ARTIFICIAL REEF STUDY REPORT

Completed by the

Sanctuary Advisory Council

Artificial Reef Working Group,

Flower Garden Banks National Marine Sanctuary

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Submitted to the Flower Garden Banks

National Marine Sanctuary Advisory Council

ARTIFICIAL REEF STUDY REPORT

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1.1 BACKGROUND FOR THE ARTIFICIAL REEF STUDY

Substantial installations of oil and gas platforms in the northern Gulf of Mexico began in the 1950s. Currently there are an estimated 3000 platforms off the coasts of Texas and Louisiana. Of that count, approximately 330 are off the coast of Texas and roughly 2700 off of Louisiana. The oil and gas industry projects the majority of these platforms will be removed in the next 10 to 20 years. Platform removal of this magnitude destroys a thriving artificial reef environment that has been beneficial to marine life and "user groups" (fishermen, divers, boaters, researchers, and others) since platform installation began.

According to the oil and gas Industry, the main reasons for platform removals are:

- Depletion of reserves in existing fields
- Typically smaller reserves in new developments
- Unstable oil and natural gas prices
- New view of hurricane risk
- Difficulty obtaining affordable platform insurance
- Potential new oil and gas taxes
- Idle Iron policy requirements enacted by Federal Gov't after Katrina

The longstanding debate of whether artificial reefs attract or produce life has generally been resolved. Most marine scientists agree now that artificial reefs both attract and produce marine populations. The following is the definition of "A Reef" as described by Dr. Quenton Dokken, CEO of The Gulf of Mexico Foundation: He says a reef functions in three ways:

1) It accumulates energy and nutrients via photosynthesis, recruitment, and the food web.
2) It diversifies and magnifies energy and nutrients through biodiversity, growth, and reproduction.
3) It exports energy and nutrients through emigration, reproduction, and the food web.

Dokken contends many platforms in the Gulf of Mexico clearly meet this definition.

There are dozens of natural banks in the northern GOM and at least three bona fide coral reefs (East and West Flower Garden Banks and McGrail Bank). However, none of these natural formations provide tropical habitats at depths shallower than 55 feet, as the numerous artificial platform reefs do. Also, it's reasonable to suggest the many ARs may actually support further development of corals on the natural reefs in the GOM or at least provide "resilience" by providing an external source of recruits. There is no debate that many of the ARs serve as biological "hot spots" in locales where no natural banks exist.

Currently, only one platform exists in Flower Garden Banks National Marine Sanctuary (FGBNMS), High Island A-389A, owned by W&T. It is an 8-pile structure installed by Mobil Oil in 1981 approximately a mile south of the East Flower Garden Bank reeftop. When the FGBNMS boundary was implemented in 1992, it wrapped around HI-A389A thus including it inside the sanctuary. Plans are now in place to consider future expansion of the FGBNMS that can likely add at least two more platforms to the sanctuary (HIA384 at West FGB and WC663 at 28 Fathom Bank).

This Artificial Reef Study examines the impacts of removal of platforms within the FGBNMS and alternatives to full removal. Five different options were examined:

1. Full Removal
2. Leave essentially as-is, out of the water but less oil and gas processing equipment and systems.
3. Leave out of the water but only one deck at ~40 ft. No provisions for overnight stays.
4. Leave out of water with minimum structure to ~30 ft above sea level and no decks.
5. Cut structure below the waterline 40-85 feet.

Refer to Section 1.3 for the formally stated Purpose and Goals, but note that some of the key questions the Study addresses for each option are:

- What is best for the marine environment?
- What is best for the FGBNMS?
- What is best for the users/constituencies?
- What are the cost ramifications?
- What are the regulatory constraints?
- What are the permitting roadblocks?
- What is the expected life of an offshore structure?

1.2 BRIEF HISTORY OF SAC AR WG (Artificial Reef Working Group)

Preceded by a Platform Decommissioning Subcommittee from 2010 to 2011, The FGBNM SAC AR Working Group was established April 20, 2011 with Frank Burek as the Chairman. Frank put together a team, set goals and purposes, developed a Study approach, and established 14 different AR alternatives to study. In June 2012, the leadership of the AR WG transferred from Frank Burek to Jesse Cancelmo because Burek's SAC membership term expired. Frank Burek remained in the WG as a participant. At the time of this leadership transition, much information was collected and organized on artificial reefs and the foundation was set for a constituency/user "Survey" on artificial reefs in the FGBNMS. During Burek's tenure as chairman, 19 different AR coordination documents were distributed and several work sessions were conducted. At the time of leadership change, the make-up of the AR WG was as follows:

1. **Irby Basco** – (SAC Recreational Fishing)
2. **Frank Burek** – Ex-team leader (ex SAC Recreational Diving)
3. **Jesse Cancelmo** – (SAC Recreational Diving)
4. **John Embesi** –(FGBNMS staff) (ex SAC Research)
5. **Joe Hendrix** – (ex SAC Commercial Fishing)
6. **Will Heyman** – (SAC Research)
7. **John Hoffman** –(SAC Oil & Gas Operations)
8. **Mike Jennings** – (SAC Commercial Fishing)
9. **Daniel (Herb) Leedy** –(BSEE)
10. **Clint Moore** – (ex SAC Oil & Gas Operations)
11. **Rebecca Nadel** –(ex SAC Oil & Gas Operations, Shell)
12. **Ellis Pickett** – (SAC Conservation)
13. **Paul Sammarco**–(Louisiana Universities Marine consortium, LUMCON)
14. **James Sinclair** – (SAC BOEM)
15. **Frank Wasson** – (SAC Diving Operations)

Past participants: Emma Hickerson (FGBNMS Staff, AR Library)

At the May 9th, 2012 SAC Quarterly meeting a motion was made (by Cancelmo) and accepted (none opposed and none abstaining) regarding the disposition of HI-A389A platform in the sanctuary:

"The Flower Garden Banks National Marine Sanctuary Advisory Council endorses deferring removal activities of HIA-389-A until September 2013 to allow the sanctuary's Artificial Reef Working Group to gather further stakeholder input to make a recommendation to the council and sanctuary management. However, if

removal activities commence prior to that date the Sanctuary Advisory Council recommends leaving all or a significant portion of HIA-389-A in place."

Soon after Cancelmo assumed the AR WG leadership, due to a variety of reasons, the make-up of the AR WG changed as follows:

Adds to the AR WG: Cher Walker (Diving Operations) and Jorge Brenner (The Nature Conservancy).

Resignations from the AR WG: Frank Wasson (Diving Operations), and Rebecca Nadel (Oil & Gas Operations).

The key milestones that followed were:

- The SAC AR Survey for constituents to consider 5 options was conducted online from September 4 to October 1, 2012. There were 432 survey participants.
- Work sessions conducted on September 12, 2012 and October 11, 2012. Attendees at latter session included Dale Shively of TPWD and Marsh Armitage of W&T
- An "early" and special stand-alone recommendation for disposition of HI-A389A was made by the AR WG to SAC on November 14, 2012. The SAC accepted the recommendation for 389 partial removal and forwarded the recommendation to Sanctuary Management
- A special WG "work session" was held on January 9, 2013 **TBD** to make final determination of Study recommendations to SAC.
- The Final Report and recommendations were completed February X, 2013 **TBD** and sent to SAC.

1.3 PURPOSE AND GOALS

07August 2012

FGBNMS SAC – ARTIFICIAL REEF STUDY
PURPOSE and GOALS

Study Purpose: Develop alternatives to removing hydrocarbon platforms in Flower Garden Banks National Marine Sanctuary and make recommendations to the SAC and FGBNMS Sanctuary Manager.

Study Goals: The recommended alternative(s) will be developed by the Working Group using feedback and inputs from the SAC, Sanctuary Management and Sanctuary users/constituents. The Study and determinations will consider at a minimum the following:

- Maximizing benefits for the marine environment
- Maximizing benefits, access and usage by all stakeholder groups
- Order of magnitude costs for conversions and for annual maintenance
- Risks and Liabilities
- Federal regulatory implications

In addition, a critical goal is to complete this study prior to the start of any significant structural decommissioning activities at HI A-389A platform.

HI A-389A Platform - Location and General Description

Location: 129 miles SE of Freeport, TX
Water depth: 410 feet
Federal Lease: OCS-G-2759
8-pile drill and central production facility platform
Production deck size: 75’ x 74’ (Quarters and processing equipment)
Main deck size: 150’ x 75’ (Power generation and electrical switchgear)
Cellar: 150’ x 75’
Heliport: 45’ x 45’
Well slots: 18
Jacket designed by: Lawrence Allison
Deck designed/installed by: Brown & Root
Installed: October 1983
Initial production: September 1988
Initial Owner/Partner: Mobil Oil/Union Oil
Current Owner: W&T

2.0 ONLINE SURVEY AND RESULTS

An Artificial Reef Survey was conducted in September 2012. This survey, available online, was targeted toward all the FGBNMS user groups (Fishermen, Divers, Researchers, Educators, Oil and Gas Industry) but was also open to the general public. Survey notices were sent out via e-mail distribution by SAC members, former SAC members, Sanctuary Management and by Kelly Drinnen via the FGBNMS news/notice distribution list. The 9-question survey was open for 27 days from September 4 through October 1 and had 432 responses. The survey taker was shown the following prior to answering the questions:

As a sanctuary user with an interest in the future of Flower Garden Banks National Marine Sanctuary (FGBNMS), you are being asked to participate in a brief survey. This is an important feedback process that may assist with future decisions about artificial reefs within sanctuary boundaries. This questionnaire will be available online until October 1st.

High Island-A-389-A, the only oil and gas production platform inside sanctuary boundaries, is located about one mile from the coral cap at East Flower Garden Bank. Oil and gas production platforms are popular dive sites in the Gulf of Mexico. The hard surfaces of the support structure under oil and gas production platforms provide places for organisms to attach and form artificial reefs. Platform HI-A-389-A was installed in 1981, many years before the sanctuary was designated.

The FGBNMS council is an advisory group to the Superintendent of FGBNMS. The public is represented by two voting representatives for each of the following seats: recreational diving, diving operations, recreational fishing, commercial fishing, oil & gas operations, research, education and conservation. The following governmental agencies provide non-voting representatives to our council: Bureau of Ocean Energy Management (Department of the Interior), United States Coast Guard, NOAA Fisheries (Department of Commerce), Environmental Protection Agency, and NOAA Office of Law Enforcement.

As an advisory council, statements contained in this questionnaire reflect the interests of its "voting" members. This questionnaire does not necessarily reflect the position of the council's non-voting governmental members, Flower Garden Banks National Marine Sanctuary, the Office of National Marine Sanctuaries or that of the National Oceanic and Atmospheric Administration.

The results of the survey in summary and for each question asked are as follows:

ARTIFICIAL REEF ONLINE SURVEY RESULTS

(432 Participants over 27 day period, Sept 5 to October 1, 2012)

Chart 1 (Survey Question 1) – Interest/User Group:

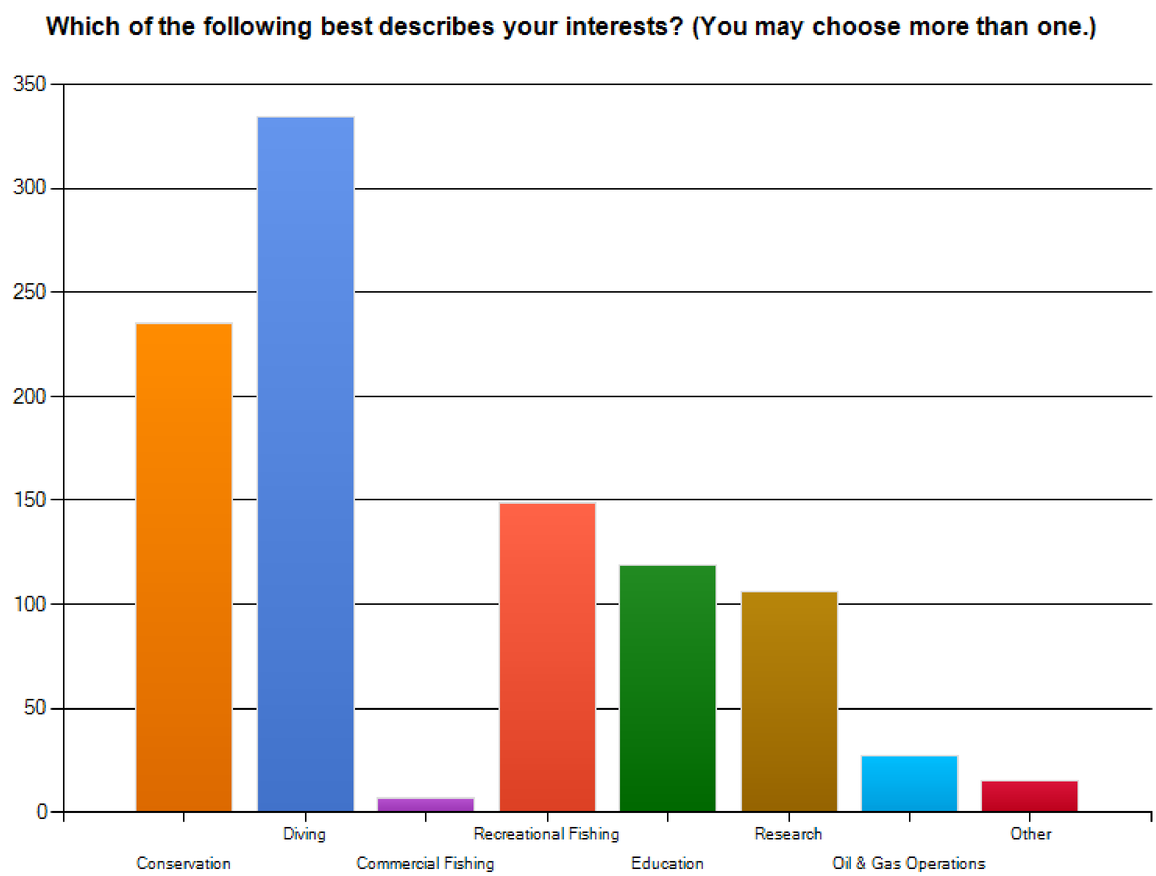


Chart 2 (Survey Question 2) – Use of HI A-389A:

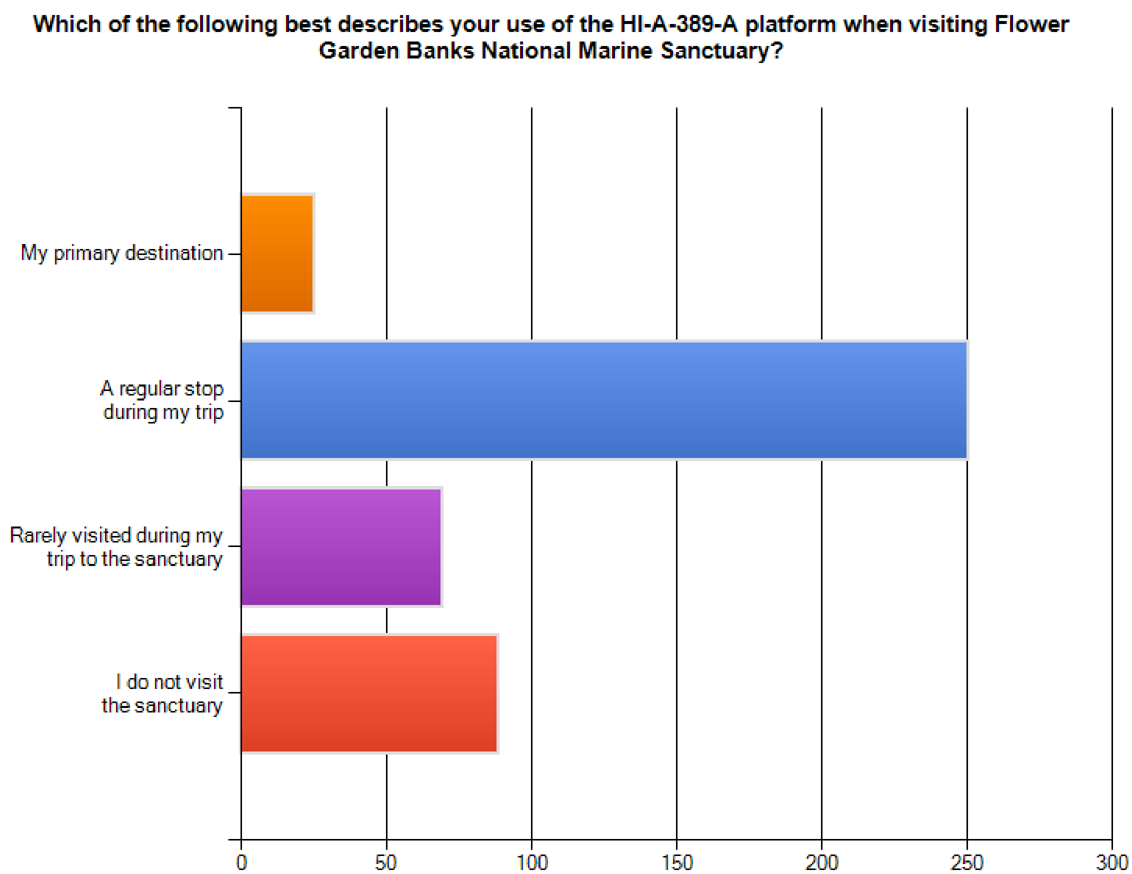


Chart 3 (Survey Question 3) – For Retaining AR in the Sanctuary:

