

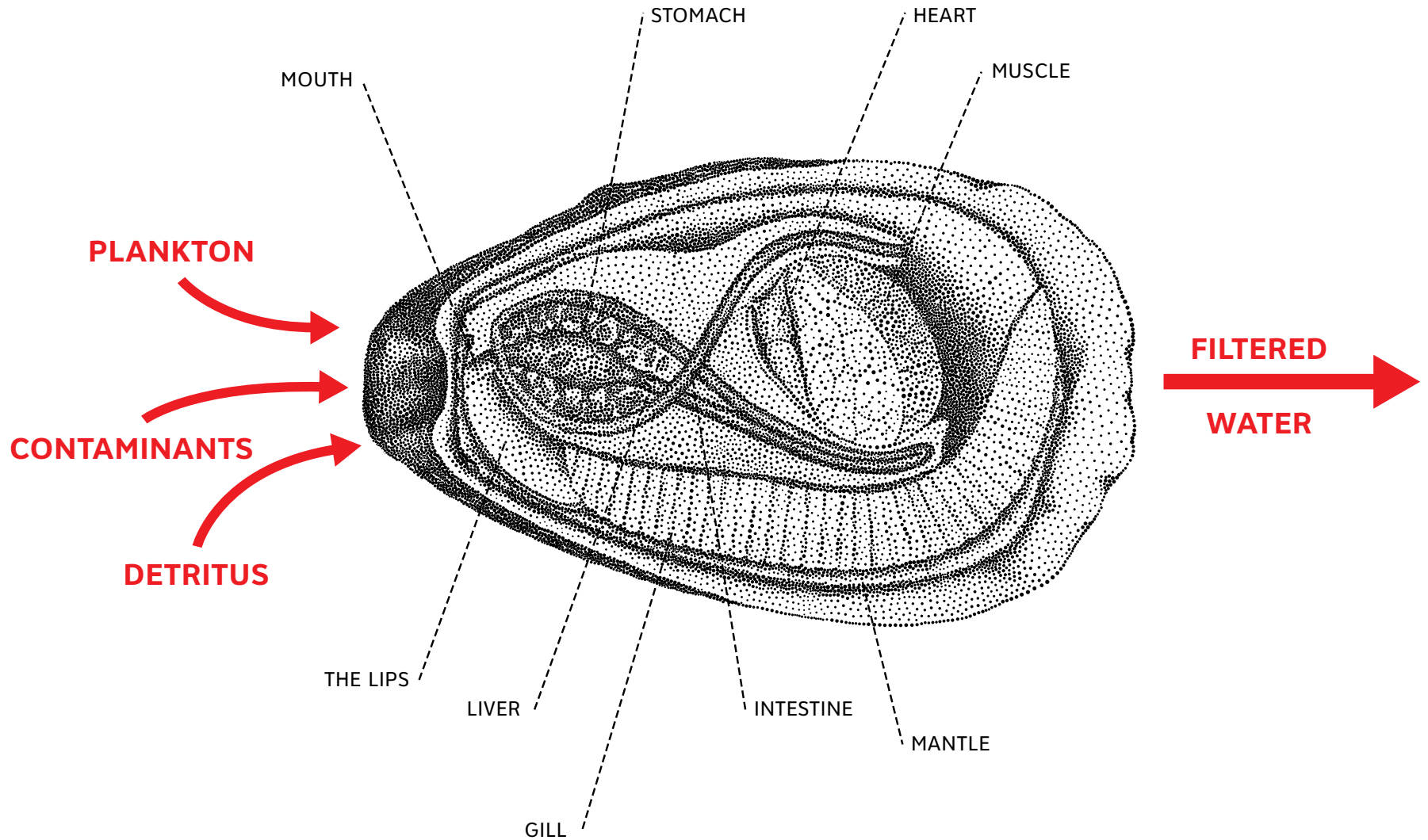
**CLIMATE CHANGE & BIODIVERSITY  
RUTGERS**

**LIVING BREAKWATERS + OYSTER-TECTURE**

**SCAPE / LANDSCAPE ARCHITECTURE  
KATE ORFF**

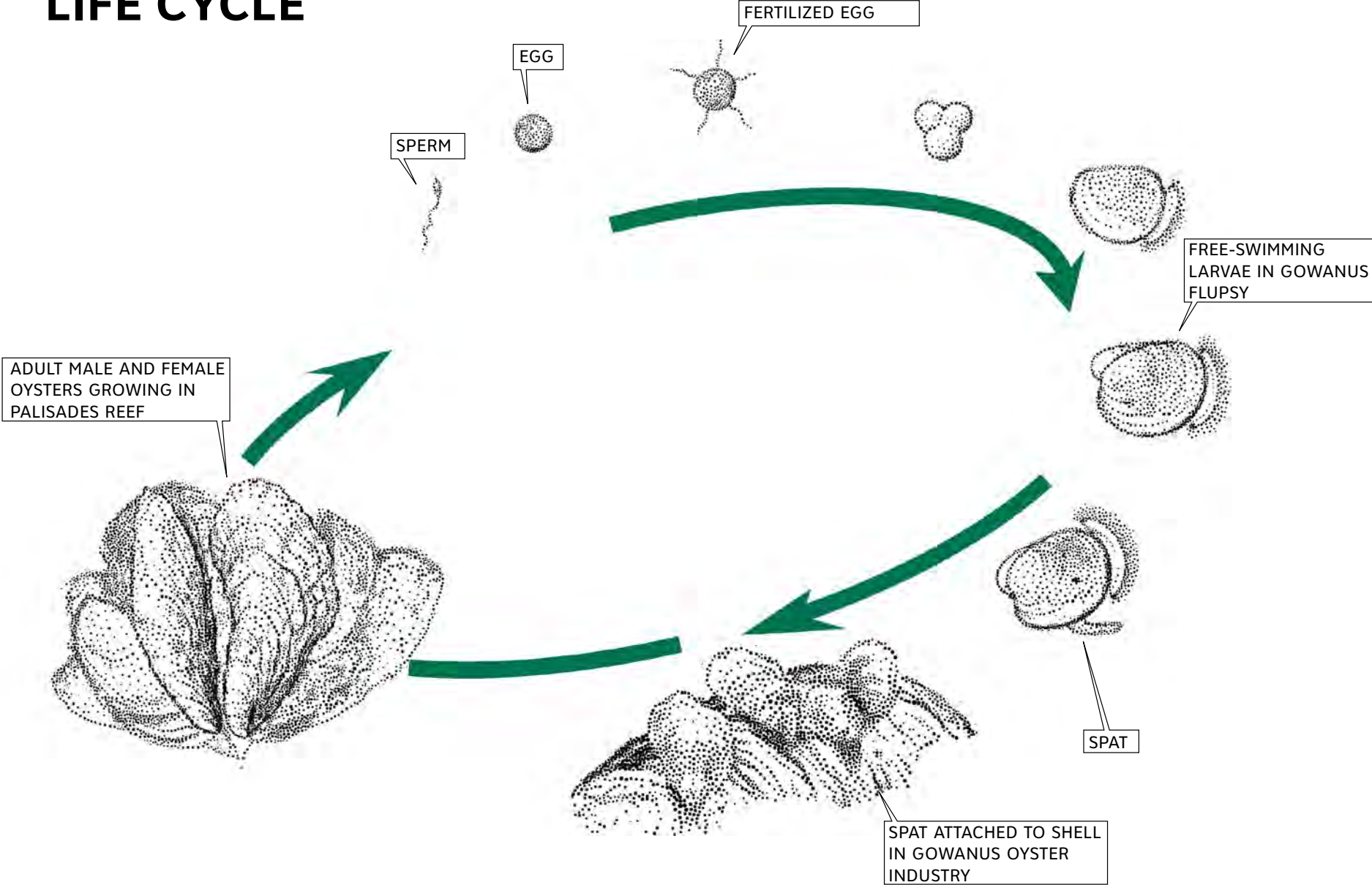


# 1. WATER QUALITY = **BIO FILTER**

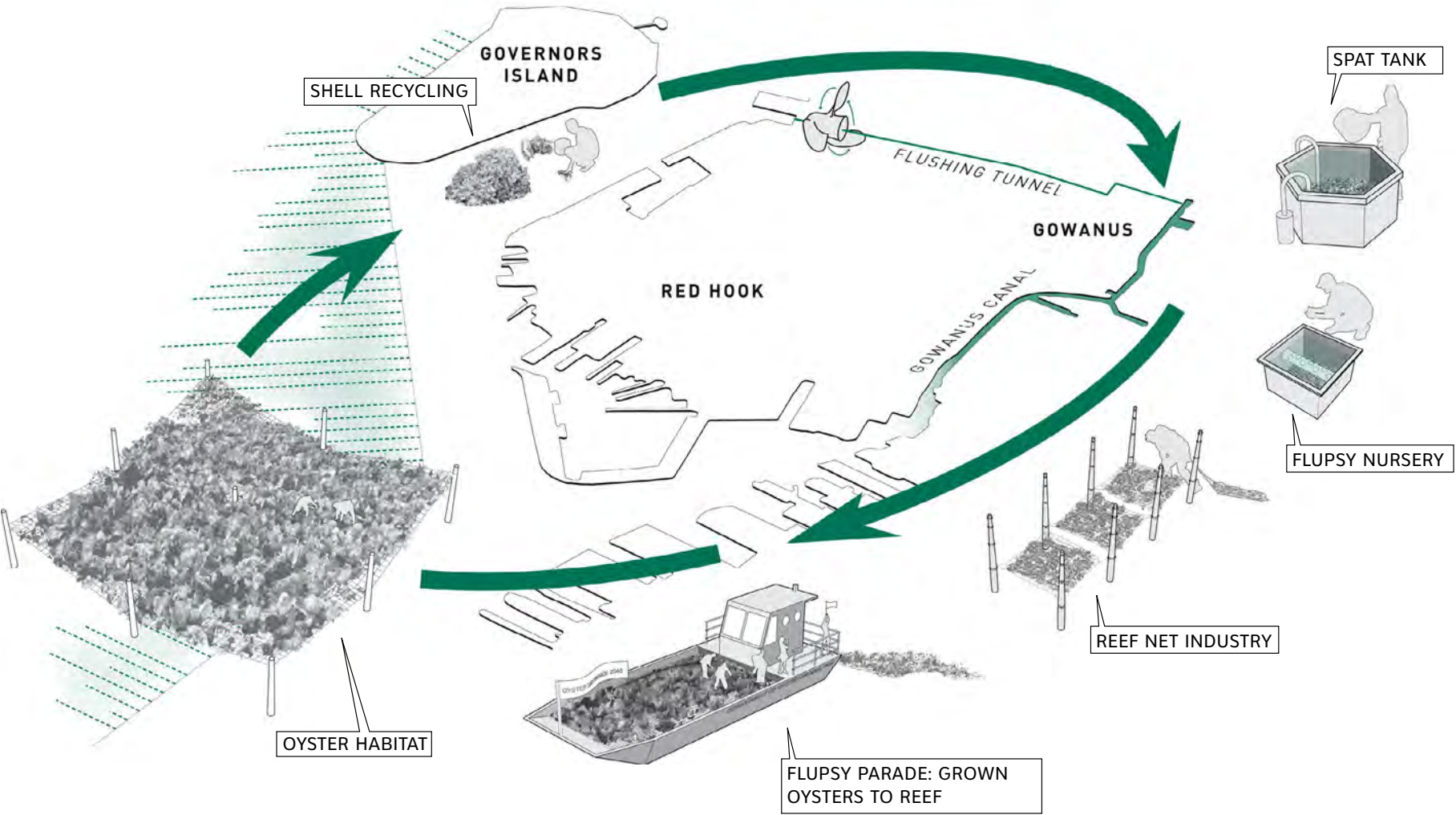


