause an imbalance because it will be used by the ecosystem resulting in the growth of noxious plants (algae) which outcompete the seagrasses.

The operations of the CCS create saline water that infiltrates the groundwater and is transported and discharged under the seagrass

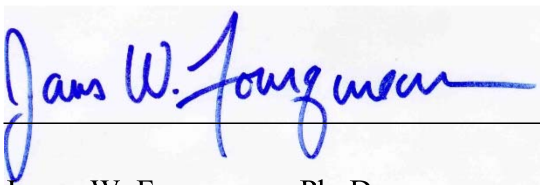
It is my opinion that operation of the CCS has 1) carried phosphorus-polluted groundwater to near-shore surface waters through the highly porous bedrock and 2) has dissolved carbonates in that bedrock, releasing additional phosphorus that had been incorporated into that rock. As this phosphorus reaches the seagrass meadows offshore in Biscayne Bay, it will continue to degrade the ecosystem and cause an imbalance and change the nature of the surrounding marine environment.

8. An imbalance of the seagrasses that form the near-shore habitat near the CCS in Biscayne Bay and provide the food at the base of the food chain harms the fish and wildlife that use these habitats and therefore effects fishing, recreational activities such as bird watching and other activities based on that habitat change and eventual loss.

Salinity and the abundance and species composition of Biscayne Bay's seagrass beds interact to control the types and numbers of animals that live in the area (Santos et al 2018, Zink et al. 2017). For example, Biscayne Bay's fish populations reflect the salinity regime along the shoreline, with lower salinity sites having fewer fish like bluestriped grunt, schoolmaster snapper and sailors choice, and higher densities of fishes like killifishes, than higher-salinity sites (Serafy et al 2003). Salinity variability can be as important as mean salinity along this coastline in influencing fish communities (Machemer et al 2014).

I submitted this report on May 14, 2018.

Signed:



James W. Fourqurean, Ph. D.

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QUALIFICATIONS

My resume is attached and contains my qualifications and a list of all publications that I have authored.

PRIOR TESTIMONY

During the past 4 years, I have participated in the following cases:
(1 deposition and 1 administrative hearing)

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 STATE OF FLORIDA
DIVISION OF                     Case No. 15-1233
ADMINISTRATIVE HEARINGS
MIKE LAUDICINA; DON
DEMARIA; CUDJOE GARDENS
PROPERETY OWNERS ASSOC.
INC.; AND SUGARLOAF
SHORES PROPERTY OWNERS
ASSOC., INC.,
PetitionerS,
vs.
FLORIDA KEYS AQUADUCT
AUTHORITY AND DEPARTMENT
OF ENVIRONMENTAL
PROTECTION,
Respondents.
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I gave deposition in this case on October 14, 2015 at Veritext Legal Solutions, 2 South Biscayne Blvd., Suite 2250, Miami, FL 33131

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 STATE OF FLORIDA                Case No. 14-5302
DIVISION OF ADMINISTRATIVE
HEARINGS
LAST STAND (PROTECT KEY
WEST AND THE FLORIDA
KEYS,b/d/a LAST STAND, AND
GEORGE HALLORAN,
Petitioners,
vs.
 KET WEST RESORT UTILITIES
CORPORATION, AND STATE OF
FLORIDA DEPARTMENT OF
ENVIRONMENTAL PROTECTION,
Respondents
__________________________/
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The final hearing in this matter was held on April 21-May1, 2015 at the Freeman Justice Center, Conerence Room A, 302 Fleming Street, Key West, Florida, before Cathy M. Sellers, an Administrative Law Judge of the Division of Administrative Hearings (“DOAH”).

