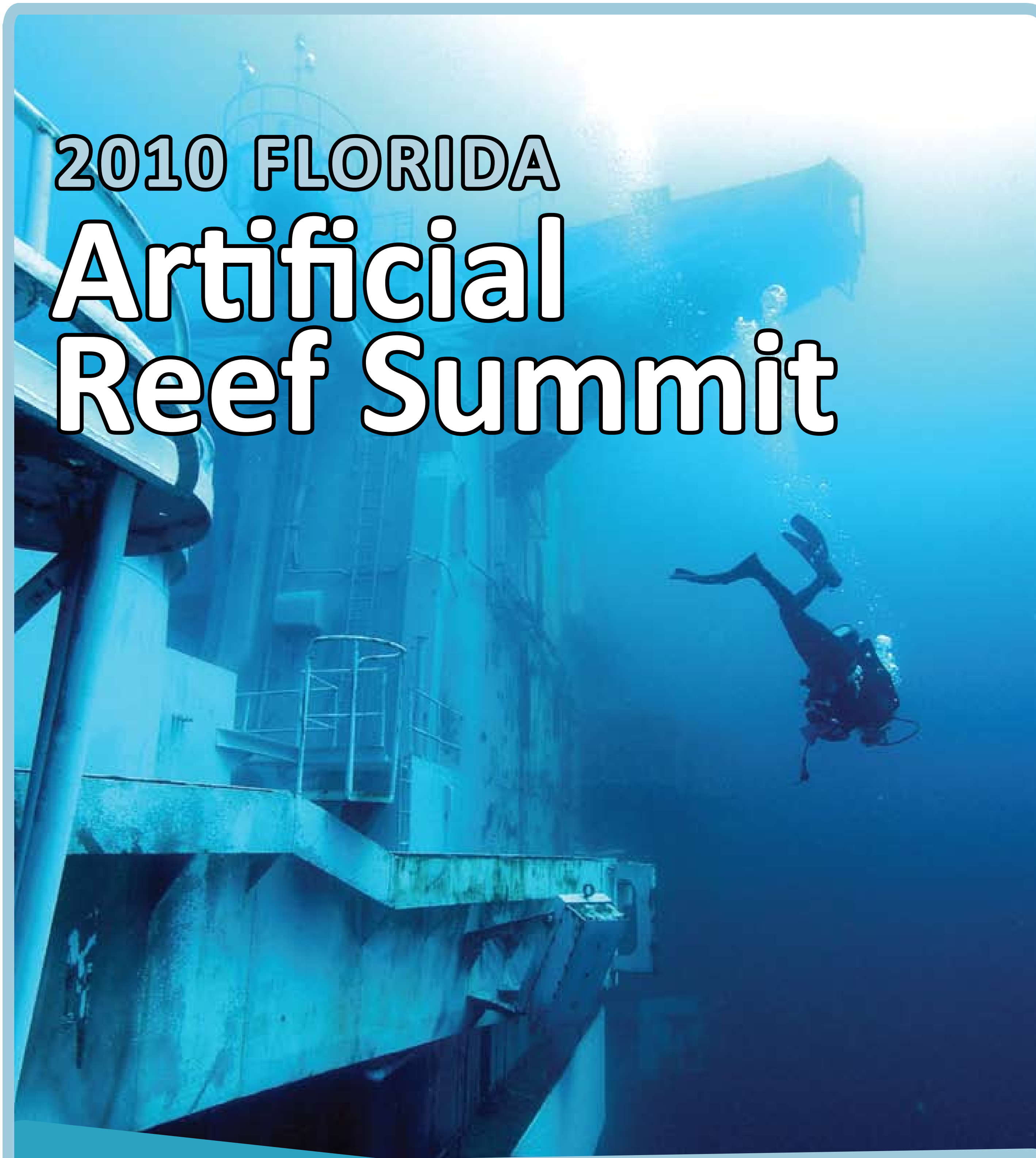
2010 FLORIDA Artificial Reef Summit



Abstracts & Program

January 21-23, 2010 • Cocoa Beach, Florida

Sea Grant Florida

UF UNIVERSITY of FLORIDA IFAS Extension

Conference Organizing Sponsors

As chairs of the organizing committee, we welcome you to the 2010 Florida Artificial Reef Summit. With 1,357 miles of coastline, involvement by 34 different counties, and over 2,500 artificial reefs deployed to date, Florida manages one of the most diverse and most active artificial reef programs in the United States. Because artificial reef development in Florida works with, and depends upon, a network of local partners, inter-county coordination and communication is critical to ensure successful implementation of statewide strategic objectives for artificial reef development.

This Summit occurs every 3 to 5 years and provides the format for local partners to meet and exchange information. It is a critical opportunity for the Florida Fish and Wildlife Conservation Commission Artificial Reef Program and Florida Sea Grant to disperse high-quality information, experience and program goals and objectives directly with all of Florida's artificial reef stakeholders.

This will be the eighth Summit. Previous summits were held in Daytona Beach (1979), Miami (1987), Tallahassee (1990 & 1993), Palm Beach (1998), Ft. Lauderdale (2001), and Sarasota (2004).

By all indications, this year's may be the most successful yet. In addition to the numerous speakers and poster presenters, please take time to visit with our summit sponsors, who have generously helped make this event possible.

John Stevely, Florida Sea Grant
Keith Mille, FWC

Cover Photo: Robert Turpin, Director of Escambia County's Marine Resources Division, descends at a depth of 97 ft alongside the control tower of the Oriskany Reef during the post-deployment inspection dive the day after the successful deployment completed by the Navy in partnership with the Florida Fish and Wildlife Conservation Commission and Escambia County. Photo by Keith Mille, Florida Fish and Wildlife Conservation Commission, May 19, 2006.

This publication was supported by the National Sea Grant College Program of the United States Department of Commerce's National Oceanic and Atmospheric Administration under NOAA Grant # NA06OAR4170014.
The views expressed herein do not necessarily reflect the views of any of these organizations.

Online copies are available at the Florida Sea Grant Web site, www.flseagrant.org.

January 2010
TP 170

2010 Florida Artificial Reef Summit Agenda

Thursday, January 21, 2010

9:00 Check in, poster set up

10:00 **Summit Welcome and Goals**
John Stevely, Mantee County Marine Extension, Florida Sea Grant
William Teehan, Fisheries Management Section Leader, Division of Marine Fisheries Management, Florida Fish and Wildlife Conservation Commission

10:15 **Synopsis of 2007 FWC Artificial Reef – Fisheries Management Science Colloquium**
Jon Dodrill and Jessica McCawley, Florida Fish and Wildlife Conservation Commission

10:35 **Synopsis of 9th International Conference on Artificial Reefs and Artificial Habitats (9th CARAH)**
Dr. Stephen Bortone, Executive Director, Gulf of Mexico Fishery Management Council

11:00 **Panel discussion on Fisheries Management and Artificial Reefs**
Moderator, Dr. William Seaman, Jr., Professor Emeritus, University of Florida

- Dr. William Lindberg, Professor, University of Florida
- Dr. Stephen Bortone, Executive Director, Gulf of Mexico Fisheries Management Council
- Dr. William Patterson, Professor, University of West Florida
- Jon Dodrill, Environmental Administrator, Division of Marine Fisheries Management - Artificial Reef Program, Florida Fish and Wildlife Conservation Commission
- Jessica McCawley, Biological Administrator, Division of Marine Fisheries Management - Fisheries Management Section, Florida Fish and Wildlife Conservation Commission

12:00 Lunch (included in registration)

1:00 **Examples of Fisheries Management Applications**
Chair, Bryan Fluech, Florida Sea Grant

- Unpublished Artificial Reefs in the Florida Panhandle, Dr. William Patterson, Professor, University of West Florida
- Red Grouper Artificial Reefs in Lee County, Justin McBride, Senior Environmental Specialist, Natural Resources Division, Lee County
- Deep-water Artificial Reefs in the Oculina Marine Protected Area, Dr. Christopher Koenig, Professor, Florida State University
- Artificial Reef Development and the Steinhatchee Fisheries Management Area, Dr. William Lindberg, Professor, University of Florida

2:20 **Contributed Fisheries Management Presentations**

- Utilization of Obsolete Vessels as Artificial Reefs to Restore *Oculina Varicosa* Habitat, Michael Barnette
- Why Birds Don't Live in Doghouses? Which Habitat for Which Species; Artificial Habitat Examples from Japan and France, Dr. Sylvain Pioch

3:00 Break (coffee and beverages provided)

3:30 **Contributed Fisheries Management Presentations (Cont.)**

- Recovery of the Goliath Grouper (*Epinephelus itajara*) Population of Florida: Significance of Artificial Reefs, Dr. Christopher Koenig
- Fisheries-Independent Monitoring of Reef Fishes on the West Florida Shelf: A Programmatic Overview and Preliminary Results from Sampling Artificial and Natural Habitats, Sean F. Keenan
- Monitoring Faunal Utilization of Artificial Reefs in Tampa and Sarasota Bays, Florida, Dr. Jay Leverone
- Using Reef Structure to Enhance Reef Function, Dr. Thomas Cuba
- River Reefs: Martin County's Inshore Artificial Reef Program: A Fisheries Management Approach to Restoring Estuarine Nursery Habitat, Ben Harkanson
- Biological Impact of a Red Tide Event on a Natural and Artificial Reef, Heyward Mathews

6:00 Networking Social and Poster Display

Friday, January 22, 2010

7:00 Check in, Continental Breakfast (included in registration)

8:00 **Regional and Statewide Artificial Reef Developments**
Chair, Christina Verlinde, Florida Sea Grant

- Statewide and Nationwide, Jon Dodrill, Environmental Administrator, Division of Marine Fisheries Management - Artificial Reef Program, Florida Fish and Wildlife Conservation Commission
- Panhandle and Big Bend, Allen Golden, P.E., Development Services Department, Planning and Zoning Division, Bay County
- Southwest, Michael Solum, Environmental Specialist, Coastal Resources, Sarasota County
- Northeast, Carl Blow, Vice Chairman, St. Augustine Port, Waterway and Beach District and Florida Inland Navigation District Commissioner for St. Johns County
- East-Central Florida, Jim Oppenborn, Marine Resource Coordinator, St. Lucie County
- Southeast Florida, Sara Thanner, M.S., Environmental Resources Project Supervisor, Department of Environmental Resources Management, Miami-Dade County

10:00 Break (coffee and beverages provided)

10:30 **State and Federal Regulatory and Permitting**
Chair, Keith Mille, FWC

- Overview of Active Florida Artificial Reef Permit Areas. Keith Mille, Environmental Specialist, Florida FWC Division of Marine Fisheries Management, Artificial Reef Program, Tallahassee
- Update on State of Florida Artificial Reef Permitting, Jennifer Smith, Program Administrator, Southeast District Environmental Resources Program, Florida Dept. of Environmental Protection, West Palm Beach
- Update on Federal Artificial Reef Permitting, Bev Lawrence, Project Manager/Biologist, U.S. Army Corps of Engineers, Jacksonville District, Regulatory Division, Jacksonville
- Overview of NOAA-NOS Artificial Reef Charting Process and Policies, Ken Forster, Chief, Products Branch B, NOAA-NOS, Office of Coast Survey, Marine Chart Division, Silver Spring, MD

11:15 **Q & A Panel Discussion,** above speakers, plus the following panelists:

- Jocelyn Karazsia, Fishery Biologist, NOAA Fisheries Service, Habitat Conservation Division, West Palm Beach
- Michael Barnette, Fishery Biologist, NOAA Fisheries Service, Protected Resources Division, St. Petersburg
- Lt. Cliff Harder, Supervisor, MSD Port Canaveral, United States Coast Guard Sector Jacksonville, Port Canaveral
- Hugh Rein, Cartographer, NOAA-NOS, Office of Coast Survey, Marine Chart Division, Silver Spring, MD

12:00 Lunch (included in registration)

1:00 **Contributed Presentations on Adaptive Management Strategies: Lessons Learned**
Chair, Robert Turpin, Manager, Marine Resources, Escambia County

- The Economic Impact of Artificial Reefs in Southwest Florida, Dr. Bob Swett
- Multi-Purpose Artificial Reefs for Coastal Protection, Ecological and Amenity Enhancement, John Hearin
- Artificial Reef Optimization using Google Earth as a Collaborative Platform for Mitigation, Monitoring & More, Todd Barber
- Near-shore Artificial Reefs of Sand Key, Pinellas County: A Case Study for Managing Mitigation for Near-shore Hardbottom with Implications for Other Regions of South Florida, Jessica Craft
- Ex-USNS Hoyt S. Vandenberg Design, Preparation and Deployment as Artificial Reef Substrate at a Permitted Site Off Key West, Jeffrey Dey

2:40 Break (coffee, beverages and snacks provided)

Friday, January 22, 2010 (Cont.)

3:10 **Ships to Reefs Session: How to Implement a Florida Ships-to-Reefs Program, Process Map (From Funding to Deployment), and Lessons Learned from Previous Vessel Deployments**
Chair, Robert Turpin, Manager, Marine Resources, Escambia County

- Introduction to Florida Ships-to-Reefs, Tom Ingram, Executive Director, Dive Equipment and Marketing Association (DEMA)
- Local Funding: How to Focus Grassroots Support, Identify Funding Sources and Setting up Endowment/Trust Funds, Robert Turpin, Manager, Marine Resources, Escambia County
- State Funding: How Citizens and Local Governments Can Coordinate Efforts to Develop Support in the Florida Legislature to Appropriate Funding for the Florida Ships-to-Reefs Initiative, State Representative Doug Holder, District 70
- MARAD Process: How to Select, Submit Applications, Receive and Deploy Vessels from MARAD, Dana Austin, Industrial Property Management Specialist, Office of Ships Disposal, DOT/MARAD
- Navy Process/USS Radford: Status of the Three-State Partnership Reefing the USS Radford, Jeff Tinsman, Artificial Reef Coordinator, State of Delaware
- Lessons Learned from Large Vessel Reefing Projects in Florida, William Horn, Fisheries Biologist IV, Division of Marine Fisheries Management - Artificial Reef Program, FWC

5:10 **Q & A Panel Discussion,** above speakers, plus representatives from large ship reefing contractors, including Tim Mullane, American Marine Group, Inc., and Joe Farrell, Resolve Marine Group, Inc.

