

The Florida Keys Environmental Coalition
in Collaboration with
The Florida Keys Community College

September 2015

Indigenous Filter Feeder Habitat Systems
Remediate & Maintain Canal Water Quality

A Presentation to NOAA WQPP
for a
Monroe County Canal Restoration Pilot Program

*Engineered Habitats for Indigenous Filter Feeder
Applying Proven Technologies to Improve Near Shore Water Quality*



This is our canals...

This is Canals on Habitat!!!

ANY QUESTIONS?

Filter Feeder Architects & Supporters

- Florida Keys Environmental Coalition (B Wray, MSEE)
- Florida Keys Community College (Dr Patrick Rice)
- Reef Relief
- Global Coral Alliance (Dr. Tom Goreau, Harvard)
- Dauphin Island Sea Lab (Dr John Dindo)
- The Global Coral Repository (Dr. Craig Downs)
- Ocean Restoration Initiative (M Calinski, FKCC 1984)
- Ocean Equities LLC (Dorothy Leonard, 20 yr NOAA Oyster Restoration)
- EcoWorld Energy
- Solarbeam International Inc.

THE SCIENCE OF CANAL & NEAR-SHORE ECOSYSTEMS

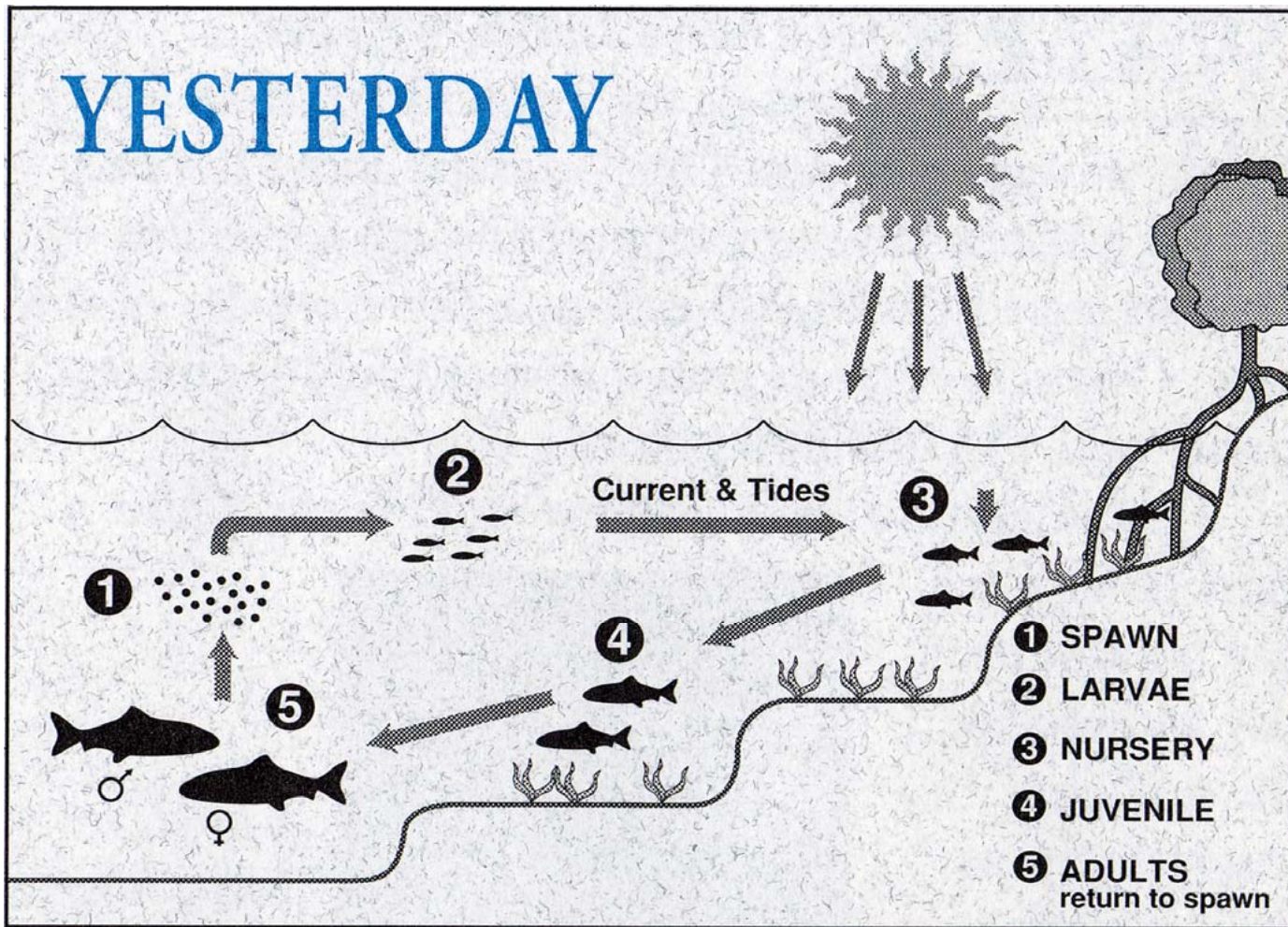
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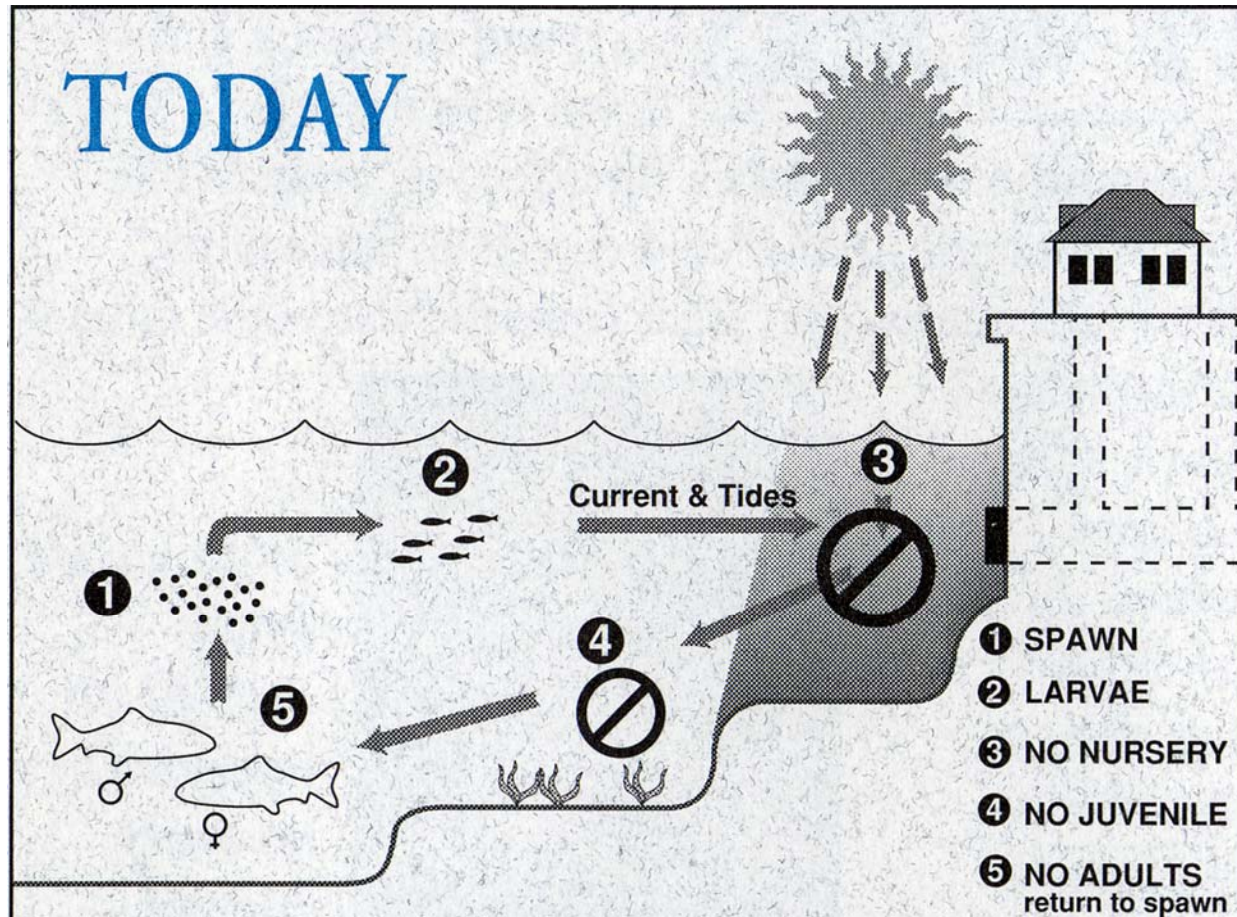


