Alabama's Artificial Reef Plan

A proposal for engineered reef deployment and marine resource management

A Joint Project by the Alabama Wildlife Federation and the Alabama Chapter of the Coastal Conservation Association in Conjunction with Alabama Marine Resources Division

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Executive Summary

Alabama is home to one of the most productive artificial reef networks in the nation. Prior to the Deep Water Horizon Oil Spill in 2010, the reef system was shown to have strengthened the ecological and environmental health of the northern Gulf of Mexico by providing habitat for economically viable reef fish, and creating a marine environment which made it possible for fish populations to flourish. This growth in the fish stock is most evident in red snapper, and it is the reason why Alabama anglers land approximately 34 percent of all recreationally caught red snapper in the northern Gulf of Mexico despite the state's claim to only 3 percent of the northern gulf coastline from Tampa, Florida, to Brownsville, Texas[1]. In 2011, this man-made reef system was directly responsible for generating over $13 million in state and municipal tax revenues for the State of Alabama, and supporting over 2,460 jobs[2].

The diverse and spatially expansive reef complex constructed offshore of Alabama significantly increased the carrying capacity of reef fish over the years and yielded an astonishing level of production. However, fishery biologists with decades of experience conducting research offshore of Alabama indicate reef fish populations are limited by a habitat bottleneck due the fact that many of state's artificial offshore reefs have reached the end of their usable life. In addition, research conducted in the years following the 2010 BP oil spill indicates that the spill may have had a tremendously negative impact on the early life-stage fish populations throughout the northern gulf, potentially reversing the previously recognized growth trends[3].

Fortunately, these problems can be resolved. Renewed investment in the construction and enhancement of Alabama's artificial reef system is needed in order to release the current fish population from competition for habitat. These enhancements will also lay the foundation necessary to support future productivity of the fishery and, in part, compensate for the negative effects of the BP oil spill.

Alabama's Artificial Reef Plan represents a comprehensive review of Alabama's artificial reef infrastructure, and proposes an engineered effort that delivers the necessary enhancement and construction required to ensure the state's Gulf waters remain productive and ecologically sound for years to come. Investment in this proven resource will allow for better management of the fishery by enhancing the inshore, nearshore, and offshore reef sites, and engineering a system that will provide desired habitat for numerous fish species as they migrate throughout their life cycle. Additionally, the proposed budget includes adequate funding to support ongoing scientific research and monitoring that will enhance our understanding of how to most effectively manage this valuable resource over the next five to ten years.

Alabama's artificial reef system first went into construction in 1953 with the deployment of 250 used auto bodies[4]. Since this time, the science and technology surrounding artificial reef construction has expanded tremendously. Thanks to modern science, future reef deployments will be made with an elevated sense of sophistication that will allow the Alabama Department of Conservation and Natural Resources Marine Resources Division to more effectively manage the state's permitted reef zones, while supporting the full life-cycle rehabilitation of the northern gulf marine ecosystem. Modern juvenile reef development projects focus on the use of low-density reef material that resembles relic oyster reefs and offers high volume protective habitat for juvenile fish species.

With proper funding, and by using science as a guiding factor in reef construction, Alabama is uniquely positioned to enhance the inshore, nearshore and offshore components of its existing

reef network. The following plan details why the State of Alabama must invest in an engineered enhancement of its artificial reef system, and is fully supported by numerous coastal and regional organizations, scientists and biologists, as well as municipalities and private citizens. A timely investment in this proven resource is a wise investment in the long-term ecological health and economic well being of Alabama's Gulf Coast.

The plan proposes to establish bridges between habitats connecting early to adult life stage requirements through the following components:

- Refurbishing thirty-one (31) existing inshore reefs
- Constructing eight (8) new inshore reefs
- Enhancing the seabed at five (5) nearshore gas platforms
- Developing a nearshore snorkeling reef complex
- Creating three (3) additional nearshore reefs zones within two to three nautical miles of the coast
- Creating an additional three (3) new reef zones within six to nine nautical miles of the coast
- Constructing new offshore juvenile red snapper habitat in the General Permit Offshore Reef Zone
- Reefing of three (3) large ships
- Enhancing existing offshore reef sites with 25' high-relief-structures
- Developing an offshore fish attracting device (FAD) program to increase economically viable pelagic fish species
- Utilizing multi-beam side scan technology to characterize the seabed both inside and outside of Alabama's General Permit Offshore Reef Zones*
- Developing a program using SCUBA and remotely operated vehicles (ROV's) for ongoing monitoring and scientific research in the General Permit Offshore Reef Zone*
- Five (5) years of scientific research and monitoring*

The estimated cost to fully implement this plan in 2014 is $42,128,583.

*When this plan refers to ongoing science and monitoring, it is referencing a number of features, including, but not limited to, the utilization of multi-beam side scan technology to characterize the seabed both within and outside of Alabama's permitted reef zones, funding for clinical research on the rates of growth within fish populations at reef sites, and monitoring the reef sites to determine when enhancement projects should be conducted.

