ARTIFICIAL REEFS FOR MITIGATION

A Brief Summary

Pat Quinn
Environmental Planning and Community Resilience Division
Types of Damage to Coral Reefs

- Anchor damage
- Beach nourishment
- Pipelines and cable
- Vessel groundings
- Water quality
Mitigation vs. Restoration

Mitigation – Offset known impacts

Substrate → Artificial reefs

Biological community

Restoration – Create original condition

Substrate → Re-create framework

Biological community
Mitigation in Martin County

- Beach nourishment project
- Deployed in 2000
- Material of opportunity (bridge)
- 3 sites
  - Reef A: 104 concrete & steel sections
  - Reef B: 150 concrete & steel sections
  - Reef C: 164 concrete & steel sections
- Single monitoring event
Martin County
Nearshore Artificial Reef

After 2 yrs soak time:

• Reef A
  fish species – 15
  benthic species – 7

• Reef B
  fish species – 21
  benthic species – none reported

• Reef C
  fish species – 18 (1 goliath)
  benthic species – 10
Mitigation in Palm Beach County

Beach nourishment projects
Tequesta: 1 acre, $0.5 million
Diamond Head Radner: 3-4 acres, $2-3 million
Singer Island: 2 acres, $1.2 million
Ocean Ridge: 2.5 acres, $1.5 million
Red Reef Park: 0.25 acres, $500,000
South Boca: 2.5 acres, $1.0 million
Diamondhead Radnor Mitigation Reefs

- Bridge parts
- Geoweb & rock
- Armor flex & piles
- Bridge materials
- Boulders/filter fabric
Filter Fabric and Limestone Boulders
1998-1999

Donald Ross Bridge Rubble
1998-1999

Royal Park Bridge Rubble
2000

Barge 2001

Geogrid & Limestone Boulders
2000
Diamondhead Radnor Mitigation Reefs

- 14-20 ft water depth
- 15,000 tons rock
- 3-4 acre area
- $2 - $3 million

- no rock underburden
- added armor flex with Kevlar mesh
- scouring continues
Singer Island Mitigation Reef - 2009

Nearshore impact due to beach nourishment
Ephemeral (50%) exposed at any time

- 45-50 reefs
- close to shore
- 2 acres
- $1.2 million
Ocean Ridge - 2009

Beach Nourishment Mitigation
Ocean Ridge Reefs

- 60 pods
- 2.5 acres
- $1.5 million

Each pod is approximately 20 ft. by 40 ft.

29 pods extend north to south

31 pods in a cluster at the south end
Phipps Mitigation Reef
Reef Mitigation in Broward County

Ship grounding site
- modules, boulders, formed concrete

Fiber-optic cable installations
- modules, coral transplantation

Hardbottom impacts from beach nourishment
- boulders, modules

Sea grass impacts from bridge construction
- boulders
Grounding of the USS Memphis

1993, a nuclear submarine grounded on a reef (d=25 ft), leaving a deep trench, scraped substrate, and piles of rubble
Grounding of the USS Memphis

- Preliminary mitigation plan was developed to determine funding requirements
  - Deploy a variety of artificial reef materials
  - Remove rock rubble
  - Stabilize reef framework fractures
  - Transplant coral colonies
  - Monitor grounding site and mitigation
Grounding of the USS Memphis

- Damage claim made by State against US Navy for $2 million
- Claim was litigated for 4 yrs
- Final settlement of $750,000 was reached
- $520,000 set aside for mitigation

Final mitigation plan scaled back due to funding
Grounding of the USS Memphis

- Deploy 300 tons of limestone boulders (Mt. Dania),
- 150 tons of concrete tetrahedrons,
- 50 Warren Modules,
- 100 Ajacks,
- 160 Reef Balls (for research),
- Research program and monitoring
Reef Impacts from Installation of Fiber-optic Cables

5 fiber-optic cables installed over parallel reef tracts
Reef Impacts from Installation of Fiber-optic Cables

30 DERM Modules deployed to mitigate for lost colonies

160 loose coral colonies were re-attached
Reef Impacts from Installation of Fiber-optic Cables

5 yrs post-deployment

• stony corals – 18 spp, high recruitment and density
• fishes – 150 spp observed
Reef Impacts from Cable Drag

Sheared sponges and octocorals

Mitigated with limestone boulders
Segment III Beach Nourishment Mitigation

8.9 acres of limestone boulders deployed

$6,000,000

Fish spp richness & abundance greater on mitigation

Benthic assemblage significantly different
Segment II Beach Nourishment Mitigation (proposed)

- 6.8 acres
- 4,000-6,000 units
- ~ 60 sq. ft/module
- $5.5-6.5 million
Reef Mitigation in Miami-Dade County

Beach nourishment mitigation

Arcos Boulder Reef
- Artificial Reef Site: Sunny Isles
- Deployment Date: August 2001
- Age During Survey: 5.5 years
- Total Tonnage: 270 tons
- Footprint: 105 m²
- Depth: 68 ft.
- Relief: 6 ft.

Port of Miami Boulder Reefs
- Artificial Reef Site: POM Site B
- Deployment Date: September 1996
- Age During Survey: 10.5 years
- Total Tonnage: 120,000 tons
- Footprint: 36,320 m² (Rows) & 20,070 m² (Piles)
- Depth: 45 ft.
- Relief: 10 ft.

0.02 acres
14 acres
Bal Harbor Mitigation Site

10 yrs monitoring vs natural reef

Benthic community approaching similarity

Fish assemblages remain distinct
Summary

• Costs ranged from $400,000 to $2,000,000/acre.

• Materials included materials of opportunity, boulders, commercial modules, designed modules.

• Few mitigation projects included comparison with the natural reef.

• Often mitigation was not designed to mimic the natural conditions of the habitat impacted.

• Beach nourishment projects may be moving more toward mimic-ification of the impacted hardbottom.

• Mitigation techniques have ‘evolved’ over the years, but don’t seem to be quite there yet.
Summary

The approach to mitigating reef impacts should involve five steps:

1) assess physical and biological impacts,

2) *project design,

3) secure funding ($700,000+/acre),

4) Construct/deploy mitigation,

5) and monitor recovery of damage and mitigation results compared to natural habitat

*emphasis on “project design” function
Bal Harbor
school 'o grunts