**CONSIDER THE LIFE CYCLE NEEDS OF NON-HUMANS**

# LIFE CYCLE



# LIFE CYCLE



# LIVING BREAKWATERS

STATEN ISLAND + RARITAN BAY  
HUD REBUILD BY DESIGN



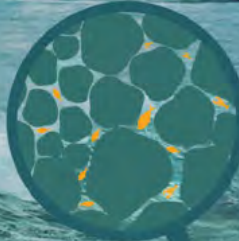
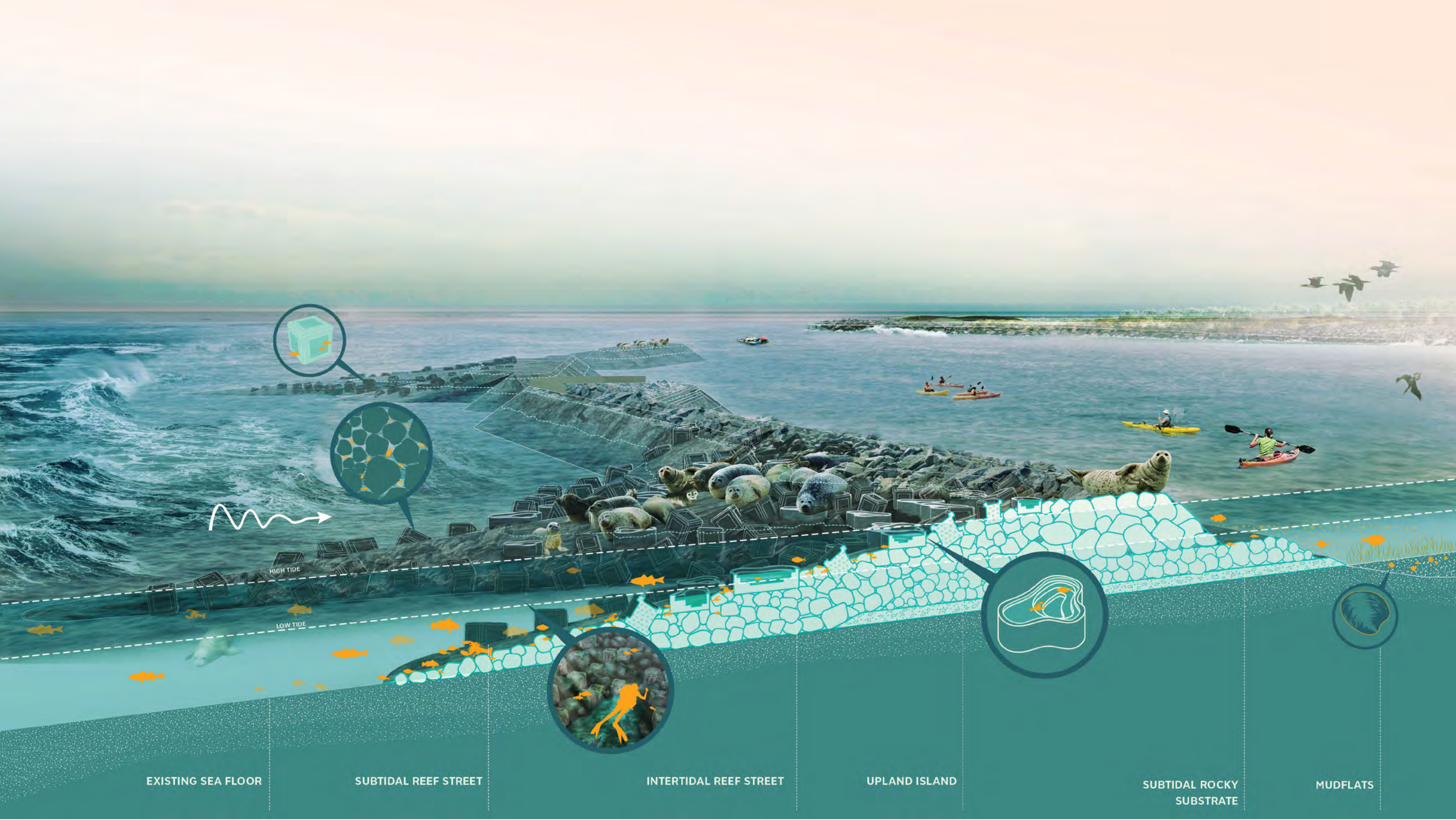
**\$60M FUNDING  
GOVERNORS OFFICE OF  
STORM RECOVERY**