Alabama's Gulf Coast Bottoms

The natural bottoms of Alabama's Gulf waters resemble a predominantly flat plain comprised of a sandy-mud mixture. In its natural state, this bottom type attracts only diminutive soft-bottom fish species of little or no economic importance[5]. However, with the addition of man-made structures fish species from throughout the fishery, such as red fish, sheepshead, speckled trout, gag grouper, red snapper, and others, have been proven to recruit to the "refurbished" bottoms and establish residency near the safe haven created by the artificial reef structures. With time, these reef structures come to resemble natural reefs in that they accumulate biomass and become home to crustaceans, bait fish, and other species found in natural reef habitats. They also provide protection and offer suitable mating grounds, which add to the replenishment of the fish stock[6].

Authoritative research conducted by marine biologists at the Dauphin Island Sea Lab, Auburn University and the University of South Alabama has followed the life cycle of red snapper in offshore reefs as they move through the juvenile growth stages of 0-1 years of age, then utilize high-relief habitats in the adult age class[7]. As fish age and increase in size, they require different types of habitat. Therefore, older and larger fish seek different reef structures, often in deeper waters, and alternative sources of food and shelter than they did when at an earlier life stage.

Today, Alabama's coastal waters foster tremendous ecological diversity. This diversity, and the subsequent economic benefit it offers to the state would not have been possible without an artificial reef system. As the reef habitat has expanded over the years and fostered ecological growth within the marine environment, it has opened the door for the state to use the system more effectively as a management tool designed to balance the economic yield and ecological benefit of Alabama's estuaries and Gulf waters for all user groups.

Alabama's Artificial Reef History

Alabama has over sixty years of experience in artificial reef deployment.

In 1953, the Orange Beach Charter Boat Association installed the first artificial reefs after receiving permission to deploy 250 car bodies offshore in Baldwin County.

In 1971, Alabama Marine Resources Division (AMRD) deployed the first inshore reefs in Mobile Bay.

In 1974, state and federal agencies reefed five "ghost-fleeted" liberty ships offshore of Alabama.

In 1987, a general permit was issued by the U.S. Army Corps of Engineers (USACOE) creating nearly 800-square-miles available for state inspected reefing material to be deployed.

In 1994 the USACOE opened the door for the deployment of obsolete military combat tanks as reef material. By the following year, a total of 100 decommissioned military tanks had been deployed. Two years later, in 1997, a second USACOE permit extended the general artificial reef zone to include deeper waters, thereby increasing Alabama's reef zone to approximately 1,030 square miles.

In 2000, the Roads to Reef program began construction of ten (10) new inshore reefs. The Roads to Reef program involved numerous federal and state agencies, industries, and organizations, including the Coastal Conservation Association, the Alabama Wildlife Federation and the Mobile County Wildlife and Conservation Association.

In 2003, AMRD partnered with Legacy Resources and Exxon-Mobil to create artificial reefs at the base of seven (7) natural gas platforms in Mobile Bay.

From 2004-2007 AMRD worked with the Orange Beach Fishing Association on the largest reef deployment project in Alabama's history, deploying 855 pyramids in the Gulf of Mexico.

In 2011, AMRD and the Alabama Chapter of the Coastal Conservation Association partnered to construct Bayou Cour Reef, the largest inshore reef in Alabama waters.

In 2011, AMRD and the Orange Beach Fisherman's Association constructed two (2) nearshore reef zones (R.V. Minton East and R.V. Minton West) within 3 miles of the coast to increase fishing opportunities for young anglers and smaller boats.

In 2013 AMRD worked with the Alabama Gulf Coast Reef and Restoration Foundation and other governmental and private organizations and businesses to deploy the 270' LuLu, Alabama's largest offshore artificial reef.

Currently, AMRD has permitting rights from the Army Corps of Engineers to enhance all of the existing inshore reefs sites, as well as to construct several new reefs within Alabama's estuaries. Also, AMRD has permitting rights from the Army Corps of Engineers to enhance existing reef sites and construct new artificial reefs within approximately 1,032 square miles of the Gulf of Mexico.

Economic and Ecological Impact

Alabama is a state with a rich abundance of natural resources, and a deeply held appreciation for the virtues of conservation. The world-class fishing opportunities presented along Alabama's Gulf Coast support the economy and are synonymous with the culture of the region. While it has long been understood that recreational fishing provides an economic boost for Alabama, recent monitoring and tagging efforts conducted after the oil spill have taken notice of the habitat bottleneck's effect on certain economically viable reef fish throughout the Gulf of Mexico[8]. This plan commits to rebuild and maintain the infrastructure required to preserve and enhance this unique resource for future generations.

Using data from 2011, the American Sportsfishing Association conducted an economic impact study examining the money spent by 133,676 individuals who purchased recreational saltwater fishing licenses in the State of Alabama that year. The results showed that these fishermen spent $214,726,406 on retail sales in advance of, during and after their fishing excursions. That's an average expenditure of $1,606.32 per angler. In addition, these revenues had a multiplier effect on local coastal economies and were responsible for supporting more than 2,460 jobs, and generating $13,487,212 in state and municipal taxes[9].