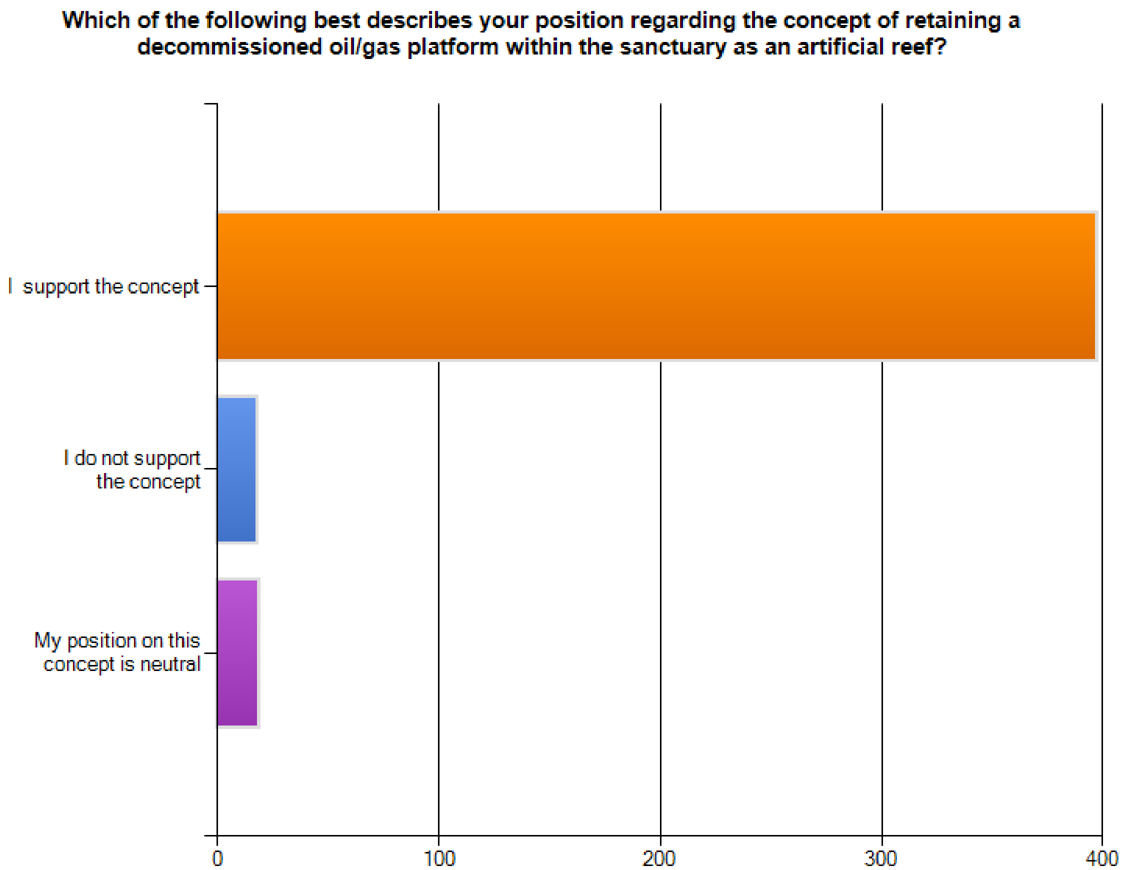


Chart 4 (Survey Question 4) – Option Ranking

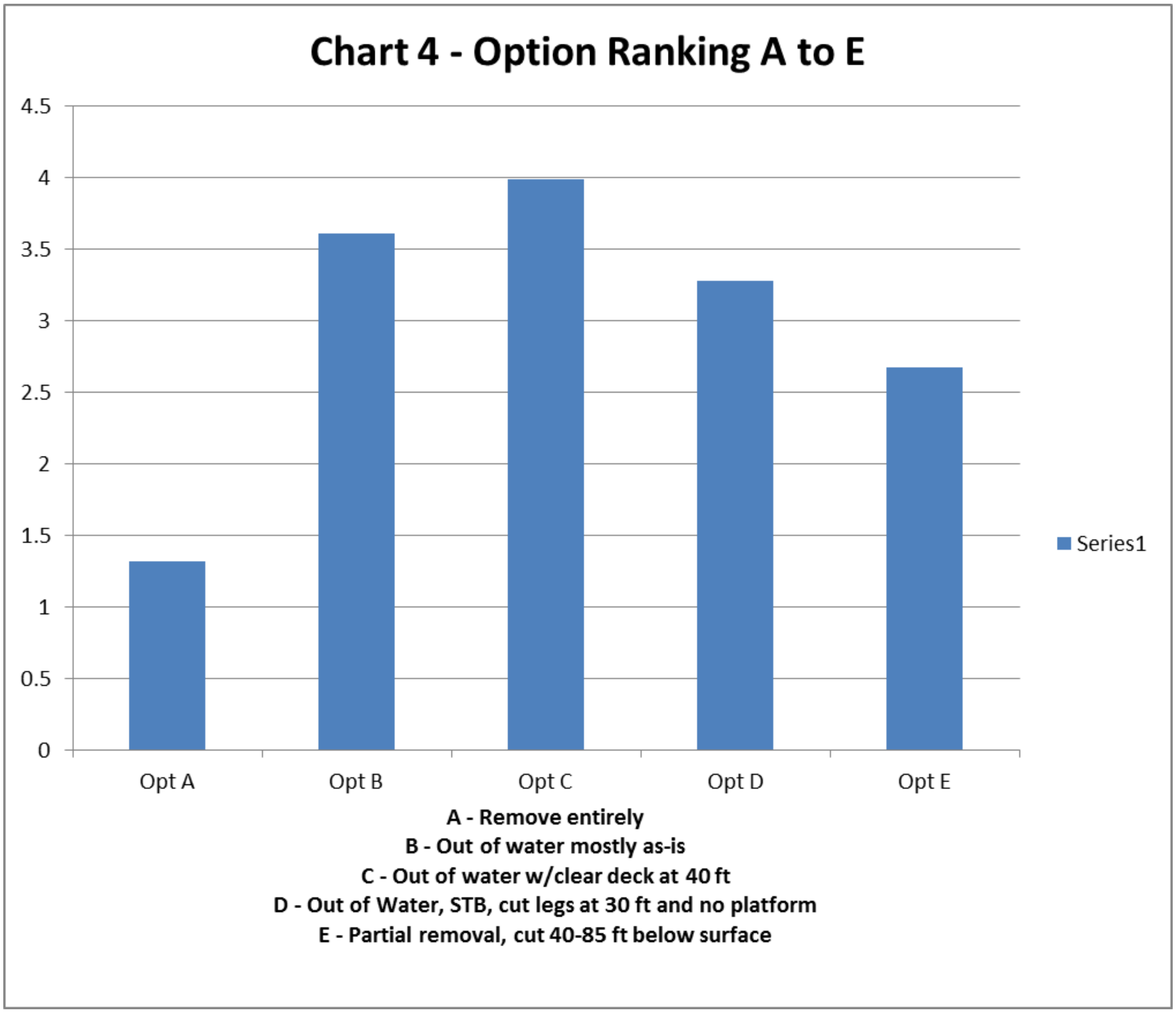


Chart 5 (Survey Question 8) – Safety Concerns

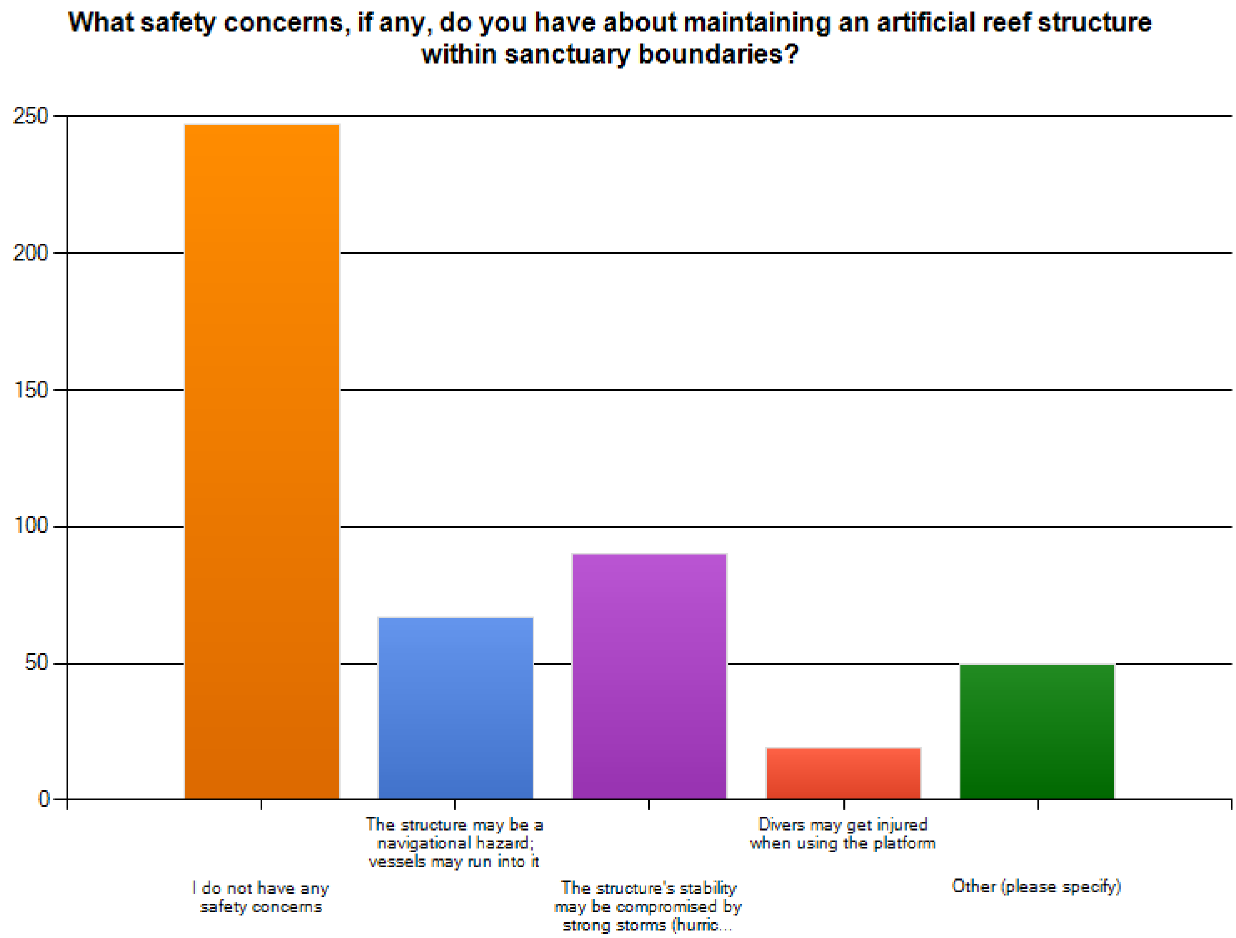
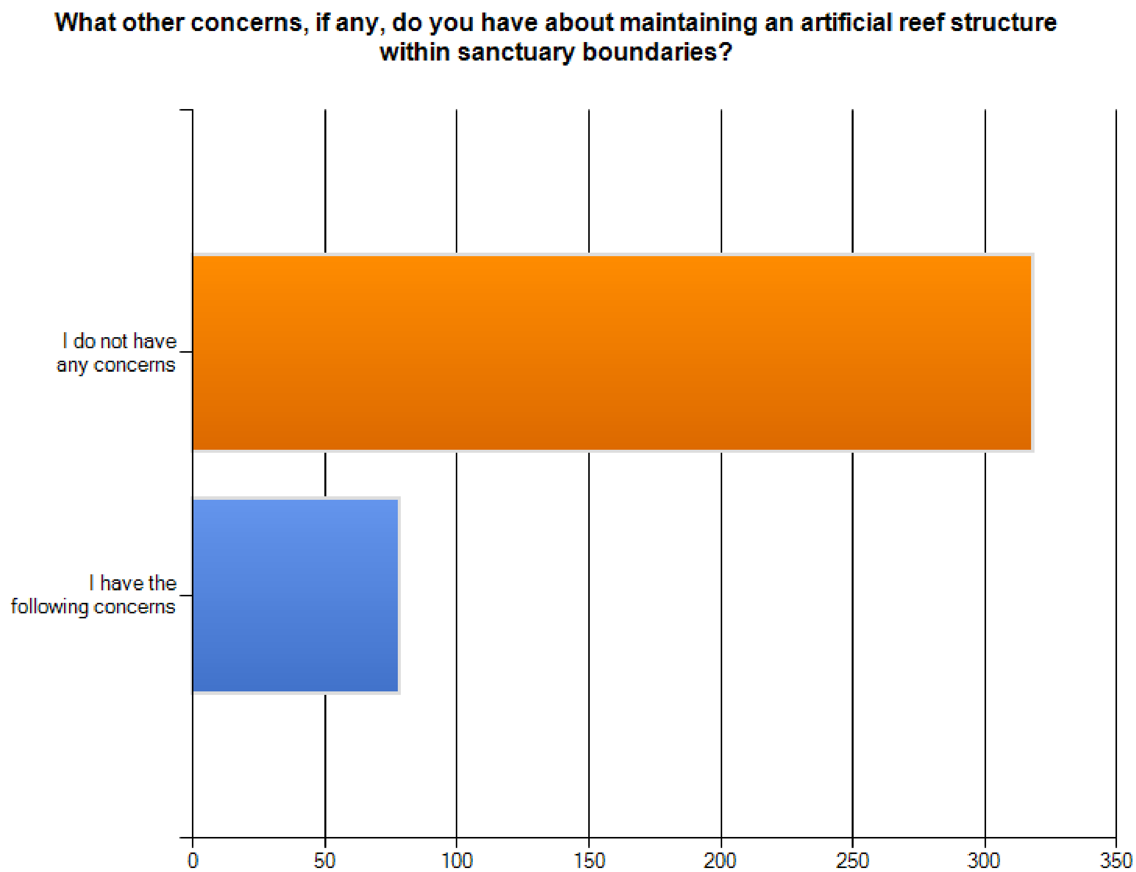


Chart 6 (Survey Question 9) – Other Concerns



COMPILATION OF # OF RESPONSES Q5 and Q6

Q5 – If you ranked "A" (full removal) as most desired option explain why (46 responses)

Leave Natural/Clutter concerns: 11

Invasive species threat: 3

Cost and Liability: 3

Hazard to natural reef: 1

Note: numerous "leave-in-place" comments made in this section

Q6 – If you ranked "B", "C", or "D" (all out-of-water) options as preferred, explain why (276 responses)

Best for Marine Life: 95

Safe haven/tie-off boat/point of reference/day or overnights stay: 44

Research and Education Potential: 38

Emergency evacuations: 30

Dive destination: 14

Best for Users, divers/fishermen/tourists: 12

Take Pressure off Natural Reefs: 2

Note other reasons included NOAA weather station and place for migratory birds.

COMPILATION OF # OF RESPONSES Q7 and Q8

Q7 – "E" as preferred option, optimum depth and why (59 responses)

40 ft (or 30-40 ft): 19

50 ft: 4

85 ft: 2

Leave in place fully: 2

12 ft, 60 ft, 75 ft: had one response each

Q8 – Other Safety Concerns (50 responses)

Navigational hazard/lighting and buoys: 12

Structural deterioration: 7

Cost/liability: 3

Invasive species: 2

Waste/trash: 2

All others: divers, threat to natural reef, fish community, etc: one response each

COMPILATION OF # OF RESPONSES Q9

Q9 - Other Concerns (78 responses)

Cost: 20

Structural Integrity/Deterioration: 12

Invasive Species: 8

Removal Destroys Life: 7

Hazard, risk for accidents: 5

Trash, waste problems, environmental hazard: 5

Burden on Sanctuary or Law Enforcement: 2

Lost dive site: 2

Vandals/Poaching: 2

All others, sediment contamination, disrupt tidal pattern, need safety stds., too many visitors, etc: one each

SURVEY MAJOR CONCLUSIONS

* 92% Responded to keep artificial reefs (ARs) in Sanctuary

*Most preferred option "C" - out of water with a single deck ~ 40 ft above sea level.

3.0 ADDITIONAL INPUTS – DATA & EVALUATIONS

This Study section provides data and evaluations covering essential comparative factors for the various artificial reef options. AR WG "Champions" representing their areas of expertise or having the appropriate resources, took on the responsibility to complete inputs for these critical areas of input to the Study.

3.1 Marine Life: Heyman and Sammarco

3.2 Cost Comparisons: Moore and Hoffman

3.3 Regulations: Leedy, Sinclair (and Tim Boriskie via Cancelmo e-mail)

3.4 Permitting: by Schmahl and BSEE

3.5 Life of Structure: Cancelmo

3.6 Risk Register For Out-Of-Water Structure: Cancelmo

3.7 Out of Water Options – Obstacles and Potential Resolutions: Cancelmo

3.1 MARINE LIFE

Biological Impacts of Decommissioning Oil and Gas Platforms
within Flower Garden Banks National Marine Sanctuary

18 January 2013 (revised with Sammarco edits)

Will Heyman and Paul W. Sammarco

Abstract

There are presently around 3,200 oil and gas platforms in the Gulf of Mexico (GOM) and these, together form the largest artificial reef complex in the world. Many of these have surpassed their productive life and, according to federal regulations, are being removed with increasing frequency (Kaiser and Pulsipher, 2005). This study evaluates and models the biological impacts of various removal scenarios for oil and gas platforms in the Gulf of Mexico with focus on Flower Garden Banks National Marine Sanctuary.

Introduction

Oil and gas platforms in the Gulf of Mexico (GOM) collectively form the largest artificial reef system in the world. Prior to their installation, started in the 1940's, the shallow GOM ecosystem was dominated by relatively barren, mud, clay, silt, and sandy seafloor with overlying waters increasing in depth to about 400 feet, and then plummeting to abyssal depths. The main exception to this general morphology includes the various salt domes that protrude from the underlying sea bottom near the shelf edge, forming deep offshore banks (Rezak et al., 1985), which provide much the natural hard substrate in the northern Gulf of Mexico (Parker et al., 1983). Two of the few banks that reach sufficiently shallow water to support true coral reefs are the East and West Flower Garden Banks ~120 mi SE of Galveston, TX, at the edge of the continental shelf (Figures 1 and 2; Sammarco et al., 2004). The Flower Garden Banks are the shallowest natural reefs in the northern Gulf of Mexico and occur in depths of ~ 55-70' (17-21 m) and harbor diverse and abundant coral communities dominated by large (up to 3m) colonies of boulder and brain corals with roughly 50 % live coral cover at 30m (Schmahl et al., 2008). Indeed, natural hermatypic coral diversity (21 species) and density in the northern Gulf of Mexico both appear to be centered on the East and West Flower Garden Banks (Figures 3 and 4; Rezak et al. 1985; Schmahl et al., 2008; Sammarco et al., 2012a).

The addition of thousands of oil and gas platforms in the Gulf of Mexico has increased the amount of hard substrate by a total of approximately 12 km^2 (LGL 1998) which compares to ~ 2,780 km^2 of natural reef habitat that has been estimated to occur within the 18 to 91 m depth range between Pensacola, Florida and the Texas-Mexico border (Parker et al. 1983). Petroleum platform habitat is thus on the order of about 0.4% of the area of natural reef habitat; perhaps substantially less considering the differences in total area and the depth ranges covered by Parker et al. (1983) and LGL (1998). Because of their configuration however, the platforms serve as a very large series of "islands" in the northern Gulf of Mexico, reaching from the sea bottom to the surface and thus providing the only hard substrate habitat shallower than 17 m in shelf-edge region of the northern Gulf of Mexico.

It has been argued that the expansive system of artificial reefs has created substantial contributions to the fish productivity of the Gulf of Mexico ecosystem. Platforms support 20-50% higher fish density than soft mud bottom areas directly around them (Kasprzak, 1997). Rooker et al. (1997) found that fish faunal assemblages were largely similar on platforms and nearby natural reefs of the Flower Garden Banks, though seasonal densities of semi-pelagic species e.g. scombrids (tunas and mackerels) and carangids (jacks) where far higher around platforms than associated natural reefs. The value of oil and gas platforms as expanded habitat for red snapper (*Lutjanus campechanus*) has been suggested (Shipp and Bortone 2009) but hotly debated (Cowan et al., 2010). That is, while it is clear that the platforms increase the catchability of fish and are thus attractive for fishermen, they may also attract predatory fish and increase fishery harvests and thus reduce overall biomass. The role of artificial reefs, particularly oil and gas platforms in fisheries production (versus attraction) remains an unanswered but crucially important question.

Nonetheless, because of their biological diversity, high fisheries productivity and catchability, and accessibility for shallow diving, platforms have become important destinations for recreational divers, as well as recreational and commercial fishers (Kolian and Sammarco, 2005) throughout the Gulf of Mexico, and particularly those that are close to the Flower Garden Banks. Indeed, HIA-389A is well known as one of the best dive sites on the most common dive charter trips in the Gulf (Fling Charters, pers. comm.).

In addition to fish diversity and abundance, platforms support diverse and abundant fouling communities that include hard and soft corals, mobile invertebrates, and many cryptic fishes that find protection within the fouling communities. Platforms are installed as bare or coated metal but are rapidly colonized by sessile organisms such that diversity, abundance, density, and rugosity of the fouling communities increase as a function of time *in situ* (Bright 1991; Kasprzak, 1997; Boland 2001; Sammarco et al., 2009; 2012 a,b; 2013). While oil and gas platforms have much less diversity, abundance and smaller colony sizes of hermatypic corals than exist on nearby natural reefs of the East and West Flower Garden Banks, they continue to provide unique and potentially valuable marine habitat.

Yet according to existing legislation, oil/gas platforms must be decommissioned, plugged abandoned, and removed in their entirety, after production ceases or they are "no longer useful" for oil and gas production (BOEM 2012). With appropriate cathodic protection, however, these artificial reefs might stay intact for hundreds of years. Nonetheless, the number of platforms that have ceased to be productive has increased rapidly in recent years (Figure 6). There are over 700 structures currently scheduled for removal. Approximately 25% of these will be removed in the next five years and the rate of removal is high and increasing (Figure 6). Several platforms have been installed within and around the existing and expanded Flower Garden Banks National Marine Sanctuary and their fate is the subject of this study.

There exist various options for decommissioning and removal. Some strategies include complete removal and using the structures to create artificial reefs that are away from the site of the existing platform, and instead installed within designated "Rigs to Reef" areas. While this option might have great ecological value for the new site, and monitoring is underway to address this question specifically, it is not part of the present analysis, which focuses on ramifications for existing sites, near and around the existing and proposed expanded boundary of the FGBNMS. The primary and available decommissioning strategies are: 1) Total removal, 2) Toppling in place, 3) Partial removal at depth (85 feet 65 feet, 40 feet), and 4) Remain intact with a portion above the waters' surface.

The objective of this study was to evaluate the possible biological impacts of various decommissioning strategies for those platforms within the existing and proposed boundary expansion of the FGBNMS.

Material and Methods - Summary

This study summarizes and synthesizes results from other studies. First, we identified and catalogued the existing platforms within the existing and/or proposed expanded sanctuary boundary. High Island A389-A is the only platform that exists within the current boundary of the FGBNMS. The recommended expanded boundaries (Figure 2A) would encompass two additional platforms, HIA384 on the West Bank and WO663 at 28 Fathom Bank (Figure 2B). HIA371 at Rankin Bank has already been removed (Sanctuary Advisory Council, 2007).