HEALTHY HABITAT

Nursery for Juvenile Fisheries Species

Water Filtering: The Near Shore "Kidneys"





Natural Habitat Void Designed Into Keys & FL Canals

- KIDNEY FAILURE – NOT ENOUGH FILTER FEEDERS
- LIFE CYCLES BROKEN – FEWER FISH, MORE REGULATION

Characterizing Canal Waterways

- Typically Hyper-Deep: >5 – 7ft (Bay = 5' near shore)
 - Reduced natural water flow & limited tide differential <2ft
 - Stratification: Hypoxic low levels*
- Canals Are Effectively Walled Caverns
 - Reduced light: Vertical Walls of Homes, Landscaping, Seawall
 - Reduced wind circulation that contributes to stratification
- Pollution Introduction: Nutrient Load, Endocrine Disruption
 - 20 yrs of leaching post sewers, pathogen contribution linked to coral disease
 - Storm-water: \$300m – \$600m estimated in 2013 by B Kruczynski (EPA)
 - Estuaries polluted from farming etc.
- Natural Process contributors
 - Salinity: Reduced turnover => Evaporation effect, Reduced Everglades freshwater flows
 - Decaying organic matter = Hydrogen Sulfide, Methane
- Unnatural Shoreline of Cement and Stone
 - Not protective habitat for species survival
 - No beneficial filtering of water run-off, or existing canal reservoir