6:00 Networking Social

Saturday, January 23, 2010

7:00 Check in, Continental Breakfast (included in registration)

8:00 **Citizen Involvement in Artificial Reef Development and Monitoring**
Chair, Dr. Janet Phipps, Coral Reef Ecologist, Department of Environmental Resources Management, Palm Beach County

- Reef Environmental Education Foundation and Volunteer Reef Fish and Invasive Species Assessments, Lad Akins, Director of Special Projects, Reef Environmental Education Foundation
- Volunteer Involvement in Surveying Goliath Grouper Populations, Angela Collins, Assistant Research Scientist, Fish and Wildlife Research Institute, Florida Fish and Wildlife Conservation Commission
- Using Volunteer Support for County Artificial Reef Construction and Monitoring Program, Dana Morton, Aquatic Biologist, Environmental Program Supervisor and Artificial Reef Coordinator, Environmental Quality Division, City of Jacksonville

9:00 **Contributed Citizen Involvement in Artificial Reef Development and Monitoring Presentations**

- Goliath Grouper Aggregation Report, Michael Phelan
- Apparent Preference of *Tubastraea coccinea* for Artificial Reef Habitats: Ecological Consequences of This Introduced Coral, Dr. Tonya Shearer
- Planning, Organizing, and Executing an Artificial Reef Clean-up Event, Nikki Hoier

10:00 Break (coffee and beverages provided)

10:30 **Contributed Citizen Involvement in Artificial Reef Development and Monitoring Presentations**

- Our Underwater Desert in Martin County, David Powell
- Mexico Beach Artificial Reef Association (MBARA), Robert L. Cox
- Reestablishing an Artificial Reef Placement and Monitoring Program in Northeast Florida, Sue Wilcox
- Quality Long-term Monitoring on a Shoestring Budget, Dr. Janet Phipps

12:00 Concluding Remarks, Dr. William Seaman, Jr., Professor Emeritus, University of Florida

12:15 **Adjourn**

Acronyms

ACOE..................... Army Corps of Engineers
ASR .... Limited Artificial Surfing Reefs
BBR .... Bring Back the Reefs
CPA .... Canaveral Port Authority
CAS .... Choctawhatchee Audubon Society
CFOA .... Central Florida Offshore Anglers
CPE .... Coastal Planning & Engineering, Inc.
CSA .... Continental Shelf Associates
E.C.C.D .... Environmentally Concerned Commercial Divers
EPC HC .... Environmental Protection Commission of Hillsborough County
FDEP .... Florida Department of Environmental Protection
FWC .... Florida Fish and Wildlife Conservation Commission
FWC-DMFM........... FWC, Division of Marine Fisheries Management
FWC-FWRI .... FWC, Fish and Wildlife Research Institute
FSG .... Florida Sea Grant
FSGE .... Florida Sea Grant Extension
FIT .... Florida Institute of Technology
FSU .... Florida State University
FPL .... Florida Power& Light Company
FRA .... Fishing Rights Alliance
FWC....................... Florida Fish and Wildlife Conservation Commission
GOFC .... Gainesville Offshore Fishing Club
GIT .... Georgia Institute of Technology
GRS .... Global Reef Solutions
GMFMC .... Gulf of Mexico Fishery Management Council
GSMFC .... Gulf States Marine Fisheries Commission
HCPA .... Hernando County Port Authority
IFAS....................... Institute of Food and Agricultural Sciences
IFREMER .... French Research Institute for Exploitation of the Sea (Ifremer)
IHA .... Innovative Health Applications
JRRT .... Jacksonville Reef Research Team
JOSFC .... Jacksonville Offshore Sport Fishing Club
KSC .... Kennedy Space Center
Lee County DNR ... Division of Natural Resources
MACAC .... Martin County Anglers Club
MBARA .... Mexico Beach Artificial Reef Association
NMFS .... National Marine Fisheries Service
NOS .... National Ocean Service
NMR .... Neptune Memorial Reef
NOAA .... National Oceanic Atmospheric Administration
NOAA NMFS
HCD .... Habitat Conservation Division
NSU .... Nova Southeastern University
OAR .... Organization for Artificial Reefs
PBCRRT .... Palm Beach County Reef Research Team
PBS&J .... Post, Buckley, Schuh & Jernigan
RMG .... Resolve Marine Group, Inc.
RS&H .... Reynolds, Smith & Hill
SBEP .... Sarasota Bay Estuary Program
SBW .... Sarasota Bay Watch
SRS .... Sea Rover Services
SAPW&BD .... St Augustine Port Waterway & Beach District
SPC .... St. Petersburg College
SRC .... Stillwater Research Group
TP&WD .... Texas Parks and Wildlife Department
UF .... University of Florida
USF .... University of South Florida
UWF .... University of West Florida

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Poster abstracts

INVITED SPEAKERS: Examples of Fisheries Management Applications

Community Structure & Population Demographics of Reef Fishes at Artificial Reefs off Northwest Florida

Patterson, W.*[1], Addis, D.[1], and Dance, M.[2]
[1]*Department of Biology, University of West Florida*
[2]*Department of Marine Biology, Texas A&M, University at Galveston*

Reef fish community structure and population demographics were examined at 27 artificial reef sites located between 15 to 20 nm south of Santa Rosa Island, Florida within the Escambia East Large Area Artificial Reef Site (EELARS). Study reefs were a subset of reefs built in spring 2003 by the FWC in the EELARS. The FWC did not advertise locations of these sites to the public in hopes of creating no-harvest refugia for exploited fishes. Reefs were composed of either paired goliath reef balls (total volume = 2.84 m3), paired fish haven pyramids (total volume = 4.90 m3), or a single concrete and rebar pyramid (4.09 m3). Three replicate reefs of each design were located in each of three depth strata: 27-31 m, 31-35 m, or 35-41 m. All reefs were sampled quarterly from fall 2004 through summer 2008 with a micro remotely operated vehicle (ROV) equipped with a laser scale. Video samples from the ROV were analyzed in the laboratory to estimate taxa-specific fish densities and to estimate fish size distributions from laser data. Over the course of 4 years of sampling, 134,698 individual fish belonging to 99 taxa were counted at study sites. Red snapper was the predominant reef fish present (occurring in 98% of all video samples), both in terms of numerical abundance (25.6% of all individuals) and percent biomass (42.8% of total estimated biomass). Other abundant fishery species (%abundance, %biomass) were vermilion snapper (5.3, 5.2), greater amberjack (3.4, 6.8), gray triggerfish (3.4, 6.1), gray snapper (2.2, 4.2), lane snapper (1.1, 0.9), gag (0.8, 5.2), scamp (0.5, 1.2), and red grouper (0.4, 3.1). Fish diversity generally increased across the study period, but annual peaks in diversity occurred in summer when invertebrate and algal fouling communities were most dense on reefs.

A tagging study also was conducted at 9 study sites to estimate reef fish site fidelity and dispersion. Fish (n = 3,115) were tagged quarterly from fall 2004 through 2007, while recaptures (n = 86 at study sites; n = 249 elsewhere) were reported through December 2009. Among the most frequently tagged fishes, red snapper (n = 211 recaptures) displayed the lowest site fidelity and greatest movement (mean ± SD = 29.4 ± 4.6 km), while gray triggerfish (n = 53) displayed the highest site fidelity and least movement (7.9 ± 2.6 km). Grouper (n = 29) were intermediate to those two fishes with respect to site fidelity and movement (19.5 ± 10.3 km).

Lastly, a fishing experiment was conducted by advertising coordinates of 9 study reefs to the fishing public in spring 2007. Estimated piscivore biomass declined by 46% at experimental (i.e., fished) reefs after spring 2007, while planktivore and invertivore biomass increased by 96% and 56%, respectively. Estimated instantaneous disappearance rates computed with catch curves indicated that mortality (y-1) increased 20.5% for red snapper and 17.3% for gray triggerfish at experimental versus control reefs following the advertising of experimental reef coordinates to the public. However, high disappearance rates for red snapper indicated that their low site fidelity likely exposed them to high regional fishing mortality rates even prior to releasing experimental coordinates, thus negating any potential refuge effect. The opposite was true for gray triggerfish, thus indicating fishes that display high site fidelity may benefit even from small-scale protected areas. These and the study results described above have important implications for the role of artificial reefs in the fisheries management, which will be discussed.

Lee County Experimental Red Grouper Habitat

McBride, J. D., Sr. Environmental Specialist
Lee County Division of Natural Resources, Marine Services

There are predominantly three species of grouper seen in Lee County waters, gag (Mycteroperca microlepis), goliath, (Epinephelus itajara) and red (Epinephelus morio). Gags are more commonly seen than reds and in greater numbers. It is our belief that the typical artificial reef constructed from secondary use concrete materials such as culverts or junction boxes, lends itself more to gags than reds. Red grouper are also noted at these artificial reefs, but in much smaller numbers and frequency. However, using information from local fishermen and our own personal observations, red grouper are found in great numbers and frequency over flat, relatively featureless hard bottom. This habitat is typically exposed limestone covered with low profile corals and sponges and pockmarked with hollows, cracks and depressions of varying sizes and shapes. The red grouper squeeze into these small openings and feed upon the invertebrates that inhabit this type of habitat.

Lee County recreated this type of habitat by constructing 35 large concrete slabs, ranging in weight from 2 tons to 10 tons and in size from 4'x6'x12" to 10'x10'x18". Limestone rubble (2"-6"), concrete blocks, large (10") and small (2") diameter pipe were all placed in the top and sides of the slabs to increase the complexity and mimic the natural areas we had observed. Ideal deployment was designed to place the slabs in close proximity to each other to simulate a large expanse of hard bottom habitat.

Deployment conditions were not ideal when the slabs were deployed within Charlotte's (fka North) reef site on June 26th, 2003. As a result the slabs were spaced further apart that we had hoped. Post-deployment we have performed 12 roving-diver surveys recording species and abundance as well as material condition and subsidence of the materials.

Throughout the surveys we have seen the expected diversity across all fish species that we would expect from a typical low-profile reef in Lee County. Initially we noted a much higher number of gag grouper than anticipated. This was very surprising to us as we did not think there was enough vertical profile to attract and hold large numbers of gag. We also did not note a large a jump in red grouper as we had hoped in the initial years. However, in recent surveys, we have seen large numbers of Red Grouper. We are not certain if this is attributable to the reef design as we have been noting larger numbers of Red Grouper at all reef sites, not just the slabs. . This increase in red grouper corresponds with data from the Gulf of Mexico Fishery Management Council June 2007 SEDAR Grouper Assessment Review which included Red Grouper. We are also observing that over half the slabs are now even with the surrounding sand bottom. There are some areas where it is obvious that the grouper are actively sweeping areas away sediment, preventing the slabs from succumbing to the sand.

Artificial Reef Development and the Steinhatchee Fisheries Management Area

Lindberg, W.J. *[1], Marcinek[1], D., Biesinger[1], Z. and Christman[2], M.
University of Florida
[1] Program in Fisheries & Aquatic Sciences, School of Forest Resources and Conservation
[2] Department of Statistics

The configurations of artificial reefs and harvest of fishes alter ecological processes that operate across spatial and temporal scales. Therefore, the science addressing practical reef issues is germane to contemporary ecological theories, and those theories can inform the design and use of reef systems to meet fisheries management objectives. As an example, habitat selection theory has an extensive ecological literature, some of which includes applications to fisheries science. This body of theory, which has several variants (e.g. ideal free distribution, density-dependent habitat selection, ontogenetic habitat shifts, the basin model and foraging arena theory), is directly relevant to artificial reefs in the context of fisheries management, including issues such as attraction-production, essential fish habitat, life history bottlenecks and regulatory mechanism in population dynamics. The practical relevance of habitat selection is illustrated by the Steinhatchee Fisheries Management Area (SFMA), a permitted large-area artificial reef site (~100 sq. mi) in the Florida Big Bend. The SFMA has been designed to test, and hopefully alleviate, a hypothesized demographic bottleneck for pre-reproductive gag (*Mycteroperca microlepis*). Construction of up to 500 "conservation reefs" is to begin in 2010, while annual monitoring of previously constructed, standardized reefs is already yielding useful results. Forty standardized reefs bracket the Big Bend as fishery-independent monitoring stations, and reveal a previously unrecognized geographic pattern in gag distribution, north to south, likely related to the natural hard-bottom habitat available to gag transiting the shallow continental shelf. A 9-year time-series of fishery-independent data from the Suwannee Regional Reef Systems, just to the south of the SFMA, confirms a declining trend in gag abundance since 2001, consistent with ecological theory and the recent gag stock assessment, although recent strong year classes are indicated. Furthermore, 2006-2007 sampling of natural reefs that varied in intrinsic habitat quality found fewer gag than expected on high quality sites, consistent with a depleted fishery stock. Thus, positive effects of the conservation reefs on gag demographic rates, due to density-dependence, are expected to be associated with strong year-classes and a recovered fishery stock.

Habitat selection is not the only theoretical framework of consequence to using artificial reefs for spatial management in fisheries; others include food web dynamics, top-down and bottom-up community interactions, and landscape connectivity. However, habitat selection is mechanistically nested within these theories, and also helps to explain spatial variation in fishing mortality. As such, a holistic concept of artificial reefs best serves the effective use of habitat enhancement across spatial and temporal scales. We further contend that ecologically effective use of artificial reefs is not a substitute for the effective management of direct and indirect fishing mortality.

CONTRIBUTED PAPER SESSION 1: Fisheries Management and Artificial Reefs

Utilization of Obsolete Vessels as Artificial Reefs to Restore *Oculina Varicosa* Habitat

Barnette, M.*
Association of Underwater Explorers

Artificial reefs have been utilized for centuries to enhance fishery resources and fishing opportunities. Recently, artificial reefs have also been employed to restore marine and estuarine habitat areas. Reefs have been created utilizing natural shell material, in order to establish oyster reefs in areas where natural reefs have been impacted or destroyed by fishing and dredging activities (Southworth et al., 2001). There have been successful efforts to manipulate or repair near-shore environments by placing reef structure to suppress wave energy, thus reducing erosion and promoting beach growth (Harris, 2003). In other instances, concrete modules or limestone boulders have been used to restore coral reef communities impacted by ship groundings (NOAA, 1999). An experimental effort to restore deep-water *Oculina varicosa* coral habitat impacted by fishing activities off the central eastern Florida coast utilizing Reef Balls™ and small concrete discs has also been attempted (Koenig, 2001). While initial results indicate that the structures are attracting groupers, snappers, and amberjack, it is questionable if they are successful at providing adequate quality habitat for actual *O. varicosa* settlement and growth.

The availability of large obsolete or decommissioned steel vessels may present an opportunity to effectively restore *O. varicosa* off the central eastern Florida coast. In contrast to Reef Balls and concrete modules/rubble, a sunken vessel presents abundant and complex surface area for coral settlement. Furthermore, the significant vertical relief presented by a sunken vessel deflects strong currents and creates numerous eddies that may facilitate coral feeding, in turn promoting *O. varicosa* settlement and growth. A large sunken vessel also presents a significant deterrent to illegal trawling activities, which are believed to impact *O. varicosa* habitat. Finally, a large sunken vessel is easily located, which facilitates monitoring efforts that may be hampered by numerous smaller, discrete artificial reefs in deep, high-current marine environments. This paper examines the efficacy of deploying a large obsolete vessel as an artificial reef to restore deep-water *O. varicosa* coral habitat on Oculina Bank.