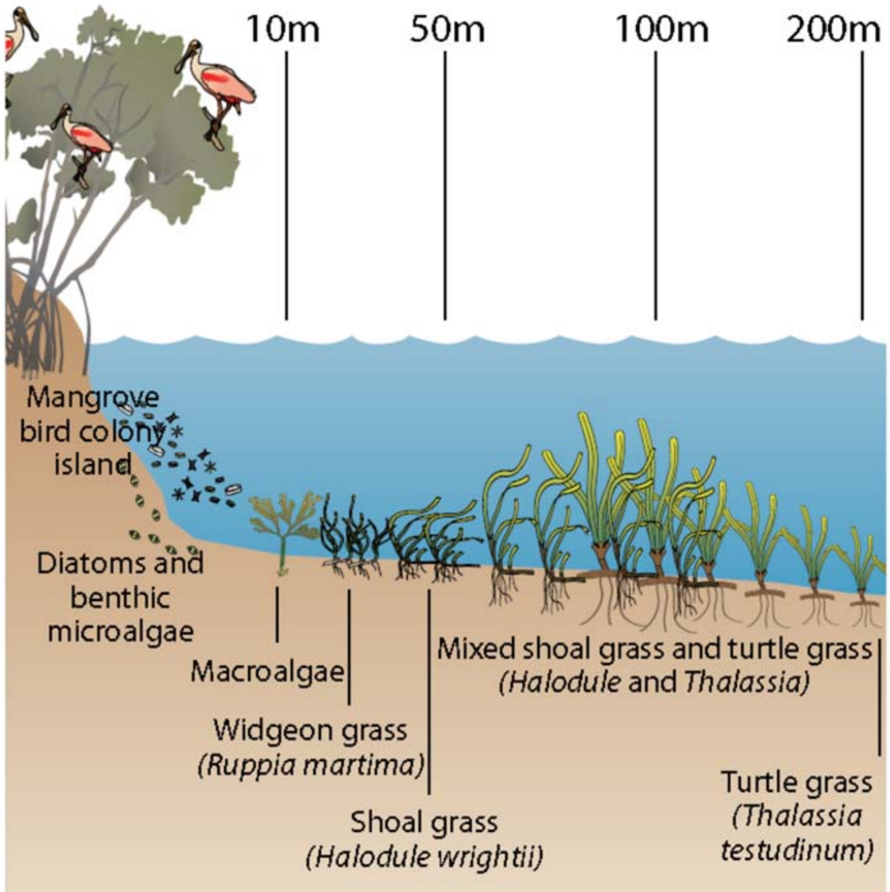

Figure 1. Islands with large bird colonies in Florida Bay are natural nutrient sources that cause zonation of the benthic habitat, with fast-growing microalgae dominant near the nutrient source and slow-growing turtle grass dominant far from the nutrient supply. See Powell et al 1991. Figure reproduced from Kryczynski and Fletcher 2012, page 276.