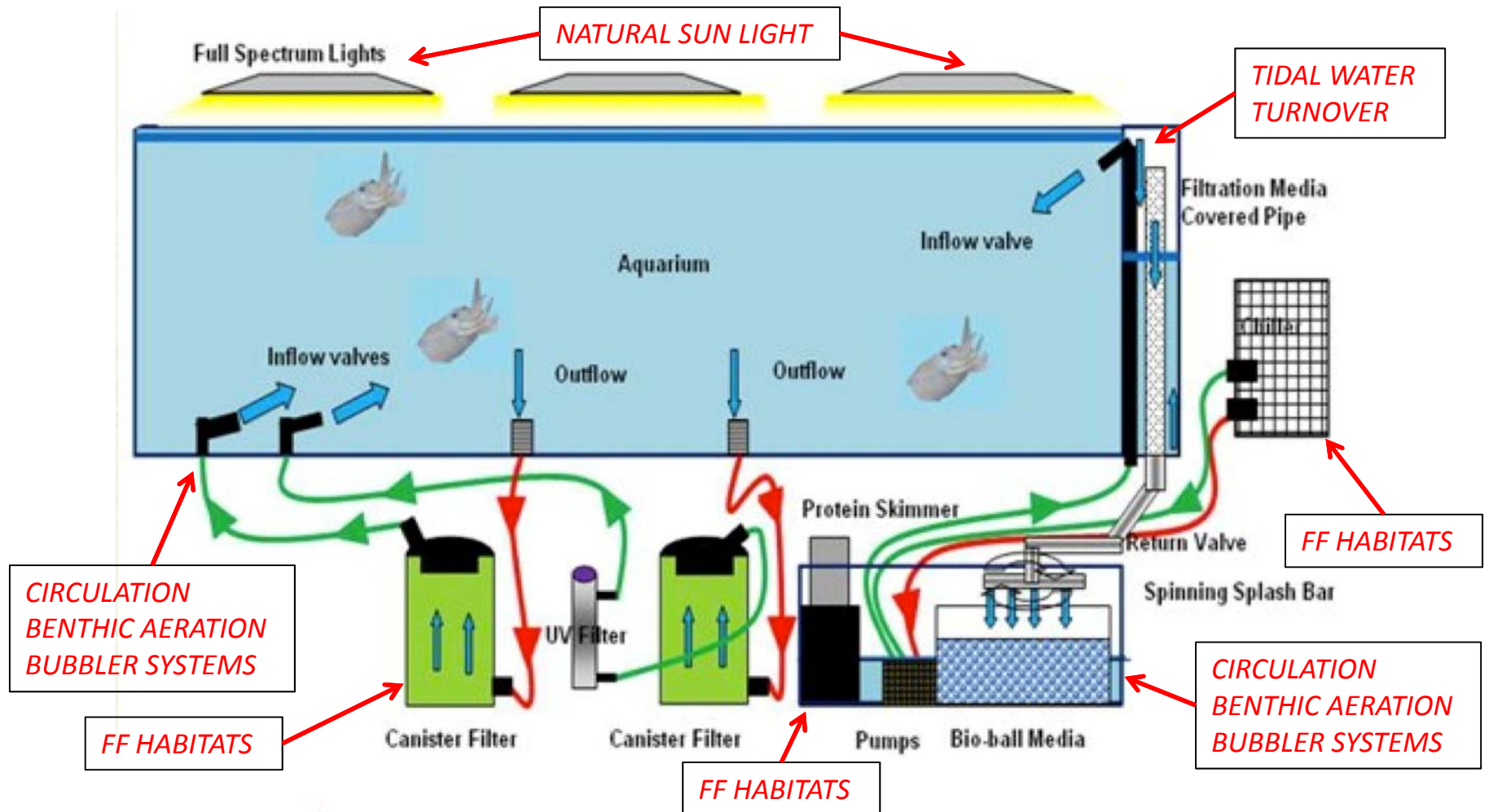
THE PRINCIPLES BEHIND ENGINEER FILTER FEEDER SYSTEMS

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Hyper-Deep Canals Analogous to Aquariums

Aquarium System use filtering, aeration and circulation to maintain WQ
 Advance filtering includes mechanical & biological (FF, Bacteria & Hydroponics)



Sampler & Full Scale Units in Test: 4 years in Keys

WHAT'S GROWING IN YOUR BACK YARD??



BEFORE



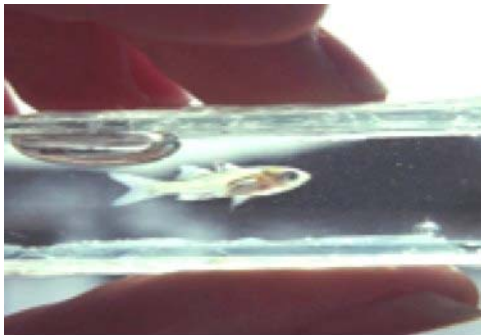
4 MONTHS LATER (Photos: ORI)



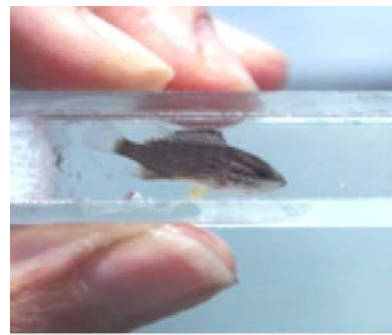
(Photos: ORI)

Engineered Habitat #55

- **Complete Eco-system:** Flat plate design where one species eats waste of another
- Distance between tiers & substrate attract target ecosystem members
- 50+ year lifespan
- 10K – 20K gal/day/unit filtered
- Fisheries species survivability improved
- Floats at dock, needs sun
- Garden in the water