"Why birds don't live in doghouses? Which Habitat for Which Species: Artificial Habitat Examples from Japan and France"

Pioch, S.*

Ifremer- Egis Eau, Visiting researcher Nova Southeastern University, Oceanographic Center, Dania Beach, Florida

The main goal of most artificial reefs is provide habitat, a space where life can develop and be sustained, for target species (usually fisheries species). In nature, fishes have specific preferences for different habitats during their life *i.e*., ontogenic stages and/or for spawning, feeding or refuge. To optimize AR design requires functionally mimicking the natural relationships between habitat and species.

In 1652, Japanese chronicled the Joo emperor recommended sinking an old boat and dumping boulders to enhance fisheries production. These practices continue today in many countries. However, during the last 60 years, Japanese scientists, through research, optimized their knowledge between target species and artificial habitat and changed their development of artificial reef (called artificial *habitat* in Japan) construction and design. Some of their conclusions regarding habitat design and pelagic, demersal or benthic species on hard substratum will be presented here,

In France, using Japanese's theories, of adapting habitat for target species, a new generation of artificial habitat is being produced primarily to increase targeted fisheries species. Further, in addition to this primary goal a complementary goal has been initiated: underwater landscape integration. I will present a recent model of artificial habitat which was designed with these goals in mind and installed on Sept. 4th 2009 in Agde, France, Mediterranean Sea.

Acknowledgement to Prof. Richard Spieler, Nova Southeastern University, Oceanographic Center, Dania Beach, Florida.

Recovery of the Goliath Grouper (*Epinephelus itajara*) Population of Florida: Significance of Artificial Reefs

Koenig, C.C.*, Coleman, F.C. and Kingon, K.C.
Florida State University Coastal and Marine Laboratory

We evaluated the distribution, abundance and habitat association of the recovering goliath grouper (*Epinephelus itajara*) population in the coastal waters of Florida based on research dive surveys (N = 695) coupled with those submitted to the Reef Environmental Education Foundation (REEF) by volunteer divers over the past 15 years (N = 27542). We used the research dive surveys (2004 to 2008) to verify the accuracy of the combined REEF surveys by both experienced and inexperienced volunteers (2004 to 2008), and found good correspondence between the two data sets. The recovering population initially increased off southwest Florida, directly offshore of the high-quality mangrove nursery of the Ten Thousand Islands. From there the population grew to the north and south, eventually increasing off Florida's central east coast. Most tagged adults (N = 2044) and juveniles (N = 2963) show extreme site fidelity, both in mangrove nursery (Koenig et al. 2007) and on offshore reefs. However, some showed movements of great distances (10s of kilometers) which appear related to spawning migrations and emigration from juvenile to adult offshore habitat. It is clear that a dominant factor in recovery is high-quality mangrove habitat. The highest abundances were found on high-relief artificial reefs, followed closely by high-relief ledges; abundances were relatively low on low-relief structure and on both high- and low-relief coral reefs. Understanding these patterns of population recovery, movement, and habitat association ensure appropriate management policies, and encourage appropriate recovery plans in other countries where the species remains critically endangered (IUCN).

Fisheries-Independent Monitoring of Reef Fishes on the West Florida Shelf: A Programmatic Overview and Preliminary Results from Sampling Artificial and Natural Habitats

Keenan, S.*, Switzer, T., Flaherty, K., Winner, B., McLaughlin, G. and McMichael, Jr., R.
Florida Fish and Wildlife Conservation Commission (FWC), Fish and Wildlife Research Institute

Many reef fishes found along the west Florida shelf are extensively targeted by commercial and recreational fisheries; however, unique life-history strategies of reef fishes, combined with acknowledged data limitations, complicate management efforts. During 2008, a comprehensive survey initiative was implemented to monitor reef fish populations through a cooperative partnership between the FWC – Fisheries Independent Monitoring (FIM) program and the NOAA National Marine Fisheries Service (NMFS). The sampling strategy relies upon the use of multiple sampling methods to target important life-history stages that range from post-settlement juveniles in estuarine habitats to fully-recruited adults in neritic waters. Sampling effort covers a broad spatial scale along the Florida Gulf coast. Estuarine sampling of juveniles involved additional sampling within areas currently surveyed by FIM (Apalachicola Bay, Tampa Bay, and Charlotte Harbor) as well as expanding monitoring efforts into St. Andrews Bay and the Big Bend region. Juvenile reef fishes are sampled with 183m seines set along shoal habitats containing seagrass and 6m otter trawls pulled over seagrass. Neritic sampling (10-110m) is partitioned by targeted habitat strata: low-relief, soft sediments and high-relief and/or hard bottom habitats. Low-relief habitats are sampled using 13m SEAMAP otter trawls with spatial coverage from the Florida-Alabama border to waters south of Charlotte Harbor. While trawling does not specifically target reef-associated species, many species are found near low-relief areas during ontogeny (e.g., juvenile red snapper, *Lutjanus campechanus*). High-relief and/or hard bottom neritic sampling targets pre-fishery recruits and fully-recruited individuals in association with structured habitat and is conducted in the waters off Tampa Bay and Charlotte Harbor. This sampling expands the spatial coverage of surveys already being conducted in the northeastern Gulf and shelf-edge areas by NMFS. Gear types utilized on these habitats include chevron traps, stationary underwater video/stereo cameras and vertical hooked gears. While these monitoring efforts are directed toward natural hard bottom habitats, results will provide a basis to compare community structure and function between communities associated with natural hard bottom and those of artificial habitats. This can be accomplished through specific research projects.

During the summer of 2009, FIM began sampling hard bottom habitats in the Tampa Bay region as part of an effort to characterize species assemblages associated with habitats normally under-represented in routine seine/trawl sampling. Monthly stratified-random sampling occurs with Z-traps near both artificial and natural hard bottom habitats within the bay and near-shore waters. In addition, targeted hook-and-line effort is being incorporated to evaluate bycatch composition and collect species/sizes not normally caught in traps. Results will be presented which describe catch composition of selected economically important species between artificial and natural hard bottom habitats.

Monitoring Faunal Utilization of Artificial Reefs in Tampa and Sarasota Bays, Florida

Leverone, J.* and Peatrowsky, S.
Sarasota Bay Estuary Program

Five artificial reefs were created in lower Tampa and upper Sarasota Bays during the first half of this decade. Each reef was constructed of "reef balls" arranged in an oval pattern of duplicate 4, 8, 16, and 32 reef ball configurations. Seasonal diver surveys were conducted to monitor reef utilization by finfish and invertebrate populations.

Diver surveys were conducted from March 2006-March 2007. Survey conditions were often restricted due to adverse weather patterns resulting in reduced visibility across all of these shallow water reef systems. A red tide (Karenia brevis bloom) entered the bay during 2005-2006 and severely reduced native finfish and invertebrate communities. This provided an opportunity to initiate our assessments on relatively depauperate reef systems and reduced the effect of reef "seasoning" on faunal abundance and distribution among reefs with different deployment dates.

Reef size (# of balls/site) influenced colonization and retention of finfish and invertebrates across reef systems. Larger reefs had higher total abundance and species diversity. Faunal density, however, tended to decline across reef systems and season as reef surface area increased.

Reef location influenced species colonization and distributions patterns. Tampa Bay reefs tended to provide habitat for sub-adult and adult life stages, while Sarasota Bay reefs generally served as habitat for juvenile finfish and invertebrates. These patterns of reef utilization may be influenced by the reef's proximity to the Gulf of Mexico.

Seasonal patterns in faunal composition were evident. Reef fauna during winter and spring was dominated by juvenile finfish and invertebrates. During summer and fall, reefs had lower numbers but larger sized finfish. Invertebrates dominated all reefs during fall. These seasonal shifts differed between Tampa and Sarasota Bay systems. Seasonal patterns in invertebrate composition at Sarasota Bay reefs were strongly influence by the blue crab (*Calinectes sapidus*) in spring and summer and the stone crab (*Menippe mercenaria*) in fall and winter. Crab abundance at Tampa Bay reefs was generally lower than Sarasota Bay reefs and was dominated by stone crabs.

These results suggest that these artificial reef systems serve as important seasonal habitats for both finfish and invertebrates in Sarasota and Tampa Bays. Future surveys will improve our understanding of faunal utilization of these artificial reef habitats.

Using Reef Structure to Enhance Reef Function

Cuba, T.* and Waters, L.
Stillwater Research Group, Inc.

It is a widely published fact that Tampa Bay has experienced heavy losses in both seagrass and mangrove habitats since 1950. During the same time, water quality also deteriorated, then partially recovered. What is less well understood is the effect, due to burial, that excessive filling for finger canal subdivisions has had on the low relief ledges that typically occurred in the near-shore shallows (8 to 15 ft). Remnant ledges can be found in areas less impacted by development activities and have been documented to support large numbers of larger juvenile and subadult grouper, snapper, and grunt. In more recent years, mangroves and seagrass have been protected and restored. Water quality has improved dramatically. Artificial reefs have been deployed using culverts and Reefballs among other materials with large cavity size. The result is that the habitats for the very young and the mature grouper, snapper, and grunt have been enhanced but the habitats for the midsized to subadult have been overlooked.

Stillwater Research Group, Inc, funded by the Gulf of Mexico Foundation, with support from local government and business, designed and deployed an artificial reef in shallow waters east of Egmont Key in Hillsborough County. The design included cavities of varying sizes designed to provide shelter for fishes in the 4 to 8 inch range. Cavities were specifically designed to be too small for larger carnivores. Several variations were installed in order to allow for the comparison of designs. Results show that the design provides habitat which completes the ontogenetic pathway of bay grouper, snapper, and grunt. Catchable fish populations can be expected to increase by providing refuge to the recruiting subadult populations. Once incorporated into general management efforts, this type of structure can be expected to improve overall fisheries management success.

River Reefs: Martin County's Inshore Artificial Reef Program: A Fisheries Management Approach to Restoring Estuarine Nursery Habitat

Martin[1], T., FitzPatrick[2] , K., McCarthy[1], A. and Harkanson*[1,] B.
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In recent years, the availability of suitable nursery habitats for the diverse larval/juvenile pool of South Atlantic Fisheries Management Council (SAFMC)-managed fish species found in Martin County, Florida has decreased at an alarming rate. The St. Lucie River Estuary alone has lost over 340 acres of productive oyster reef habitat – vital habitat for juvenile fish species and invertebrates that serve as a food source for sub-adult and adult fishes. The Martin County Board of County Commissioners has a long-standing Artificial Reef Program (MCARP) that has been developing since the early 1970s when the first offshore artificial reef site was established. Since that time, the program has grown to include near-shore and, more recently, inshore reef sites as part of the River Reefs Program in recognition of the need for diverse habitats to support each stage of finfish ontogenetic development in hopes of replenishing finfish stocks in Martin County and southeast Florida.

In 2004, MCARP designed and constructed the first River Reefs inshore artificial reef using relic oyster shell and Mini-Bay Reef Balls™ for the purpose of enhancing essential fish habitat (EFH). From 2005 to 2006, two additional sites were constructed using oyster cultch material (composed of relic shell, steel, and concrete rubble) and Bay Reef Balls™. One site, the St. Lucie Oyster Reef Restoration (SLROR) Site, consists of 88 individual oyster reef patches in two areas of the central estuary. Oyster densities in 2007 were measured to be 400 adult oysters/m2, meaning over 1 million individual oysters recruited to the patches over a 2-year period. These oyster densities are comparable to oyster reef habitats in undeveloped sections of the Loxahatchee River.

In June 2009, Martin County was awarded more than $4 million in Federal funding from the National Oceanic and Atmospheric Administration (NOAA) for the Martin County Oyster Reef Restoration Project (www.oysterrestoration.com) as part of the American Recovery and Reinvestment Act of 2009. This project will restore over 24 acres of oyster reef habitat using oyster cultch material in the St. Lucie River and Loxahatchee River Estuaries. Construction began in August 2009, and initial monitoring indicates colonization by obligate and facultative oyster reef resident invertebrates and demersal fish species. Preliminary data currently being collected by project partners on habitat utilization and colonization is anticipated in early 2010. A review of MCARP, the role of the River Reefs Program in fisheries management, lessons learned from inshore reef design and construction, and a status update on the latest project will be presented.

Biological Impact of a Red Tide Event on a Natural and Artificial Reef

Mathews, H.* and Patterson, S.
St. Petersburg College

In 2005 the Gulf off Tampa Bay experienced a severe Red Tide fish kill. This kill occurred in early spring after a strong thermocline had developed several meters off the bottom out to about 10 meters of depth. On inshore reefs with large fish populations, the dead fish sank below this thermocline and rapid decomposition resulted in a low oxygen event that killed almost all of the benthic invertebrates on both artificial and natural reefs. Sand bottoms and hard bottom communities with low fish densities escaped the low oxygen kill. Two hard coral species were the only survivors, along with the benthic algae populations on both reefs. The artificial reef off Clearwater Beach and a small hard bottom community just inshore from the artificial reef had large schools of small bait fish in the Menhaden Family. In most past Red Tide kills, most of the fish killed floated to the surface and usually washed up on the beach, but since most of these small bait fish killed fell apart so quickly, they sank below the thermocline and depleted the oxygen to almost zero. The production of hydrogen sulfide was so high on these reefs that divers reported their rings and necklaces turned black, so the hydrogen sulfide levels may have added to the kill. Two species of hard coral, the Staghorn coral Acropora and the Star Coral Siderastrea survived the low oxygen kill, possibly due to the zooanthellea within their tissues. These two corals turned white, but in several months regained their natural color.

The author and his student assistant were making regular check out dives on these two reefs with his college scuba class, so they began making fish and invertebrate counts to document the recovery after the kill. By late fall of 2005 it was apparent that the fish kill had a significant negative impact on the local diving economy, so questionnaires were sent to local dive shops and dive boat captains. Most dive shops reported up to 40% reduction sales for the remainder of 2005 after the kill, while dive charter boat captains reported up to 50% losses. This study found that while the fish populations returned to similar levels by the following spring, the invertebrate populations were much slower to return, and with some species have still not returned after 4 years. In addition, some of the invertebrate populations were significantly different after the kill.

The fact that some of the populations changed after the kill point out the need for establishing base line data on both the vertebrate and invertebrate populations on our near-shore reefs, both natural and artificial. With the very real possibility that Florida may soon allow oil drilling within 3 miles of our coast, such base line data on our reefs before a disaster is vital.