## LIVING BREAKWATERS



### SCAPE TEAM

SCAPE / LANDSCAPE ARCHITECTURE  
OCEAN AND COASTAL CONSULTANTS  
PARSONS BRINCKERHOFF  
ARCADIS  
SEARC ECOLOGICAL MARINE  
CONSULTING  
LOT-EK ARCHITECTURE  
MFS CONSULTING ENGINEERS  
PRUDENT ENGINEERING



HIGH TIDE

LOW TIDE



EXISTING SEA FLOOR

SUBTIDAL REEF STREET

INTERTIDAL REEF STREET

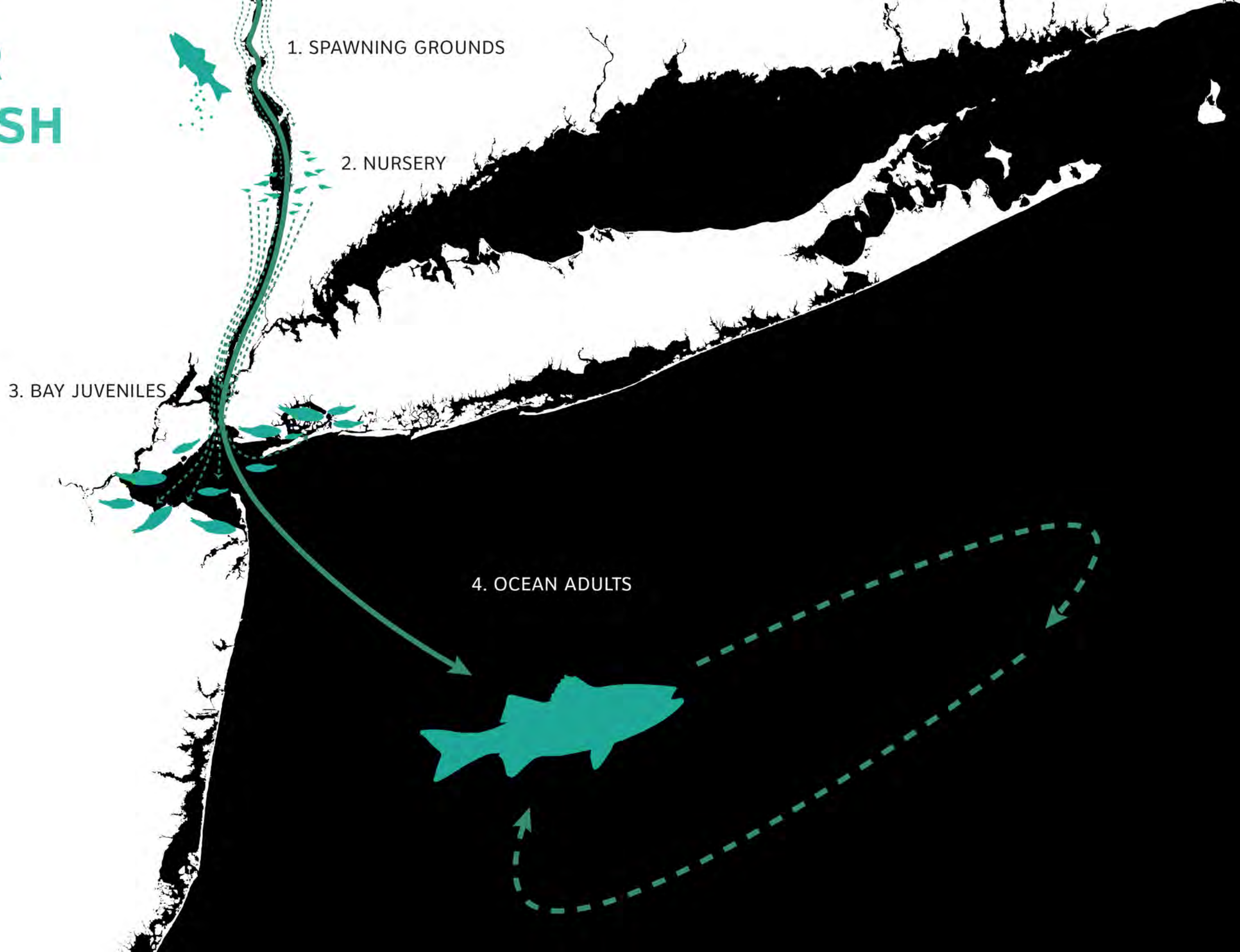
UPLAND ISLAND

SUBTIDAL ROCKY SUBSTRATE

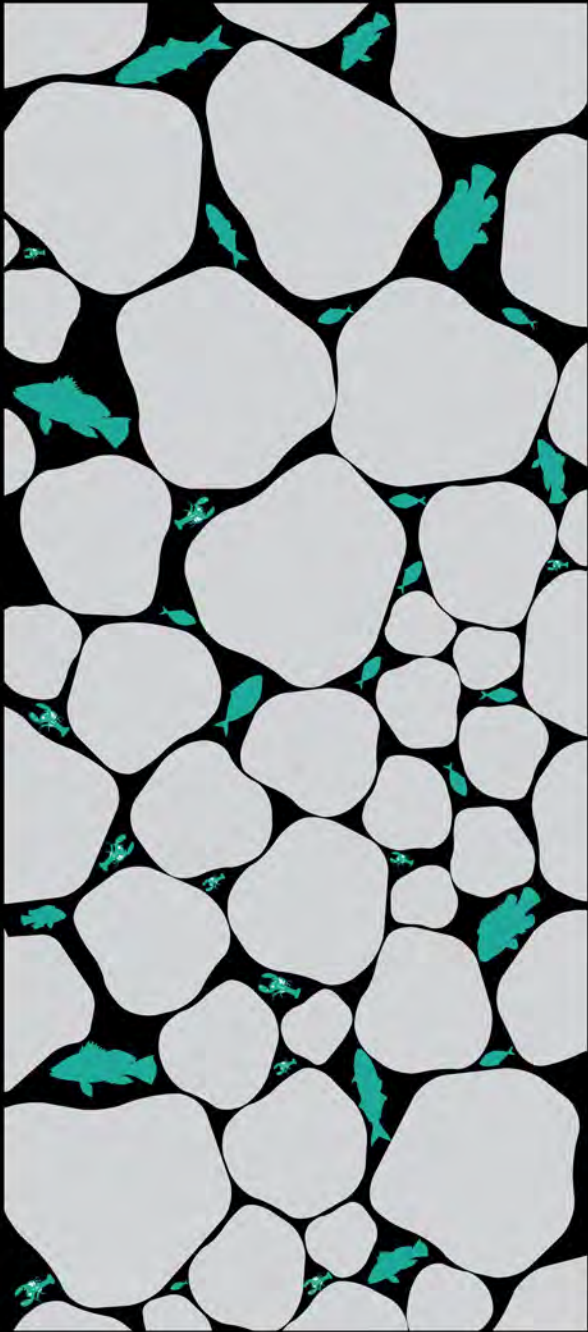
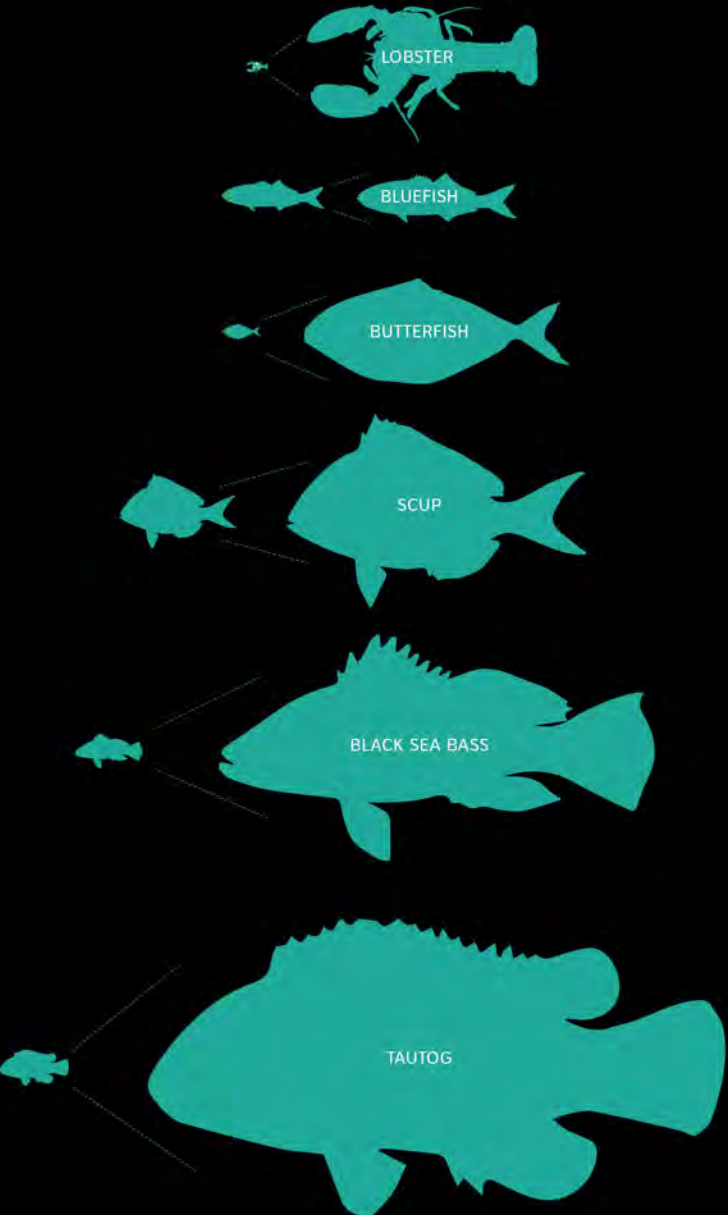
MUDFLATS