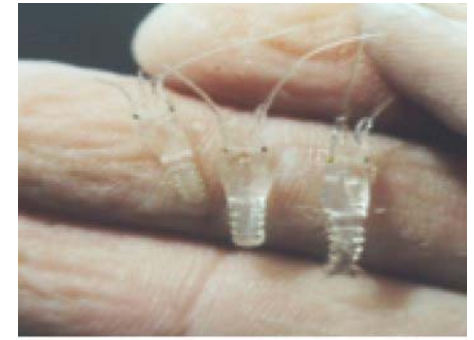
SNOOK



SNAPPER



STONE CRAB

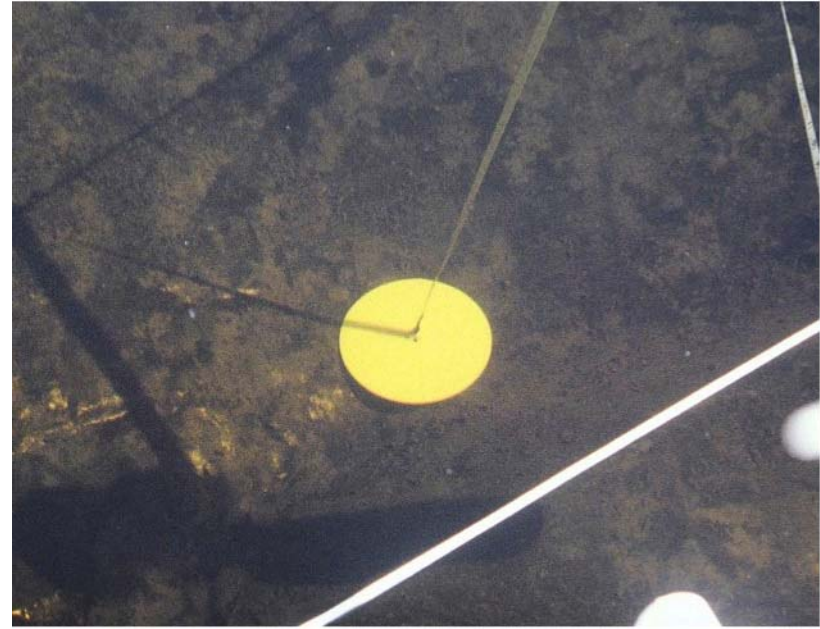


SPINY LOBSTER

20,000 GALLON/ 24 Hr TEST



(Photos: ORI)