HI A389-A is perhaps the best-studied individual platform in the Gulf of Mexico (Boland et al., 1983; LGL, 1998; Boland 2001). But even for 389-A, data are relatively sparse. As a proxy for the species that *might exist* on platforms near the East and West Flower Garden Banks, species lists for the natural reefs of the Flower Garden Banks were compiled for sessile organisms (Flower Garden Banks NMS, 2012a,b) and fish (Boland, 2001; Rooker et al., 1997; Gulf Productions, 2012) and supported by fish and coral biology databases (Froese and Pauly, 2009). This method produced a list of seventy-five fish species (Table 1) that were defined based on species' depth range, status on the IUCN Red List, and specific threats (Furfey et al., 2012).

A biodiversity and habitat loss calculator was created based on the known depth ranges of both the fish and sessile organisms. The calculator output indicated species loss of 100% if the removal depth was greater than the maximum depth of the species. Otherwise, species loss was calculated as the percentage of lost habitat. The modeling method depends on the assumption of uniformity – i.e. that organisms are spread uniformly within their possible depth range and that species distribution is uniform between platforms (Furfey et al., 2012). The method provides an illustrative model of the biodiversity effects of platform removal strategy.

For coral, recent works by Sammarco and others have been summarized in answer to a variety of questions including: What species and densities are found on platforms? What are the depth ranges of corals on the platforms? What is the geographical and genetic distribution of corals on platforms? What is the ecological role of platforms in the resilience of native reefs through connectivity?

Results

Depth distribution of corals on oil/gas platforms

Hermatypic (reef-building) coral diversity and abundance are highest in the northern Gulf of Mexico near the Flower Gardens (Figure 3A,B). Hermatypic coral density is highest in the shallower regions of platforms (Figure 4A) but deeper regions support higher ahermatypic corals (Figure 4B) (Sammarco et al., 2004). This is primarily because reef-building corals are highly dependent on symbiotic zooxanthellae to support their survival and growth and are thus found in more shallow where there is more light.

Coral diversity, abundance, and species composition on platforms differs than on nearby natural reefs. Coral species documented on Platforms e.g. HI 389A include only *Madracis decactis, M. asperula, Diploria strigosa, Millepora alcicornis, Porites astreoides* and *Tubastraea coccinea* (G.P. Schmahl pers. comm.; Bright et al. 1991). Sammarco et al. (2012) found twelve species of corals on surveyed platforms (including those from an earlier study in the region; Sammarco et al., 2004) nine hermatypic/zooxanthellate corals, including a hydrozoan coral, and three ahermatypic/azooxanthellate species. They are listed here in order of abundance: hermatypic/zooxanthellate: *M. decactis* (Lyman, 1859), *D. strigosa* (Dana, 1848), *M. cavernosa* (Linnaeus, 1766), *Porites astreoides* (Lamarck, 1816), *Madracis formosa* (Wells 1973), *Colpophyllia natans* (Houttyn, 1772), *Stephanocoenia intersepta* (Lamarck, 1816), *Stephanocoenia michelinii* (Milne Edwards et Haime, 1848), and *Millepora alcicornis* (Linnaeus, 1758); hydrozoa; and ahermatypic/azooxanthellate: *T. coccinea* (Lesson, 1829), *Oculina diffusa* (Lamarck, 1816), and *Phyllangia americana* (Milne Edwards and Haime, 1849). For comparative purposes, the FGB are reported to have 24 species of hermatypic corals and 3 spp. of ahermatypic corals (Rezak et al., 1985; Schmahl et al., 2008; E. Hickerson, pers. comm.).

Biological Impacts of Decommissioning Scenarios – Summary of modeling studies

Total removal of platforms (for placement onshore or in a designated Rigs to Reef area on the sea bottom) can be equated with total loss of artificial reef habitat and associated organisms at the existing platform location. This would include total loss of high season densities of scombrids and carangids (Rooker et al., 1997) that are of interest for fishers and divers.

Toppling in place can be equated with near total loss of coral and other sessile invertebrates and most demersal and pelagic fishes since fragile habitat in the upper photic zone (< ~ 85') would suffer damage during toppling and not be sustained in the deep (>300 feet) waters near the base of the platforms. (This habitat loss also pertains to platforms donated to and installed within existing Rigs to Reef programs, though new habitat will be created and re-colonized in that new location).

Removal at depth will sustain some biological benefits and diversity of the artificial reefs but there is increasing loss with increasing depth of removal (Figures 7,8,9 and Table 1). Using a model based on proxy species lists for platforms in the area, and the respective habitat ranges for each of these species we calculate:

> Removal at 85 feet will reduce fish diversity by 40% and sessile organism diversity by nearly 70% (Table 1 and Figure 7). The mean percentage habitat loss for all 127 species is 53% and habitat for 20% of the species will be removed completely (Figures 8, 9).
>
> Removal at 40 feet will reduce the mean percentage habitat loss for all species to 27% while percentage of species that lose their habitat entirely shrinks to just below 10% (Figures 7,8,9). While the impact of a 40 foot removal is less than that of deeper removal, there will still be many species of fishes and invertebrates that will be lost completely (Figure 6), and many others that will be heavily impacted (Figures 7, 8, 9 and Table 1).

Remain intact with a portion above water's surface will allow for the maximum maintenance of hard substrate habitat (albeit artificial) within the existing or proposed expanded boundary of the FGBNMS. It will also allow for possible future use of platforms as a possible research station to support monitoring, research, enforcement, and evacuation (via helicopter) within the sanctuary.

Summary Results

1. Platforms serve as the vast majority of "islands" in the northern Gulf of Mexico in that their structure connects the substrate with the water's surface and above. The shallowest natural reefs in the Flower Garden Banks are at 17 m depth. Platforms provide the only solid habitat between 17 m and the surface in the northern Gulf of Mexico.
2. Platforms have increasing fouling community density (including coral cover) as a function of age (time in the water). Natural reefs have been in place for tens of thousands of years while artificial reefs have been there no more than about 50 years.
3. The Flower Garden Banks are the center of hermatypic coral species diversity (24 species) in the northern Gulf of Mexico and the northernmost true coral reefs in the Atlantic. The banks harbor some of the healthiest coral reefs in the world with live coral cover over 50% in many areas and dominated by large, densely spaced boulder and brain corals.
4. Coral diversity, abundance, and species composition on platforms is very different than on nearby natural reefs. There are 9 species of hermatypic corals typically found on platforms (Sammarco et al., 2012) with *Madracis decactis* being the most abundant.
5. The only exception is the non-native Orange Cup Coral *Tubastrea coccinea.* Though some argue that *T. coccinea* is an invasive species, being propagated by high density populations on platforms, the species has become an integrated part of the benthic community in the western Atlantic, including the northern Gulf of Mexico. This issue requires further research.
6. Corals and fishes associated with oil/gas platforms share connectivity with nearby natural reefs via larval transport and adult migration (for fishes only), and thus serve as a possible refuge for reseeding and thus may contribute to natural coral reef ecosystem resilience in the area (Sammarco pers. comm.).
7. Those platforms near the edge of the continental shelf, that have been in place for 35 years or more, and that are located in and around a 45-60 km radius of the FGBNMS, generally have allowed development of diverse and productive artificial reefs for coral, other invertebrates and fishes, and are particularly valuable for marine eco-tourism and fishing industries.
8. Total removal equates to total habitat loss at the site; though habitat benefits may accrue to other sites if the structure is reefed elsewhere (e.g. within a designated reefing site.) Topple in place, which moves habitat from 20m depth to over 100m

depth destroys the shallow habitat benefits but creates new, deeper habitat near to the location of the existing structure.

9. Platforms provide important sites for marine research on a variety of topics.
10. A standing platform, outside of the water, could serve as an excellent platform for research but this opportunity would be lost if all platforms are cut below the surface or removed entirely.

Discussion

The issues surrounding artificial reefs in and around marine sanctuaries are complex and multi-faceted (Broughton 2012). One of the main questions has to do with the role of artificial reefs as attractors or producers of biomass and diversity. This question has been addressed with modeling studies (e.g. Carr and Hixon 2007) and theories about their importance for red snapper (e.g. Shipp and Bortone 2009; Cowan 2010) yet robust field experiments are rare and often inconclusive. Most can now agree that artificial reefs serve both as attractors and as producers depending on the taxa or species in question, the environment, and the spatial arrangement of natural and artificial reefs (Broughton 2012). Comparisons of fish faunal assemblages between artificial and natural reefs are confounded by the different sampling techniques required in these physically different habitats (Rooker et al., 1997). Further research on these issues is warranted.

Modeling studies completed by Furfey et al., (2012) and reported herein are based on species lists for the Flower Garden Banks, rather than for the platforms themselves and should be considered as illustrative of patterns in species composition with depth, rather than as absolute numbers of species lost at various depths. Further studies on the on the actual biological composition of platform and natural reef habitat are warranted.

Coral diversity and abundance is centered in the northern Gulf of Mexico around the Flower Garden Banks where 24 species have been documented. Platforms, however, maintain less diversity and a somewhat different species composition. It is not unusual that a platform, young or old, might have low coral cover, low species diversity, and a low coral density, particularly compared to natural reefs which have had experienced tens of thousands of years of natural evolution. The variance is high between platforms regarding their coral populations; *i.e.,* some have high populations and some have low ones. Population density is correlated broadly with platform age, although there are many other factors that might influence this relationship. Nonetheless, scleractinian corals are protected by international treaty and are currently under consideration for listing by CITES as threatened and endangered. It would be wise to survey and assess each platform prior to considering decommissioning and seriously consider the presence of members of this taxon as a potential signal for disallowing removal.

The major exception to the native coral species inventories and discussion in the results section regards the “non-native” Orange Cup Coral *Tubastrea coccinea.* Though some argue that *T. coccinea* is an invasive species (Schmahl et al., 2008), being propagated by high density populations on platforms,. This Indo-Pacific invasive species has been present in the western Atlantic since the 1940s. Its distribution is now extant, present from southern Brazil to the northern GOM and the Florida Keys. Recent surveys of competitive interactions between this species and other sessile epibenthic species on platforms indicate that these communities have reached an equilibrium (Figure 10), and that if any active competitive exclusion of species have occurred because of this new species, such are most likely no longer occurring. The species has become an integrated part of the benthic community in the western Atlantic, including the northern Gulf of Mexico. Indeed, it is the most abundant coral species in the Gulf of Mexico, and may now be considered as much a part of the community as any other species (P. Sammarco pers. comm.). In addition, in its native habitat of a natural reef setting, its competitive abilities are greatly reduced. It is only on artificial substrata, such as platforms, that its populations thrive.

The value of platforms for future research

There is unmatched research potential of the largest artificial reef system in the world. A few avenues for research are offered as examples.

1. Platforms provide optimal sites to explore the relationships between artificial and natural reefs via connectivity, seeding, adult, larval and juvenile recruitment.
2. Coral growth rates can be calculated and calibrated using radiocarbon dating and the known installation date of platforms (Roark et al., 2009).
3. Larval transport and recruitment studies that combine physical oceanography.
4. The role of platforms as attractors (e.g., red snapper) or producers (e.g., demersal species) of fish e.g. (Nowling et al., 2010; Szedlmayer and Shipp, 1994).
5. Studies on the differential potential effects of invasive species such as the orange cup coral, the newly discovered black cup coral, and lionfish on native species (e.g. Shearer, 2009; Sammarco et al., 2010, 2011, 2012a,b).
6. Platforms provide ideal sites for long-term monitoring of physical and biological indicators of ecosystem health.

Recommendations

From the biological perspective, we recommend that at least one platform should be maintained, fully or in part so as to allow the possible development of an offshore research station. In addition, since the platforms provide the only hard substrate habitat shallower than 17m in the vicinity of the Flower Garden Banks, we recommend further studies and long term monitoring of these platforms, to further evaluate their biological role. If all of the platforms are removed, this is no longer a possible avenue for study. Finally, we recommend that a strategy be designed to prioritize platform conservation plans and to ensure that at least some platforms are maintained as artificial reefs.

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Figure 1: Location of Flower Garden Banks National Marine Sanctuary within the Gulf of Mexico, at the edge of the continental shelf and in relation to depth contours (m). Position of oil platform HIA-389A within the East Flower Garden Bank also shown (star) (top figure from NOAA and bottom figure from Rooker et al.,1997).

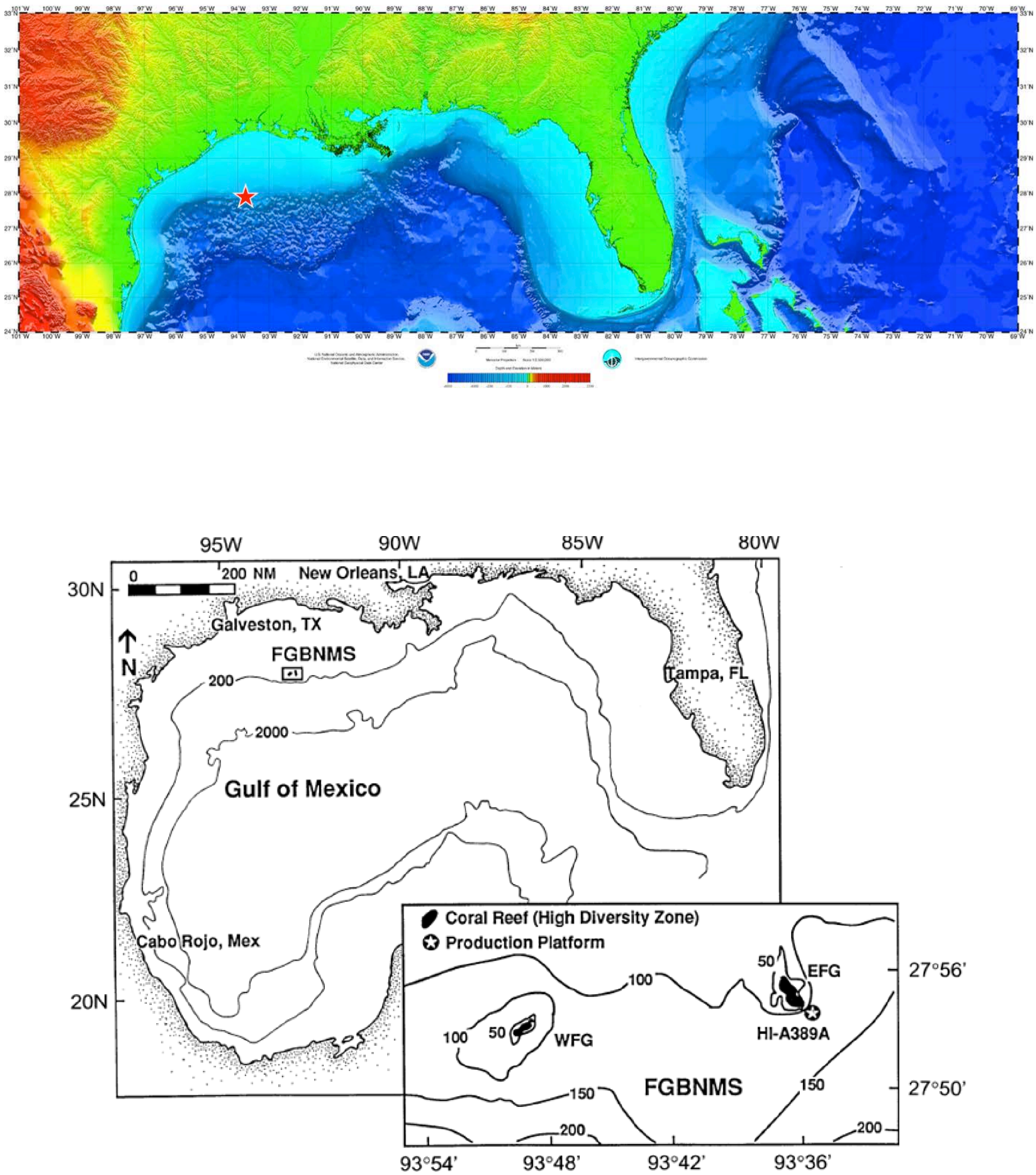


Figure 2: A) NOAA-FGBNMS - Sanctuary Advisory Council recommendations for proposed Sanctuary boundary expansion in relation to existing oil/gas infrastructure in the Gulf of Mexico (FGBNMS 2012)

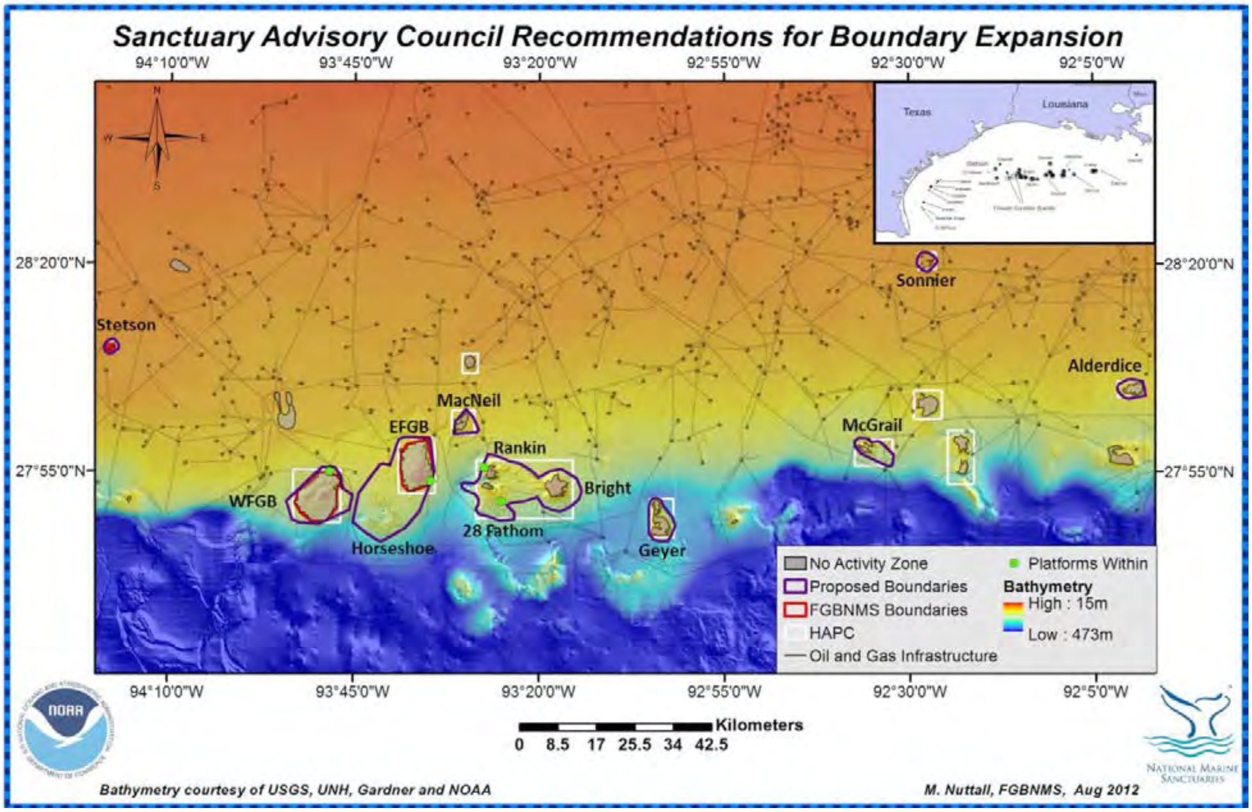
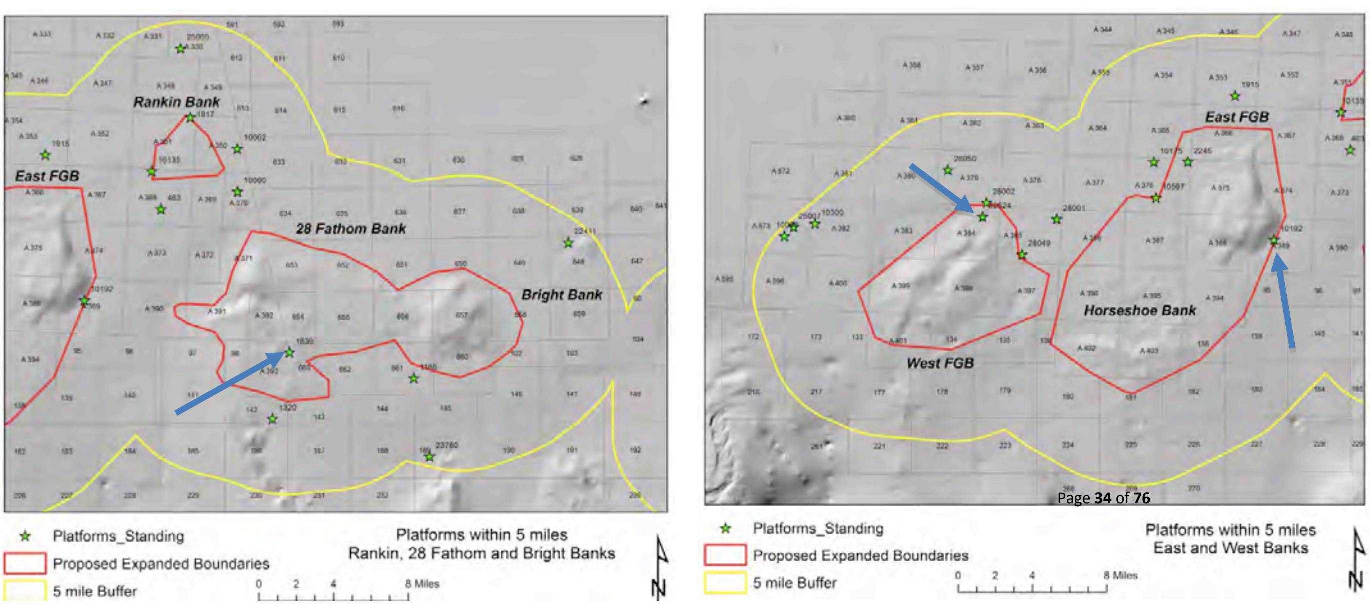


Figure 2: B) Platform locations in relation to proposed expanded boundaries. Blue arrows indicate platforms within existing or expanded sanctuary boundaries.