Alabama's expansive artificial reef system has not only been an economic asset to the state, it has also proven to benefit the ecological viability of the overall northern Gulf of Mexico. The habitats created by the artificial reefs have increased the carrying capacity and provide fertile mating grounds for fish species. In his 2007 paper titled, A Review of Movement in Gulf of Mexico Red Snapper: Implications for Population Structure Dr. Will Patterson of the University of South Alabama identified that as reefs meet their carrying capacity and become overcrowded, red snapper in Alabama's artificial offshore reef system often migrate to neighboring coastal waters in search of additional habitat[10]. As it relates to the red snapper population, it has been shown that this spillover has had a positive economic impact on other states, such as Florida, as their ability to produce economically viable fish has increased[11].

Dr. Patterson's work also demonstrates that the fishery management goals and benchmarks, established by the state in an effort to support the proliferation of various fish species, are attainable through proper enhancement of a well planned and productive artificial reef zone. By taking a comprehensive approach to engineering the reef zone as a fishery management tool, limitations imposed on the natural growth of the fish stock due to the dual threats of the BP oil spill and habitat restrictions can be reversed.

In the case of an artificial reef system, the inshore, nearshore and offshore reefs each have an important and complementary role to play. As is true with any well-functioning system, all parts must work in tandem with one another in order to deliver the best outcome. This connectivity between reef complexes provides continuous available habitat from Alabama's estuarine waters to the outer continental shelf. While they serve a unique purpose independently, the reef zones combine to create a reef system that supports the whole life maturation of reef fish while strengthening Alabama's coastal economies and improving the overall ecology of the northern Gulf of Mexico for years to come.

Fun Facts

- There are approximately 60 million anglers in the U.S.
- Anglers generate $48 billion in retail sales annually throughout the country
- Recreational fishing has a $115 billion impact on the nation's economy
- In 2011, recreational saltwater fishing generated $13,487,212 in state and local tax revenues for Alabama's economy
- Fishing tackle sales grew more than 16 percent in the past five years

Did You Know?

- More Americans fish (60 million) than play golf (21 million) and tennis (13 million) combined.
- In 2011, revenues generated from fishing ($48 billion) were greater than Lockheed Martin ($47 billion), Intel ($44 billion), Chrysler ($42 billion) or Google ($38 billion).
- More than twice the number of people fished in 2011 than attended every NFL game combined.

Project and Budget

Alabama Marine Resources Division has deployed a variety of offshore reef materials, and constructed a number of inshore reefs in the waters of the Mississippi Sound, Mobile Bay, and Perdido Bay.

As described by Dr. Stephen T. Szedlmayer in the 2007 publication titled "An Evaluation of the Benefits of Artificial Habitats for Red Snapper, Lutjanus campechanus, in the northeast Gulf of Mexico," juvenile red snapper ages 0-1 utilize a wide variety of low relief habitats that differ greatly from preferable habitats for fish ages 1-2, 2-7, or 8 and older[12]. As juvenile fish mature and increase in size, they become less dependent upon the protective environment of the relic shell rubble ridges, or low-relief reef sites, and migrate to deeper or more open waters in search of food and adequate protection from predators.

Inshore Projects

Inshore projects pertain to all reef projects in the waters of Mobile Bay, Weeks Bay, Pelican Bay, Point Clear, Alabama's estuary system and the Mississippi Sound. Inshore reefs provide important habitat for oysters, and numerous types of fish throughout their life cycle.

Alabama Marine Resources Division (AMRD) began its inshore reef program in 1971. Since this time a diverse range of materials, such as roadway material, oyster cultch, bridge pilings, and limestone gravel have been used to increase finfish habitat and promote oyster production. Modern inshore reef development projects range from offering high volume protective habitat for juvenile fish species to the deployment of six foot pyramids for adult red fish, speckled trout, sheepshead and other species.

To date, AMRD has constructed thirty-one (31) inshore reefs, and plans to build an additional eight (8). Of the proposed reefs, two have already been permitted by the Army Corps of Engineers, and the other six are in design. This plan (Figure 1.A) proposes enhancement of the existing thirty-one reefs (Figure 1.B), construction of the eight (8) planned inshore reefs (Figure 1.C), and five years of ongoing scientific research and monitoring. Permitting has already been secured to enhance and refurbish the existing reefs, many of which have deteriorated as years of storm activity and natural degradation have decreased their levels of production.

The total cost of the proposed inshore projects, including five years of scientific research and monitoring is $25,037,146.

Inshore Reef Project	Cost
Construction of eight (8) new reefs	$2,869,406
Enhancement of thirty-one (31) existing reefs	$20,292,740
Monitoring (5 years)	$625,000
Research (5 years)	$1,250,000
Total	$25,037,146

Figure 1.A: Proposed Inshore Reef Zone projects, and estimated cost for construction and material based on 2014 figures.