Filter Feeder Performance

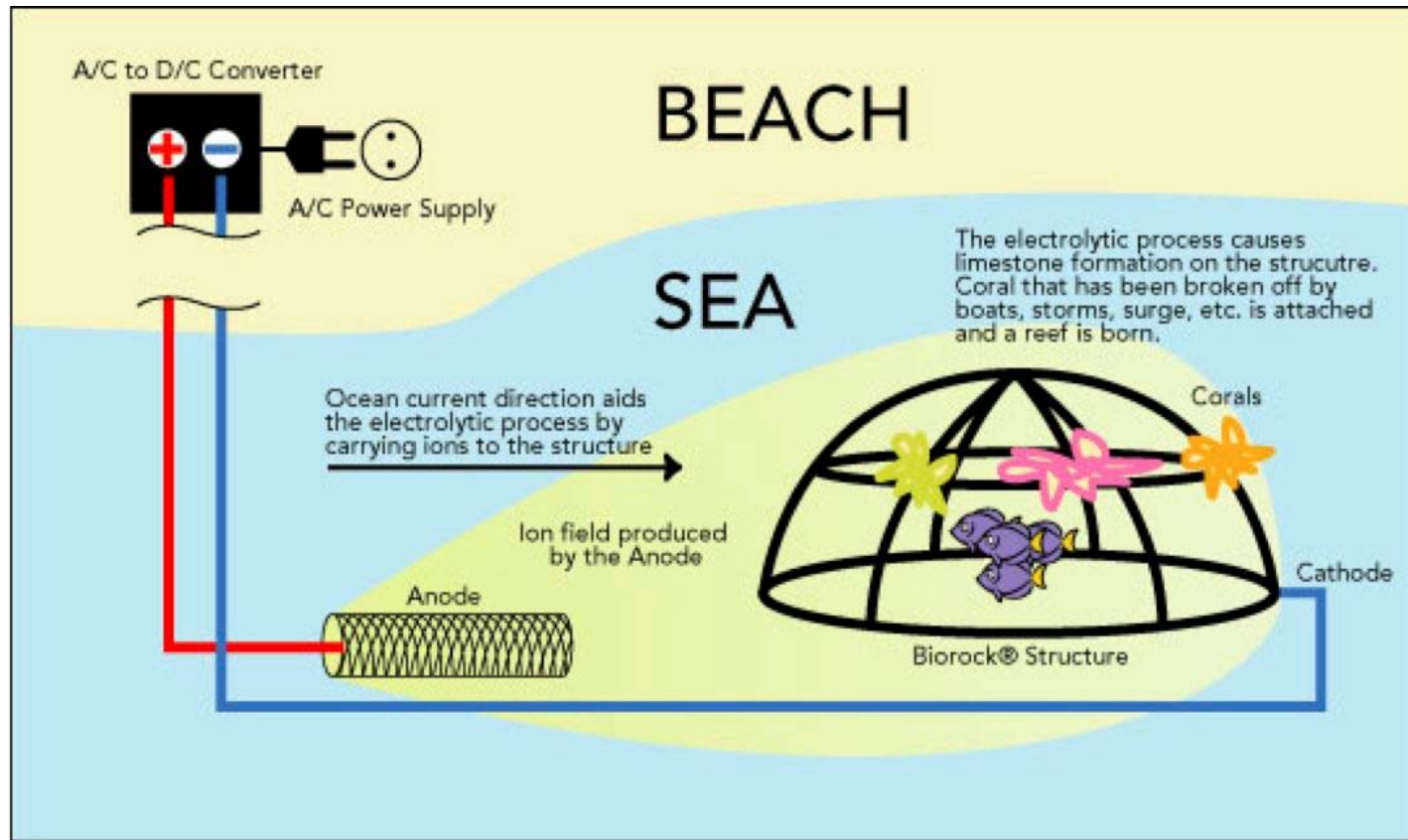
- Abundance of scientific research quantifies and the performance and benefits of various filter feeders
- Pilot Habitats in Indian Waterways & FKCC Lagoon for 4 years
- Active testing provides volumetric estimates for engineered habitat filtration rates: $12 \text{ ft}^3 \Rightarrow 15,000 - 20,000 \text{ gpd}$
- Circulations of aeration systems known & detailed studies in Islamorada show quantified DO improvement performance
- Address difficult storm-water remediation per CWA
- Unknowns:
 - Optimum water volume turn over rates: 5 – 10 days/turn
 - Optimum inhabitant composition: Bi-valves, Sponges, etc.

Living Indigenous Filter



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Biorock: Accelerate Growth & Severe Environment Assist



- Creates High Alkaline Environment: Highly beneficial for marine species growth
- Accelerate Production/Growth: Oysters documented to grow at 4 – 5 times avg. rate
- Insure Robust Sustainable Systems in Severely Degraded Water Quality Environments
- Pilot Potential Coral Restoration Initiatives: Reefs are self-sustaining after initial start
- Alternative energy powered: Solar & Wave

Biorock in Operation



3 years



5 years

Latest photographs of the Pemuteran, Bali Biorock project. 5 Yr taken in May 2012
by EunJae Im

PILOT PROGRAM FOR CANAL FILTER FEEDER REMEDIATION SYSTEM

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Filter Feeder Pilot Program Plan