Total Hermatypic Coral Density – N. Gulf of Mexico

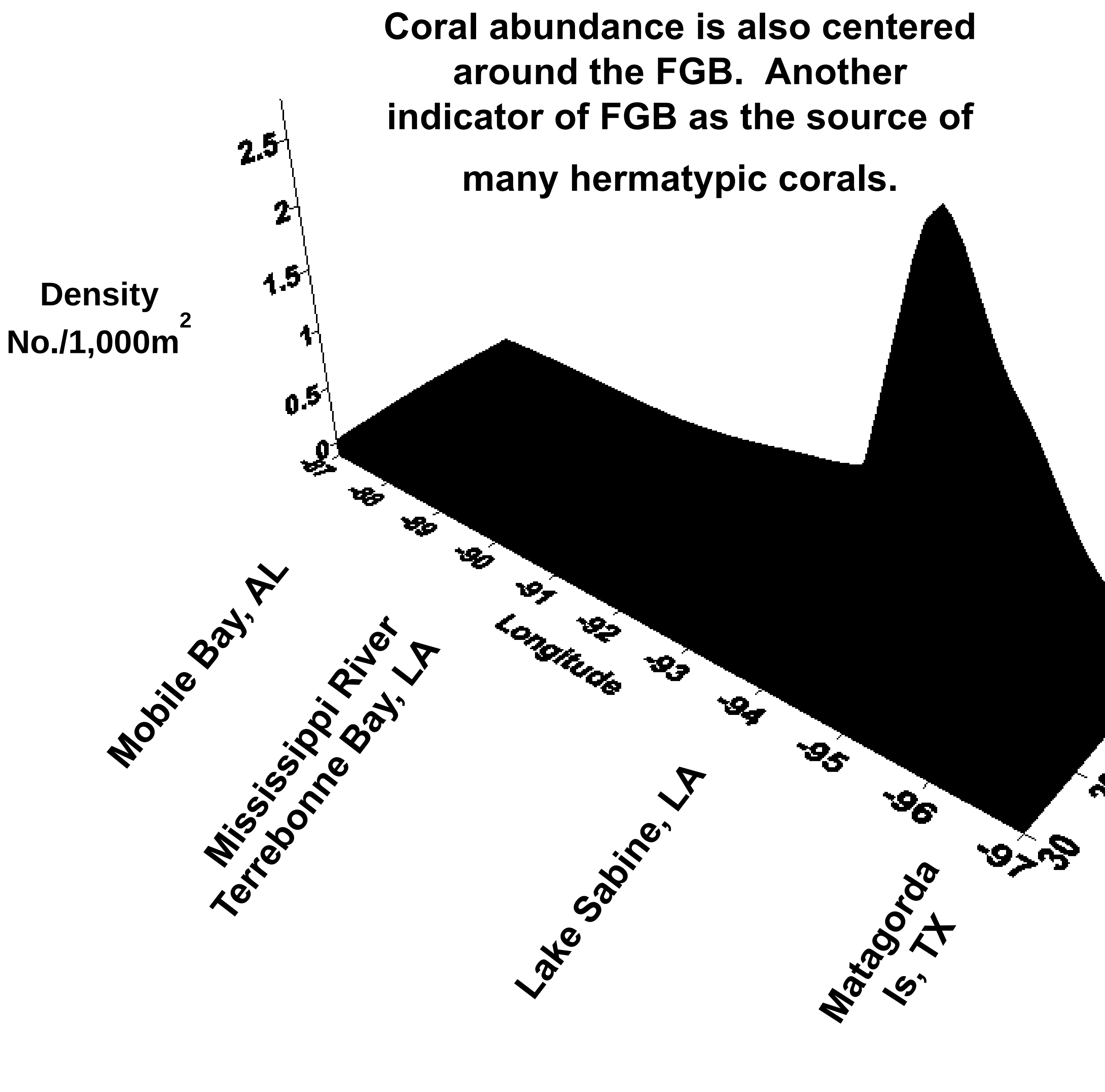


Figure 3A: Coral density in the northern Gulf of Mexico.

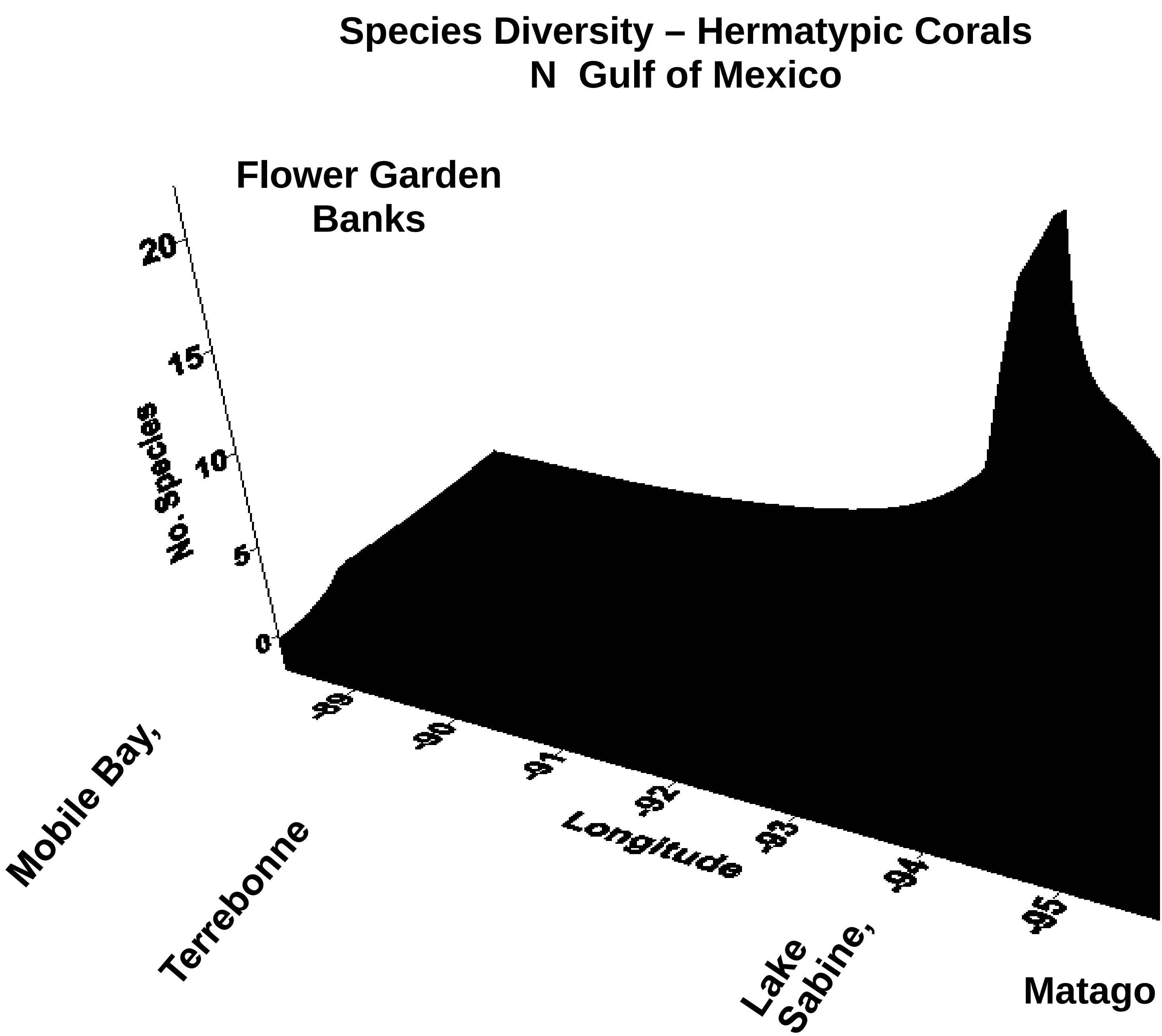


Figure 3B: Coral diversity in the northern Gulf of Mexico.

Reef-building coral diversity is centered around the Flower Garden Banks, indicating that corals most likely come from there.

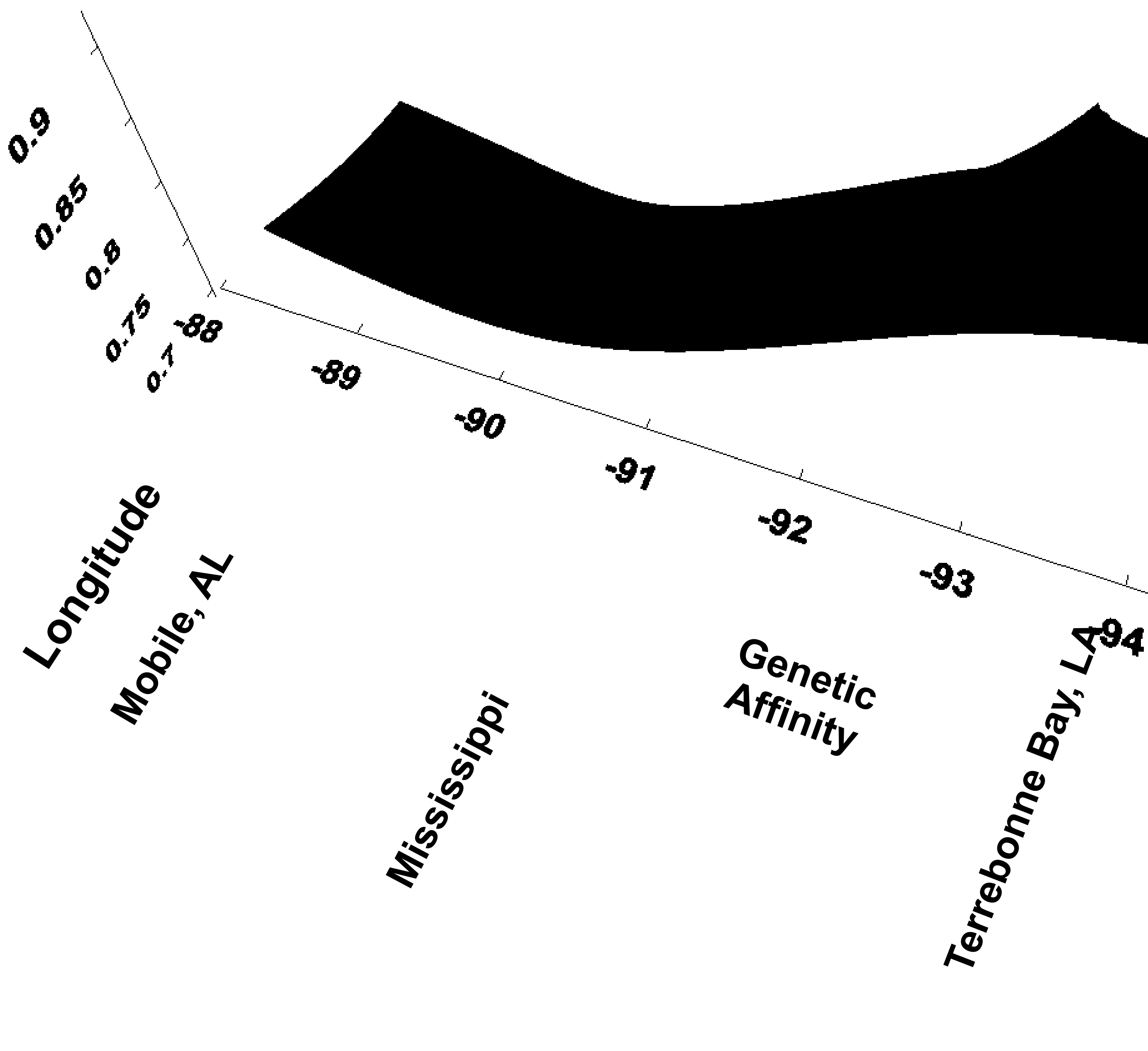


Figure 3C: Genetic affinities between populations of the coral *Madracis decactis* in the West Flower Garden Banks and nearby platforms in the northern Gulf of Mexico (Sammarco et al., 2012b**).

4A. Depth distribution of a hermatypic coral (*Madracis decactis*) on platforms in the region of the Flower Garden Banks. Note that the depth distribution of this coral peaks at ~30 m, falling off sharply after that. (Sammarco et al., 2004)

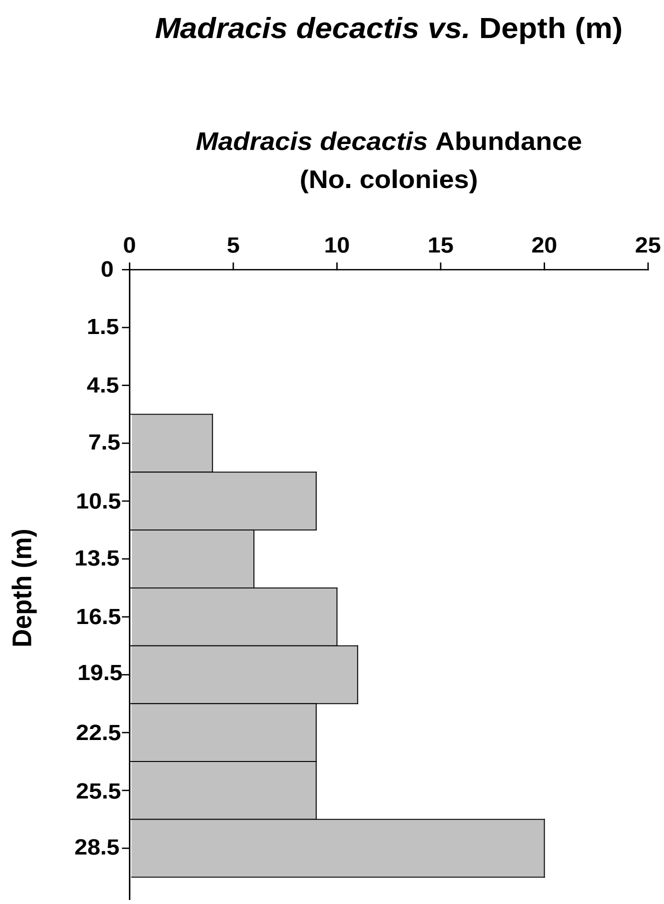


Figure 4B. The depth distribution of an ahermatypic coral (*Phyllangia americana*) on platforms in the northern Gulf of Mexico. The right-hand figure shows that on standing, undisturbed platforms, the maximum depth of distribution is 85 m (280'). (Sammarco et al., 2011)

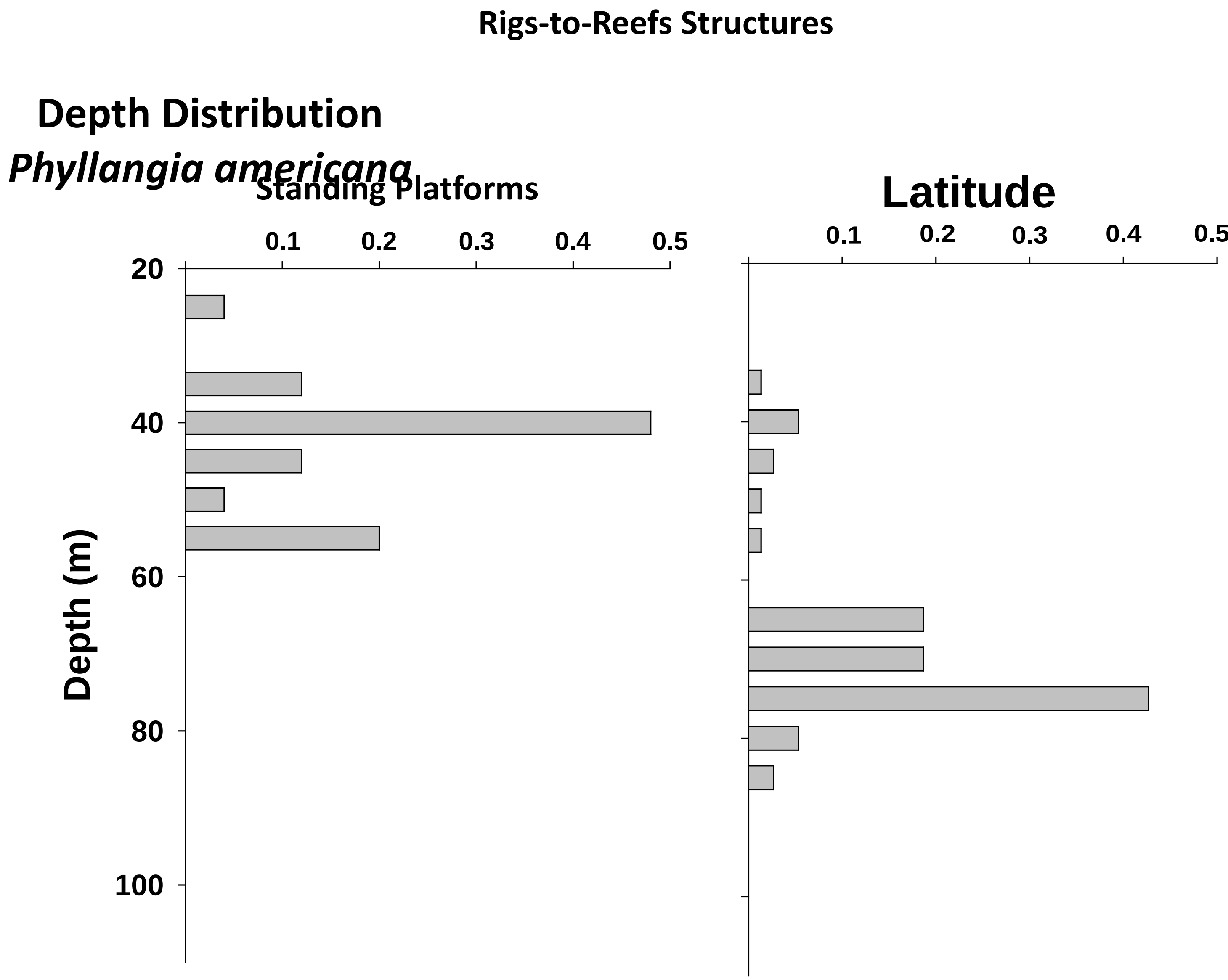


Figure 5. A. General structure of an oil/gas platform. Platforms extend from the bottom, through the water column, into the atmosphere and thus creating a true island. http://www.consrv.ca.gov/dog/picture_a_well/offshore_platform.htm

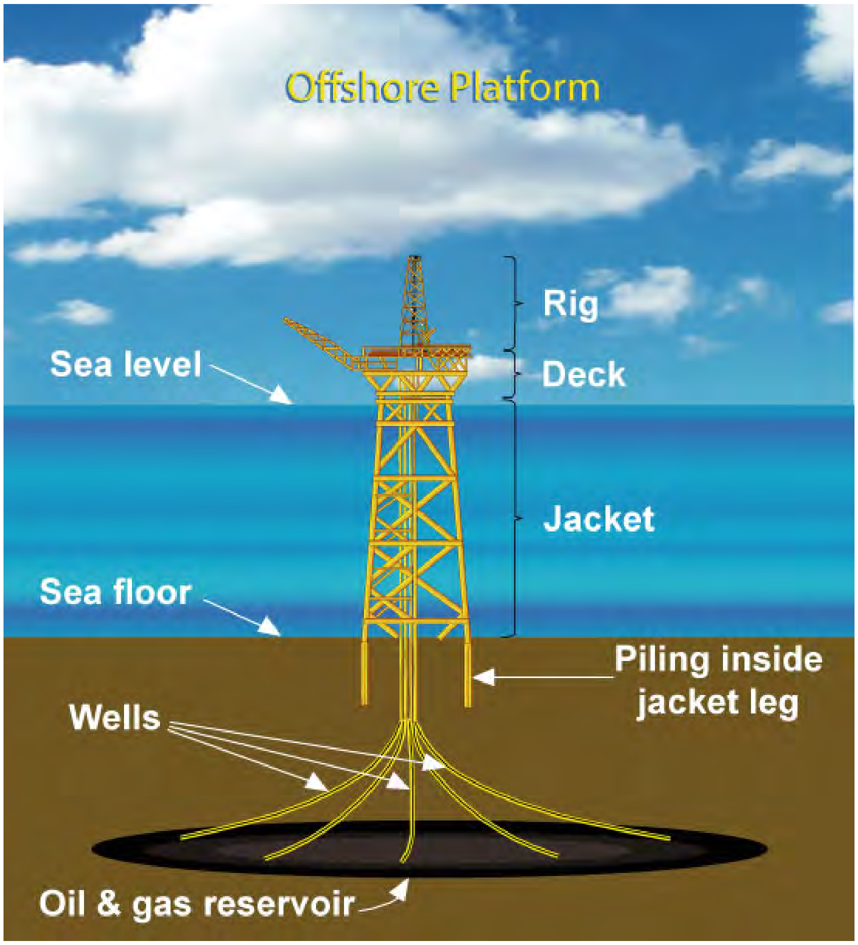


Figure 6. Oil platform installation and removal over time (from Apache 2012). Installation started in the 1940s and rapidly increased. We have now entered a phase of increasingly rapid removal.