# DESIGN FOR JUVENILE FISH



# CREATE NICHES



# DESIGN FOR HABITAT



TYPICAL BREAKWATER



MODIFY FORM TO AVOID  
CRITICAL HABITAT  
ECOLOGICAL VALUE- HIGH

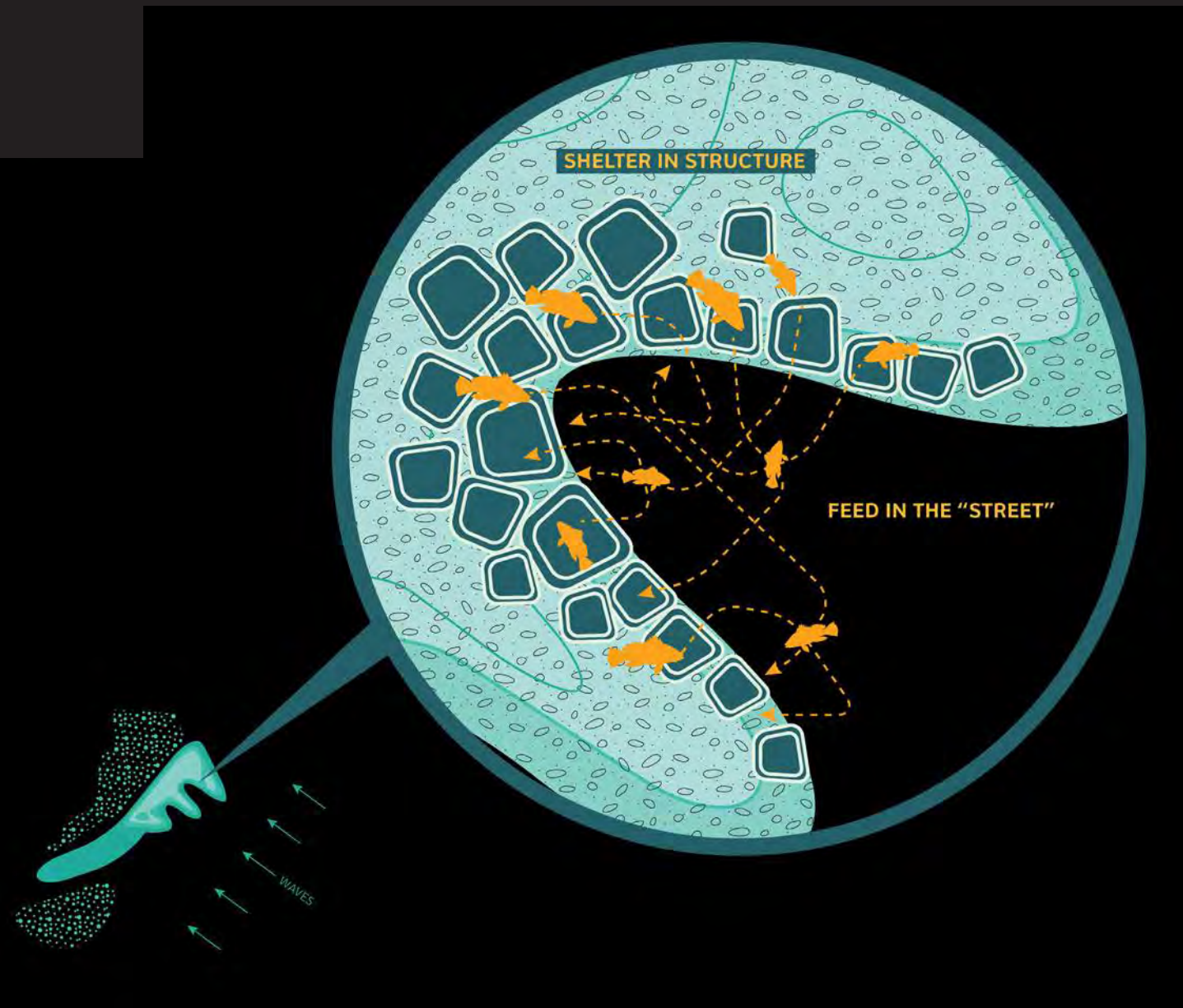


MODIFY FORM FOR LOCALIZED,  
MICRO-SCALE COMPLEXITY  
ECOLOGICAL VALUE- HIGH



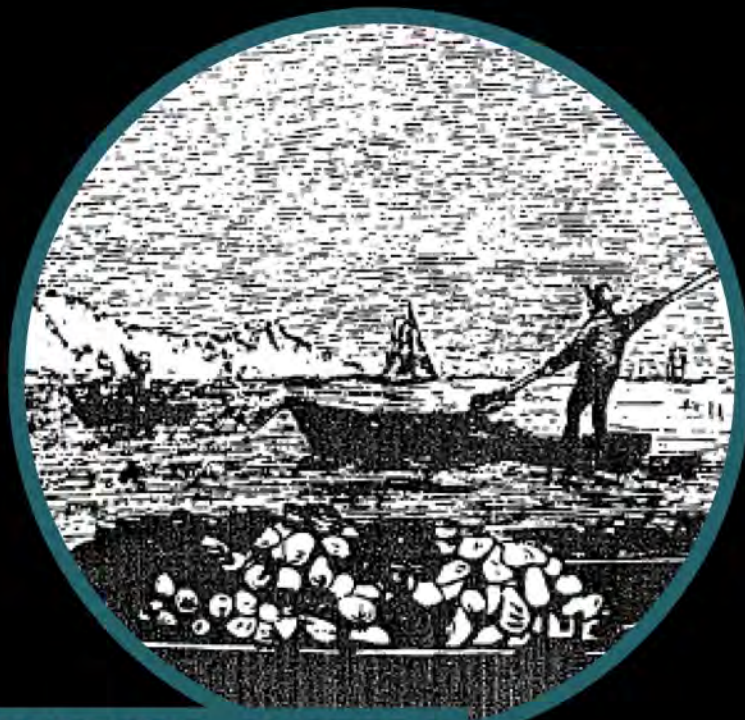
HARD STRUCTURE COMPLEXITY  
ON WAVE-WARD SIDE  
PORE SPACE REMAINS OPEN

# REEF STREETS





# HISTORIC BEDS pre 1850's



TONGING FOR OYSTERS  
IN RARITAN BAY



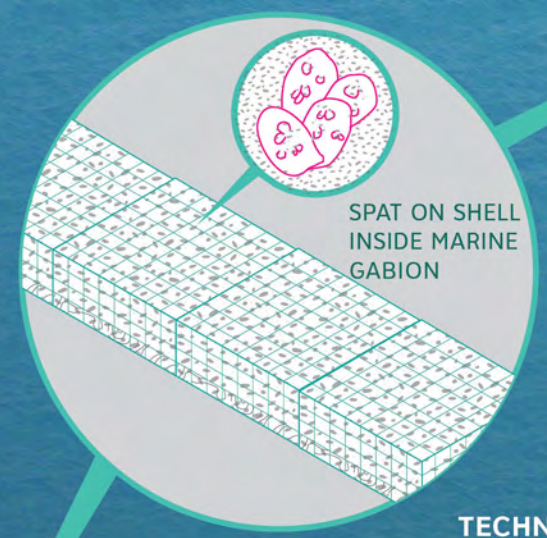
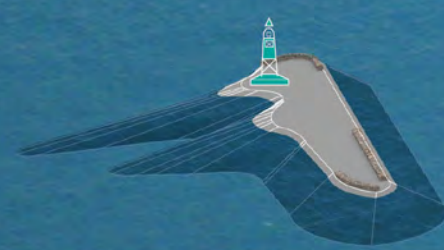
# LEASED BEDS 1850s-1900s



OYSTER WORKERS FROM SANDY GROUND, STATEN ISLAND



# OYSTER CULTURE



SPAT ON SHELL  
INSIDE MARINE  
GABION

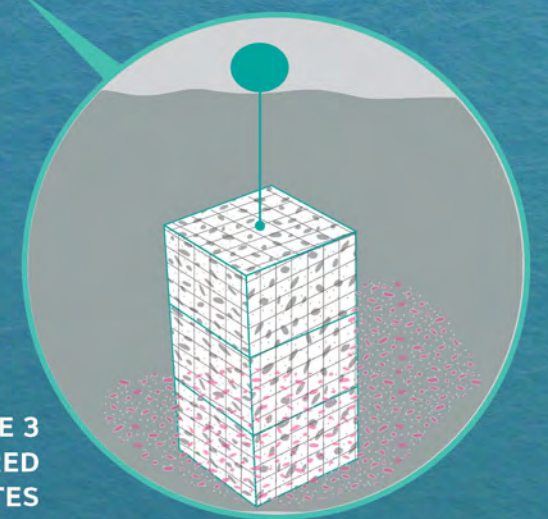
**TECHNIQUE 2:  
OYSTER GABION  