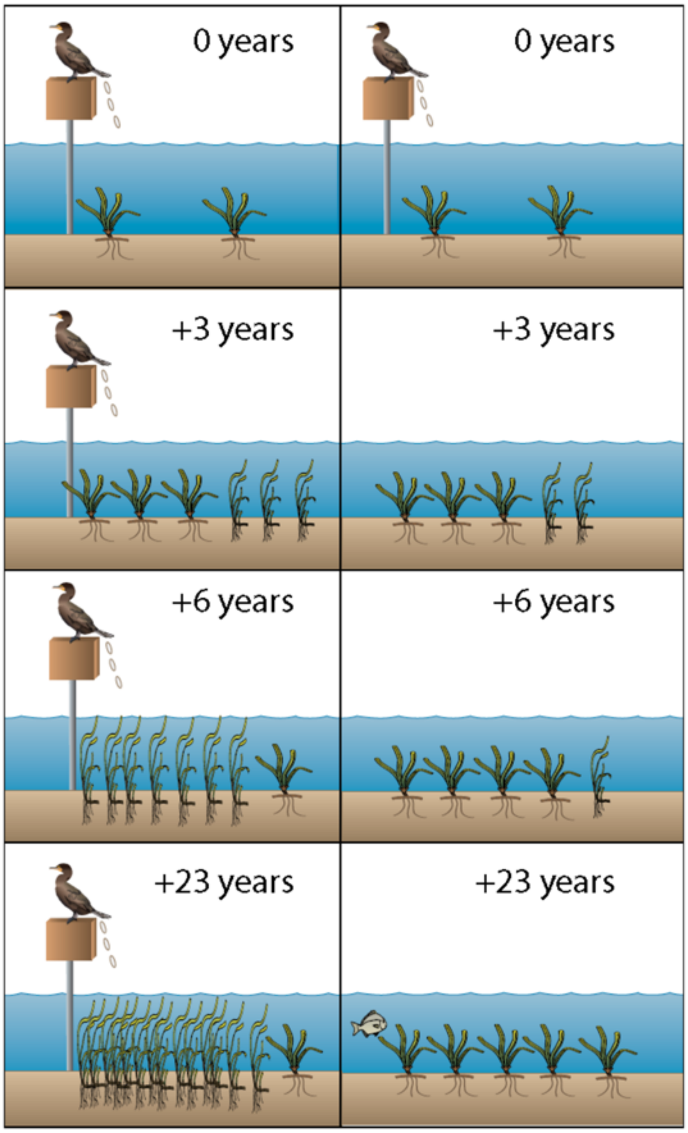

Figure 2. Artificial bird perches have been used to study the effects of nutrient additions to nutrient-limited seagrass beds in south Florida (Fourqurean et al 1995). Fertilization initially leads to more turtle grass, but that turtle grass is replaced by faster-growing shoal weed (left column). Short term fertilization has impacts that last for decades (right column). Figure reproduced from Kryczynski and Fletcher 2012, page 276.

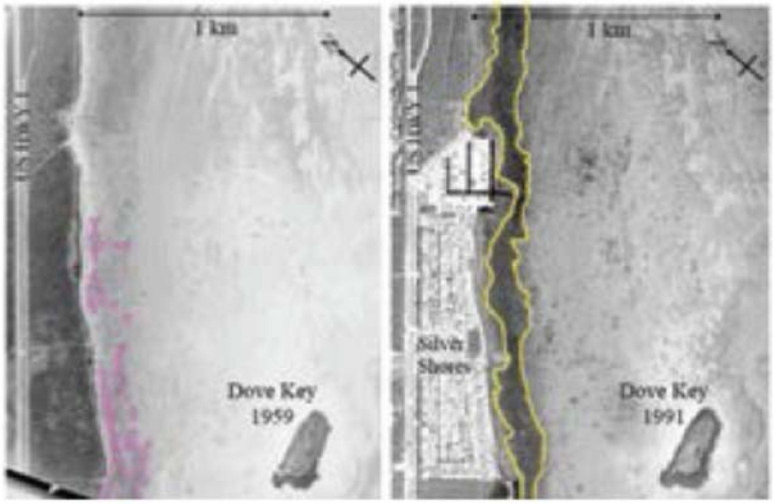

Figure 3. Seagrass distribution along the shoreline of Key Largo near Dove Key in 1959 (left) and 1991 (right). Prior to development, seagrass coverage was sparse along the shoreline. However, by 1991 seagrass coverage and density increased substantially along the shoreline in response to nutrients emanating from development. Figure reproduced from Kryczynski and Fletcher 2012, page 277.