INVITED SPEAKERS: State and Federal Regulatory Permitting

Environmental Resource Permitting for Artificial Reefs

Smith, J.
Florida Department of Environmental Protection

The construction and placement of artificial reefs require an Environmental Resource Permit and Sovereign Submerged Lands authorization from the Department of Environmental Protection for artificial reefs constructed in state waters (within 3 miles on the Atlantic coast, 9 miles on the Gulf coast). The Environmental Resource Permitting Program addresses dredging, filling, and construction in wetlands and other surface water, as well as stormwater and surface water management systems in uplands. The program is designed to ensure that activities in uplands, wetlands and other surface waters do not degrade water quality or degrade habitat for aquatic or wetland dependent wildlife. In addition to issuing a regulatory permit, the Environmental Resource Program is also tasked with processing the Sovereign Submerged Lands authorization, as needed. The two authorizations are processed concurrently.

Artificial reefs may qualify for a Noticed General Permit if the project meets criteria and the specific conditions outlined in the Administrative Code. If the project exceeds any of the Notice General Permit thresholds or is unable to meet the specific conditions then a Standard General or Individual Permit will be required, which may have a longer review period. Artificial reefs generally qualify for a letter of consent for the Sovereign Submerged Lands authorization; however other rule criteria must still be taken into consideration. The application for are available on the Department's web site.

During the application review, the Department will typically request information regarding the materials to be used, the location of the proposed reef, the current conditions and existing natural resources in the subject area, deployment methodology, and best management practices. In order for the Department to deem your application complete, we must have reasonable assurance that the material to be used for the artificial reef is clean and will not cause water quality violations and that the material is stable and will not move around and potentially damage adjacent natural resources. Some important information that the Department is looking for in the permit application include the results of detailed habitat assessments (SCUBA surveys, fish counts, side scan and other remote sensing techniques), an evaluation of essential fish habitat and description of protected species protection measures, detailed description of the materials proposed to be deployed, stability analysis and an evaluation of the past performance of other similar materials, a description of the proposed tow, anchoring, and sink plan, and a description of the oversight and other measures of reassurance the permittee will be able to provide during construction and long-term monitoring of the artificial reef permit area. Since artificial reef development does not fit exactly into the standard questions on the ERP form (developed primarily for wetland impacts), and due to the variable nature and uniqueness of artificial reef planning and development, applicants are strongly encouraged to have a pre-application consultation with the department to review the proposed informational needs for each artificial reef permit proposal. The final permit will contain conditions which will include requirements for preconstruction meetings, cargo manifest and pre-deployment notification, and monitoring of the reef and adjacent resources, amongst other conditions.

U.S. Army Corps of Engineers – Artificial Reef Permitting Process

Lawrence, B.
U.S. Army Corps of Engineers, Jacksonville District

A permit is needed from the U.S. Army Corps of Engineers (Corps) to deploy material for artificial reefs in waters of United States. The Corps is authorized to issue artificial reef permits pursuant to Section 10 of the Rivers and Harbor Act and Section 404 of the Clean water Act. The extent of the Corps jurisdiction for permitting artificial reefs extends from the mean high water line to the outer continental shelf.

The basic form of authorization for an artificial reef is a standard permit (the general permit 50 (SAJ 50) is no longer valid). Processing and evaluating the proposal can be completed in three steps: pre-application consultation (for new reef sites or material not previously used), formal project review, and decision making. Applicants are strongly encouraged to contact their local Corps of Engineers field office and the Florida Fish and Wildlife Conservation Commission Artificial Reef Program staff prior to submitting a permit application.

This presentation will provide guidance on each of the recommended steps for submittal of permit applications for artificial reef construction, the timeline for permit review, a description of the standard list of minimum material types, and other information on the review, consultation, processing, and issuance of permits from the Corps for artificial reef construction in Florida.

Charting of Artificial Reefs

Forster, K.
National Oceanic & Atmospheric Administration, Marine Chart Division/Office of Coast Survey

The Office of Coast Survey of the National Oceanic and Atmospheric Administration's (NOAA's) National Ocean Service (NOS) is congressionally mandated to produce nautical products for U.S. waters. Our mission is to ensure safe navigation by maintaining approximately 1000 nautical charts.

Permits issued by the U.S. Corps of Engineers (USACE) are the sole source for charting obstructions classified as artificial reefs/fish havens. The NOS treats Artificial Reefs and Fish Havens similarly. Upon receipt of a USACE public notice, cartographers will pre-process the information checking for inaccuracies, completeness, and potential charting conflicts.

Essential information is required for NOS to chart artificial reefs including accurate geographic positions (NAD83) and accurate dimensions of the reef (is the reef a square, circular or rectangular). NOS must also receive an authorized minimum clearance which is needed to portray the available water to the mariner. Accurate information allows NOS to verify that there are no conflicts with other charted item (i.e. safety fairways, anchorages, etc.). NOS charts the artificial reef at the start of construction.

CONTRIBUTED PAPERS SESSION 2: Lessons Learned and Adaptive Management Strategies

The Economic Impact of Artificial Reefs in Southwest Florida

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Many of Florida's coastal counties have had artificial reef deployment and monitoring programs for several years. The reef systems that have resulted from these programs have proven to be important destinations for both recreational boaters and for-hire boat businesses. Fishing and diving activities on artificial reefs in the northeast and southeast regions of Florida, and the expenditures associated with these activities, have been shown to be important sources of economic activity that benefit local coastal communities. This presentation reports on a socioeconomic analysis for the artificial reef systems located in the southwest region of Florida.

A series of surveys were sent to private boat owners, for-hire business owners, and for-hire patrons who likely had boated and visited artificial reefs located off the coasts of Lee, Charlotte, Sarasota, Manatee, Hillsborough, and Pinellas Counties. The surveys were designed to solicit information regarding expenditures associated with trips to artificial reefs. Private boat owners were asked via a mail survey to provide information on the launch location, county of residence, number and length of trips, expenditures on most recent trip, location of expenditures, and other information. For-hire business operators (six-pack charter vessels, guide boats, party/head boats, and dive charters) were asked via mail and phone surveys to provide information on the numbers of trips taken to artificial reefs annually, the average number of clients per trip, and whether clients were residents or nonresidents. For-hire patrons were asked via a web-based survey to provide information on their most recent for-hire trip, including the type of operator hired, county of residence, launch county, expenditures, and other information.

The expenditure information was incorporated into an IMPLAN model to develop estimates of economic impact on a county basis. The information derived provides estimates of the jobs, incomes, business taxes, and economic output generated by activities associated with artificial reef usage. This information will be particularly useful to statewide and local agencies deciding how to best use scarce funding for competing programs.

Multi-Purpose Artificial Reefs for Coastal Protection, Ecological and Amenity Enhancement

Hearin, J.* and Mead, S.
ASR Limited

Traditional coastal engineering solutions have often had a negative impact on the beach, shoreline and the littoral environment. Multi-purpose artificial reefs are near-shore submerged breakwaters which provide protection from beach erosion while creating new habitat for marine life and providing increased recreational amenities such as fishing, diving and surfing.

The use of multi-purpose reefs is becoming more common in order to meet sustainability issues, such as limited sources for beach nourishment material.

We describe the design and function of these innovative coastal structures with a focus on their environmental and ecological enhancement. Case studies of existing multi-purpose reef projects in Australia, New Zealand and England are used to support the descriptions of their functions and impacts. Findings from peer reviewed technical journals and independent long term post-construction monitoring programs will be presented to demonstrate the positive environmental and ecological impacts of the reefs. Proposed designs for some Florida communities including Cocoa Beach, New Smyrna Beach and Daytona Beach will also be presented.

Multi-Purpose artificial reefs offer coastal communities a more sustainable option to address their shoreline erosion issues while providing a new ecosystem for marine life and boosting recreational amenities.

Artificial Reef Optimization using Google Earth as a Collaborative Platform for Mitigation, Monitoring & More

Barber, T.* [1], Chisholm, B. [2], Jadot, C. [3], Kirbo, K. [1], Krumholz, J. [4] and Lennon, D. [5]

[1]The Reef Ball Foundation, [2]Florida International University, [3]Reef Consultants Ltd., [4]Graduate School of Oceanography, University of Rhode Island, [5]Reef Ball Australia

The Reef Ball Foundation, a public 501(c)3 non-profit organization specializing in innovative use of artificial reef technologies, has implemented an innovative decision making tool using Google Earth (GE) coupled with a handheld GPS and digital camera. Our tool is designed to simplify the process of gathering and synthesizing a wide array information used to make managerial decisions when planning, creating, and monitoring artificial reefs.

Open source software combined with GE allows project managers to rapidly circulate, filter and analyze pertinent information. This helps them to obtain accurate advice from experts around the world, facilitates stakeholder involvement, and improves the transparency of project design. Information can be organized and viewed spatially, over time, using transparent overlays, and linked to pertinent images, websites or knowledge bases. The required hardware and software are inexpensive, easy to use and widely available.

This GE based decision making tool has allowed Reef Ball Foundation projects to organize using a "team management" concept by seeking out expert guidance from resources spread around the world rather than relying completely on locally available experts/resources. The tool also provides a convenient medium by which to share our work with others attempting similar projects, so they can learn from our successes and failures.

We present an overview of the process, along with links on where to obtain all the software and hardware required. Moreover, will also demonstrate how GE facilitates the assembly of monitoring photographs, marine charts, physical and biological models, and many other data sources. Finally using case studies, the Reef Ball Foundation demonstrates how this tool has been used for artificial reef project citing, deployment & monitoring.

Near-shore Artificial Reefs of Sand Key, Pinellas County: A Case Study for Managing Mitigation for Near-shore Hardbottom with Implications for Other Regions of South Florida

Craft, J.*
Coastal Planning & Engineering, Inc.

With increasing coastal development and impacts to near-shore benthic resources, artificial reefs are now widely used as a means of mitigating these impacts. Although Florida waters support over half of the nation's artificial reefs there is still a need for accurate data in order to make decisions regarding construction materials, optimal siting and functionality of the installations. The greatest challenge in mitigation assessments involves determining how to best characterize the health and level of services provided by the damaged site in its natural state. Further, one must determine the rate of progression of natural recovery or succession of the mitigation site to conditions that would prevail had the damage or injury not occurred. As recovery rates are often dependent on environmental conditions and geographic location, specific data for ecosystem recovery and succession at mitigation sites for different regions of coastal Florida are needed to accurately determine permit conditions and mitigation requirements.

The near-shore artificial reefs off Sand Key in Pinellas County provide a case study for colonization rates of mitigation reefs on the west-central gulf coast of Florida. A total of 16 artificial reefs were constructed between 1997 and 2006 in order to meet state permit requirements for mitigation of impacts associated with beach renourishment activities. In order to determine at what age the artificial reefs off Sand Key successfully mitigate for loss of natural hardbottom impacted by project activities, the benthic communities on artificial reefs of different ages were sampled in 2007 and 2008 and compared to natural hardbottom sites.

Analysis of trends in benthic communities resulted in the determination that the original permit requirement of two years for the artificial reefs to reach functional equivalency with the natural hardbottom was inadequate, as these reefs take closer to three years to mimic the surrounding natural communities. It is hoped that this information can be used in determining permitting and monitoring requirements for future coastal construction projects in the region. In addition, certain biotic functional groups can be used to determine age or successional phase of artificial and natural reefs. This study determined hydroids are primary colonizers on the artificial reefs in the Sand Key area and are only found in high density on the youngest installations. Octocorals appear to be the dominant organis on the artificial reefs, and exhibit a clear successional pattern that can be used not only to age the artificial reef, but also to provide supporting data on the age at which the artificial reefs reach functional equivalency with the natural hardbottom.

In conclusion, permit requirements should be geographically specific as benthic communities differ from region to region, including structure and rugosity as well as types of benthos colonizing the substrate. The near-shore hardbottom of the central gulf coast of Florida are different from those of Broward and Palm Beach Counties on the Atlantic coast. Furthermore, differences exist even within regions of a county. Thus, specific regional data needs to be gathered and disseminated to coastal managers in order to accurately determine mitigation and other regulatory requirements.

Ex-USNS Hoyt S. Vandenberg Design, Preparation and Deployment as Artificial Reef Substrate at a Permitted Site off of Key West, Florida

Dey, J.* and Adryan, C.
REEFMAKERS

This is case history for the Vandenberg Artificial Reef Project deployed in Key West, Florida on May 27, 2009. REEFMAKERS discusses lessons learned during this project including; the vessel acquisition process, site permitting process, vessel preparation planning, BMP planning, vessel preparation, and deployment of the vessel.

We will review issues managed during the Vessel Transfer Application preparation and the process of interfacing with Florida Fish and Wildlife Conservation Commission (FWC) and with MARAD. Highlights of the ACOE/FDEP Joint Artificial Reef Application and FKN permitting process are evaluated. There were many practical lessons learned throughout the acquisition and permitting process and we have a unique perspective on how to streamline these processes. There were lessons learned during vessel surveying, inspection and vessel preparation planning. Several issues were encountered during PCB sampling plan preparation and BMP guidance incorporation into the vessel preparation plan.

Various factors were considered during project design relative to maximizing benefit to the reef ecosystem along with benefit with regard to economic return on investment.

Lessons were learned relative to the vessel preparation process and how to streamline the project timeline and budget. Materials of concern (MOC) abatement were performed using various production methods based on the specific MOC location and quantities. We will review man hours expended to abate each category of MOC and review of production plan for MOC abatement by type versus by location on the vessel.

The execution of the vessel preparation work affects the project timeline. Issues like heavy weather planning and resource availability had various impacts on the project. Specific resources are required for each phase of vessel preparation. We will present the lessons we learned in selection of and utilization of these resources.

REEFMAKERS will review the planning and execution of the vessel deployment plan that allowed for deployment of the vessel in the optimal location and orientation within the permitted area. During vessel transportation, anchoring and deployment processes there are key factors that can have a significant impact on the optimal execution of the plan.

CONTRIBUTED PAPERS SESSION 3: Citizen Involvement in Monitoring and Reef Development

Big Fish Tails: A Goliath Survey of Reefs and Wrecks in the Gulf of Mexico

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The tendency to aggregate over complex, high relief habitat increases a species' catchability and vulnerability to exploitation. The association between goliath grouper and artificial reefs has been well established, and historically, fishing efforts for this species were concentrated over wrecks or other man-made habitat. Predictable aggregations and relative ease of harvest contributed to a rapid decline in population numbers, prompting managers to completely close the fishery in 1990. Since the moratorium, the goliath grouper population along the west coast of Florida has been showing signs of recovery; however, efforts to assess the status of the stock have been hindered by a lack of quantitative data. Assessing habitat associations, abundance and size distribution of goliath grouper allows for a more comprehensive understanding of the species' ecology and recovery. This project was designed to gather these types of data within a defined geographic region along the central west coast of Florida, an area historically identified as a center of abundance for this species. Specific sites, ranging in depth from 7 – 48 m (21 -146 ft), were designated to include both natural and artificial habitat. Site features were mapped to investigate relationships between habitat characteristics and goliath grouper density. Sites are routinely surveyed throughout this ongoing study (November 2007 – present) in an attempt to detect seasonal patterns. During each survey, total number of observed goliath grouper is recorded and size distributions are assessed using underwater video. To gather data on movement, fish are also opportunistically tagged. Goliath grouper are more often observed over artificial habitat than over natural bottom (ledges). Goliath grouper have been present during 90% of artificial reef surveys but during only 35% of natural bottom surveys. The number of goliath grouper increased with site depth and site relief. At this time, over 165 goliath grouper have been tagged, and 16% have been resighted or recaptured. Time at large has ranged 1 -204 days. Most recaptures and resightings have occurred at the site of initial tagging, but fish have been recaptured up to 125 miles from their initial tagging site. It is hopeful that these preliminary data will increase our understanding of the biology of this species and assist with future management efforts.