SUBTIDAL UNITS ONLY**



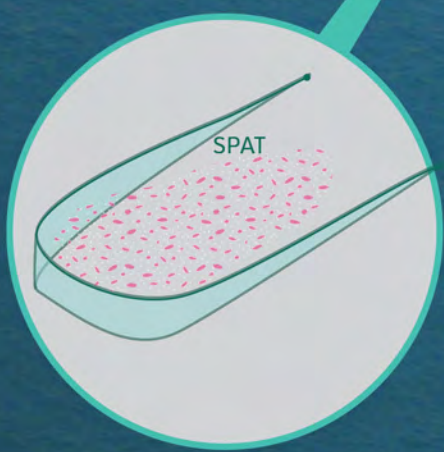
LIVING SHORELINE

MARINE PIERS

LIVING SHORELINE

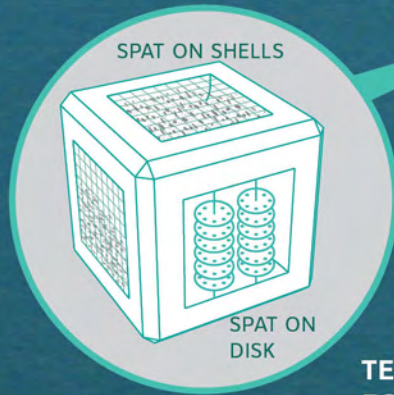


**TECHNIQUE 3  
SPAT SANCTUARY WITH FLOATS MOORED  
TO MARINE PIERS AT MONITORED SITES**



SPAT

**TECHNIQUE 4:  
TANK-LESS SETTING**



SPAT ON SHELLS

SPAT ON  
DISK

**TECHNIQUE 1  
ECONCRETE OYSTER DISK  
ATTACHED TO SUBTIDAL UNITS ONLY**



OYSTER CAM

**NAVIGATIONAL GUIDE AND  
MONITORING CAMERA TO  
PREVENT POACHING**



# SCHOOLS AT THE WATERFRONT



# OYSTER GARDENING MANUAL



ROSS



ARS FARM



"On Spaceship Earth, there are no passengers, only crew."  
- Marshall McLuhan, *Pilgrimage*

Voyager

Spaceship Earth Directives  
1. Respect all people, property, and ideas.  
2. Follow decisions the first time.  
3. Be prepared.