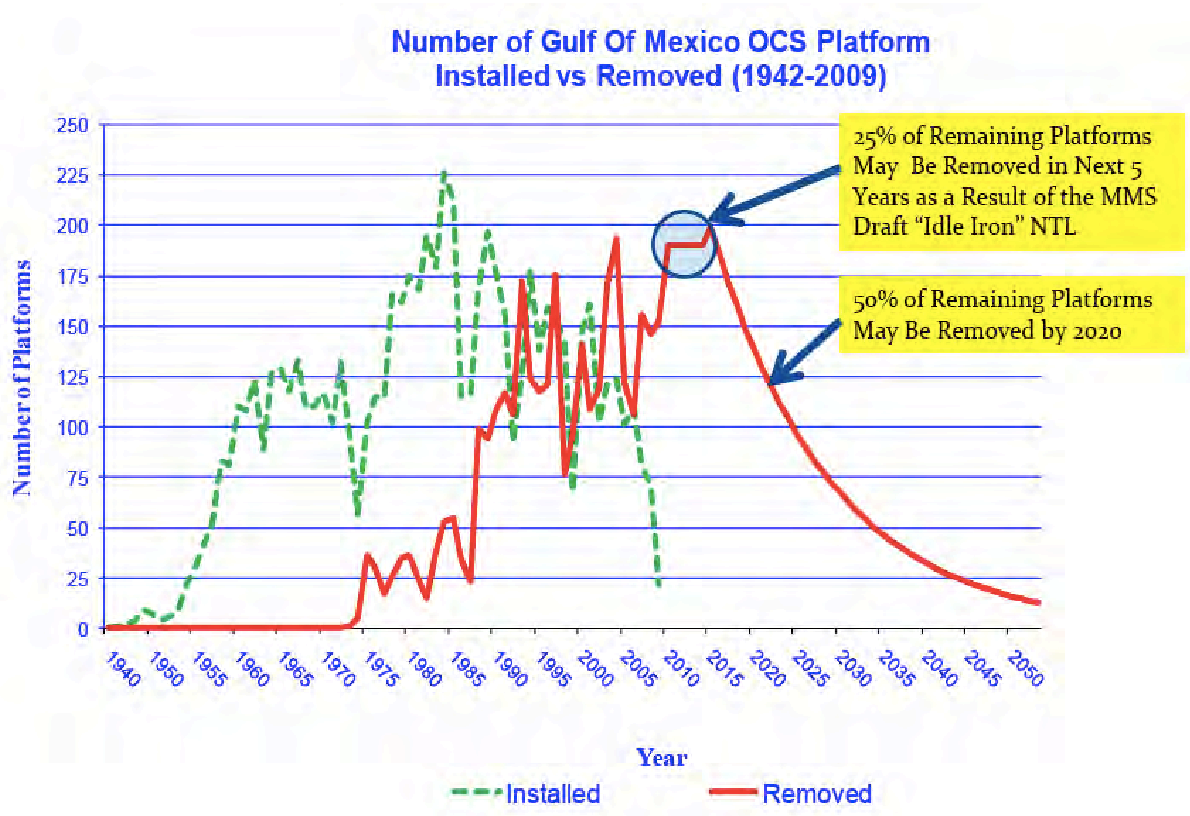


Figure 7. Removal depth effect on total (100%) species loss by organism type (Furfey et al., 2012).

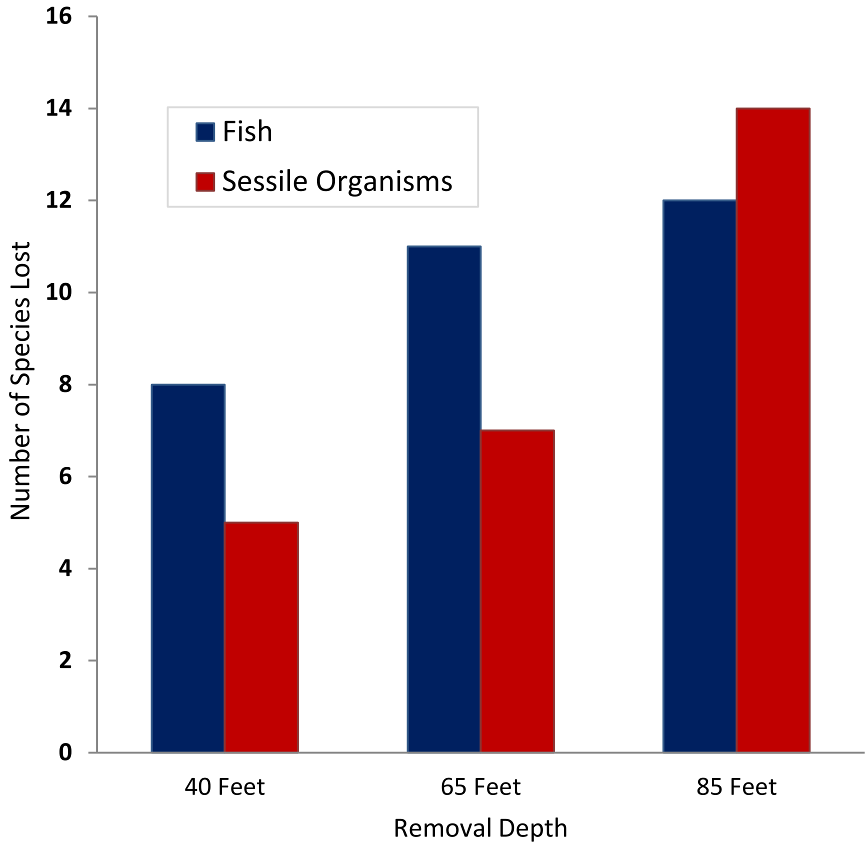


Figure 8. Removal depth effect on habitat loss by organism type (from Furfey et al., 2012).

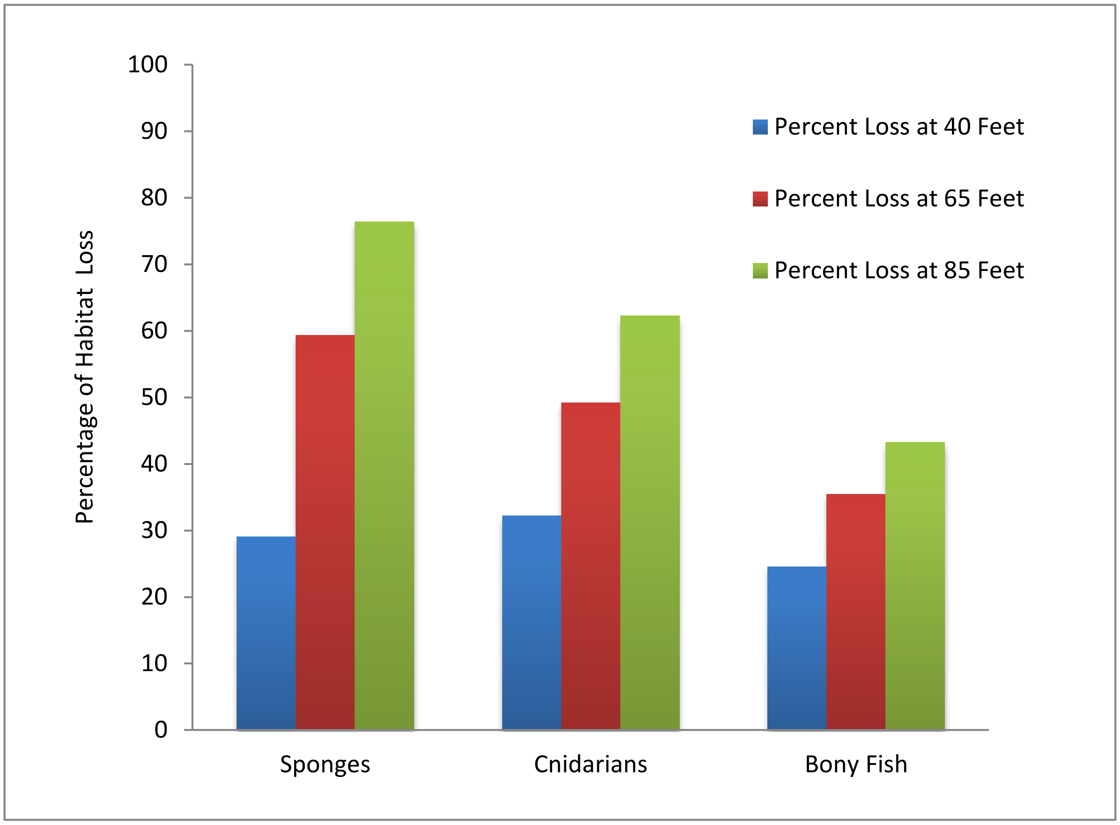


Figure 9. Removal depth effect on percentage habitat loss for the most common shallow-water fish groups (from Furfey et al., 2012).

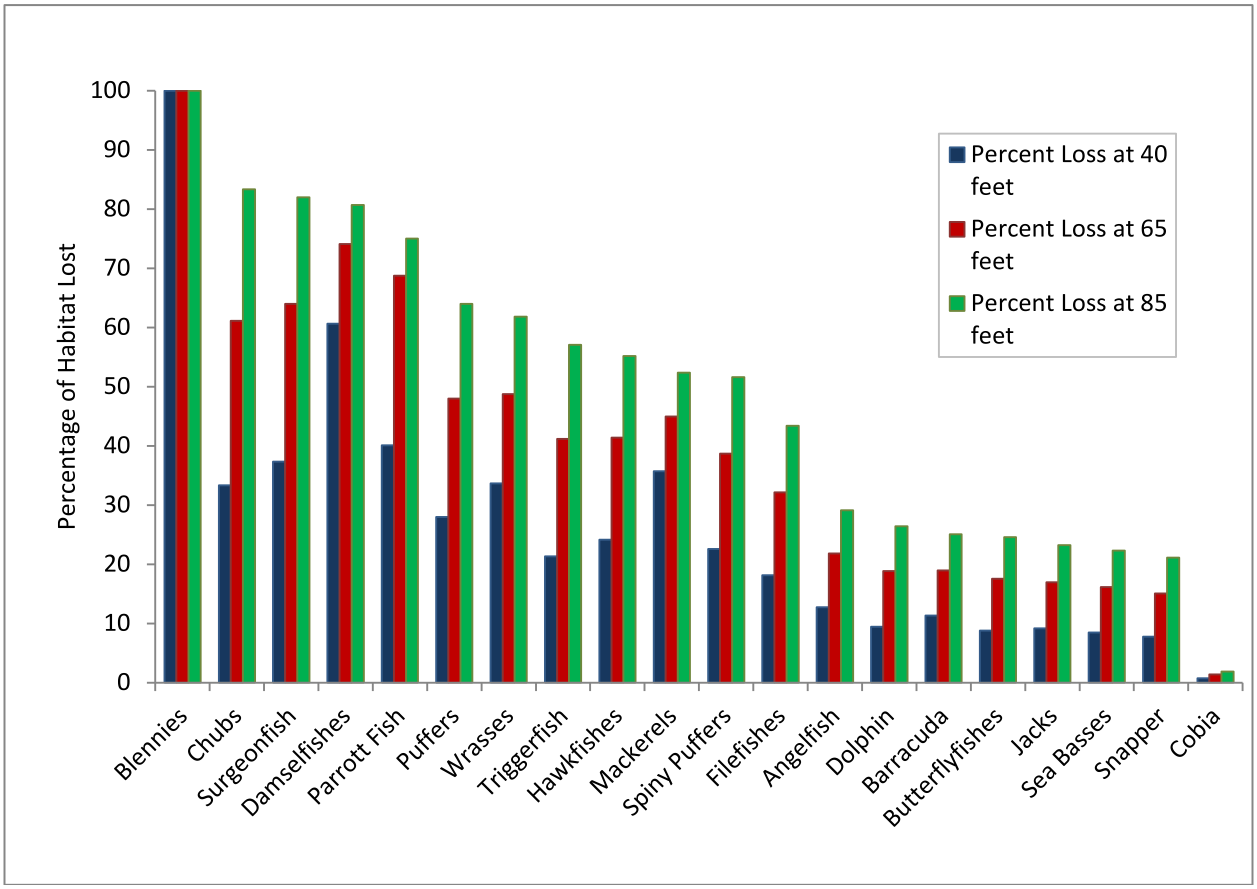


Figure 10. Summary of interactions between *Tubastraea coccinea* and other sessile epibenthic organisms in competition for space on standing platforms in the northern Gulf of Mexico. The low variance between platforms and an overall positive competitive win frequency of 50-60% indicates that, although this species is still competitively superior to others, the community has most likely come to near equilibrium (Sammarco et al., 2012 c, d).

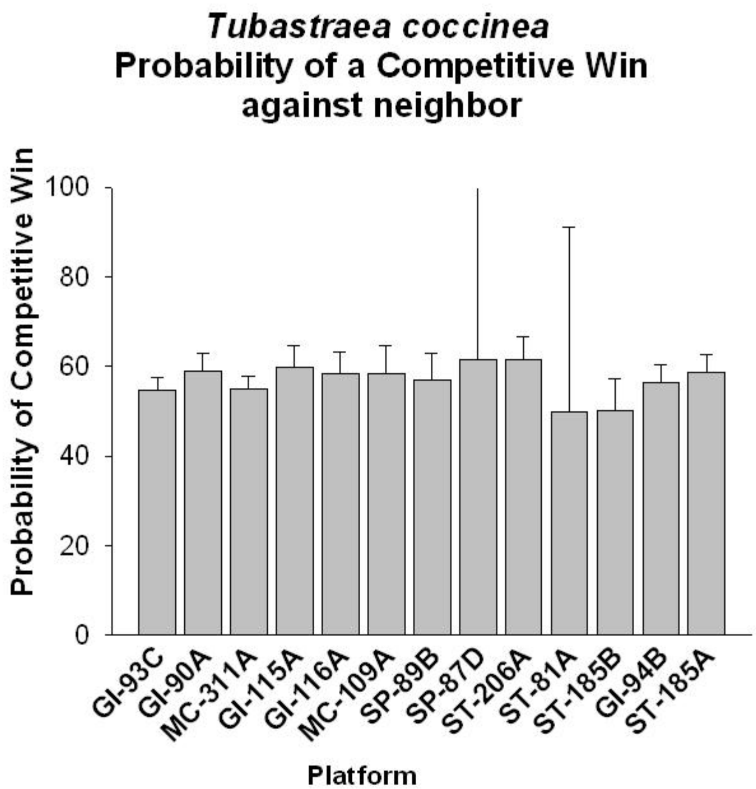


Table 1. Percent of fish lost at three removal depths (Furfey et al., 2012). Fish species that inhabit platforms in the NW Gulf of Mexico, listed in alphabetical order by scientific name.

Common Name	**Scientific Name**	**40 Feet**	**65 Feet**	**85 Feet**
Sergeant Major	*Abudefduf saxatilis*	78	100	100
Night Sergeant	*Abudefduf taurus*	100	100	100
Doctorfish	*Acanthurus chirurgus*	47	80	100
Blue Tang Surgeon Fish	*Acanthurus coeruleus*	28	48	64
Scrawled Filefish	*Aluterus scriptus*	8	14	19
Red-spotted Hawkfish	*Amblycirrhitus pinos*	24	41	55
Gray Triggerfish	*Balistes capriscus*	18	32	44
Spot-fin Hogfish	*Bodianus pulchellus*	0	2	8
Spanish Hogfish	*Bodianus rufus*	100	100	100
Whitespotted Filefish	*Cantherhines macrocerus*	28	48	64
Orangespotted Filefish	*Cantherhines pullus*	19	34	47
Sharpnose Puffer	*Canthigaster rostrata*	28	48	64
Blue Runner	*Caranx crysos*	11	18	25
Crevalle Jack	*Caranx hippos*	3	5	7
Bar Jack	*Caranx ruber*	29	52	71
Reef Butterflyfish	*Chaetodon sedentarius*	9	18	25
Brown Chromis	*Chromis multilineata*	16	29	39
Creole Wrasse	*Clepticus parrae*	10	35	55
Mahi-Mahi	*Coryphaena hippurus*	9	19	26
Marbled Grouper	*Dermatolepis inermis*	4	8	11
Spot-fin Porcupinefish	*Diodon hystrix*	23	39	52
Rainbow Runner	*Elagatis bipinnulata*	2	7	12
Rock Hind	*Epinephelus adscensionis*	9	15	20
Graysby	*Epinephelus cruentatus*	6	10	14
Calico Grouper	*Epinephelus drummondhayi*	0	0	0
Red Hind	*Epinephelus guttatus*	28	48	64
Jewfish	*Epinephelus itajara*	21	39	54
Red Grouper	*Epinephelus morio*	2	5	6
Warsaw Grouper	*Epinephelus nigritus*	0	0	0
Snowy Grouper	*Epinephelus niveatus*	0	0	0
Little Tunny	*Euthynnus alletteratus*	7	12	16
Bermuda Blue Angelfish	*Holacanthus berudensis*	12	20	27
Yellowedge Grouper	*Hyporthodus flavolimbatus*	0	0	0
Tessellated Blenny	*Hypsoblennius invemar*	100	100	100
Bermuda Sea Chub	*Kyphosus sectatrix*	33	61	83
Hogfish	*Lachnolaimus maximus*	33	61	83
Mutton Snapper	*Lutjanus analis*	0	6	13
Schoolmaster	*Lutjanus apodus*	38	69	94
Red Snapper	*Lutjanus campechanus*	1	5	8
Cubera Snapper	*Lutjanus cyanopterus*	16	27	36

Common Name	Scientific Name	40 Feet	65 Feet	85 Feet
	Lutjanus griseus	4	9	12
Dog Snapper	*Lutjanus jocu*	28	48	64
Lane Snapper	*Lutjanus synagris*	1	3	4
Silk Snapper	*Lutjanus vivanus*	0	0	0
Black Triggerfish	*Melichthys niger*	25	50	70
Yellowtail Damselfish	*Microspathodon chrysurus*	75	100	100
Black Grouper	*Mycteroperca bonaci*	22	50	72
Yellowmouth Grouper	*Mycteroperca interstitialis*	6	11	15
Gag Grouper		6	11	15
Scamp	*Mycteroperca phenax*	0	0	0
Yellowfin Grouper	*Mycteroperca venenosa*	26	48	65
Yellowtail Snapper	*Ocyurus chrysurus*	2	6	10
Redlip Blenny	*Ophioblennius atlanticus*	100	100	100
Seaweed Blenny	*Parablennius marmoreus*	100	100	100
Creole-fish	*Paranthias furcifer*	5	13	20
Emperor Angelfish	*Pomacanthus imperator*	11	18	25
Bluefish	*Pomatomus saltatrix*	5	9	12
Wenchman	*Pristipomoides aquilonaris*	0	0	0
Cobia	*Rachycentron canadum*	1	1	2
Wermillion Snapper	*Rhomboplites aurorubens*	0	0	0
King Mackerel	*Scomberomorus cavalla*	0	23	41
Spanish Mackerel	*Scomberomorus maculatus*	100	100	100
Greater Amberjack	*Seriola dumerili*	15	26	34
Lesser Amberjack	*Seriola fasciata*	0	0	0
Almaco Jack	*Seriola rivoliana*	5	10	14
Redband Parrotfish	*Sparisoma aurofrenatum*	58	100	100
Great Barracuda	*Sphyraena barracuda*	11	19	25
Dusky Damselfish	*Stegastes fuscus*	100	100	100
Beaugregory Damselfish	*Stegastes leucostictus*	100	100	100
Bicolor Damselfish	*Stegastes partitus*	3	12	18
Threespot Damselfish	*Stegastes planifrons*	37	63	84
Cocoa Damselfish	*Stegastes variabilis*	37	63	84
Bluehead Wrasse	*Thalassoma bifasciatum*	25	46	63

3.1 CONT'D MARINE LIFE – SUPPLEMENT **by Paul Sammarco**

Supplement to Living Resources Section
Oil and Gas Platforms – Impact of Removal
Artificial Reef Working Group
Sanctuary Advisory Council
NOAA Flower Garden Banks National Marine Sanctuary

Jan. 7, 2013

Depth distribution of corals on oil/gas platforms

We now have evidence that most of the hermatypic (reef-building) corals in the northern Gulf of Mexico exist in the shallower regions of the platforms (Sammarco et al., 2004). This is primarily because these organisms must possess symbiotic microalagae - zooxanthellae – which require light and allow the coral to survive and grow. The depth distribution varies between species. This is particularly pertinent to the platforms, because no natural reefs within most of the northern Gulf of Mexico come closer than 55-70' (17-21 m) of the surface.