Goliath Grouper Aggregation Report 2009 Jupiter, Florida USA

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Monitoring of goliath grouper (*Epinephelus itajara*) aggregation at four artificial reef sites located among the off-shore reefs of Jupiter Florida was conducted during August through October, 2009. Aggregation behavior was observed during all dives at four artificial reef study sites consisting of steel hull ships or a steel barge. The largest aggregation consisted of 69 specimens being sighted during the full moon phase on September 4, 2009 at the Zion Train – Esso Bonaire artificial reef corridor. Multiple occurrences of presumptive pre-spawning behaviors such as pale and dark body coloration changes, stacking, and booming were noted on most dives. Aggregation totals and species behaviors are similar to the trends reported in 2008 Aggregation behaviors at other nearby Palm Beach County artificial reef sites were observed as well suggesting that the range of the aggregation behavior in late summer may be larger than previously reported.

Keywords: Goliath Grouper, Jewfish, *Epinephelus itajara*, Aggregation, Spawning, Artificial Reefs, Jupiter Florida.

Apparent Preference of *Tubastraea coccinea* for Artificial Reef Habitats: Ecological Consequences of This Introduced Coral

Shearer, T. *
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The introduction of the orange cup coral, *Tubastraea coccinea,* into the Caribbean, western Atlantic and Gulf of Mexico and subsequent range expansion into federally protected reef habitats has largely occurred unnoticed. Since this species appears to preferentially inhabit artificial reef habitats, steel hull shipwrecks and oil platforms for example, the ecological consequences of this introduction have raised little concern. Biological and ecological characteristics of *T. coccinea* are consistent with qualities of highly invasive marine species and suggest this species has great potential to negatively impact native reef communities. Presence of this species has resulted in partial mortality of native corals through overgrowth and allelopathic competition, inhibition of recruitment by local species and reductions in biodiversity. In addition to its competitive dominance, *T. coccinea* is highly prolific, capable of producing sexual and asexual larvae throughout the year that can be locally and widely dispersed. Unlike most scleractinian corals, colonies of this species can be reproductive at a small size (2-10 polyps) contributing to rapid population expansions. The only documented predator of this species, the Indo-Pacific gastropod *Epitonium billeeanum*, has not been documented in the Caribbean. In addition, this species is azooxanthellate, and therefore not constrained in settlement location due to light requirements of symbiotic algae. More importantly, this characteristic allows this species to be unaffected by increased water temperatures while other scleractinian corals suffer from increased mortality due to bleaching.

The current distribution and abundance of this introduced species are generally undetermined, especially in reef habitats in Florida. Recent surveys of several artificial reef habitats in south Florida and the Florida Keys have confirmed the presence of this species, including the USS Spiegel Grove, deployed in 2002. At one site, USCG Duane (Key Largo), thousands of *T. coccinea* colonies dominated significant portions of the wreck to the exclusion of virtually all native species in some areas. Despite the apparent preference for artificial substrate, this species inhabits natural substrates in Brazil, as well some areas throughout the Caribbean and northwestern Gulf of Mexico. Some institutions recognize the potentially negative effects of this species and actively remove colonies to minimize population increases. Since *T. coccinea* has the biological potential to become an increasing threat to native reef communities, efforts should be made to document and monitor this species to evaluate negative ecological impacts.

Planning, Organizing, and Executing an Artificial Reef Clean-up Event

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An artificial reef clean-up event can be an effective means to spark community interest and involvement in an artificial reef program, creating a sense of stewardship by removing lost fishing gear and other debris from the reefs. Key factors to success include: 1) the early involvement of reef user groups through local fishing clubs, internet forums, and dive shops, 2) organizing the effort into dive tea with specific missions and objectives, 3) safety and emergency planning, and 4) a mechanism to thank and acknowledge participants and keep them involved in the artificial reef program.

Indian River County has a modest artificial reef program that has deployed eight reefs since 1999 in approximately 70 feet of water 11-13 miles offshore of Sebastian Inlet. With no immediate plans for additional deployments, a reef clean-up event was seen as a productive way to keep up interest in the program. The Sebastian Inlet Sportsfishing Association (SISA) has been a consistent supporter of the County's artificial reef program since its inception, and SISA board members took the lead in organizing the initiative. Volunteer divers and boat captains were recruited through the club its contacts, a local dive shop, and the Florida Sportsman internet fishing forum. The local dive shop, which participates in project AWARE--an environmental awareness program developed by Professional Association of Diving Instructors (PADI), provided dive gear, air and nitrox fills, and for to document and quantify the debris collected. SISA provided funds to cover boat expenses for the volunteer captains, and Indian River County provided a vessel and staff time for their Coastal Resource Manager.

On the date of the clean-up event, 6 boats and 20 divers met at a staging area near the launch ramp where specific reef assignments and safety plans were discussed. Staying within no-decompression limits, avoiding entanglement hazards and dealing with heavy debris were stressed. A working VHF radio channel was agreed to, and the fleet departed Sebastian Inlet for the reef sites. Participants kept in touch via VHF radio throughout the day, and met in the afternoon at the staging area to compare notes and quantify the amount and types of debris collected. This small scale effort, conducted entirely by volunteers, collected hundreds of feet of monofilament line, steel leaders, hook and sinkers, and an estimated five hundred pounds of anchors, line, and other debris. A fine time was had by all, dangerous and unsightly debris was removed from the reefs, and members of the community got a chance to become involved in their local artificial reef program.

Our Underwater Desert in Martin County

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There are records dating back to the 1970's showing materials being deployed for artificial reefs in Martin County's vast deepwater desert. Permitted areas have been charted since then and named Donaldson, Ernst & Sirotkin in honor of fishing enthusiasts known as "Reeftirees". Local businesses, civic groups and volunteers were building an underwater metropolis for marine life. Over the years, divers Dr. Lee Harris, Kerry Dillon, Merle Stokes and others performed still and video underwater photography. Their documentation verifies the artificial reef locations and monitors the condition of the reef materials. Reports are available on the MartinReefs.com website.

MCAC Reef Fund, Inc. was established in 2002 as a 501(C3) corporation (mcacreeffund.org) to enhance the artificial reef program of Martin County. The selling of naming rights generates cash for the fund and all proceeds go towards artificial reefs. Members are John Burke, founder and president, Dave Powell, vice-president, and members Curt Croteau, Kerry Dillon, Joe Lehner and Karl Wickstrom. Our goal is *"to obtain suitable vessels and materials to make artificial reefs in the deep waters of Martin County to improve recreational fishing, the offshore environment and tourism"*. There are dozens of volunteers involved with our projects and fund raising events. We have had 3 very successful fishing tournaments and are busy selling the naming rights to future or existing unnamed artificial reefs. The fund works closely with Martin County to insure our long term strategy meets both of our goals.

In 2003 new materials were added to the deep water (150-190 ft) of the Sirotkin Site including a ship (Wickstrom), a tug (High Queen) and concrete railroad ties. Our recent successes include four 37' tall obsolete steel Navy towers built and donated by Harbor Branch Institute in Fort Pierce. The towers are named Baratta Sight-Sea-Er, Debbie Schmidt, American Custom Yachts and Bausch American Towers. Six new reefs were deployed offshore in south county located midway between St. Lucie and Jupiter Inlets. All six reefs have new names: The Heap, Jack MacDonald, Shirley, Lentine, Fogel Capital Management and Ann Marie. All are local people interested in contributing to the program! Their generous contributions cover our deployment costs.

This year's new project is the tug "BIG AL" donated by American Custom Yachts. This 69' 1954 vintage coastal tug's propeller was sold for $3,000.00 and after a year of local contractors cleaning up the vessel, it's ready to go. The naming rights were purchased by a local businessman, Ted Glasrud, covering nearly the entire cost of the project. The BIG AL will be deployed south of the Wickstrom, by a local tug operator, creating a long north-south reef along with the 3 new 500 ton concrete rubble reefs out there looking for new names! Right now they are known as Alpha, Beta & Charlie. This year we published a brochure with reef names, latitude, longitude, water depth, and distance from the St. Lucie Inlet. It includes a location map listing all 62 artificial reefs for fishing and diving. This ongoing program of new artificial reefs is our welcome mat for migrating fish of all kinds to remain and enjoy the hospitality offered in Martin County's underwater desert. Our vision is that future generations will be blessed with an abundance of offshore marine life due to our foresight and dedication.

Mexico Beach Artificial Reef Association (MBARA)

Cox, R.L.
MBARA, Board of Directors President

The MBARA was formed in January of 1997 by a group of community volunteers in Mexico Beach, Florida. Since our establishment, we have deployed over 200 artificial reefs. The primary function of the organization is the conservation and environmental improvement of our natural and artificial marine reef systems in the Gulf of Mexico near Mexico Beach, but that is not all that has been done by our organization. Since inception, the MBARA has also worked very hard to conduct and promote scientific research and evaluation of reef designs, biomass development, and fish productions.

The third function of the MBARA is educating the public about the importance of reef systems to the marine ecosystem, and the impact they have on the coastal communities where they are built. All parties benefit when the information on reefs is disseminated to the public. School children, the organization's members, and the general public need to know all about reefs and reef building in order to help promote conservation and environmental improvement of the marine reef systems.

The MBARA is an IRS 501 (c) (3) non-profit organization. We get our support through fundraising, contributions/donations, corporate sponsors/grants, and grants from the Florida Fish and Wildlife Conservation Commission. We concentrate our reef construction and monitoring in six active permit areas plus two inactive permit areas cooperatively managed by the City of Mexico Beach and MBARA. We have also expanded our reef deployment and monitoring into a large area artificial reef site managed by Bay County’s Artificial Reef Coordinator.

The MBARA publishes its works on our website at www.MBARA.org and in monthly newsletters to our supporters. Our website provides public viewing of reef locations, monitoring reports, and underwater video/photography.

Reestablishing an Artificial Reef Placement and Monitoring Program in Northeast Florida

Wilcox, S.* and Perkner, J.*
Jacksonville Reef Research Team

After more than a 5 year hiatus, the City of Jacksonville, reestablished it's artificial reef program in 2009 with a great deal of help from the Jacksonville Offshore Sport Fishing Club and Jacksonville Reef Research Team. The focal point of this effort was the placement of the tug boat *Spike*. Placement required significant community involvement and the donation of materials, vessel support, and thousands of volunteer hours in *Spike* preparation and deployment.

The Jacksonville Reef Research Team helped with the *Spike* pre-deployment survey, the placement survey, and the post-deployment survey a month later. However, we have been doing a lot of Reef monitoring work during the City's hiatus and since the last Reef summit. Our presentation will focus more broadly on our approach to deployment work, and the monitoring grant work we have done over the past 3+ years. We will also focus on pre dives we have done on our upcoming grant project site the Coppedge Reef.

As mentioned above our presentation will briefly cover the deployment work and several completed monitoring projects from 2006-2009. The monitoring findings provided us with some great insights on Artificial Reef biodiversity and fish populations across various sites and materials. The work will be featured through the data output form those monitoring projects as well as slides and video.

We are also excited to preview our upcoming monitoring project at the Coppedge reef site. This site contains the Coppedge freighter (at 31.3 meters) plus over 150 concrete culverts and pill boxes spread over an area of over 100 meters in diameter. This is one of the most interesting monitoring projects we have undertaken. The focus is on one of our oldest reef placements in Northeast Florida. The Coppedge reef is located approximately 20 nm east of the inlet at Mayport Florida and rests at a depth at just over 24 meters. It was first documented and mapped nearly 20 years ago when it was newly deployed. This reef monitoring project will provide great insight to the long-term stability and biodiversity of a ship placement versus concrete placement since they are within 100 meters of each other and have been deployed the same amount of time.

Initial fish counts on the Coppedge already indicate over 25 species on a single series of dives with multiple sightings of Lionfish (invasive species). The Coppedge wreck itself appears to be in good shape (for 20 years of submersion) and holds a great number of game and tropical fish. We have both video and photographic documentation of this dive that we would share with Summit participants.

Quality Long-term Monitoring on a Shoestring Budget

Phipps, J.
Palm Beach County Environmental Resources Management

The Palm Beach County Reef Research Team (RRT) was formed December 1991. The RRT brings citizen involvement, PR, and support to the Artificial Reef Program. Originally the RRT members paid to go out and collect data; however since 1997 ERM has been successful in obtaining FWC Artificial Monitoring Grants to cover costs. The costs, over the last 6 years, were approximately $8,000/year staff time and $9,000/year in expenses. The majority of the costs (86%) are for chartering commercial dive boats. Comparable monitoring by a consulting firm would cost more than 20 times more.

Other benefits include development of a long-term affordable monitoring program. This data, although not research oriented, i.e., answering a specific question, is as valuable because it provide long-term information. Management of the data has its own issues. Data management should be addressed initially and planned for in advance. The venue should be a relational database and ideally should be web-accessible. A look at some of the fish data for Governor's River Walk Reef is taken. This reef was initially 4 vessels deployed in 2002 and limerock/concrete "corridors" were added in 2005 and 2006. This enhancement of the reef is shown in the fish data. The RRT has monitored the reef from its initial deployments to today.

One issue using volunteers is liability. Our approach is to have the RRT affiliated with a 501(c)3 organization. All diving is aboard commercial dive boats, not private vessel, and RRT members are required to carry individual diver insurance. In conclusion, having a RRT takes a commitment on both sides, you to provide guidance, initial training, data/grant/contract management, and theirs to learn how to and collect quality data. If all parties are willing, you can have a very affordable and meaningful long-term monitoring program.