Existing Reef	Acreage	Cubic Yards of Gabion Stones	Tons of Gabion Stones	Total Cost of Materials and Installation in 2014
Battles Wharf	3.8	4,303	5,551	$360,815
Bayou Cour	32.4	36,558	47,156	$3,065,140
Bayou St. John	5.3	5,978	7,712	$501,280
Bender/Austal	3.3	3,671	4,735	$307,775
Boykin	5.8	6,528	8,420	$547,300
Brookley Hole	0.8	897	1,157	$75,205
Buddy Beiser	3	3,348	4,318	$280,670
Choctaw Pass	0.5	580	749	$48,685
Dell Williamson	0.3	338	437	$28,405
Denton	70.2	79,186	102,141	$6,639,165
Exxon Mobil 63AB	1	1,128	1,455	$94,575
Exxon Mobil 76A-76A-Aux	1	1,117	1,440	$93,600
Exxon Mobil 95E	0.4	395	509	$33,085
Exxon Mobil: Alex Maisel Memorial Reef	1.4	1,579	2,037	$132,405
Fish River	4.3	4,809	6,203	$403,195
Fort Morgan Barge	2.1	2,369	3,056	$198,640
Legacy - Miocene Rig 615#1	0.3	282	364	$23,660
Legacy - Miocene Rig 615#3	0.3	282	364	$23,660
Legacy - Miocene Rig 615#4 Expanded	3.7	4,140	5,340	$347,100
Legacy Resources	0.3	282	364	$23,660
Mississippi Sound #1	3.4	3,835	4,947	$321,555
Mississippi Sound #2	18.8	21,178	27,317	$1,775,605
Mississippi Sound #3	3.7	4,174	5,384	$349,960
Ono Island	9.3	10,513	13,561	$881,465
P. Grey Cane, Jr.	6.4	7,188	9,272	$602,680
Rockpile	14.1	15,905	20,516	$1,333,540
Ross Point	4.4	4,963	6,402	$416,130
Shellbank	9.9	11,167	14,405	$936,325
Shrimpboat	2.3	2,594	3,347	$217,555
Upper Wreck	1.5	1,659	2,140	$139,100
Zundel's Landing	1	1,083	1,397	$90,805
Totals	**212.5**	**239287**	**308659**	**$20,292,740**

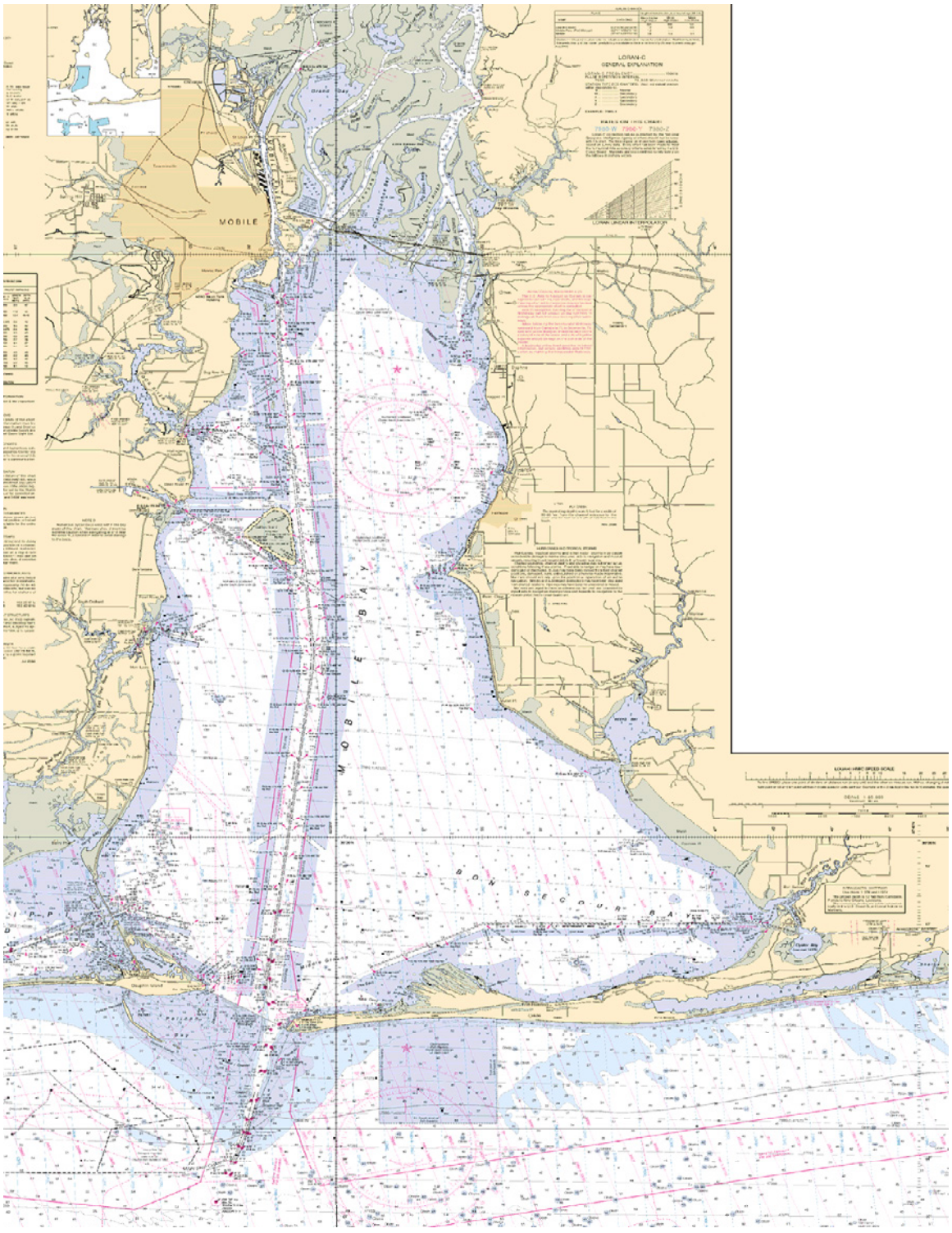
Figure 1.B: Enhancement of thirty-one (31) existing inshore reefs. Name, acreage, volume of 6"-8" limestone gabion needed for enhancement, mass of material needed for reefing, estimated cost of enhancement operations to sufficiently enhance each existing site.