- Maintain a MC Improved Canal or Install New Demonstration Project
- Project funded via research grant to FKCC for 18 mo program
 - FKCC Oversees Science Program and Financial Management
 - FKCC supports engineering and project management services as needed
 - FKCC Internship added contribution 15hr/wk = \$3500 per semester
 - MC High School Marine Science program participation: Basic marine science measurements, Biodiversity and Quantification studies
- Water quality monitoring overseen by FIU assisted with local FKCC and MC School Support
 - DO, Salinity, Temp, etc. to assist FIU data collection
 - Habitat build assistance
- Resident Citizen Scientist contribution
 - Secchi Disk readings, photos, observation comments
- Estimated Cost = \$50/ Linear ft with testing and maint. Program
 - Aeration, Habitat Production & Growth, Test Assist, Habitat Exchg, Energy Cost
 - Prefer min 1000 ft canal for economy of scale
 - FKCC to place Aeration system

Estimated Budgets

Budget	80,000.00					
Systems Implementation Costs Assumptions						
Ft/Unit	60.00					
Cost per unit	400.00	Est cost is \$350 w lic fee, +20% test spares				
Canal sides	2.00					
Ft/Diffuser	100.00					
Cost/diffuser	500.00					
Install cost diff	300.00	Includes electrical work and parts, Solar power difficult				
Prod cost /Unit	60.00	Growing units at Aquaranch and transporting to Canal project				
Biorock PS	500.00	Includes electrical work and parts, Solar powered				
% Bio Rock	0.30					
Installed Cost Est						
	Length(ft)	Units	Diffuser	Blended Unit	Diffuser	Total
Mohawk/Pueblo	1,100.00	36.67	11.00	22,366.67	8,800.00	
Pueblo/Navajo	850.00	28.33	8.50	17,283.33	6,800.00	
		65.00		39,650.00	15,600.00	55,250.00
Permitting	8,000.00	With Engineering Support, Unused will produce Spares				
FKCC Support	8,000.00					
FKEC Oversight	5,000.00					
Prod cost	3,900.00					
Total cost	76,250.00					
Remander	3,750.00	Transport of FKCC students, advisor & consultant expenses, etc.				
Avg \$/ft Pilot	41.03	WQ testing / fisheries monitoring will be from DEP, EPA, etc.				

Projected Program Timelines

- Habitat Production 5 mo build & grow
 - Dec build start with growing start in Feb
 - Biorock growth comparison studies & compatibility plan
- Identify Target Canal: Baseline WQ Testing: Nov – April
 - Monthly Measurements
- Canal Habitat Introduction – April
- Monthly Monitoring Integrated with FIU
 - Nitrogen, Phosphorous, TSS, DO (Benthic), Turbidity, Salinity
- Bio Diversity & Habitat Mass Density Reports
- Program Evaluation – April '16 – Oct '17

Comparison of Restoration Techniques

Attribute	Technique					
	Filling	Dredging	Culverts	Weed Gates	Water Pump	FF System
Nutrient Reduction/ Energy Transfer	None	None	None	None	None	Yes
Pathogen/MRSA Mitigation Potential	None	None	None	None	None	Yes
Fisheries Recruitment Improvement Potential	None	None	None	None	None	Yes
O2 Improvement	Yes	None	Potential	None	Yes	
Destratification/ Circulation Improvement	Yes	None	Yes	None	Maybe/ Volume?	Yes
Weed Reduction	TBD	None	TBD	Yes	None	None
Storm Water Treatment Potential	None	None	None	None	None	Yes
Ease of Permits	Difficult/ But historically permitted	Difficult/ But historically permitted	Difficult/ But historically permitted	Simple	Unknown	Simple/ Aeration, Habitats = bait bucket/ lobster trap
Home Owner Acceptance	TBD	TBD	TBD	Good	TBD	High
Cost of Implementation	Very High	Very High	Very high	Low	Low/Med	Low
Cost of Operation	None	TBD	None	Low	Medium	Low
Ease of Implementation	Complex	Complex	Complex	Simple	Simple	Simple
Scientific Knowledge of Systems	Minimal	Minimal/None	Minimal	Some	Minimal	FF Very High, Aeration High, As a system Aquariums
Adheres to FKNMS WQ Mgmt Plan Strategy for Canals W.10	No	No	No	Yes	No	Yes

2013 Bill Kruzenski: Storm water treatment for MC to range from \$300M - \$600M
 Availability of land presents impractical approach for terrestrial treatment in MC