POSTER SESSION

Site Fidelity and Movement of Reef Fishes Tagged at Unreported Artificial Reef Sites off Northwest Florida

Addis, D. and Patterson, W.
University of West Florida

A tagging study was conducted at unpublished artificial reefs (n=9) located 15-20 miles south of Pensacola, FL. Reef fish (n = 3,110) were tagged with anchor tags on quarterly tagging trips from March 2005 to December 2007 to estimate species-specific site fidelity and movement. The most frequently tagged species were red snapper (n = 2,114), red porgy (n = 422), gray triggerfish (n = 267), and gag (n = 96). Eighty-six tagged individuals were recaptured at tagging reefs on subsequent trips and fishers reported a total of 249 fish recaptured through December 2009 that were caught away from tagging reefs. Mark-recapture modeling results indicate that red snapper displayed low site fidelity (21% y^{-1}), while higher site fidelity was observed but not quantified as an annual rate for groupers and gray triggerfish. Mean (± sd) distance moved for red snapper, groupers, and grey triggerfish was 29.4 km (± 4.6), 19.5 (± 10.3), 7.9 (± 2.6), respectively. Site fidelity and dispersion will be discussed in the context of the efficacy of unreported artificial reef sites to positively affect reef fish spawning stock biomass.

Snook Population Dynamics Utilizing Acoustic Tracking Technology

Ault, E.*, Stoecklin, G., Whittington, J. and Young, J.
Florida Fish & Wildlife Conservation Commission, Florida Wildlife Research Institute

Previous research conducted by the Florida Fish and Wildlife Conservation Commission (FWC) involving common snook (*Centropomus undecimalis*) has evolved into a broad-scale study, linking six major estuaries on the East Coast of Florida along with adjacent offshore habitat. The focus of this study is to develop a better understanding of the population dynamics for this species as it relates to movements and exchange rates between freshwater, estuarine, and coastal reef habitats. Acoustic tracking technology is the primary method being employed to gather information. This method requires establishing and maintaining a series of stations (acoustic signal receivers) that encompassed the entire sampling area. Inshore station placement was based mostly on the lay of the land, taking into account key access points, bottlenecks and peripheral channels. In regards to the offshore component of this study, factors influencing station placement were comprised of information acquired through our own visual surveys, coastal resource managers and reports from user groups (divers and fishermen). This information resulted in the targeting of both natural and artificial reef structures. In addition to our previously stated goals, we hope to better elucidate the role of these structures as it relates to the habitat usage of common snook. This study is being conducted as part of a wider effort involving multiple groups/agencies performing similar research. This regional coordination is known as the Florida Atlantic Coast Telemetry array (F.A.C.T.) and is aimed at tracking the movement patterns of numerous fish species within and between ecosystems. Because this collaboration is shared, every additional participant translates into an expansion of the acoustic network. From this partnership a more detailed understanding of the spatial distribution and connectivity between estuarine and offshore common snook populations can be obtained.

Fine-Scale Movement and Habitat Data for Gag Grouper

Biesinger, Z.*, Bolker, B. and Lindberg, W. J.
University of Florida

Fisheries models often treat demographic parameters as constant across large spatial scales. However, spatial variation in habitat-dependent processes may be important to population dynamics, especially in species with spatially structured life histories. One reason for assuming process spatial homogeneity has been the logistic and technological challenges of gathering movement and landscape data at appropriate scales. Using acoustic transmitters and a fully submergible autonomous hydrophone array, we record 2- and 3-dimensional position estimates to sub-meter performance every several seconds for weeks at a time for grouper ranging >200m.

During June through December of 2009 we acoustically tagged a total of 56 gag grouper living on 3 experimental artificial reefs placed in sand-bottom landscapes and 3 reefs in live-bottom landscapes. Gag center their activity at the reef and forage about the surrounding landscape. With transmitters sounding every 2s we recorded individuals' positions for 14 days. In conjunction with detailed water flow measurements (obtained from an Acoustic Doppler Current Profiler) and habitat maps (obtained from our side-scan sonar imagery), the gag positional data can be used to relate movement metrics to landscape and environmental characteristics. We compare space-use metrics (like utilization distributions or average distance to reef) of individuals in both sand- and live-bottom landscapes, including temporal changes over daily and tidal cycles. Finally, measures of gag size and growth will allow us to link landscape type, gag behavior, and expected gag fitness. Understanding how individual movement relative to landscape features at such fine-scales affects gag size and growth will improve fisheries models which incorporate spatial variation in demographic parameters.

Utilizing Side Scan Sonar as an Artificial Reef Management Tool

Cuevas, K.*, Sanders, J. and Broussard, E.
Mississippi Department of Marine Resources

Artificial reefs generally occur over broad areas of water bottoms which is a challenge for reef managers. These man-made habitats must be monitored to ensure compliance with U.S. Army Corps of Engineering permits and navigational clearance. Millions of dollars are spent on the deployment of reef material in Mississippi's permitted public reef sites and future artificial reef development will continue as funding becomes available. With this large financial investment in artificial reef construction, it is critical that artificial reef deployments be monitored and assessed for stability and durability to determine the optimum material type to be used, and the proper positioning of these materials. Side scan sonar can map large areas relatively quick. Images obtained from side scan can provide detailed information on latitude and longitude, orientation of reef material, relief of material, footprint and scouring around the reef material. The artificial reef can be scanned over time to determine the degree of stability (movement or subsidence) and durability (degradation of reef material). This tool is also very instrumental in obtaining information due the effects of hurricanes. It allows Mississippi reef managers to accurately measure the damage to artificial reefs. Knowing the damage that occurred, reef managers can acquire funding to rebuild the loss habitat.

A total of 400 nautical miles of transects have been surveyed to date. The transect covers approximately 11,000 acres of water bottoms. In Mississippi, side scan sonar is utilized to detect movement and subsidence of deployed material and provide accurate locations of all deployments surveyed. Accurate mapping of deployments has allowed reef managers to begin strategically placing materials different designs that researchers have found to be most productive habitat for reef fish.

Acoustic Monitoring of Near-shore Natural and Artificial Reefs

Dean, B. and Irlandi, E.*

Florida Institute of Technology, Department of Marine and Environmental Systems

Erosion of beaches, whether triggered by human activities or by natural events, is an issue of primary importance along the coast of Florida. Many millions of dollars are being spent on beach nourishment and sand by-pass projects to mediate the impacts of both natural and anthropogenic processes that influence erosion on Florida's beaches. While nourishment projects are seen as necessary to provide storm protection and restore eroded beaches, they are costly and the biological consequences of them are not completely understood. In particular, there is significant concern about the impacts of beach nourishment on near-shore hard bottom habitats. If beach nourishment projects adversely affect these hard bottom areas, the projects are generally required to mitigate the impacts which may involve the creation of near-shore artificial reef habitat. Unfortunately, assessment of the impact of beach nourishment on near-shore habitats and the adequacy of mitigation efforts is hindered in part due to the difficulty in working in these high-energy surf zones. Annual aerial photography and diver surveys are typically used to evaluate the extent of exposed rock reef and community composition of fishes, invertebrates and algae living on and around natural and mitigation reefs. The quality of aerial photos and the ability to delineate reef from sand is dependent on water clarity and sea surface conditions. These factors contribute to significant variability in photo quality from year to year thus influencing our interpretation of reef lines. Also, rough seas and poor visibility limit the frequency that divers can make *in situ* observations and limit the effectiveness of visual, video and still photography surveys. Finally, of great importance is our lack of knowledge regarding the natural intra-annual variation in sand burial and exposure of these near-shore reefs. We employed an acoustic ground discrimination system (RoxAnn®) and GPS to map bottom types in the near-shore areas of a portion of Indian River County, including the County's mitigation reef off of Vero Beach. RoxAnn® uses two echo returns to characterize the hardness and roughness of surfaces. By ground truthing, we created categories of bottom types corresponding to return signatures. An interpolation program was used to estimate bottom type for areas between survey points and to create point layers that could be imported into ArcMap. We determined the precision of the method and conducted multiple surveys of near-shore areas to assess temporal and spatial changes in bottom types. While our efforts do not allow in-depth assessment of percent cover of epibiota specific to rock reefs (e.g., bryozoans, algae by species, tunicates, etc.), we were able to map the spatial distribution of several sediment types, bare rock surfaces, Sabellarid worm reef, sponge covered rock, and rock covered with two different algal morphologies over large areas under conditions of suboptimal visibility. Use of acoustics for monitoring in low visibility environments provides a means of conducting spatially and temporally intensive surveys over large areas to determine impacts of natural and anthropogenic processes that may affect near-shore bottom types. Further development of acoustic techniques to assess changes in percent cover of epibiota is promising, but requires additional research.

Fish Surveys at Four Charlotte County Artificial Reef Sites

DeBruler, Jr., R.*[1], Staugler, E.[2], Blackburn, B.[3], Joseph, J.[4]
[1]Charlotte County Government, [2]Florida Sea Grant, University of Florida, [3]Bluewater Environmental, LLC., [4]Fantasea Scuba

Artificial reef studies that incorporate reef structure and assemblage information to explain the reef community are useful as a management tool. This study was designed to describe the fish community by joining fish census and physical reef data.

The study areas are located off shore of Charlotte County, Florida at the four predominate artificial reef sites, Novak (aka. Gasparilla) Reef, Palm Island Ferry Reef, Tremblay Reef, and Stump Pass Reef. The reefs are of different ages, depth, profile complexity, and are composed of concrete and steel materials. The ages range from five to seventeen years and the depths range from 30 to 60 feet. A total of 200 visual counts and 36 mapping surveys, distributed over the four reefs, were preformed during 2008, and 2009. Four GIS maps were generated from the 36 mapping surveys.

In the 200 visual counts, 46,509 individual fish were enumerated from 48 species comprising 24 families. The mean number of species observed per census was 20.25. The top five families included Groupers, Grunts, Snappers, Wrasses, and Porgies respectively. Seasonality was seen within the families and species, but was not seen in the total assemblages for each of the reefs. Seasonality was determined by water temperature rather than by calendar. The habitat complexity did not have an affect on the fish assemblage between the reefs.

This study, by uniting the census and physical data, has provided preliminary data that demonstrates that reefs can be described by physical structure, dominate fishes, fish assemblages, and seasonality.

Coral Recruitment on Artificial Reefs off Fort Lauderdale, Florida

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[1] *PBS&J*
[2] *Florida Department of Environmental Protection*

As part of mitigation for the installation of five telecommunication cables over the reefs off southeast Florida, thirty designed artificial reef modules were installed. These modules were installed at a permitted artificial reef site off Fort Lauderdale, Broward County, Florida, and were designed to compensate for impacts to scleractinian corals that could not be restored or remediated (such as where the cable could not be moved off of a stony coral and, subsequently, shades or touches a portion of the coral). When they were deployed in January 2000, the modules were placed on the bottom in five groups of six modules each in a wave stable configuration. After four years, field measurements (Differential GPS coordinates and physical measurements between modules) confirm that the modules have not moved significantly from their installation location. The epibiota on the artificial reefs changed considerably (i.e., more species and coverage by different species) between year one and year four. The epibiota on the artificial reefs changed enough in year three to begin analyzing the quarter quadrats using PointCount'99© software. This analysis was repeated in year four. Overall in all 28 quadrats, macroalgae occupied 91.39% of the surface area; sponges, 7.89%; crustose coralline algae, 0.43%; hydrocorals (fire corals), 0.11%; scleractinians (hard corals), 0.11%; and octocorals (soft corals), 0.07%. Thirteen species of hard coral recruits were identified on the fourteen monitored modules. There was an average of about six species and twenty-two individuals on each module with an estimate of 9.56 coral colonies per square meter. Thirty-four species of fishes were noted on, in, and around the modules. Grunts (in particular, Tomtate, *Haemulon aurolineatum*, and French grunt, *H. flavolineatum*), Daelfishes (in particular, Blue Chromis, *Chromis cyanea*, Threespot Daelfish, *Stegastes planifrons*, and Cocoa Daelfish, *S. variabilis*), Goatfishes (in particular, Yellow Goatfish, *Mulloidichthys martinicus*), Wrasses (in particular, Bluehead wrasse, *Thalassoma bifasciatum*), and Snappers (in particular, Gray Snapper, *Lutjanus griseus*) dominated the artificial reef in numbers.

Spatial and Temporal Distribution of Macroalgae Colonizing Rock Revetments at Port Canaveral Harbor, Florida

Holloway-Adkins, K. *[1], Scheidt, D.[2], Garreau, C.[2], Reyier, E.[2] and Hanisak, M.D.[1]
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Artificial structures created from concrete, wood pilings, and rock retainer walls, frequently used in the construction of inlets and jetties, provide areas for the attachment of marine flora and fauna. At several areas within Port Canaveral, shorelines are lined with algae-laden granite boulders that provide food and shelter resources for juvenile green turtles and herbivorous marine fishes. Cape Canaveral has been documented as a major temperate-subtropical transition zone for several fish and macroalgal species. This study documented the spatial and temporal distribution of macroalgae colonizing areas of rock revetment lining the Port. Macroalgal samples (n = 594) were collected every 20 cm along twelve randomly selected transect locations, every 3 months from June 2008 to March 2009. Transects were established perpendicular to shore, extending from the rock-sand interface in approximately 2 meters of water, shoreward, to the high mean water line. Macroalgae in the study area are extremely-turfed and sampling required a coring device and specially designed collection boxes. Results from the first year indicate that species composition was dominated by red algae (85%) and green algae represented approximately 14% of species composition. Brown algae were detected in minute or trace quantities in two samples (< 1%). The most frequently observed species were: *Gelidium americanum*, *Gelidiopsis* spp., *Amphiroa fragilissima* and *Hypnea spinella.* Results from the first year of this study indicate no significant differences in the temporal or spatial distribution of the macroalgal composition. We discuss the ecology of artificial habitats within inlet systems and their potential to provide shelter and food resources for a diverse and abundant aggregation of herbivorous fishes and sea turtles.

Assessment of Near-shore Artificial Reefs in Okaloosa County, Florida by Volunteers Using Side Scan Sonar

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[2]*Emerald Coast Reef Association*

The sea floor in the western panhandle region of Florida consists mainly of unconsolidated sediments, causing the counties in this area to support the creation of artificial reefs to provide habitat for local fish populations. Several issues have emerged with these sites, including inaccurate coordinates for the original deployment of materials, movement of reef materials by hurricane wave action, structure failure, and deterioration.

Emerald Coast Reef Association, a local group of fishers and divers, partnered with Florida Sea Grant Extension to conduct a side scan sonar survey of selected near-shore reefs in Okaloosa County during 2005. Presented are survey methods using recent innovations in side scan sonar technology as well as the survey results.

Information systems in conjunction with the use of low-frequency side scan sonar allowed for accurate location of previously deployed reef materials. High-frequency scanning further refined reef material location and was used to evaluate reef condition. Side scan sonar surveys provided the foundation for future monitoring activities such as video and diving assessments.

A number of the structures detected during the survey illustrate valuable lessons for artificial reef deployment and management. Care in the placement of reef materials during deployment needs to be prioritized in order for structures to function as they were originally designed. Cylindrical objects need to be deployed in deeper waters and modified to improve storm stability. Reef deployments made during the era of Long Range Navigation may not have been recorded accurately compared to today's standards. Accurately calibrated navigational instruments and professional records are essential tools for future reef managers.