Permitted Reef	Acreage	Cubic Yards of Gabion Stones for 100% Coverage	Tons of Gabion Stones	Total Cost of Materials and Installation in 2014
Point Clear	9.74	10,987	14,172	$921,161
Weeks Bay	2.6	2,933	3,783	$245,895

Reefs in Design	Acreage	Cubic Yards of Gabion Stones for 100% Coverage	Tons of Gabion Stones	Total Cost of Materials and Installation in 2014
Arnica Bay	3	3,384	4,365	$283,725
Mississippi Sound Wreck #1	3	3,384	4,365	$283,725
Mississippi Sound Wreck #2	3	3,384	4,365	$283,725
Mobile Bay at Buoy Reef	3	3,384	4,365	$283,725
Pelican Bay	3	3,384	4,365	$283,725
Portersville Bay	3	3,384	4,365	$283,725
Totals	**30**	**34,224**	**44,145**	**$2,869,406**

Figure 1.C: Construction of eight (8) proposed new inshore reefs. Name, acreage, volume of 6"-8" limestone gabion needed for construction, mass of material needed for reefing, estimated cost of operations to sufficiently construct eachof the proposed reef sites.

Figure 1.D: Map of Mobile Bay, depicting the Inshore Reef Zone. Each icon represents the location of an existing inshore artificial reef.



Nearshore Projects

Nearshore reefs play an integral role in the ecological and economic productivity of Alabama's artificial reef system. First designed by former Alabama Marine Resources Division Director R. Vernon Minton as a means to make fishing opportunities more accessible to children, they play an important role as a "habitat bridge" for numerous fish species. Nearshore reefs provide transitional habitat for fishes such as grey snapper and gag grouper as they outgrow their inshore juvenile habitats and migrate offshore to their adult reef habitats. Red drum, flounder, and sheepshead also utilize the nearshore waters of the Gulf of Mexico during their annual migratory patterns.

Following Director Minton's passing in 2010, AMRD began construction on two (2) specific areas designated as nearshore reef zones, the R.V. Minton East, and R.V. Minton West reefs, respectively. Each has added proven value to the state's overall reef system. However, despite the ecological importance of the nearshore area to a wide variety of economically important finfish, the nearshore zones comprise the most underdeveloped portion of Alabama's entire artificial reef system.

This plan proposes engineering a number of enhancements for the nearshore reef zones, such as:

- The deployment of an additional 250 juvenile fish shelters constructed from modular limestone gabions containing interior void spaces to provide refuge for juvenile reef associated fishes from predators within R.V. Minton East and R.V. Minton West.

- Enhancing the seabed at five (5) specific gas platforms with 6"-12" rip rap, deploying approximately 5,456 tons of stone at up to 24" elevation over 0.25 acres of seabed at each oil rig.

- Developing a snorkeling reef complex by deploying seventy-five (75) anchored reef structures, similar to eco-reefs, which would run parallel to the beach in the waters off the Baldwin County shoreline. This development will serve as a major tourism draw for the coastal communities, and diversify the use of the reef structures across a larger human population while providing transitional habitat for fish species.

- Creating three (3) additional nearshore reef areas approximately 2-3 nautical miles offshore in the Gulf of Mexico. This project consists of constructing both juvenile and intermediate stage habitats and requires the deployment of one hundred and fifty (150) 6' concrete/limestone pyramids, as well as one hundred and fifty "juvenile fish shelters" within each newly formed reef zone.

- Creating three (3) additional reefs within the newly zoned waters up to nine nautical miles of the coast. These reefs are estimated to measure 90-100 square acres.

The total estimated cost for the proposed nearshore projects, including five years of scientific research and monitoring, is $4,607,937 (Figure 2.A).

Figure 2.A: Proposed Nearshore Reef Zone projects and total estimated cost for construction and material based on 2014 figures.

Nearshore Reef Project	Cost
150 Fish Shelters in each of 3 New Nearshore Zones	**$900,000**
150 Pyramids in each of 3 New Nearshore Zones	**$582,750**
Juvenile Shelters in R.V. Minton Nearshore Zones	**$500,000**
Monitoring	**$625,000**
Reefing Base of five (5) Gas Platforms	**$600,187**
Research	**$1,250,000**
Snorkeling Reef	**$150,000**
Total	**$4,607,937**

Figure 2.B: Location of R.V. Minton East nearshore reef zone permitted by the United States Army Corps of Engineers permit #SAM-2010-0505-DEM.