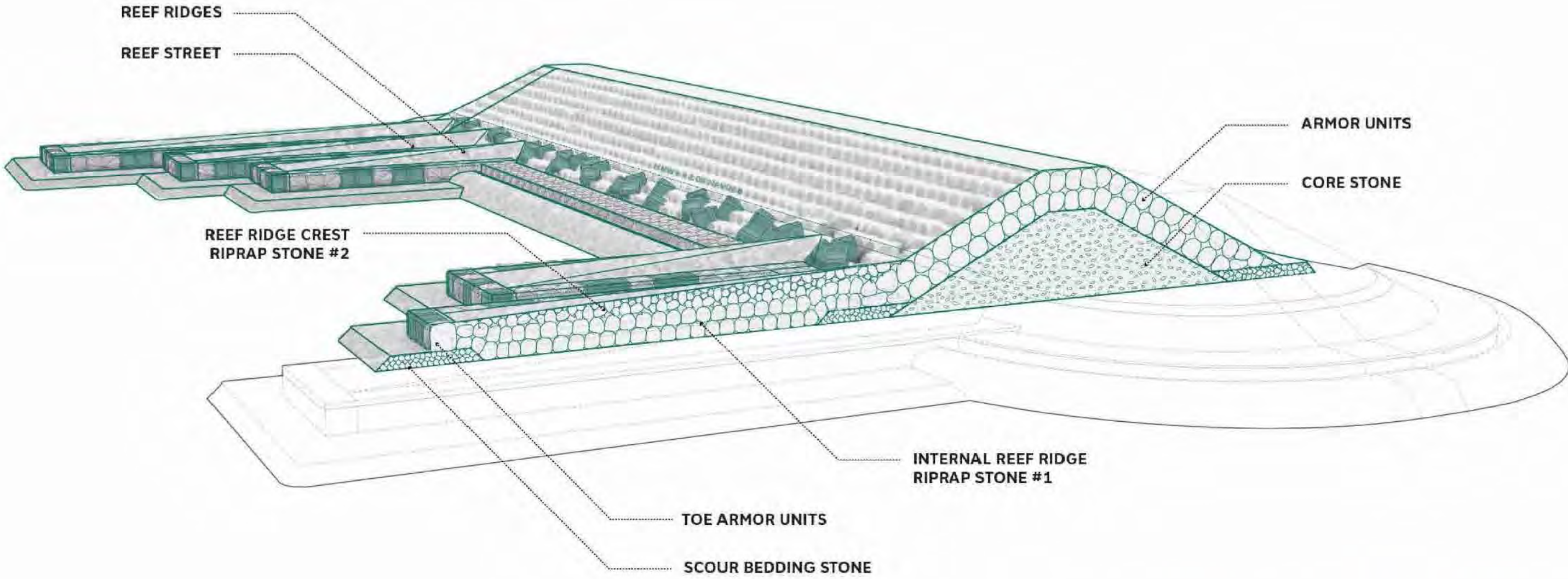
Essential Questions  
□ How does the Earth's environment influence human life?  
□ What are the impacts that human beings have on the Earth's Environment?  
□ How can design impact the environment?  
□ How do various perspectives influence design/engineering decisions?



5/15/16 Mission #7 Water Quality Design Challenge  
Challenge #6 I can design the lowest Esplanade at Gowanus Canal  
Ecosystem  
Risk  
Culture  
99 probe  
GARBAGE  
LOW PUBLIC ACCESS  
FLOODING  
No PLANTS  
AIR QUALITY  
POLLUTION  
WATER QUALITY  
DANGER TO  
LOW BIODI  
BORING