Our experience from these surveys also indicates it may not be necessary to locate all lost reefs, even though fishermen and divers may benefit. Previous research studies suggest that lost reefs are utilized as de facto refugia, potentially benefiting fisheries stocks. Near-shore, however, it is prudent to manage all reef structures closely due to the presence of natural reefs, trawling activity, and navigational lanes.

The success of this survey suggests skilled volunteer groups can play a larger role in artificial reef management and monitoring. The capacity to execute these types of projects at the local level complements traditional research information from universities and government entities and is of great value to local artificial reef program managers.

Multibeam Investigation of Artificial Reefs Settlement Offshore the West Coast of Florida (Gulf of Mexico) and in Adriatic Sea (Italy)

Manoukian, S.[1], Fabi, G.[1] and Naar, D.[2]
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[2] *USF-College of Marine Science*

Artificial reefs (AR) are becoming a popular biological and management component in shallow water environments characterized by soft seabed, representing both important marine habitats and tools to manage coastal fisheries and resources. Because of the unstable nature of sediments, they require a detailed and systematic investigation that acoustic systems can provide. An AR into the marine environment acts as open system with exchange of material and energy, altering the physical and biological characteristics of the surrounding area. The AR stability will depend on the balance of scour, settlement, and burial resulting from ocean conditions over time. The acoustic systems are efficient tools in monitoring the environmental evolution around AR, whereas water turbidity can limit visual dive and ROV inspections. High-frequency multibeam echosounder offers the potential of detecting fine-scale distribution of reef units, providing an unprecedented level of resolution, coverage, and spatial definition. In the present study two ARs deployed offshore the west coast of Florida, Gulf of Mexico, and in the Western Adriatic Sea, Italy, are investigated using the Kongsberg Simrad EM3000 and the new EM3002 respectively. The Gulf of Mexico surveys were conducted in 1999 and 2007. The Adriatic Sea survey was conducted in 2006 and regards the first scientifically-planned AR in Italy deployed during 1974-75. A considerable scouring around the structures of both the ARs and some vertical/horizontal movements of the single units regarding the AR located in Adriatic Sea has occurred. Moreover a depression of the whole area hosting the Italian AR was observed.

Digitizing the Florida Artificial Reef Program Reference Library Using EndNote X2

Mata, C.*, Mille, K. and Scott, C.
Florida Fish and Wildlife Conservation Commission, Division of Marine Fisheries Management

The Florida Fish and Wildlife Conservation Commission's (FWC) Division of Marine Fisheries Management is tasked with providing technical support to all of Florida's coastal governments involved in artificial reef development. One critical aspect of FWC's technical support to the local artificial reef coordinators is to provide citations and references to aid in the planning, monitoring, on research of artificial reefs. Peer reviewed publications, grey literature, unpublished reports, and even historical newspaper or magazine articles, can be important reference material for artificial reef planning, report and grant writing, as well as researching the history of specific artificial reef deployments.

Since the inception of the Florida Artificial Reef program, the reference library has been housed in a series of 3-ring binders containing paper copies of reports and publications organized by general category. By 2001, with the emergence of .pdf files and electronic reports, the paper binders were increasingly supplemented by corresponding digital folders on the FWC intranet. In 2008 the FWC began the process of digitally scanning the paper files to .pdf and selected bibliography software called EndNote to help digitally manage the Florida Artificial Reef Program Reference Library.

The EndNote software has quickly proven to be an extremely powerful tool for artificial reef information sharing and referencing. Linked directly to the Microsoft Office Suite, FWC staff can now quickly search and directly insert full citations into email and letter correspondence for stakeholders to quickly insert into reports and grant proposals.

As of November 2009, the digital library contains 1,306 publications, consisting of 491 (37.6%) reports, 393 (30.1%) journal articles, 153 (11.7%) magazine and newspaper articles, 112 (8.6%) conference papers and proceedings, and 157 (12.2%) other publications (e.g., newsletters, thesis, books, personal communications, legislative documents, bibliographies, pamphlets). Future development includes establishing keywords and notes to better facilitate reference search and selection.

Attendees of the 2010 Artificial Reef Summit are encouraged to visit this poster during the poster session for a laptop demonstration of the EndNote software and to review the new FWC digital Artificial Reef Reference Library.

A Comparison Between Artificial Reef Boulders and Natural Hardbottom Communities in Broward and Palm Beach Counties

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In order to mitigate for anticipated burial of natural hardbottom due to beach nourishment, an 8.9-acre artificial reef and a 3.1-acre artificial reef were constructed in Broward County (BC) and Palm Beach County (PBC), in 2003 and 2004, respectively. Both reefs were constructed of limestone boulders; the BC reef was constructed using 4-6 ft diameter boulders in 15-20 ft water depth and was meant to mitigate for natural hardbottom in similar water depths, whereas the PBC reef was constructed of 3-4 ft diameter boulders in 6-8 ft water depth and was meant to mitigate for intertidal and subtidal hardbottom. The Benthic Ecological Assessment for Marginal Reefs (BEAMR) methodology was conducted on both artificial and natural reef systems in order to determine if and when the artificial reef approached, matched, or surpassed the functionality of the natural hardbottom benthic community. The near-shore natural hardbottom in both counties is relatively low-relief (1-4 ft). On the higher-relief BC reef, the benthic community remained significantly distinct from the natural hardbottom as of five years post-mitigation; however, similarity has increased notably over time. It was also noted that the BC reef appeared to be reaching a point of stabilization, i.e. less change has occurred between the most recent monitoring events. The lower-relief PBC reef, on the other hand, could not be significantly differentiated from the benthic community of the surrounding natural hardbottom as of four years post-mitigation. Quantitative comparison of the benthic communities indicates that similar substrate composition may not be enough to attain similar functionality between a mitigative artificial reef and surrounding natural hardbottom. The ultimate limiting factor may be attributed to the differences in structural complexity.

Fishes Inhabiting the Trident Submarine Basin and Adjacent Public Waters within Port Canaveral, East-Central Florida

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Coastal deep-water ports are often considered poor fish habitat due to high rates of anthropogenic disturbance but this view is rarely substantiated by empirical evidence. While entirely manmade and highly industrialized, Port Canaveral, east-central Florida offers expansive artificial hard bottom substrates in the form of subtidal rock revetments and concrete wharfs with the potential to support a diverse assemblage of reef-associated marine fishes. The Port also serves as the only connection to the adjacent Indian River Lagoon system (via the Canaveral Lock) over a 140 km span of Florida coastline and thus appears to function as an important migratory corridor for estuarine-dependant fish taxa. We are currently conducting a two year multi-gear survey of military (restricted) and adjacent public waters within Port Canaveral to assess local ichthyofaunal richness and document seasonal abundance trends for ecologically and economically valuable fish species. Sampling consists of monthly otter trawls, bottom longlines, minnow traps, and chevron traps throughout the facility as well as quarterly underwater visual censuses, gill net, and rotenone collections within military waters only. During the first year of the study (April 2008- March 2009), a combined 11,694 fishes from 158 distinct taxa have been collected or observed. The most speciose families documented thus far include the Sciaenidae (dru and croakers, 14 taxa), Carangidae (jacks, 10 taxa), Serranidae (groupers and seabasses, nine taxa), and Gobiidae (gobies, eight taxa). Several economically valuable crustaceans were also recorded and no non-native fish species have been documented. While catches are dominated by juvenile size classes, results also suggest that Port Canaveral supports high adult densities of certain fish taxa including common snook (*Centropomus undecimalis*) and goliath grouper (*Epinephelus itajara*) both of which are intensively managed. This study, which when completed will serve as one of the more rigorous faunal surveys of any deep-water port in the S.E. United States, should provide insights as to how to manage, or in some instances, enhance fish habitat (and the economic benefits derived from them) in highly urbanized port facilities.

Reef-Roc: Assessment of a New Design in Artificial Reefs of Natural Limestone

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There are significant unresolved problems in using artificial structure to restore ship groundings and to mitigate near-shore hardbottom impacted by beach renourishment. These problems include the formation of different fish and invertebrate assemblages, and ontogenic stages, on artificial reefs or pre-impacted substrate. These new assemblages may, in turn, have a negative impact on neighboring biota on natural reef. Further, in the view of many, the artificial substrates currently in use do not meet requisite aesthetic considerations. The artificial reefs, proposed here, called “REEF-ROC” by the inventor, are made of natural marine material, of similar weight as concrete. It is softer than limestone boulders and should provide substrate accessible to endolithic organisms. In its current form, this material mimics low-relief near-shore hardbottom and appears to be an ideal substrate for restoration and mitigation of coral reef, especially shallow nursery areas. What is not clear is if this appearance equates to functionality. Our ongoing research (initiated July 2009) examines the biological and physical effectiveness of this material and thus is a critical first step in evaluating this material for artificial reef management of fisheries and related resources. The experimental design would consist of quarterly comparisons of the fish and invertebrate assemblages (species richness and abundance by size class) on two replicate artificial reefs of 25m^2 each with two replicate neighboring hardbottom patches of equal size. If it is actually as effective as appearances lead us to believe, this material will likely become the material of choice in artificial reef projects.

Effects of a Novel Invertebrate Substrate on Assemblages of Fish Associated with Concrete Modules

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Most coral reef restoration efforts have concentrated on limited target organisms, e.g. returning coral populations, usually by transplant, or fish populations, by providing artificial refuge. Normally these restoration efforts do not make specific attempts to increase the non-coral invertebrate assemblages. This study experimentally manipulated the natural cover of invertebrate epibiota, by the addition of a novel invertebrate substrate, on small artificial reefs (Reefballs®, 0.8 m height x 1.0 m diameter). Thirty-two commercial concrete reef modules (Reefballs®) were deployed with one of four treatments: 1) with an artificial invertebrate substrate (AIS) and internal fish refuge (concrete blocks), 2) with only invertebrate substrate, 3) with only internal refuge and, 4) without added substrate or refuge (control). Control ARs had lower fish abundance and species richness than other treatments in all seasons. Though not statistically different, artificial reefs with AIS and block were higher in all seasons for abundance and richness than AIS or block alone. Treatment-specific differences in abundances appeared to exist for some fishes particularly for four of the relatively abundant fish species (*Thalassomma bifasciatum*, *Haemulon aurolineatum, Haemulon melanurum*, and *Stegastis partitus*). Our results clearly support past research on the importance of refuge in structuring fish assemblages on ARs. It is also now clear that providing artificial invertebrate substrate to ARs will affect the associated fish assemblage as well.

Effects of Proximity and Depth of Placement on Benthic and Fish Assemblages on Miami-Dade Artificial Reef Modules

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Prefabricated Artificial Reef Modules (ARM) have been deployed offshore of Miami-Dade County for a variety of purposes including mitigation and fisheries enhancement. This study, conducted in 2009, sought to evaluate two relationships: 1) Influence of proximity of AR on fish assemblages and 2) Depth of placement of AR on both fish and benthic assemblages. The modules evaluated in this study are located in the Port of Miami Artificial Reef Site A (POM-A) and the Bal Harbour Mitigation Site (BHM) in the Sunny Isles Artificial Reef Site. The POM-A modules were deployed in July and August 1996 and the BHM modules were deployed in May 1999. Results of this study indicated that the modules in the four spatial arrays (less than 10', 25', 50', and 100' on-center) and two depths (25' and 68') supported abundant and diverse biological assemblages. The benthic assemblages at POM-A and BHM were dominated by an algal "turf" coverage followed by sponge (Porifera) and then (to a much lesser extent) stony corals (Scleractinia) and soft corals (Octocorallia). The shallower POM-A modules had more stony corals (mostly Oculina diffusa). Fish assemblages on all POM-A spatial arrays were dominated by Haemulidae (Grunts) and Labridae (Wrasse). Gobiidae (Gobies) was most abundant on the deeper BHM modules. Overall, fish abundance was highest on modules that were closest together (i.e., less than 10'). This study provided information for evaluating the effectiveness of these reefs in meeting the objectives for which they were constructed and will assist in future artificial reef planning.

Spatial Implications of Artificial Reef Placement: A Red Snapper (*Lutjanus Campechanus*) Ecosystemsm and Fuzzy Rule-based Model

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The state of Alabama has the nation's largest artificial reef programs, and it is estimated that there are between 8,000-20,000 artificial reefs in the 4210 km^2 Alabama artificial reef permit zone. However, little regard has been given to the effects of reef placement, and how the fish populations the reefs support may interact. In this study, models were used to simulate consumption requirements for red snapper on a typical artificial reef, and to examine variability in reef spacing and its effects on the spatial dynamics of foraging. To accomplish this goal I used bioenergetics, Ecopath with Ecosim and Ecospace, and fuzzy logic theory.

A rough set theory model utilizing fuzzy sets was developed to investigate artificial reef placement based on fish ecosystem components. The model incorporates consumption estimates and presumed foraging behavior to provide a rule-based approach to determine how far apart artificial reefs must be placed to eliminate density-dependent competition for prey resources. Simulation of the ecosystem parameters and potential reef distances as triangularly defined fuzzy sets generates input into the rules. Then, based upon the strength of belief in a rule, the artificial reef placement location can be accepted or rejected as being conducive to consumption at the reef and foraging behavior of the species. Ease of utilization of the model is highlighted by spreadsheet application to a red snapper (*Lutjanus campechanus*) ecosystem in Gulf of Mexico waters off the coastal shelf of Alabama.

This study on reef placement involves two aspects: 1) the development of a unique bioenergetics model for red snapper *(Lutjanus campechanus)* in Gulf of Mexico waters off the coast of Alabama where significant numbers of artificial reefs, although not totally documented, are thought to exist, and 2) a fuzzy rough set model by which parameters determined from the bioenergetics model can provide, through extensive simulations, a decision for optimal reef distances. By age class, the bioenergetics and consumption rates of red snapper foraging on artificial reefs in the Gulf of Mexico off the coast of Alabama provided input into the fuzzy rule-based model. After conducting various simulations, highest certainty in optimal reef spacing was achieved for reef distances between 0.50 to 0.95 km such that no more than 2 fit within a 1 km^2 area. Implications exist for managing placement of artificial reefs to affect the health and survival of overfished species targeted by fisheries managers.