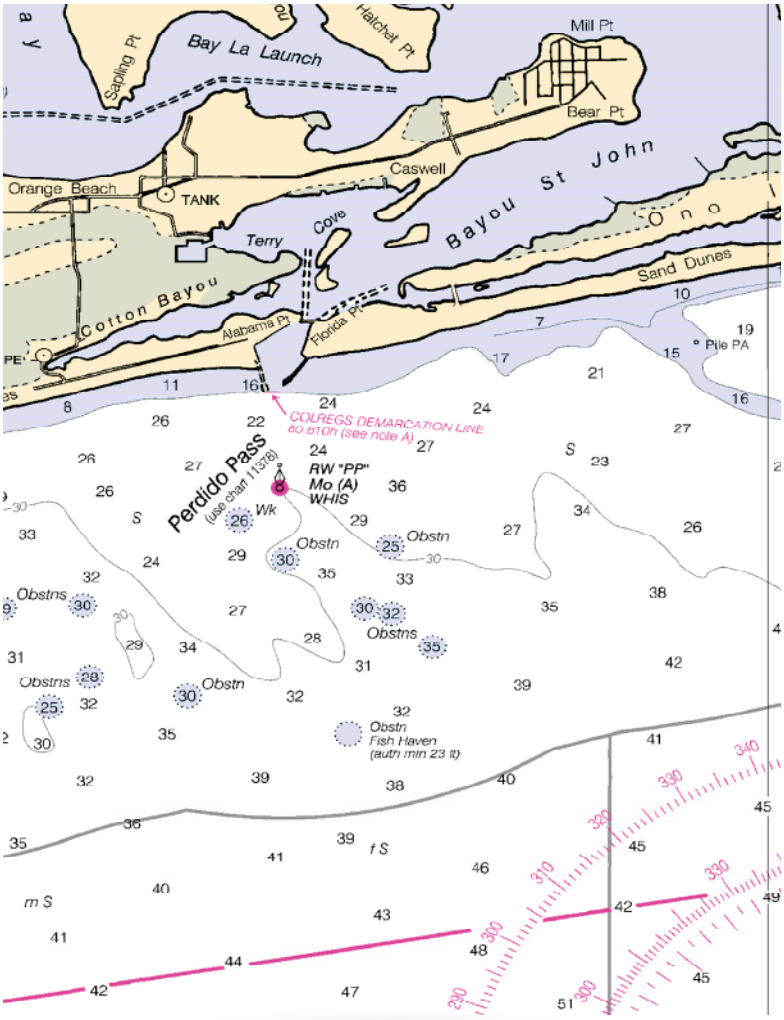
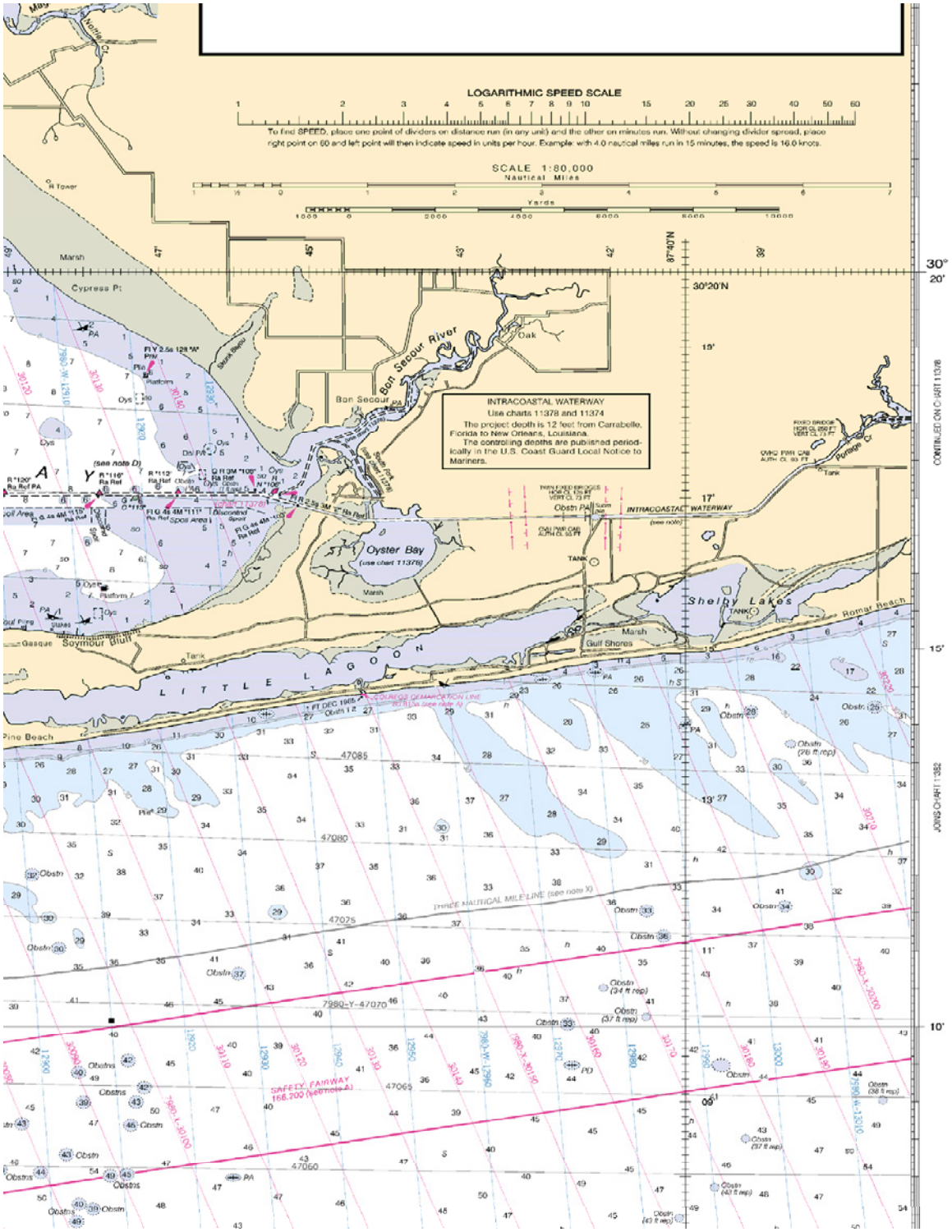