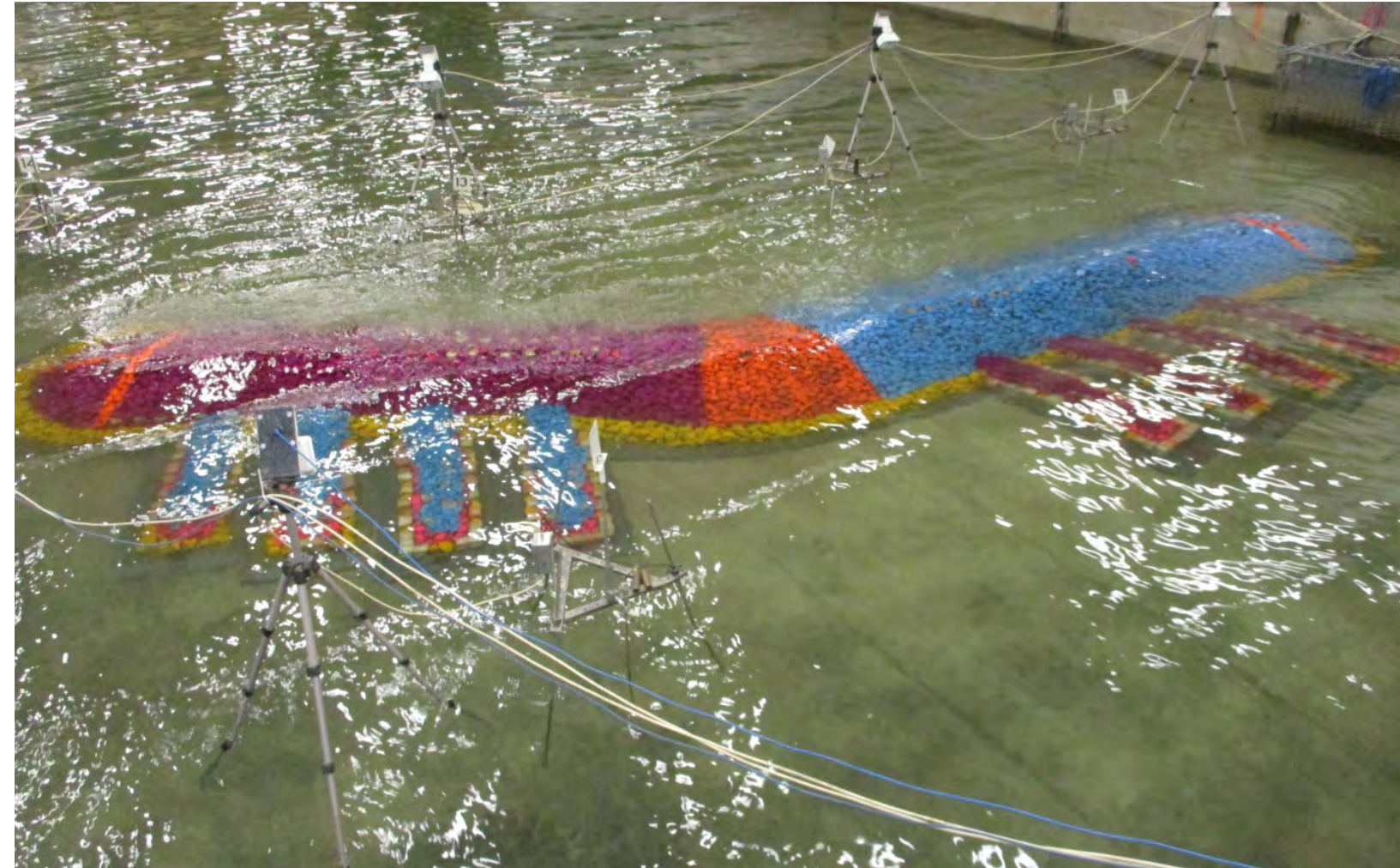
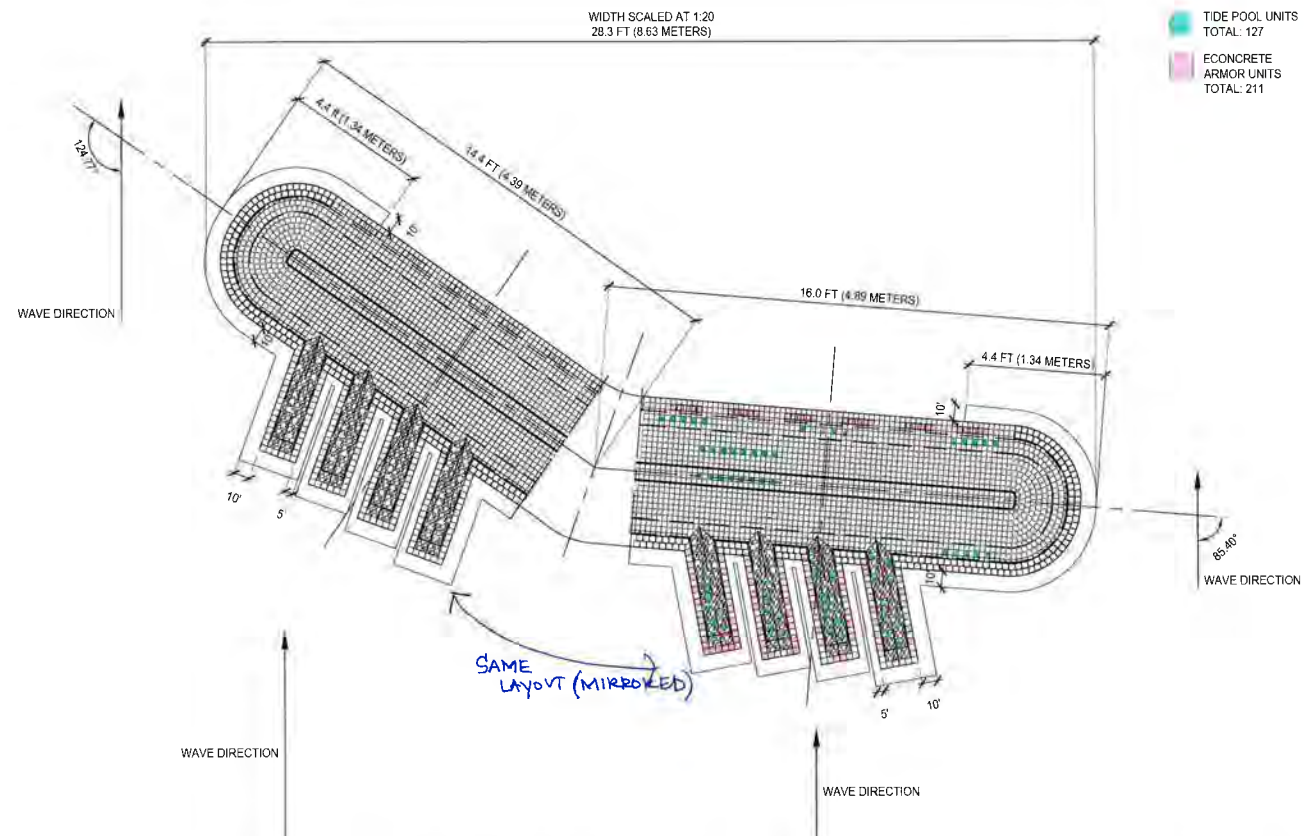
# DESIGN FOR HABITAT ENHANCEMENT