Microhabitat Use by Newly Settled Grunts (Haemulidae) and Other Taxa on Natural and Artificial Hardbottom in Southeast Florida

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Use of natural and artificial microhabitats was examined by comparing biotic and abiotic substrate characteristics within quadrats occupied by newly settled fish to substrate characteristics in randomly chosen quadrats within the same locations. Data were collected during summer months of 2003, 2004, and 2009 in coastal waters of Palm Beach County, Florida. Quantitative photography was employed to assess percent cover of substrates used by newly settled grunts (*Haemulon* spp., *Anisotremus virginicus*, *A. surinamensis*) and other taxa (*Stegastes variabilis* and *Pareques* spp.). Discriminant function analysis revealed that substrate characteristics of most sites occupied by fishes differed significantly from substrate characteristics of randomly chosen sites at natural and artificial locations. However, sites used by several taxa were poorly classified by the analyses. Newly settled *Haemulon* spp. preferred areas with detached algae, sand, and exposed hard bottom at the base of the natural or artificial structures. Our results indicate that for the areas studied biotic substrate characteristics were not an important element of microhabitat selection; but sand-rock margins of hardbottom features were selected by most newly settled individuals. In addition, the effects of relief, water depth, and other physical factors on microhabitat use by newly settled grunts from ongoing studies will be presented. These data are being applied in management analyses to determine the efficacy of artificial hardbottom as partial mitigation for losses of natural hardbottom due to coastal construction activities.

Comparison of Fish and Benthic Assemblages on a Mitigation Artificial Reef and Adjacent Natural Reefs: Year 10 Post-placement Assessment

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The Bal Harbour Mitigation Artificial Reef Project (BHM) was conducted as mitigation for sedimentation impacts to natural reefs sustained during a beach renourishment project. Deployed in 1999, BHM is composed of pre-fabricated concrete and limerock modules arranged in a grid surrounding a large limerock boulder area. This study documents the current status as well as the historical account of the benthic and fish assemblages on BHM with comparisons to adjacent natural reefs. Consistent diversity, similarity, abundance, and cover were observed on the natural reefs indicating stable benthic and fish populations. As expected, BHM showed fast and remarkable changes during the first four years after placement with more gradual changes in the last six years, and now the artificial reefs support diverse benthic and fish assemblages. Fish assemblages on BHM and the natural reefs have not demonstrated increases in similarity during this study; rather distinct differences have remained after ten years. Fish assemblages on the artificial reef share many species with the natural reef areas, but the abundance of those species differ, with more Haemulidae and Gobiidae on BHM. Similarity between benthic assemblages, on the other hand, has continued to increase during the ten-year study, although differences still remain. A significant contributor to these differences is the low octocoral abundance on the artificial reef materials. Differences in the physical characteristics (shape, relief, cryptic spaces, etc.) between BHM and the natural reefs are expected to continue affecting the extent to which the overall assemblages become truly similar.

Assessment of Potential Factors Causing Burial of Artificial Mitigation Reefs

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As beach erosion continues, beach nourishment remains the primary means for shoreline protection in Florida. However, as the filled beach profile equilibrates, sediment migration can result in the burial of natural hardbottom and habitat. Construction of artificial reefs is one accepted method to offset those impacts. The underlying goal of near-shore hardbottom mitigation is to create a replacement habitat that will replicate the epibiota and fish assemblage structure found on local natural hardbottom. To accomplish this goal the physical habitat must be closely imitated, to include providing similar substrate, vertical relief, and structural complexity. However, mitigation sites are typically required to be placed as closely as possible to the impacted areas, likely within the near-shore zone, subjecting them to a highly energetic environment and potential movement, settlement and even burial occurs as a result. When burial of the reef units occur, the mitigation reef no longer mimics that of the natural hardbottom for which it replaced, therefore, the structural characteristics and biological integrity of the reef is undermined and less efficient.

The use of mitigation reefs is increasing and there is a need to refine mitigation reef design and monitoring standards. This study evaluates the potential factors causing artificial substrate burial which include: (a) vertical sediment displacement, (b) sediment deformation, and (c) sediment transport. In order to evaluate the three factors of burial, an assessment of the local environmental characteristics was conducted. The assessment included evaluation of the soil characteristics, water depth, wave climate, bathymetric surveys, beach profile data, jet probe data, and volumetric changes. An assessment following that protocol was conducted for a limestone boulder mitigation reef site in Indian River County, on the East Coast of Florida. This reef site was chosen due to its design complexity and prime subjectivity to seasonal harsh wave climates typical of the Florida East Coast.

A primary issue noted in the study was the lack of data available for analysis. Several such mitigation reefs have been constructed in Florida; however, structural monitoring and data for this type of structure are limited. It is recommended that regulatory agencies streamline and standardize design and monitoring requirements to reduce the subjectivity involved when reviewing and permitting mitigation reefs.

Reestablishing an Artificial Reef Placement and Monitoring Program in Northeast Florida

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Jacksonville Reef Research Team

After more than a 5 year hiatus, the City of Jacksonville, reestablished it's artificial reef program in 2009 with a great deal of help from the Jacksonville Offshore Sport Fishing Club and Jacksonville Reef Research Team. The focal point of this effort was the placement of the tug boat *Spike*. Placement required significant community involvement and the donation of materials, vessel support, and thousands of volunteer hours in *Spike* preparation and deployment.

The Jacksonville Reef Research Team helped with the *Spike* pre-deployment survey, the placement survey, and the post-deployment survey a month later. However, we have been doing a lot of Reef monitoring work during the City's hiatus and since the last Reef summit. Our Poster presentation will focus more broadly on our approach to deployment work, and the monitoring grant work we have done over the past 3+ years. We will also focus on pre dives we have done on our upcoming grant project site the Coppedge Reef.

As mentioned above our Poster presentation will briefly cover the deployment work and several completed monitoring projects from 2006-2009. The monitoring findings provided us with some great insights on Artificial Reef biodiversity and fish populations across various sites and materials. The work will be featured through the data output form those monitoring projects as well as slides and video.

We are also excited to preview our upcoming monitoring project at the Coppedge reef site. This site contains the Coppedge freighter (at 31.3 meters) plus over 150 concrete culverts and pill boxes spread over an area of over 100 meters in diameter. This is one of the most interesting monitoring projects we have undertaken. The focus is on one of our oldest reef placements in Northeast Florida. The Coppedge reef is located approximately 20 nm east of the inlet at Mayport Florida and rests at a depth at just over 24 meters. It was first documented and mapped nearly 20 years ago when it was newly deployed. This reef monitoring project will provide great insight to the long-term stability and biodiversity of a ship placement versus concrete placement since they are within 100 meters of each other and have been deployed the same amount of time.

Initial fish counts on the Coppedge already indicate over 25 species on a single series of dives with multiple sightings of Lionfish (invasive species). The Coppedge wreck itself appears to be in good shape (for 20 years of submersion) and holds a great number of game and tropical fish. We have photographic documentation of this dive that we would share with as part of our poster presentation.

Economic Aspects Associated with Large Ship Artificial Reefs

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The USS Oriskany and the USS Vandenberg were the most recent large ships that were intentionally sunk to create artificial reefs. Large ships as reefs are unique in that in addition to the obvious fishery economic activity they also generate diving economic activity. Research is presented that documents the economic activity generated by the Oriskany after its sinking off of Pensacola in 2007 and the Vandenberg after its sinking off of Key West in 2009. In both instances, a travel cost model is used to estimate the diving demand for the large ship artificial reefs. For the Vandenberg results are presented both prior to the sinking event (stated preferences) and after the sinking event (revealed preferences). Expected diving pressure shift from natural to artificial reef is measured as well. For the Oriskany, the economic valuation result from sinking another large ship nearby is developed and the economic impact of the ship settling deeper is measured as well. Finally policy implications for large ship reefing are suggested based on the economic valuation results and recommendations for additional research are made.

The Influence of Artificial Reef Associated Fish Assemblages and Varying Substrates on Coral Recruitment

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This study examined enhancing coral recruitment to artificial substrate by manipulating fish assemblages and the use of coral attractant substrates. One hundred sixty artificial reef modules were organized into 40 four-module replicate configurations (quads) of varying complexity to induce different fish assemblages. The deployment array consisted of the 40 quads, each in a square configuration with three to four-meter sides (approximately 1 m separation between modules) measured from the outside corners. The quads were divided into four fill treatments of differing complexity: Empty, Small, Mixed, and Large. Each quad had four potential coral attractant treatments on settlement plates: $CaCO_3$, iron, coral transplants, and control. Each module in a quad contained a different attractant. Fish counts were conducted quarterly (January, April, July, October) for three years. During the study, fishes comprised of 166 species from 40 families were counted. Twenty-six species accounted for 90% of the fish counted with bluehead wrasse (*Thalassoma bifasciatum*), juvenile grunts (*Haemulon* spp.), and slippery dicks (*Halichoeres bivitattus*) making up over 55% of the fishes counted. Fish abundance and species richness were significantly less on Empty treatment quads than the other three treatments while species richness was less on the Empty and Small treatments than the Mixed and Large. Because of low coral recruitment rates, a single survey was conducted at the end of the study period to record the number and species of coral recruits. A total of 186 coral recruits were counted on a sub-sample of modules. *Porites astreoides* was the most abundant recruit (47.8%) followed by *Agaricia agaricites* (13.4%). Coral recruits were categorized by size and, based on an assumed 12 mm/yr^{-1} coral growth rate, separated into year classes post reef deployment. Size classes were then compared with fish abundance data. Correlations were found with Year 1 coral recruits and daelfishes (Pomacentridae), reef butterflyfish (*Chaetodon sedentarius*), and grunts (*Haemulon* spp.). Additionally, correlations were found between Year 3 recruits and all fish species combined, and between Year 4 recruits and reef butterflyfish. Thirty coral recruits were counted on the settlement plates, with *P. astreoides* making up over 63% of the recruits. Due to the low number, rigorous statistical analysis could not be performed on the data; however, $CaCO_3$ plates had almost twice the number of recruits than the other attractants. Recommendations from this study include design of artificial reef with holes and shadowed refuge, placement of reef near natural hard-bottom or reef, and use of limestone aggregate to enhance coral recruitment. Additionally, coral transplantation may be an effective coral recruit attractant, but care should be taken in transplant species selection and collection methodology.

Texas Clipper Ship Artificial Reef Project: A Case Study

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The *Texas Clipper* ship began life as the USS *Queens*, a World War II attack transport ship. Shortly after the end of the war, the USS *Queens* was modified into a high end cruise liner and renamed the SS *Excambion* within the Four Aces fleet. After it completed it's time of service as the SS *Excambion*, the vessel was then turned over to Texas A&M University for use as a maritime training ship and was again renamed as the *Texas Clipper*.

In 1997, TPWD committed to acquire the Clipper ship for use as an artificial reef. In 1999 an initial application was submitted to the US Maritime Administration (MARAD). However, for various reasons the project was delayed until 2003. After another application submission and a hazardous materials survey, the reef site was permitted by the US Army Corps of Engineers in 2005.

A third application was submitted in 2006 to MARAD and while awaiting the decision, the Clipper sunk on her stern in the harbor. TPWD worked with the Texas Governor's Office and MARAD to raise the ship and patch the hole. After the ship was repaired, the US Environmental Agency (EPA) approved TPWD's cleanup plan. Resolve Marine Services, Inc was awarded the contract to tow and reef the vessel. ESCO Marine, Inc was then subcontracted for the overall clean-up and hull modifications. In November 2006, the *Texas Clipper* left Beaumont, TX for Brownsville, TX to begin remediation.

During the clean-up and remediation process all floatables, debris, asbestos, hydrocarbons, and PCBs were removed. Total materials remediated consisted of 327,952 gallons of hydrocarbons and non-hazardous liquid wastes (bilge water, etc), 400,310 pounds of waste (oil sludge, PCBs), and 3,090 cubic yards of solid materials (asbestos, debris, and floatables).

After clean-up, the ship was modified for reefing so that as much of the physical structure and detail remained as possible. All vertical structures were partially cut to allow for the required 50 foot clearance over the ship. Large openings were cut along upper decks to allow for water circulation and diver access. Interior spaces were cleared to prevent entanglement and allow for diver access. Over 700 tons of metal was removed during the process.

Within the permitted reef site, the top of the vessel was designed to be 50 feet below the surface, making it a fairly shallow dive. Controlled flooding was used to reef the ship rather than explosives. Weather conditions adversely affected the reefing of the vessel, for when the valves were opened the ship listed to the port side. The *Texas Clipper* lies on its port side, with the shallowest depth to the hull being 66 ft.

The University of Texas - Brownsville conducts biological monitoring on the *Texas Clipper* to provide supplementary data for evaluating increased recreational fishing, diving, and tourism. Dives are made to quantify the growth of the fouling community, collect specimens, measure water quality parameters, and the survey the fish community.

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In Memoriam

The 2010 Artificial Reef Summit is dedicated to the memory of Chris Koepfer, the long-time Lee County Artificial Reef Coordinator who passed away in 2009. Chris was a well-respected member of Florida's artificial reef community and played a major role in establishing one of the most successful county artificial reef programs in the state. He is greatly missed by his family, friends, and colleagues.

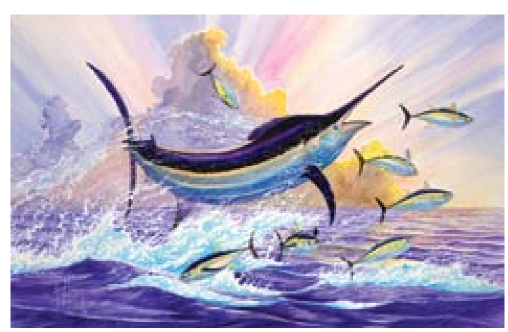
"Chris maintained one of the best examples of a comprehensive, county artificial reef plan, which we have often used as a template for other counties around Florida getting new artificial reef programs up to speed," said Keith Mille, an artificial reef coordinator with the Florida Fish and Wildlife Conservation Commission (FWC).

"As a member of the 2003 FWC Artificial Reef Advisory Board, Chris helped FWC develop our 2004 Florida Statewide Strategic Plan. He was also proactive in developing unique artificial reef designs, such as the Lee County red grouper modules, and the Lee County radio tower modules, now among the most popular fishing and diving sites in SW Florida," Mille said.

"Chris also acquired valuable materials of opportunity, such as limestone boulders and concrete bridge material. He was in the field as often as possible to follow up the county deployments with long-term monitoring to evaluate material and design performance."

"Chris was always to us a highly esteemed colleague and consummate professional. His opinion and insight on artificial reef issues was always greatly valued by us as was his friendship," said Mille.

Chris Koepfer Education Fund Raffle



A raffle to help support the future educational expenses for Chris's two daughters will be held during the summit.

The Guy Harvey Ocean Foundation has generously donated original artwork signed and numbered by the famous artist to support this endeavor.

This giclée print, titled "Bases Loaded," is valued at $500. Summit attendees will have the opportunity to win it as well as other signed and numbered artwork by Harvey, Jim Barry, and other artists -- all while supporting a worthy cause. Raffle tickets are available at the summit for only $20 each, or $30 for two tickets. Entry into the raffle also entitles attendees to win other artwork and prizes!

Conference Sponsors

These organizations are contributing to the research and outreach that supports the wise development of artificial reef programs and sustainable management of Florida's marine fishery.

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