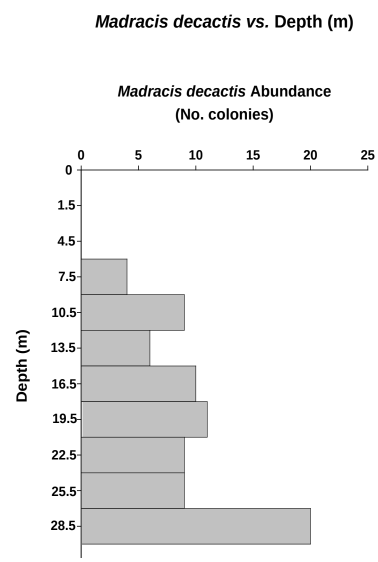


Figure 1. Depth distribution of a hermatypic coral (*Madracis decactis*) on platforms in the region of the Flower Garden Banks. Note that the depth distribution of this coral peaks at ~30 m, falling off sharply after that.

The distribution of ahermatypic corals is much deeper (Sammarco et al., 2011, 2012a,c,d). This is because these organisms do not bear zooxanthellae and do not require light for survival and growth. Therefore, their depth distribution is much broader on the platforms.

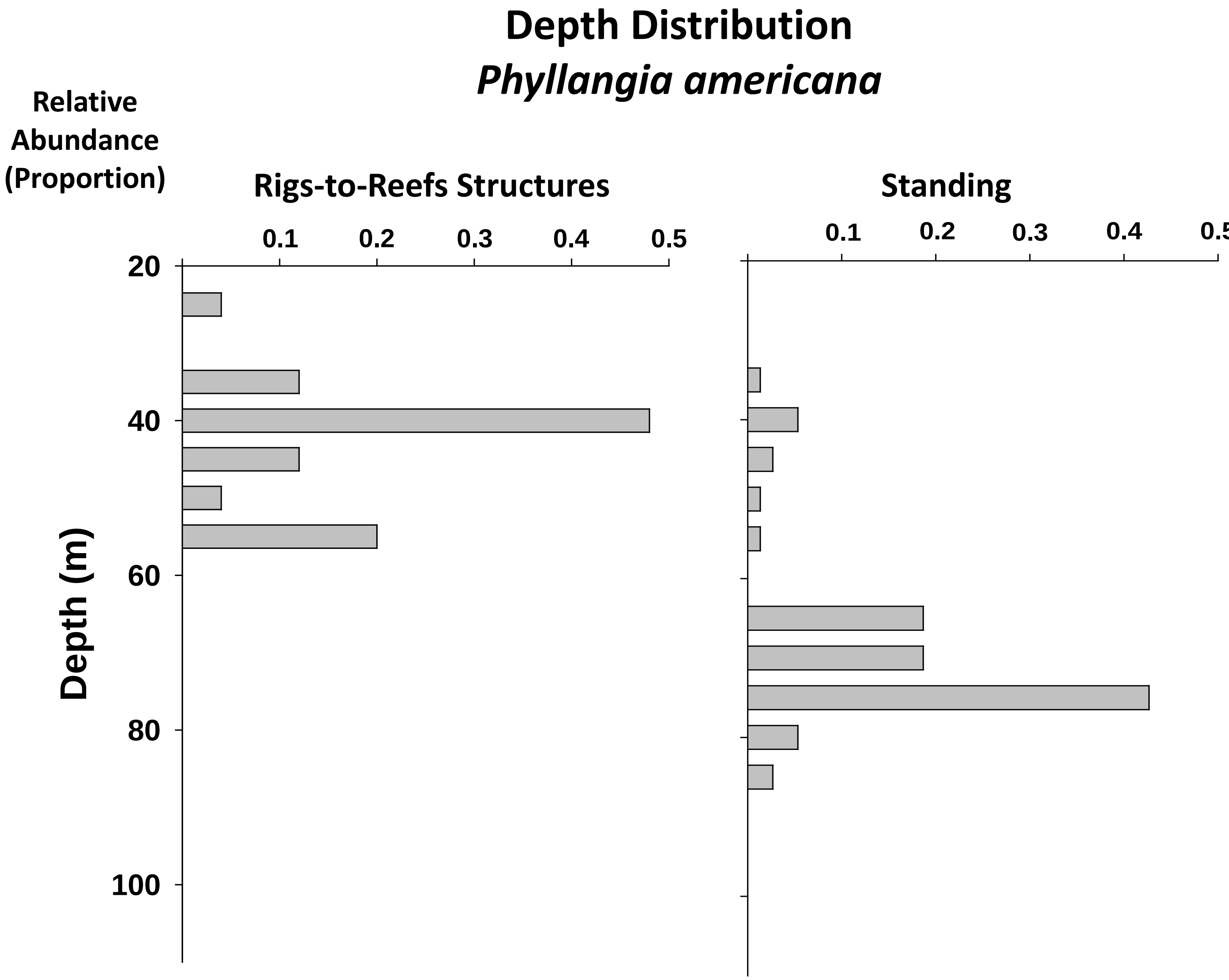


Figure 2. The depth distribution of an ahermatypic coral (*Phyllangia americana*) on platforms in the northern Gulf of Mexico. The right-hand figure shows that on standing, undisturbed platforms, the maximum depth of distribution is 85 m (280').

Impact of Platform Coral Populations on Natural Reefs

It has been shown that most hermatypic (reef-building) corals on platforms in the northern Gulf of Mexico were derived from Flower Garden Banks (Sammarco et al., 2012a,c,d). This genetic relatedness decreases with distance from the FGB. It is important because the platform populations serve as a "reserve" for FGB coral populations as a potential source for re-populating them, should a major environmental perturbation on the FGB occur, causing mass coral mortality there.

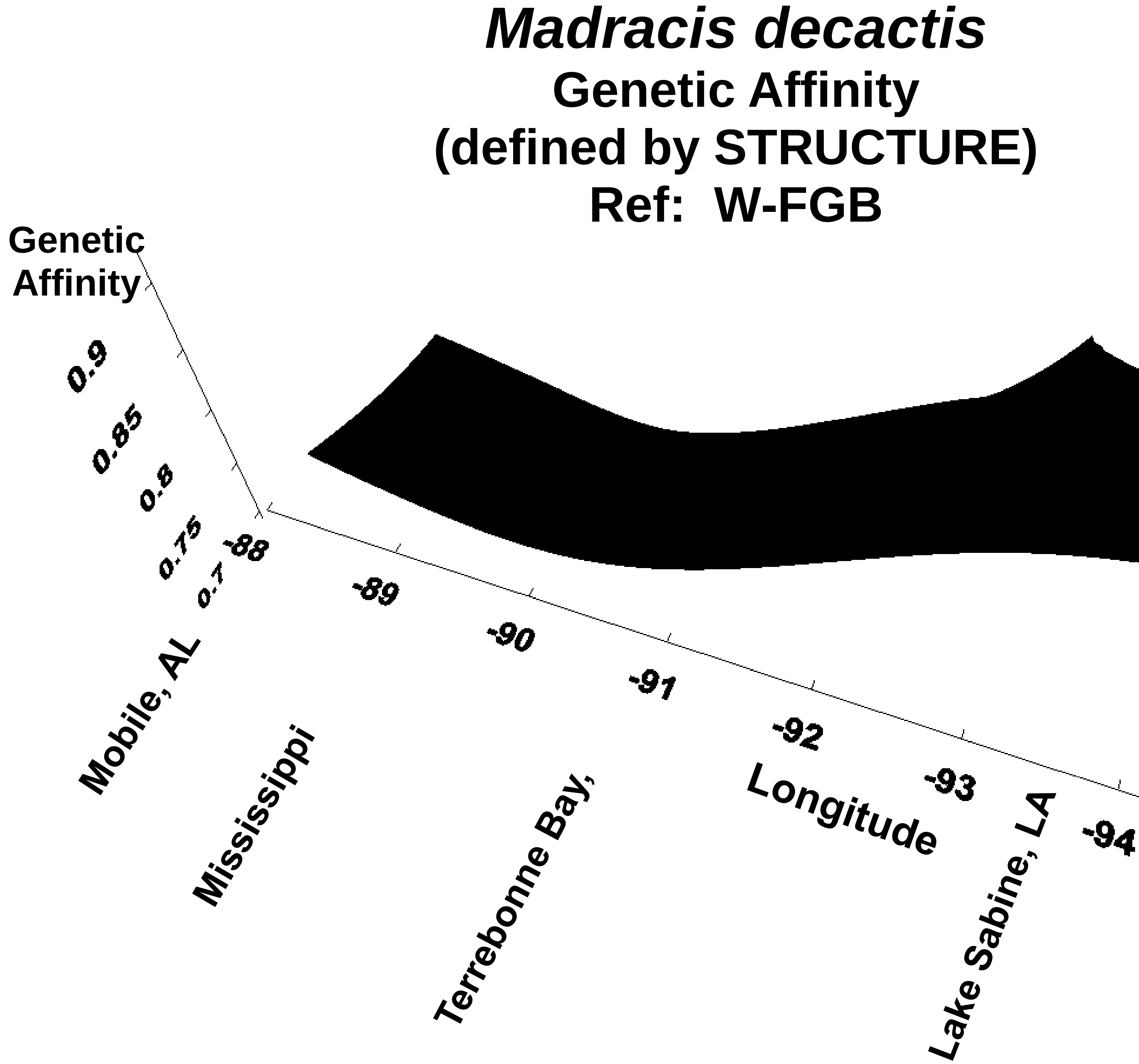


Figure 3. Three-dimensional graph showing the geographic distribution of the genetic relationships between populations of the coral *Madracis decactis* on platforms and around the Flower Garden Banks. Firstly, this demonstrates that key hermatypic corals in the northern GOM were probably derived from the FGB. Secondly, it implies that the platforms would be a stabilizing force for the FGB in the event of a mass mortality there of key populations.

Comments on Reports Regarding Coral Populations on HI-389-A

It has been reported by the NOAA-FGBNMS that only five colonies of two species of hermatypic coral have been found on HI-389-A, between 0 and 36 m depth. In addition, a large population of *Tubastraea coccinea* were observed, and these were considered to be an undesirable invasive species.

It is not unusual that a platform, young or old, might have low coral cover, low species diversity, and a low coral density. The variance is high between platforms regarding their coral populations; *i.e.,* some have high populations and some have low ones. Population density is correlated broadly with platform age, although there are many other factors that might influence this relationship. Nonetheless, scleractinian corals are protected by international treaty and are currently under consideration for listing by CITES as threatened and endangered. It would be wise to survey and assess each platform prior to considering decommissioning and seriously consider the presence of members of this taxon as a potential signal for disallowing removal.

Regarding the presence of *T. coccinea*, this Indo-Pacific invasive species has been present in the western Atlantic since the 1940s. Its distribution is now extant, present from southern Brazil to the northern GOM and the Florida Keys. Recent surveys of competitive interactions between this species and other sessile epibenthic species on platforms indicate that these communities have reached an equilibrium, and that if any competitive exclusion of species have occurred because of this new species, such are most likely no longer occurring.

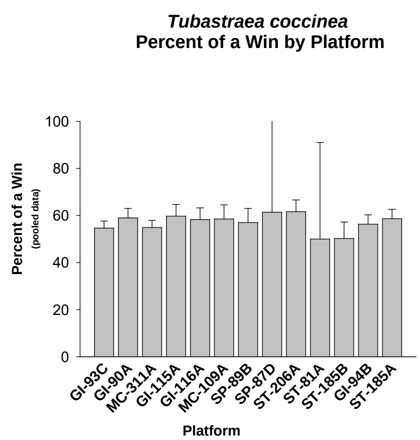


Figure 4. Summary of interactions between *Tubastraea coccinea* and other sessile epibenthic organisms in competition for space on standing platforms in the northern Gulf of Mexico. The low variance between platforms and an overall positive competitive win frequency of 50-60% indicates that, although this species is still competitively superior to others, the community has most likely come to near equilibrium.

T. coccinea has become an integrated part of the benthic community in the western Atlantic, including the northern Gulf of Mexico, and may now be considered as much a part of the community as any other species. In addition, in its native habitat of a natural reef setting, its competitive abilities are greatly reduced. It is only on artificial substrata, such as platforms, that its populations thrive.

References

[See master document]

3.2 Cost Comparisons of AR Options

By Clint Moore and John Hoffman

Cost estimates for the Study were provided by Clint Moore and John Hoffman. Costs were determined working with Black Elk Energy Engineering and Construction Manager.

The following was reported:

I. Study Cost Analysis For Options A-E

Below are estimated one-time costs for removals or partial removals and modifications (MM is millions; K is thousands):

Option A: Total Removal to R2R site - $5.5 MM

Option B: “Research Station” style - $ 750 K

Option C: “Lower Deck Remains” style - $1.5 MM

Option D: “Save The Blue” style - $1 MM

Option E1: 72’ or 28’ BSL cut style - $ 4 MM

Option E2: 85’ BSL cut style - $ 4.5MM

II. Above Sea Level Scenarios Annual Costs

Annual Costs were estimated that pertain to the AR options designated below:

Options C and D: $ 50 K per year with every 5th year at $150 K, for “Lower Deck” & “STB” options

Option B: $ 60 K per year with every 5th year at $180 K, for “Research Station” option

Annual Costs include:

- Cathodic protection
- Topside & navigation-aid maintenance and inspections
- Painting every 5 years
- Anode replacements "as needed"

III. Below Sea Level Scenarios Buoy Purchase or Rental Costs

The following cost estimates pertain to Option E, below sea level partial removal:

1) Purchased buoys & mooring - $ 30 K

2) Rental service - buoys & mooring - $ 11 K/yr

3) GPS Monitoring - $ 1 K per year

4) Installation Costs - $ 50+ K – one time trip

5) Repair costs - $ 50+ K per round trip plus parts

IV. Survey Options Annual Insurance Costs

The following are annual liability insurance cost estimates for each of the options.

OPTION A: Total Removal to R2R site - ~ $ 1 K per million. This is required for period of time needed for platform removal.

OPTION B: "Research Station" style - $ 10-15 K/MM

OPTION C: "Lower Deck Remains" style - $ 5-10 K/MM

OPTION D: "Save The Blue" style - $ 5 K/MM

OPTION E1: 72' or 28' BSL cut style - ~$ 1 K/MM

OPTION E2: 85' BSL cut style - $ 1-? K

3.3 Regulatory Assessments

The following Study inputs regarding "regulations" were completed by:

3.3.1 Herb Leedy of BSEE
3.3.2 James Sinclair and Herb Leedy of BSEE
3.3.3 Tim Boriskie of USCG

3.3.1 Artificial Reef Study Options (By Herb Leedy):

(A) **Remove platform in its entirety.** There are no regulatory issues associated with this option. The operator would follow the established decommissioning process for removing platforms found in 30 CFR § 250.1725. For HI-A-389A, the operator will also be required to coordinate with the Sanctuary to fulfill the requirements found under 15 CFR § 922.49.

(B) **Leave platform in place mostly "as is".** The platform must meet the following conditions found under 30 CFR § 250.1730 (a) *the structure becomes part of a State artificial reef program, and the responsible State agency acquires a permit from the USACOE and accepts title and liability for the structure.*

(C) **Leave platform in place with one deck for day-use only.** The platform must meet the following conditions found under 30 CFR § 250.1730 (a) *the structure becomes part of a State artificial reef program, and the responsible State agency acquires a permit from the USACOE and accepts title and liability for the structure.*

(D) **Leave structure out of water, but no decks. STB concept.** The platform must meet the following conditions found under 30 CFR § 250.1730 (a) *the structure becomes part of a State artificial reef program, and the responsible State agency acquires a permit from the USACOE and accepts title and liability for the structure.*

(E) **Structure cut below the surface 40-85 ft deep.** The platform must meet the following conditions found under 30 CFR § 250.1730 (a) *the structure becomes part of a State artificial reef program, and the responsible State agency acquires a permit from the USACOE and accepts title and liability for the structure.*

Additionally, for each of the options (B) through (E), the proposal would be reviewed for compliance with BSEE regional engineering, stability, and environmental reviewing standards found in the Rigs-to-Reefs policy addendum of 2009. The following set of standards will eliminate Option (B) and potentially Options (C) and (D) from consideration:

- Reef material (i.e., platform jackets) must be stable and not endanger nearby infrastructure and/or protected resources. **(Depending on engineering analysis, Options (C) and (D) could be eliminated from consideration)**
- Rigs-to-Reef sites must be free from all potentially hazardous/nonstructural material. All submerged decks and their separated components/equipment must be removed from the seafloor. **(Option (B) would be eliminated due to potentially hazardous non-structural material left on the topsides)**

U.S. Coast Guard Authority

The U.S. Coast Guard (CG) has authority to establish private aids to navigation to ensure that obstructions in U.S. waters are properly marked for the protection of maritime navigation. This authority is granted under OCSLA, 43 U.S.C. 1333{d} , 14 U.S.C. 81-87, and 33 CFR, parts 64-66. For the 8th USCG District (Gulf Coast) the policy is based on:

Depth (mean low tide): Type of buoy(s) required if the clearance from the water surface to the top of the reef is:

1. less than 85 feet – yellow special purpose buoy(s) with a flashing six second yellow light;
2. 85 to 200 feet – unlighted yellow special purpose buoy(s);
3. 200 feet or more – markings not required.

Size: Number of buoys required if the longest side of the reef is:

1. less than ½ nautical mile (approximately 4000 x 4000 feet) – one buoy positioned in the center of the reef;
2. ½ to 1 nautical mile – one buoy positioned at each corner of the reef;
3. over 1 nautical mile – one buoy set on each corner of the reef and additional buoys positioned on the reef's perimeter at 1 nautical mile intervals or as directed by the District Commander.

Location: If the reef is located within 1500 feet of a fairway, channel, or anchorage area, a quick flashing (red or green) buoy between the edge of the reef and the navigational area is also required.

Waivers may be granted for the lighted buoy requirements on reefs with over 50 feet of water clearance provided:

1. the reef is over 2 nautical miles from fairways, channels, or anchorage:
2. there is no history of deep draft traffic in the area;
3. the entire reef complex is adequately marked.

Waivers may also be granted for the marking requirement on reefs with over 85 feet of water clearance provided:

1. the reef is included on updated National Ocean Service navigational charts;
2. the reef is over 2 nautical miles from fairways, channels, or anchorage;
3. there is no history of deep vessel traffic in the area.

These criteria are general guidelines and decisions are made by the USCG on a case-by-case basis.