## BREAKWATER MATERIALS

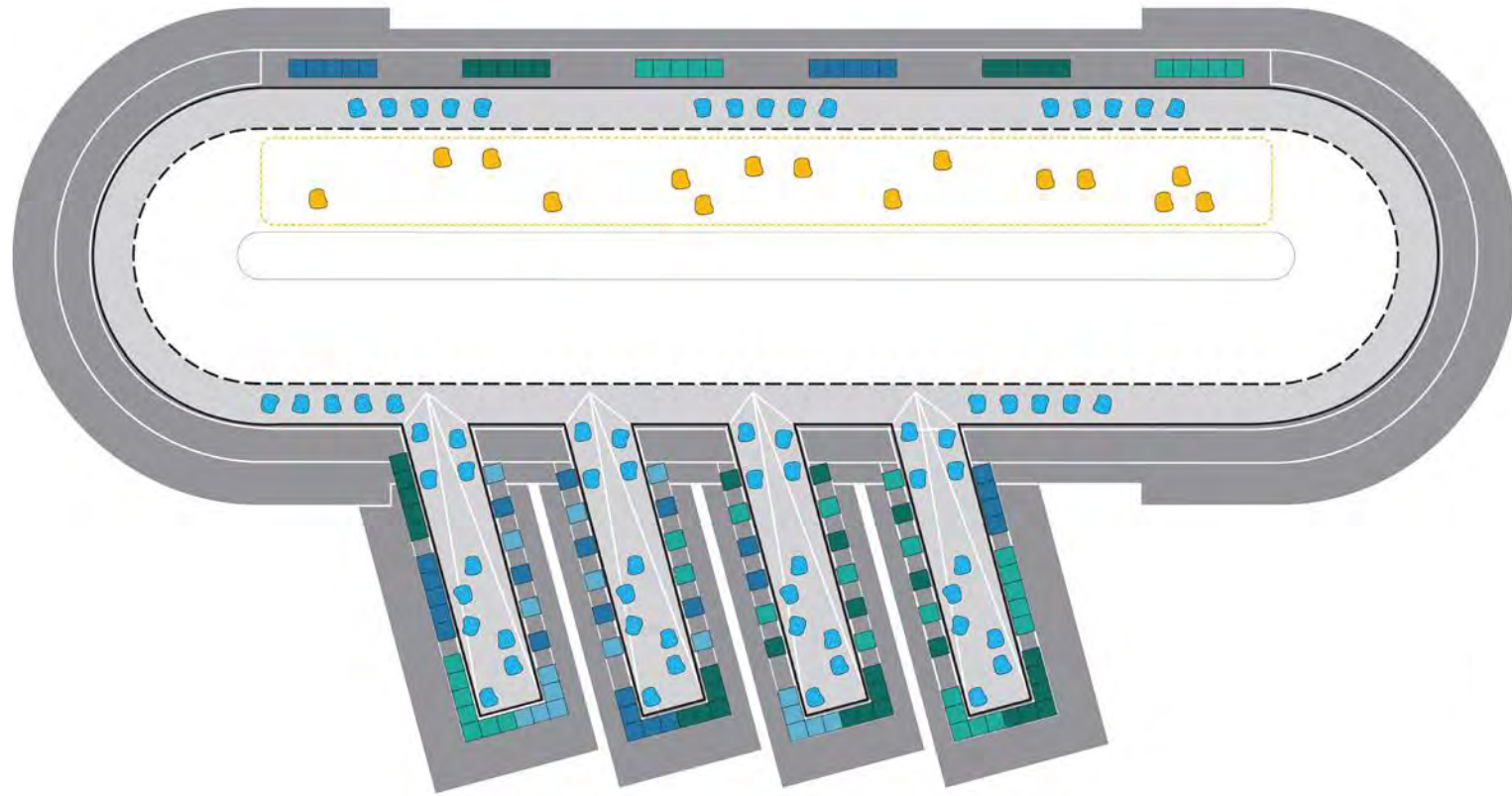


								
<b>INTERNAL CORE STONE</b> D50= 4"	<b>SCOUR APRON STONE</b> D50= 12"	<b>INTERNAL REEF RIDGE RIP RAP STONE #1</b> D50= 30"	<b>REEF RIDGE CREST RIP RAP STONE #2</b> D50= 36", 24", 15"	<b>STONE ARMOR UNIT</b> D50= 30"	<b>STONE TOE ARMOR UNIT</b> D50: 48"	<b>BIO ENHANCED ARMOR UNIT</b> Dimension: 30"x 30"	<b>BIO ENHANCED TOE ARMOR UNIT</b> Dimension: 48"x 48"	<b>BIO ENHANCED TIDE POOLS</b> Dimensions vary with placement

# PHYSICAL MODELING



# EXPERIMENTAL ECOLOGICAL LAYOUT



**BIO-ENHANCING CONCRETE ARMOR UNITS**



**BIO-ENHANCING CONCRETE TIDE POOLS**



FISH HUB 1  
(with mesh)



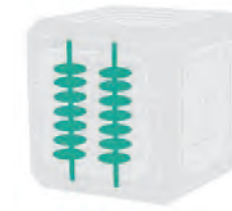
FISH HUB 2  
(with mesh + rock)



OYSTER HUB 1  
(seeded discs)



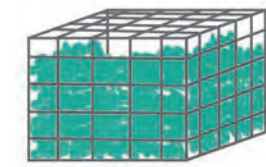
OYSTER HUB 2  
(with mesh + seeded shell)



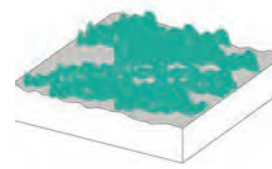
OYSTER HUB 1  
(seeded discs)



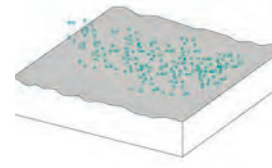
OYSTER HUB 2  
(with mesh + seeded shell)



OYSTER GABION  
(contained seeded shell)



LOOSE SPAT-ON-SHELL



IN-SITU SETTING

\*not final design

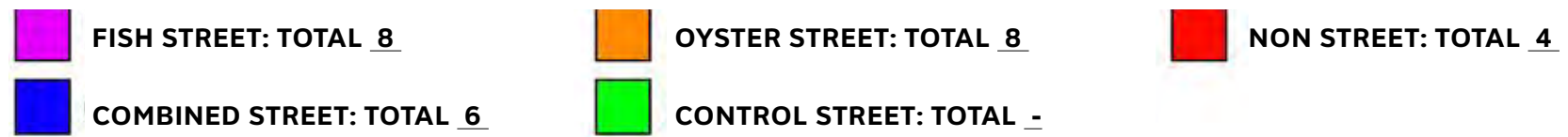
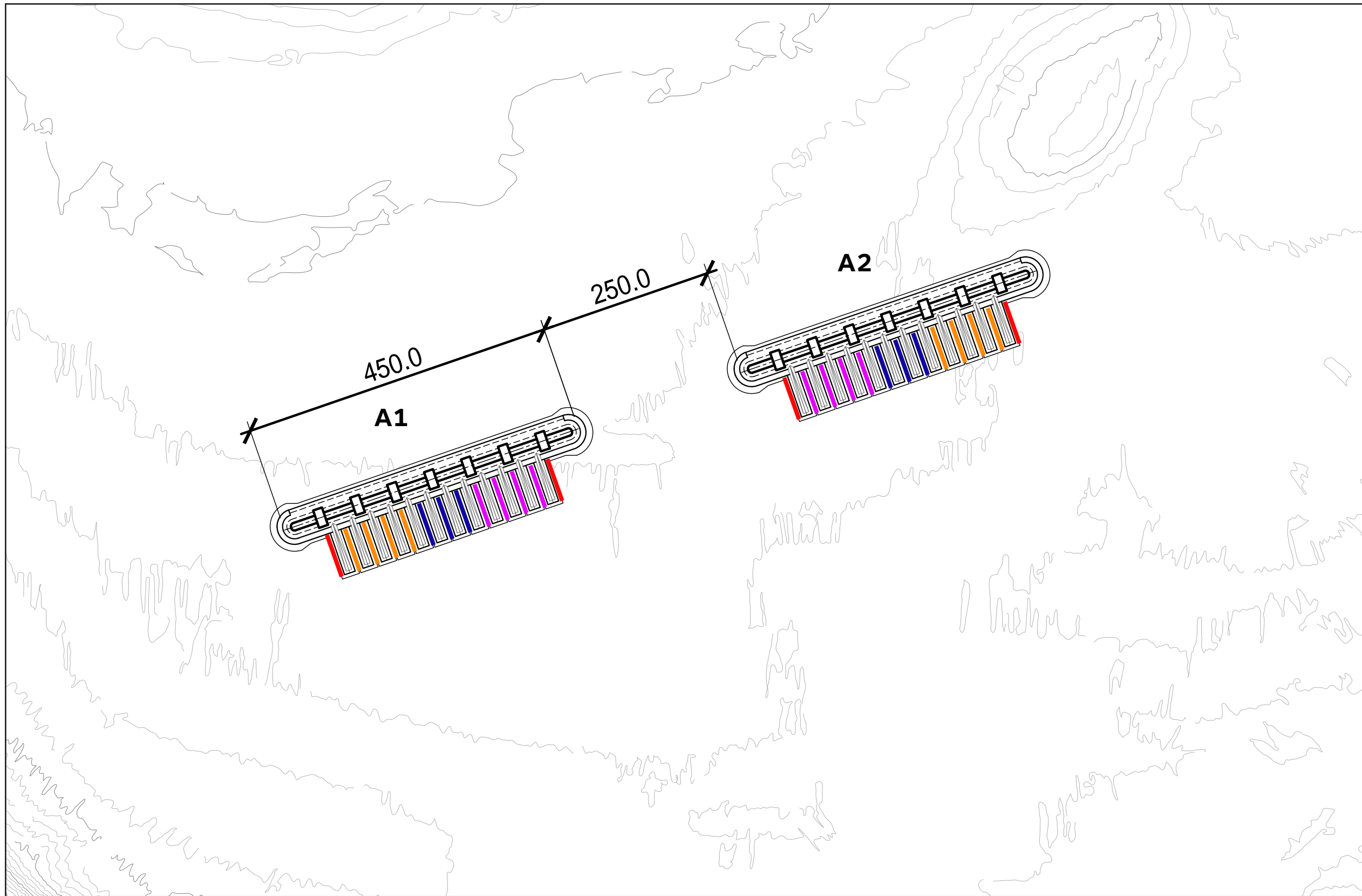


Figure 2. BREAKWATER TYPE A TREATMENTS

# PILOTING RESTORATION TECHNIQUES