Figure 2.C: Location of R.V. Minton West nearshore reef zone permitted by the United States Army Corps of Engineers permit #SAM-2010-0505-DEM.



Offshore Projects

Alabama has five (5) permitted offshore reef zones measuring an approximate total of 1,030 square miles. Within these waters, the state and independent organizations have deployed numerous artificial reef structures over the course of the past sixty years. Further development of these sites using diversified reef materials will have a number of benefits, including building the connectivity between the five zones and establishing offshore habitat in the deeper waters near the outer limits of the reef zones, to provide a foundation for the long-term sustainability of the fish stock.

In order to meet the management goals of supporting the long-term sustainability of a diverse and abundant fish stock, it will be necessary that the offshore system be engineered using diversified reef materials. Specific offshore projects proposed in this plan are listed in (Figure 3.A), and include:

- Utilizing multi-beam side scan technology to characterize the seabed both inside and outside of Alabama's five Offshore General Permit Reef Zones. This technology will allow researchers to identify juvenile red snapper habitat, determine exactly which bottoms are best suited for habitat enhancement, and identify additional substrate formations that can be useful to the system.

- Deployment of low-relief habitat in twenty (20) acres of homogeneous sandy substrates for increased juvenile red snapper habitat. Multi-beam side scan technology will be utilized to identify suitable sub strates within a safe distance from the nearest high-relief adult reef fish structures.

- Deployment of at least 100 exceptionally high-relief structures (+25' in height) to diversity reef habitats within the reef zones and meet fishery management goals and benchmarks for numerous fish species. These high relief structures are favored by amberjacks, gag grouper, red grouper, scamp, triggerfish and many other reef fish.

- Purchasing, preparing and deploying at least 3 large ships (+300' in length) for the development of dive sites available to SCUBA enthusiasts. This project could be accomplished through a partnership with the Alabama Reef and Restoration Foundation, Alabama Marine Resources Division, and others.

- Acquiring decommissioned gas rig jackets and platforms to be deployed in water depths ranging from 150' to 500'.

- Development of a Fish Attracting Device (FAD) program to increase catch rates of economically im portant pelagic fish – fish such as tuna, dolphinfish, wahoo, marlin and others. FADs will be deployed along gas rig reef sites and within waters ranging from 500' to 3,000' up to 100 nautical miles offshore.

- Deploy a total of six hundred (600) 6' pyramids within the planned reef zones located six to nine nauti cal miles off the coast.

- Seek opportunities to revitalize the Alabama Marine Resource Division Reef-Ex program for the pur pose of re-commissioning ex-military equipment for use as reef materials.

- Develop contract procedures with reef builders to prepare, transport, and deploy material such as barges, concrete well-heads, concrete culverts, decommissioned bridges, etc. which are donated to Alabama Marine Resource Division for use in reef construction.

- Development of a 5-year offshore monitoring program using SCUBA and Remotely Operated Vehicles (ROVs) to track the rate of ecological succession associated with newly constructed reef sites.

- Funding academic research to evaluate production rates associated with our newly created artificial reef sites over the course of 5 years.

Additional opportunities for future reef enhancement may exist in numerous offshore sites, such as the historic natural reef infrastructure found along the Relic Oyster Shell Ridge. This ridge is a series of ancient oyster reefs that proliferated approximately 10,000 years ago, before the last ice age, and which are believed to have deteriorated as a result of storm activity and natural degradation. The use of side-scan technology proposed in this budget will identify the locations of these ancient reefs, and allow the state to focus management efforts accordingly.