3.4 Permitting

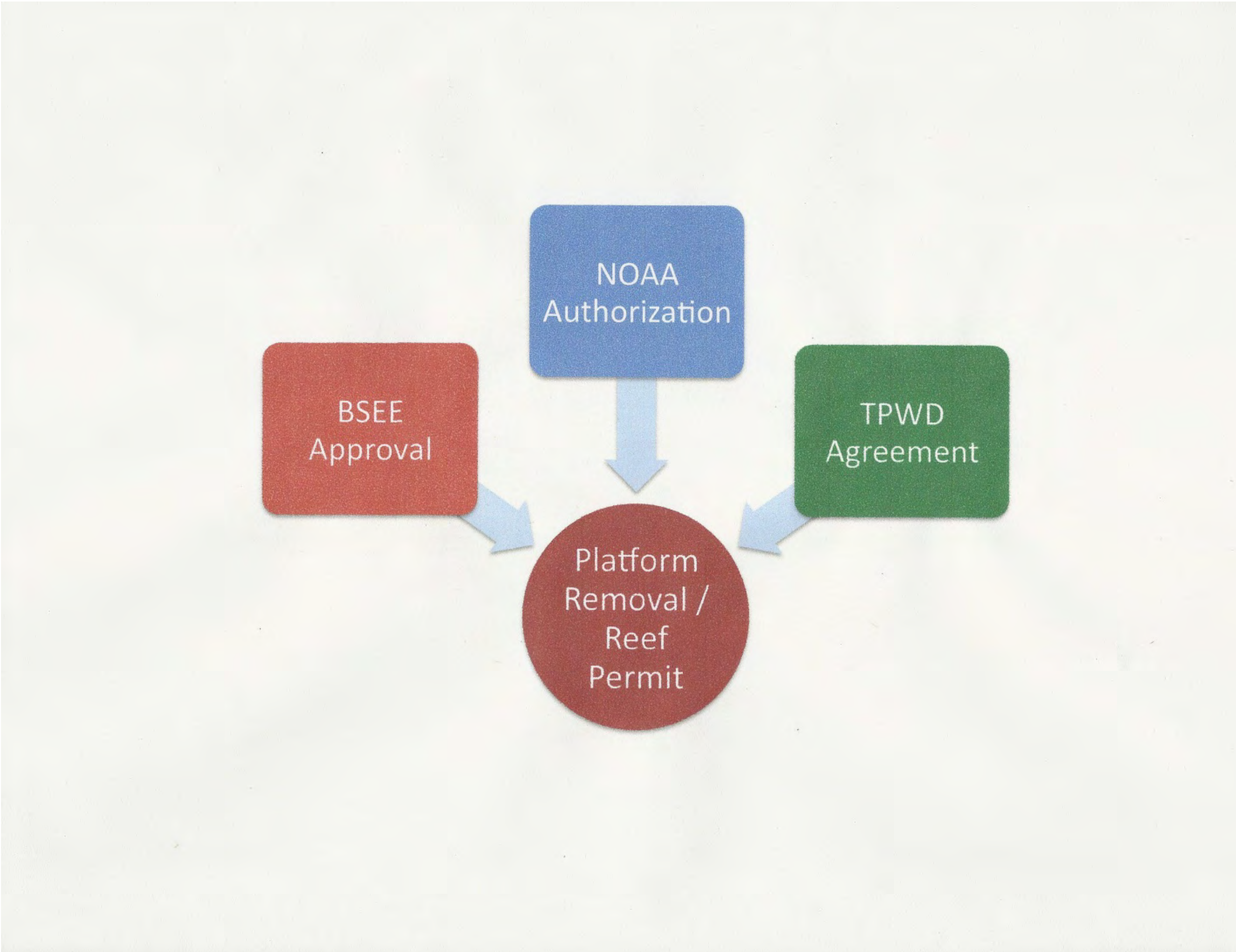
This section includes three documents that address the permitting process for an Artificial Reef in the Gulf of Mexico. The first permitting flowsheet, by GP Schmahl, addresses the permitting process in a National Marine Sanctuary.

3.4.1 Permitting process by GP Schmahl

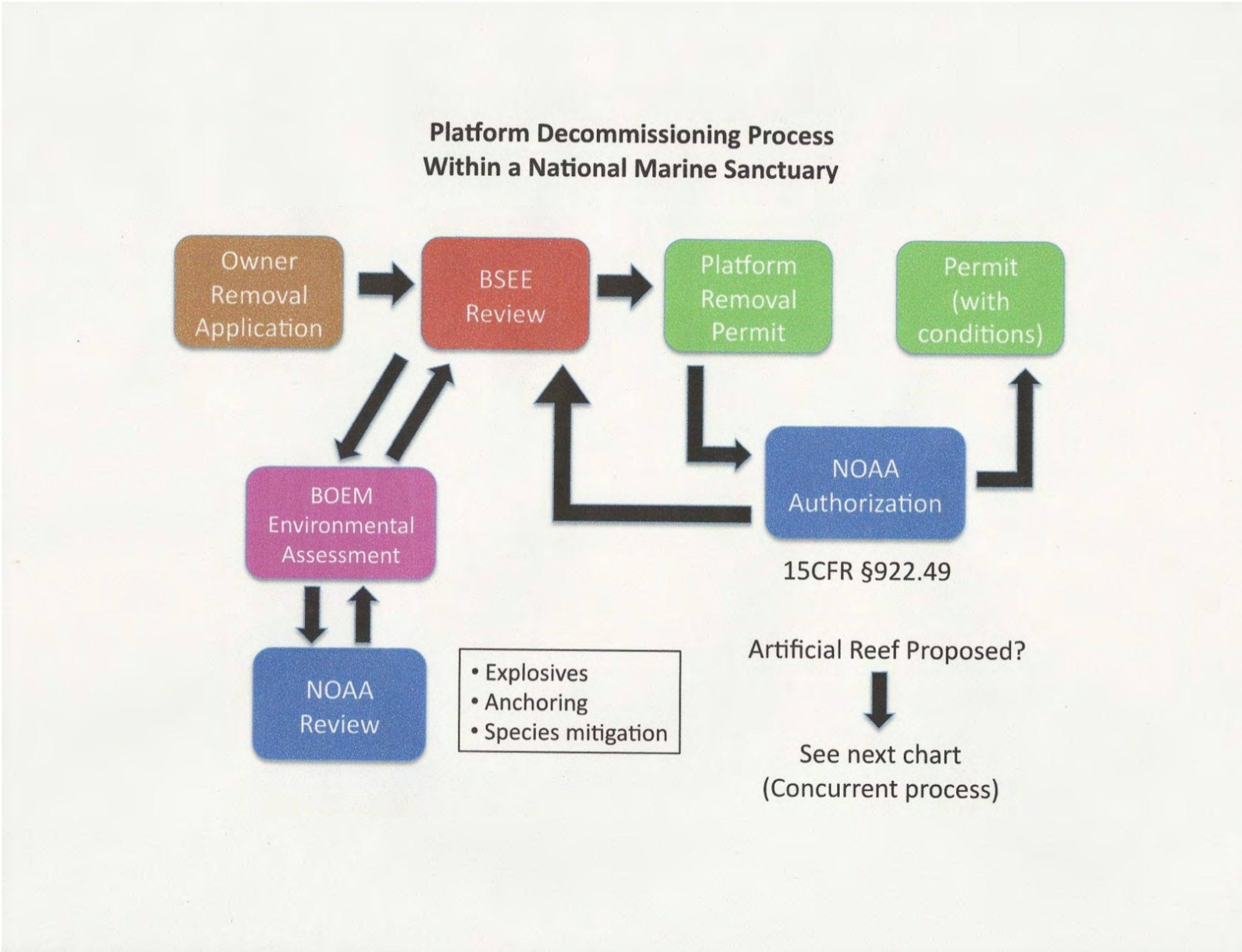
3.4.2 Permitting process by BSEE

3.4.3 Permitting process by Apache

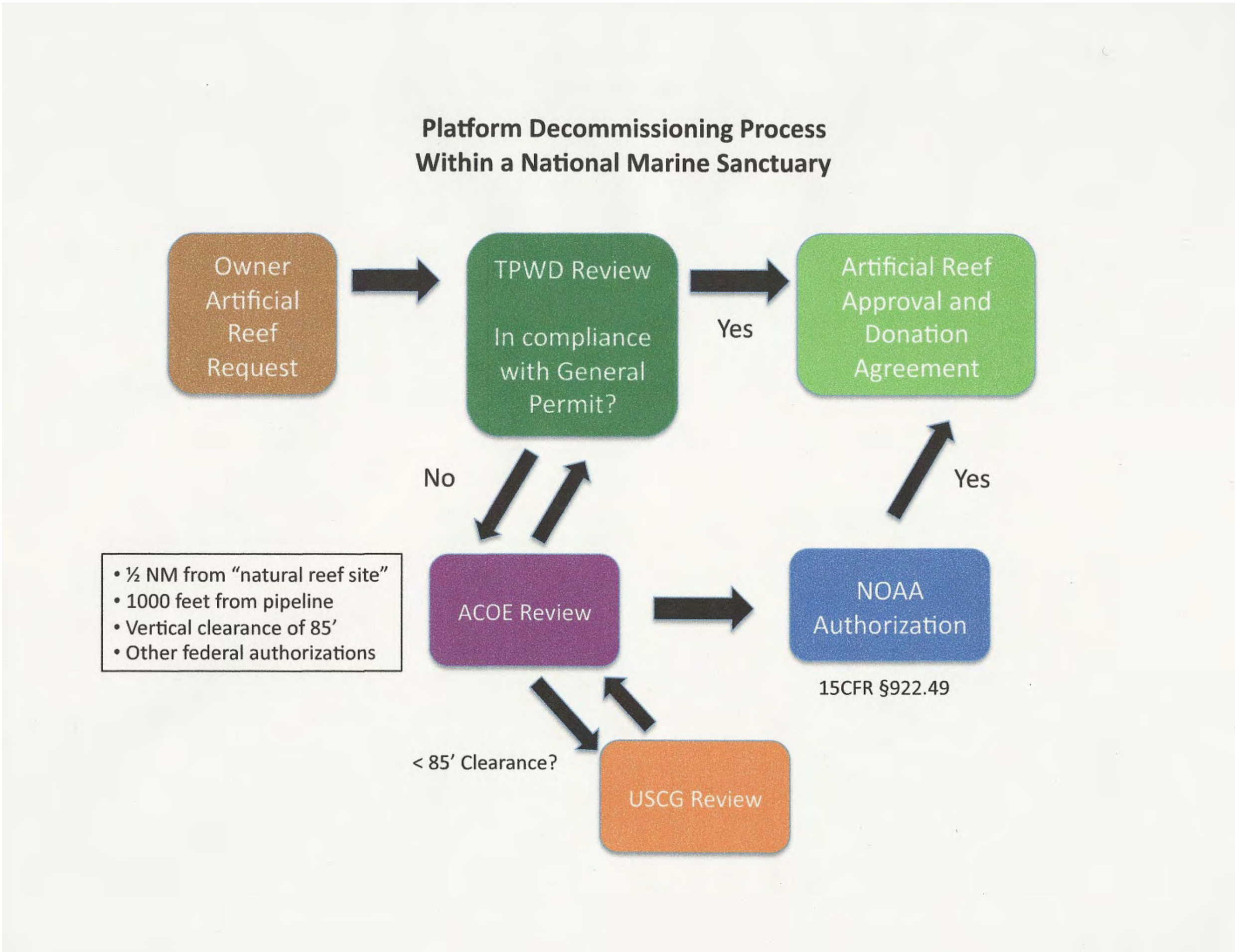
3.4.1 Permitting Process by GP Schmahl – Sht 1 of 3



Sheet 2 of 3

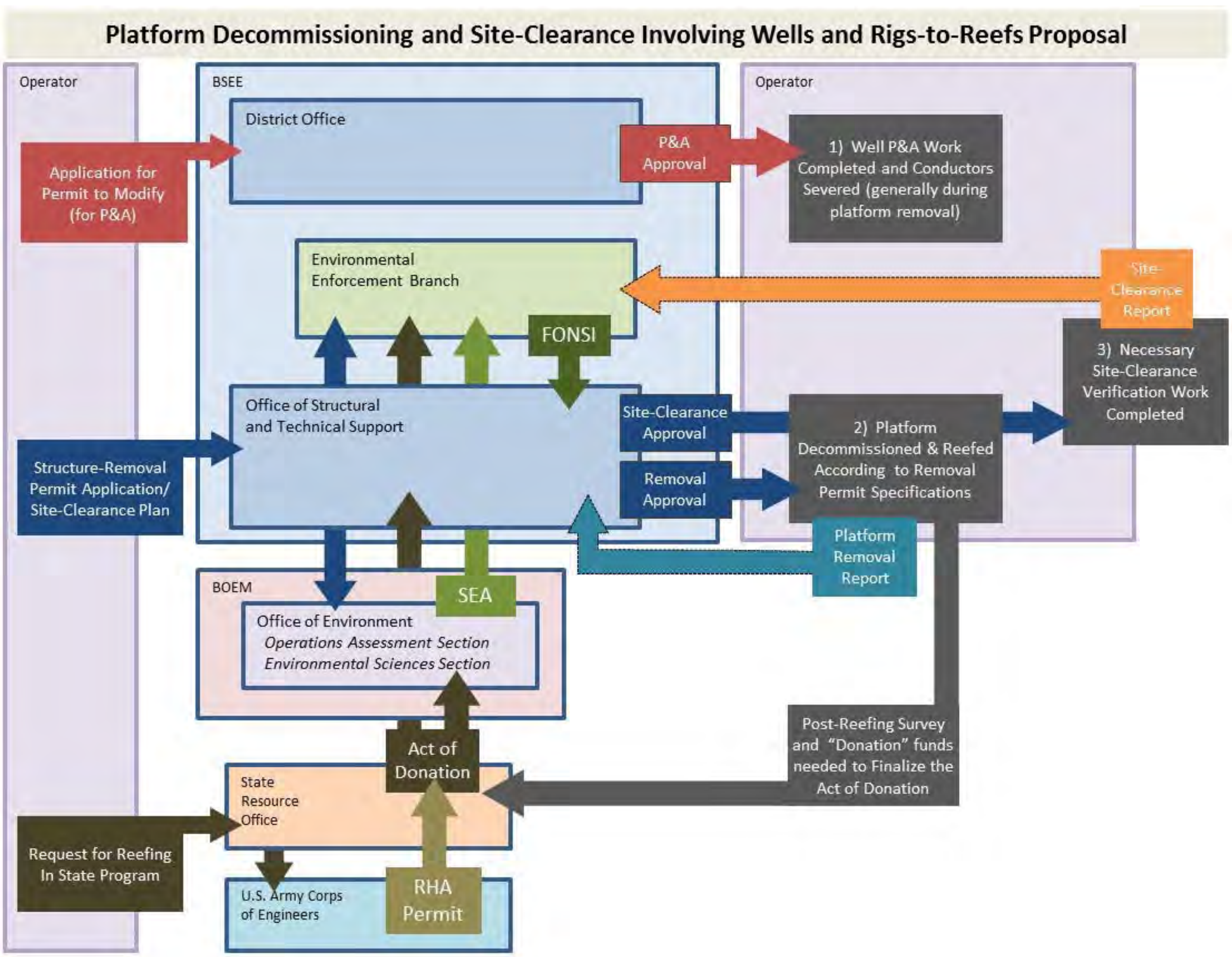

Platform Decommissioning Process
Within a National Marine Sanctuary
Owner Removal Application
BSEE Review
Platform Removal Permit
Permit (with conditions)
BOEM Environmental Assessment
NOAA Authorization
15CFR §922.49
NOAA Review
• Explosives
• Anchoring
• Species mitigation
Artificial Reef Proposed?
See next chart
(Concurrent process)

Sheet 3 of 3


Platform Decommissioning Process
Within a National Marine Sanctuary
Owner Artificial Reef Request
TPWD Review
In compliance with General Permit?
Yes
Artificial Reef Approval and Donation Agreement
No
Yes
• ½ NM from "natural reef site"
• 1000 feet from pipeline
• Vertical clearance of 85'
• Other federal authorizations
ACOE Review
NOAA Authorization
15CFR §922.49
< 85' Clearance?
USCG Review

3.4.2 Decommissioning Processes in BSEE

Platforms/Site Clearance: OSTS Permitting Process



3.4.3 Permitting Process per Apache

Reef Permitting Details (per Apache power point presentation on R2R)

- Operator Proposes Reef Candidate to the State
- State Accepts Proposed Reef Candidate, Location, Layout & Clearance (or Proposes Alternative)
- State Prepares And Submits Permit to US Army Corps of Engineers (COE)
- The COE Reviews Application & Submits to Other Federal Agencies for Comments
- Coast Guard Comments on Shipping Hazards And Buoy Requirements
- NMFS Provides Biological Opinion
- MMS Reviews for Archeological, Biological, Pipelines, Lease, Future Development
- 30 Day Public Comment Period

- COE Approves Reef Permit, Permit Issued to the State
- Operator Submits to MMS Platform Removal Permit Application Listing Reefing as the Removal Option
- Even If COE Issues Reef Permit to the State, the MMS May Still Deny Reefing the Jacket at the Approved Artificial Reef Site.

- Operator Proposes Reef Donation to State and Prepares Draft Act of Donation Agreement
- Donation Calculated as Half of the Savings Realized Between the Complete Removal And Reefing Costs.
- Donation Amount Agreed Prior to Mobilization
- Reef Donation (Tax) Submitted After the Platform Is Reefed
- Recent Permit Cycle Time Is 4 to 6 Months for Non-SARS Sites
- Buoy Is Placed And Maintained Until It Is Charted (If New Reef Site)
- Operators Submits to the StateDeed of Donation -Signed By Company Officer Executed Prior to Mobilizing

- Certified Plat Showing Placement And Clearance is Submitted

  - State Issues a Certificate of AcceptanceState Accepts Title to the Reef Donation
  - State Accepts Future Liability for Reef

3.5 Life Expectancy of An Offshore Structure

By Jesse Cancelmo

Several offshore structure experts were contacted and queried on expected lifespan of offshore platforms.

Paul E. Versowsky, former Senior Facilities Engineering Advisor for Chevron and currently with BSEE advised that offshore structures without cathodic protection will last at least 100 years. With cathodic protection, the structures will last "forever". He said he's seen 40-50 yr old structures with cathodic protection that have welds that look like they were made yesterday. Versowsky said a partially removed structure can be fitted with a passive system consisting of sacrificial anodes.

Peter Casbarian (peter.casbarian@braemar.com) of Braemar Casbarian Inc. of New Orleans sent an e-mail stating "the life expectancy of a structure if properly maintained could be as much as 50 years." He continued, "If the structure was cut below the surface, say about 80 feet, this would reduce the metocean forces on the structure. However, the structure is still susceptible to corrosion. Maintaining the corrosion protection could increase the life expectancy by an additional 20-30 years."

Derren Liu of KBR (281.721.2382), a PhD in Structural Engineering, said according to NACE (National Association of Corrosion Engineers), a typical platform has a corrosion rate of less than 0.02mm/yr. The 0.2mm/year corrosion allowance was a design factor, the actual corrosion may be more or less depending on the corrosion protection and on the effectiveness of the anti-corrosion system.

According to Liu, even without proper maintenance, the structure should last over 300 years in the water. With proper maintenance, the structure could last over 500 years. (Liu also passed along typical platform removal cost estimate per ton from Twachtman Snyder and Byrd, Inc., a Houston estimating firm: $1000/ton.)

Cancelmo comment: Using the NACE "design" corrosion rate, 0.02mm/yr, for a major structural member having a wall thickness of 0.75", after a hundred years the wall thickness decreases 2 mm, or .08 inches. So the wall thickness reduces from .75 inches wall to about .67 inches, or to 89% of original thickness.

ADDITIONAL INFORMATION – FROM ONLINE SEARCHES

Offshore platforms are structures that require anti-corrosion protection due to their installation in marine environments. The most efficient method of protection against corrosion for offshore platforms is through the use of cathodic protection systems with sacrificial anodes.

Maximum corrosion occurs on a structure at a small distance below the water surface and gradually decreases with depth. Corrosion in the mud part areas is usually much less severe than below the water surface. Both the submerged steel surfaces and the steel in the mud part areas can be cathodically protected.

Table below from:

CORROSION PROTECTION OF OFFSHORE STRUCTURES

By Soeren Nyborg Rasmussen
HEMPEL A/S
Lundtoftevej 150
2800 Kgs. Lyngby
Denmark
E-mail: snr@dk.hempel.com
Website: www.hempel.com

Table 1: Offshore corrosion rates as steel thickness loss per year
Area Corrosion rate (steel loss per year)
Atmospheric zone (C5-M) 80 - 200 µm (3 - 8 mils)
Splash zone 200 - 500 µm (8 - 20 mils)
Immersion (Im 2) 100 - 200 µm (4 - 8 mils).
1 mil = .001”

Cancelmo comment: This table shows corrosion rate of steel in submerged area not much different than in area exposed to salt air. However, the air/water interface area has a corrosion rate 2x that of the submerged steel. Do note the corrosion values in this table are very conservative compared to the NACE values. Hempel is a coating company.

This chart available online appears to be in agreement with NACE.