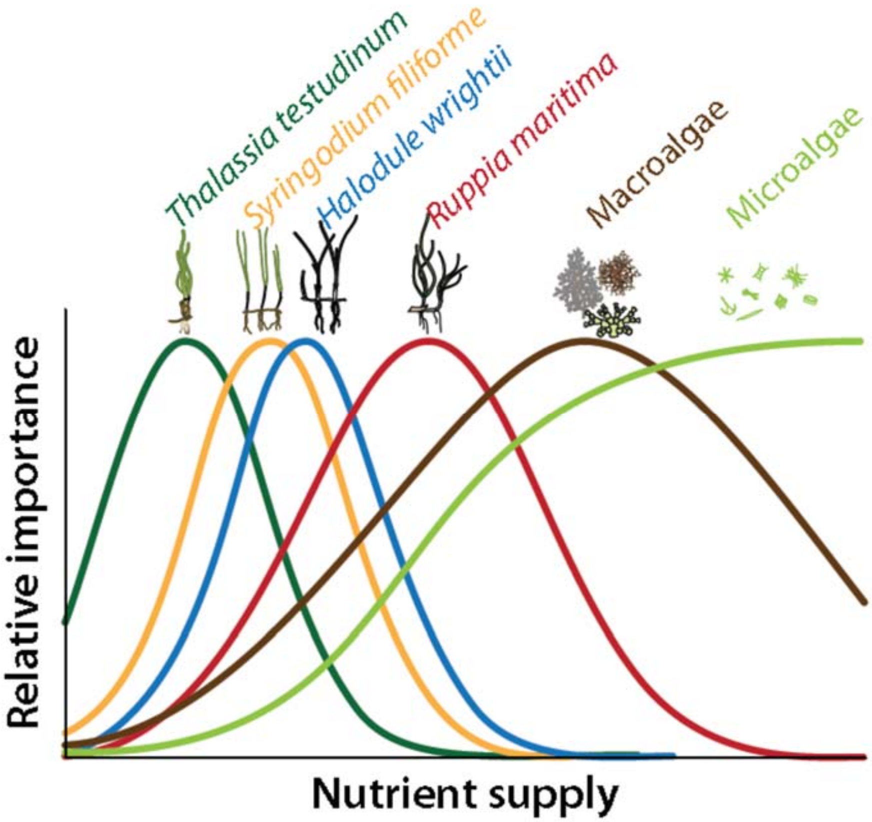

Figure 4. This model describes how the dominant organisms from shallow Biscayne Bay change with addition of nutrients. Nutrient supply can increase either with an increase in concentration OR and increase in volume of nutrient sources. This figure is based on Fourqurean and Rutten (2003) and is reproduced from Kryczynski and Fletcher 2012, page 276.

Curriculum Vitae
James W. Fourqurean, Ph.D.

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Palmetto Bay, FL 33157

Profile
James Fourqurean is a marine and estuarine ecologist with a special interest in benthic plant communities and nutrient biogeochemistry. He received his undergraduate and graduate training in the Department of Environmental Sciences at the University of Virginia, where he became familiar with the Chesapeake Bay and its benthic communities. He developed a love of tropical ecosystems while doing his dissertation research in Florida Bay. After a post doc at San Francisco State studying planktonic processes in Tomales Bay, California, he was recruited to return to south Florida to join a new research group at the newest research university in the country, Florida International University. He has at FIU since 1993, where he is now Professor of Biological Sciences and the Director of the Center for Coastal Oceans Research in the Institute for Water and Environment. For the past three decades, his main research areas have been in the seagrass environments of south Florida, but he has also worked in coastal environments around the Gulf of Mexico, in Australia, Indonesia, Mexico, Panama, Bahamas, Bermuda, the United Arab Emirate and the western Mediterranean. He is the lead scientist and overall manager of FIU's Aquarius Reef Base, the world's only saturation diving habitat and laboratory for research, education and outreach. He has served as the Principal Investigator of over $25M in grants and contracts at FIU, and published 127 papers in the refereed scientific literature and 13 book chapters. Seven graduate students have received PhD degrees working under his direction, along with 15 MS students. His global leadership in coastal oceans research was recently recognized when he was elected President of the Coastal and Estuarine Research Federation, the world's leading body of scientists who study coastal issues.

Education
Ph.D.	1992	University of Virginia, Department of Environmental Sciences
M.S.	1987	University of Virginia, Department of Environmental Sciences
B.A.	1983	University of Virginia, Depts of Biology and Environmental Sciences

Career Summary
2006-	Professor, Department of Biological Sciences, Florida International University
2017 -	President-elect, Coastal and Estuarine Research Federation
2014 -	Adjunct Professor, School of Plant Biology, University of Western Australia
2014	Visiting Research Fellow, Oceans Institute, University of Western Australia
2012-	Director, Center for Coastal Oceans Research, Institute of Water and Environment, Florida International University

2012- Director, Center for Coastal Oceans Research, Institute of Water and Environment, Florida International University
2012- Visiting Research Fellow, Oceans Institute, University of Western Australia
2002 - 2006 Chair, Department of Biological Sciences, Florida International University
2001 - 2002 Visiting Professor, Institut Mediterrani d'Estudis Avançats, CSIC-Universitat des Illes Balears, Esporles, Mallorca, Spain
1998 - 2006 Associate Professor
1993 - 1998 Assistant Professor, Department of Biological Sciences and Southeast Environmental Research Center, Florida International University
1992 Postdoctoral research associate, San Francisco State University
1983 - 1992 Graduate research assistant, University of Virginia. J.C. Zieman, advisor.
1983 - 1987 Research biologist, National Audubon Society

Scientific Publications

Scientific Journals

127. Bonthond, G., D.G. Merselis, K.E. Dougan, T. Graff, W. Todd, J.W. Fourqurean and M. Rodriguez-Lanetty. 2018. Inter-domain microbial diversity within the coral holobiont *Siderastrea siderea* from two depth habitats. Peer J 6:e4323.
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115. Howard, J.L., A. Perez, C.C. Lopes** and J.W. Fourqurean. 2016. Fertilization changes seagrass community structure but not blue carbon storage: results from a 30-year field experiment. Estuaries and Coasts 39:1422-1434.
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