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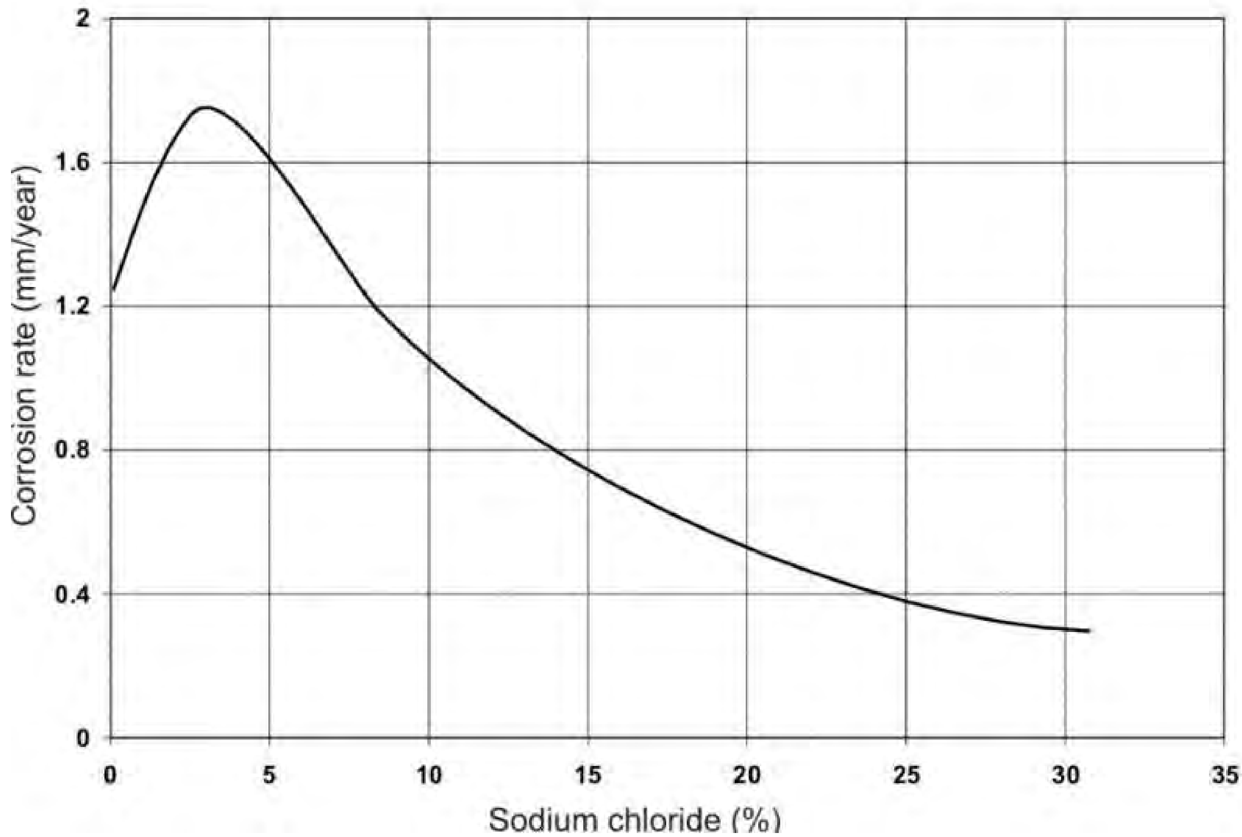

Cancelmo comment: Salt content of sea water ~ 3.5%

Conclusion:

Variations in design factors (conservatism in design) and history of maintenance make it challenging to generalize on the life of offshore structures. However, based on the information obtained during the time of this Study, it appears that the life of a well-maintained structure in the GOM should be a minimum of 100 years.

3.6 RISK REGISTER FOR OUT-OF-WATER STRUCTURE

By Jesse Cancelmo

The funding in a liability account for an out-of-the-water artificial reef must be an amount that considers at a minimum, the following risks:

1. Hurricanes
2. Ship collisions
3. Owner insolvency
4. Owner refusal to maintain adequately
5. Structural failure/collapse due to corrosion or fatigue
6. Helicopter crash
7. Malicious damage

4.0 SUMMARY ADVANTAGES AND DISADVANTAGES FOR OPTIONS A to E

OPTION A: Remove Platform entirely

Advantages

- No liability issues
- No navigational hazard
- No maintenance costs
- Return to natural state

Disadvantages

- Destruction of the platform area ecosystem (unless transferred to a R2R site)
- Loss of all “steel island” advantages
- Greatest cost to dismantle, as much as $10million (for owner)
- If taken to shore, no benefit to Texas R2R

OPTIONS B, C and D: Retain structure above the waterline - Fully or near fully

Advantages

- Greatest amount of marine life preserved and maximum biological benefit to the FGBNMS
- Platform coral populations serve as a “reserve” for natural reef corals and is a source for repopulation
- Island in the GOM
  - Includes a reef community from 60 feet to the surface (unlike existing natural reefs)
  - Convenient for divers, fishermen and boaters
  - For research
  - For evacuations
  - Surveillance and monitoring
  - Possible “Alternate Uses”, marine uses or renewable energy generation
  - Migrating birds
- Will allow the NMS to better understand the management of an AR
- Least cost to dismantle (for owner)

Disadvantages

- Liability issues
- Regulatory issues – boomerang liability
- Greater hurricane risk
- Cost to maintain (nav lights, paint, anodes, etc)
- Navigational hazard
- Boat tie-ups limited to favorable conditions only

OPTION E: Mechanically cut platform below waterline at minimum allowable depth (approx. 60-85 ft deep) and install a permanent mooring buoy

Advantages

- Retention of significant amount of marine life
- Platform coral populations serve as a "reserve" for natural reef corals and is a source for repopulation
- No (or minimal) liability issues
- No navigation hazard
- No maintenance costs
- Structurally, potentially longer lifespan (for structure and marine life)
- Permitting process in place
- Higher availability for boat tie-ups
- Less cost to dismantle than full removal (for owner)

Disadvantages

- Less marine life preserved (~ 50-60% retained)
- Loss of all "steel island" advantages

3.7 OUT-OF-WATER OPTIONS - OBSTACLES AND POTENTIAL SOLUTIONS

There are two possible regulatory paths for out-of-water platform ARs in the GOM that could also apply to platforms in the FGBNMS. The first path is the TPWD Rigs to Reef path that ultimately places platform liability on the State of Texas. The second path is the “Alternate Use” path. Here are pertinent discussion points for each path:

1) TPWD Rigs to Reef. With this path, the platform’s owner (prior to decommissioning) severs its liability and transfers it in full to the State of Texas. The liability issue remains a challenge for this path but it’s possible to overcome without requiring any changes to federal legislation. Preliminary discussions with TPWD Dale Shively indicate that if another State-related entity such as the Harte Institute was interested in using a platform as a research station and was able to demonstrate not only its ability to properly maintain the structure over time but the financial resources (say in the order of $10 million) to escrow a funded liability account, the State of Texas may be willing to work cooperatively with Harte Institute to make this option a reality. To move forward down this path will require at least five key elements:
    a. A “state-related” entity such as a Harte Institute (hypothetically) express interest/willingness to convert a platform to a research station
    b. This entity and TPWD agree on the specifics of their “cooperative agreement”.
    c. This entity secures the funding for the liability escrow, conversion costs, and the maintenance costs.
    d. The oil and gas company owner agreement to decommission per the Texas Rigs to Reef procedures and terms.
    e. The FGBNMS agree to host an out-of-water structure in the sanctuary.

2) The Alternate Use Path allows a lease holder (oil & gas company) to sell an idle platform to another company for another use, for example, an offshore wind generation electric plant, a fish farm, or a research station. Regulations and permitting definition exists for this path but the huge obstacle in this path is the so called “boomerang liability” currently in federal regulations (see 30 CFR 285 1000, at 250.1731). This means that if a platform is sold to another entity for

alternate use and an event occurs resulting in major costs for clean-up, dismantling and removal (e.g. hurricane damage), the liability does not stop at the alternate use company. The liability extends back to the previous owner or owners. This prolonged risk exposure is the primary reason owners are reluctant to entertain alternate use options. If federal regulations were modified to accept a funded liability escrow account or equal in lieu of the boomerang liability provision thereby allowing owners to sever liability upon property transfer, there would be another viable path to allow platform conversion to research station or other out-of-water uses. Obviously, such a change would require congressional action and would take a considerable amount of effort and time to complete.

5.0 SPECIAL EARLY RECOMMENDATION FOR HI-A389A

The following was presented to the FGBNM SAC for approval on November 14, 2012. The 389 “special” recommendations were endorsed by SAC on a 9 to 2 vote.

Preface to HI-A-389A Recommendation:

The following recommendation is endorsed by 11 of the 14 members of the AR Working Group. Three members "abstained" from endorsement. None opposed. This recommendation applies only to HI-A389A and is NOT the final recommendation of the AR Study which is not yet complete. The need to make this special recommendation now is due primarily to the owner's time constraints and desire to be released of all liabilities by summer of 2013. It is the intention of the AR Working Group to present a recommendation for 389 that will allow maximum retention of marine life in the Sanctuary based on a plan that is "doable" now. At the AR Working Group meeting on October 11, 2012, all parties (W&T, TPWD, BOEM/BSEE, and FGBNMS) agreed the partial removal path is "doable".

Formal AR WG Recommendation to SAC November 14, 2012

"The FGBNM Sanctuary Advisory Council AR Working Group recommends that HI-A389A platform structure remain in the FGBNMS but be mechanically cut below the surface at a nominal depth of 60 feet which is the same depth as the natural reefs nearby. This is called a "partial removal". Additionally, we recommend that a) the 10 vertical well conductors be retained to maximize the marine environment and b) the FGBNMS Management and TPWD AR Program agree on a monitoring program that makes sense for benefitting the Sanctuary without requiring the donating operator to pay more than called for by the typical Rigs to Reef Program rules. These recommendations apply only to HI-A389A and in no way indicate the final recommendations of the AR Study. Because of W&T's timing to complete decommissioning, it's critical that FGBNMS management communicate the preferred disposition to W&T before the end of this year."

6.0 STUDY MAJOR FINDINGS & FINAL RECOMMENDATIONS TO SAC

6.1 Major Findings

The following are the twenty (20) major findings by the SAC AR Working Group:

1. Artificial Reefs currently exist in three other NMS and in one National Monument: The Monitor NMS, our nation's first; the Thunder Bay NMS has more than 50 ARs (shipwrecks) and like the Monitor NMS, serves to protect the historically significant wrecks ; Florida Keys NMS has nine ARs, wrecks that serve as marine habitats; and Papahanaumokuakea in the NW Hawaiian Islands that has at least 60 ARs/historic wrecks that date back to 1818.
2. The role of the Federal Government in the DOI's Rigs to Reef Policy per Q14 in the excerpt below from DOI document in Report Reference Document 2. In essence, the State takes the lead and assumes liabilities in the R2R Program and the Federal Government serves to set requirements and provide guidance:

See Study Reference Document 2.

Q14: What is the Department of the Interior's Rigs-to-Reefs Policy?

A14: The Department of the Interior's Rigs-to-Reefs policy encourages the reuse of obsolete oil and gas facilities as artificial reefs and describes the conditions under which DOI would waive OCSLA platform removal requirements. The decision to pursue donation of a decommissioned platform to a coastal State under the Rigs-to-Reefs process is optional and completely at the discretion of the lessee.

The Department's Rigs-to-Reefs policy is implemented by BSEE and BOEM, which administer different provisions of the OSCLA. These platform removal waiver conditions include:

1.The structure must become part of a State artificial reef program that complies with the criteria in the National Artificial Reef Plan;

2.The appropriate State agency acquires a Rivers and Harbors Act section 10 permit from the U.S. Army Corps of Engineers and accepts title and liability for the reefed structure once removal and reefing operations are concluded;

3.The reefing proposal complies with BSEE Regional Engineering, Stability, and Environmental Reviewing Standards and Reef-Approval Guidelines, as well as consistent with the best management practices and cleanup standards in national guidance prepared by EPA and the Maritime Administration regarding the preparation of vessels intended for use as artificial reefs;

4.The operator satisfies U.S. Coast Guard navigational safety requirements; and development.

5.The structure does not pose an unreasonable impediment to future mineral and energy

3. The Federal Government currently is not willing to take on the liability of an out-of-water structure in a NMS, however it does not rule out the State or another entity for taking on required liabilities.
4. 92% of online Survey respondents support the concept of retaining a decommissioned platform in the Sanctuary.
5. The AR option with the highest ranking from Survey respondents was an out-of-water option with a single clear deck at 40 feet above sea level.
6. Platforms provide the only solid habitat for marine life between 17 meters and the surface in the northern Gulf of Mexico OCS.
7. Benthic and demersal marine life is most abundant on the platforms from the surface to the first 17-21 meters of depth. Below this depth, it diminishes considerably.
8. Corals and fishes share connectivity with nearby natural reefs and serve as a possible refuge for reseeding.
9. There are only two species of reef-building coral on HIA-389A.
10. Platforms close to the natural reefs have greatest amount of corals; amount of coral on platforms decrease as their distance from natural reefs increase.
11. Each platform set for decommissioning needs to be surveyed and assessed individually for its potential value as an AR.
12. Costs to maintain an out-of-water platform are significant (see Section 3.2)
13. Liabilities for an out-of-water structure are the greatest obstacle for making this option possible
14. For partial removals, the USACOE dictates vertical clearance requirements; the USCG specifies navigation/buoy requirements.
15. It is possible to have a partial removal cut at a depth shallower than 85 feet approved by the USACOE and US Coast Guard. (the traditional 85 ft depth clearance associated with the Coast Guard is <u>not a requirement</u>, but is a guideline.)
16. The total permit cycle time for a partial removal AR is about 6 month.
17. It is possible to have an out-of-water AR off Texas with current legislation and BOEM permitting requirements as long as the State of Texas is willing to backstop the liability and the NMS is willing to host an out-of-water structure in the Sanctuary.

18. The minimum expected life of an offshore structure without anode protection is around a hundred years. With anode protection, structures can last several hundred years.
19. The so-called “boomerang liability” clause referenced in the Federal Government’s 30 CFR 285.1000, at 250.1731 makes the “Alternate Use” provision for decommissioned platforms unattractive to the oil and gas company owners. To date, no owners have opted to utilize this option.
20. The limitations of current language in the Federal CFR below that does not allow a structure to become part of an appropriate Federal agency (only State as shown in red). 30 CFR 250, Subpart Q - Decommissioning Activities

    250.1730- When might MMS approve partial structure removal or toppling in place?

    The Regional Supervisor may grant a departure from the requirement to remove a platform or other facility by approving partial structure removal or toppling in place for conversion to an artificial reef if you meet the following conditions:

    (a) The structure becomes part of a ***State artificial reef program***, and the responsible ***State agency*** acquires a permit from the U.S. Army Corps of Engineers and accepts title and liability for the structure; and

    (b) You satisfy any U.S. Coast Guard (USCG) navigational requirements for the structure.

6.2 Process for Making the Final AR Recommendations

To arrive at final recommendations from the Study effort, the AR Working Group met on January 9, 2013 in Galveston for an Artificial Reef work session. All WG members were sent a packet of Study information prior to the meeting. In the first part of the working group session, the WG Champions/Subject-Area Experts reviewed their respective Study inputs to the WG team to provide a comprehensive study overview and allow further discussions and clarifications. This included presentations by Cancelmo, Moore, Sammarco, Heyman, Leedy and Sinclair. Afterwards, the question was asked (by Cancelmo) if the group felt we had sufficient Study inputs/information to make a recommendation(s) to SAC. The unanamous answer was "Yes". Cancelmo then opened the floor for a recommendation(s). The attached recommendation is the result of a team-effort with inputs from many in the group. Once the final wording was crafted, by show of hands, and voice, all agreed to forward this attached recommendation to SAC.

AR Working Group Attendee List: Burek, Cancelmo, Embesi, Heyman, Moore, Pickett, Sammarco, Leedy (phone in), Sinclair (phone-in). GP Schmahl and Jennifer Morgan were also in attendance as was a Texas A&M student invited by Will Heyman.

6.3 Final AR Recommendation to SAC (by AR Working Group January 9, 2013)

Beyond HI-A389A, the preferred option of the FGBNMS council's Artificial Reef Working Group is an artificial reef with an out-of-water structure, in order to maximize the benefits to FGBNMS, the GOM, and the sanctuary's stakeholders. If this is not feasible, the maximum amount of structure should be retained standing as is in the sanctuary, but cut at a depth no more than 60 feet below sea level. We understand the costs and liability issues for out-of-water structures, and realize such option will require an organization with suitable interests and adequate funding to own, maintain and handle applicable liability requirements.

ADDENDUMS

A-1: AR Work Group Members

A-2: TPWD List of Partial Removals

A-3: Recommendation for Boundary Expansion

(platforms within)

A-1 ARTIFICIAL REEF WORK GROUP MEMBERS A/O January 2013

Irby Basco – (Recreational Fishing)

Jorge Brenner – (The Nature Conservancy)

Frank Burek – Ex-team leader (ex SAC Recreational Diving)

Jesse Cancelmo, Chairman – (Recreational Diving)

John Embesi –(FGBNMS staff) (ex SAC Research)

Joe Hendrix – (ex SAC Commercial Fishing)

Will Heyman – (Research)

John Hoffman –(SAC Oil & Gas Operations)

Daniel (Herb) Leedy –(BSEE)

Clint Moore(ex SAC Oil & Gas Operations)

Ellis Pickett – (Conservation)

Paul Sammarco – (Marine Sciences)

James Sinclair – (SAC BOEM)

Cher Walker – (Diving Operations)

A-2 TPWD LIST OF PARTIAL REMOVALS

Reef Site Name	Type of Material	Placement Procedure	Removal Method	Quantity	Material Description	Material Type
PN-A-58	4-pile jacket	Partial Removal	Mechanical	1	4-pile jacket	Oil & Gas Jacket
HI-A-355	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-532	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
PN-A-72	3-pile jacket	Partial Removal	Mechanical	1	3-pile jacket	Oil & Gas Jacket
GA-A-125	3-pile jacket	Partial Removal	Mechanical	1	3-pile jacket	Oil & Gas Jacket
GA-189 - Mitchell's	Two 4-pile jackets & Caisson	Partial Removal	Mechanical	2	4-pile jacket	Oil & Gas Jacket
GA-189 - Mitchell's	Two 4-pile jackets & Caisson	Partial Removal	Mechanical	1	Caisson	Oil & Gas Componer
HI-A-570	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-477	6-pile jacket	Partial Removal	Mechanical	1	6-pile jacket	Oil & Gas Jacket
HI-A-462	4-pile jacket	Partial Removal	Mechanical	1	4-pile jacket	Oil & Gas Jacket
HI-A-302	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-302	8-pile jacket	Partial Removal	Mechanical	1	Deck	Oil & Gas Componer
HI-A-285	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-327	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-497	4-pile jacket	Partial Removal	Mechanical	1	4-pile jacket	Oil & Gas Jacket
HI-A-313	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-349	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-330	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
MI-A-7	4-pile jacket	Partial Removal	Mechanical	1	4-pile jacket	Oil & Gas Jacket
GA-288 - Buccaneer	12-pile jacket	Partial Removal	Mechanical	1	12-pile jacket	Oil & Gas Jacket
GA-288 - Buccaneer	4-pile jacket	Partial Removal	Mechanical	1	4-pile jacket	Oil & Gas Jacket
GA-296 - Buccaneer	12-pile jacket	Partial Removal	Mechanical	1	12-pile jacket	Oil & Gas Jacket
GA-296 - Buccaneer	4-pile jacket	Partial Removal	Mechanical	1	4-pile jacket	Oil & Gas Jacket
HI-A-286	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-310	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
MU-A-16	8-pile jacket	Partial Removal	Mechanical\Explosives	1	8-pile jacket	Oil & Gas Jacket
MU-A-85	8-pile jacket	Partial Removal	Mechanical\Explosives	1	8-pile jacket	Oil & Gas Jacket
HI-A-571	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-317	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-356	8-pile Jacket	Partial Removal	N/A	1	8-pile jacket	Oil & Gas Jacket
HI-A-555	8-pile jacket	Partial Removal	Mechanical	1	8-pile jacket	Oil & Gas Jacket
HI-A-323	8-pile Jacket	Partial Removal	N/A	1	8-pile jacket	Oil & Gas Jacket
HI-A-517	4-pile tied to 8-pile	Partial Removal	N/A	1	4-pile jacket	Oil & Gas Jacket
HI-A-517	8-pile Jacket	Partial Removal	N/A	1	8-pile jacket	Oil & Gas Jacket

A-3 RECOMMENDATION FOR BOUNDARY EXPANSION