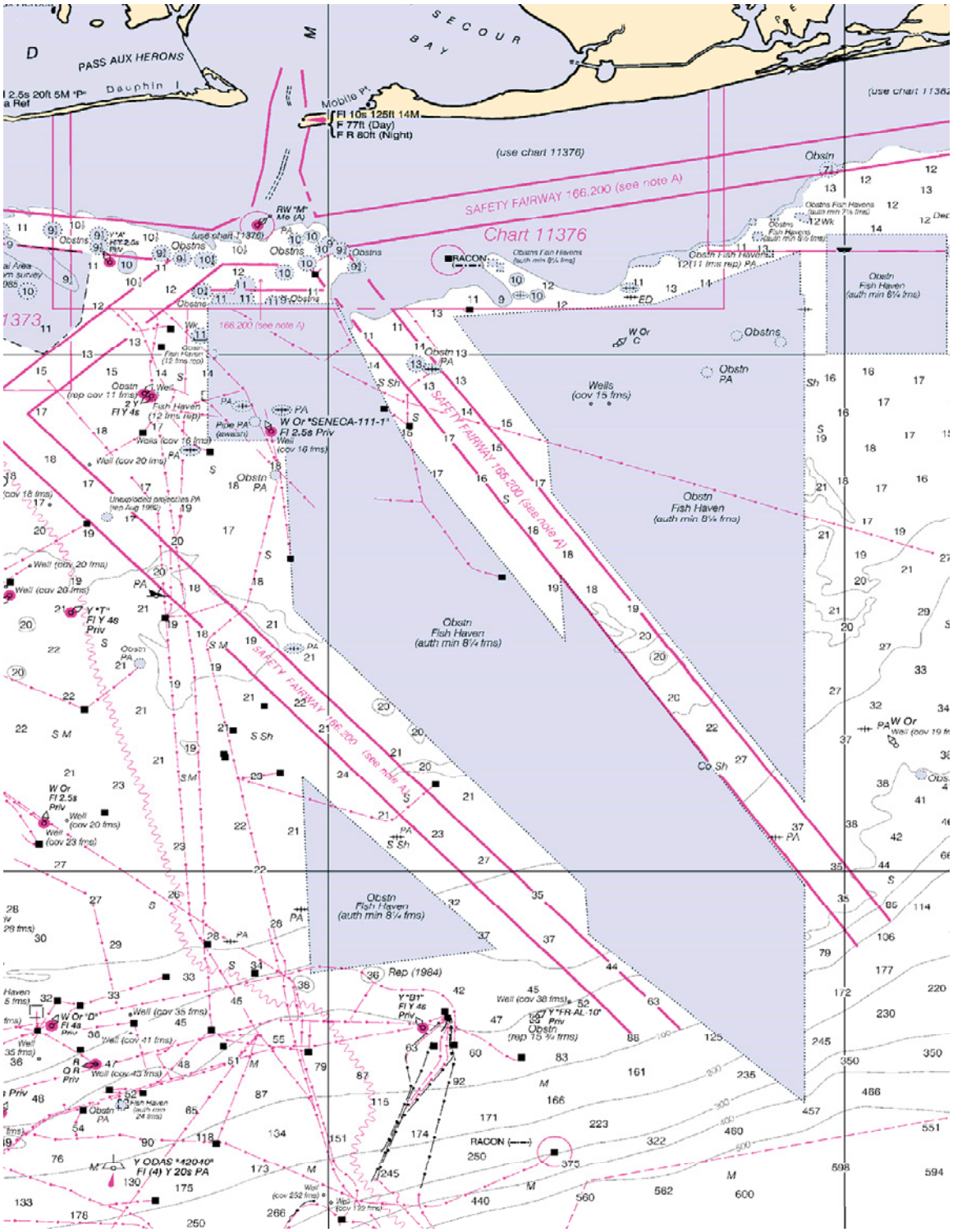
By diversifying the offshore reef zones in the manner proposed, this plan allows for the Alabama Marine Resource Division to more effectively monitor the state's precious marine resources, while at the same time expanding the opportunities for multiple user groups to benefit from the investment – recreational fishermen, commercial fishermen, divers, the science community, the state and local municipalities. The combined impact of these user groups will have positive economic ripple effects for an untold number of supportive industries through increased tourism and commercial opportunities.

The total cost of the proposed offshore projects, including five years of scientific research and monitoring is approximately $12,483,500.

Figure 3.A: Proposed Offshore Reef Zone projects, and total estimated cost for construction and material based on 2014 figures.

Component of Offshore Project	Cost
Multi-beam side scan inside Permitted Reef Zone (5 yr)	**$450,000 ($90,000/yr)**
Multi-beam side scan outside Permitted Reef Zone (5 yr)	**$450,000 ($90,000/yr)**
Enhancement of seabed with Juvenile red snapper habitat	**$1,600,500**
Survey program on production of juvenile habitats (5 yr)	**$375,000 ($75,000/yr)**
Deployment of exceptionally high-relief structures	**$1,500,000**
Estimated cost for converting 3 large ships into dive sites	**$1,500,000 ($500,000/ea)**
Acquiring decommissioned gas rig jackets and platforms	**$32,500**
Development of FAD program for multiple stage use	**$63,500**
Deployment of 600 pyramids within the planned six-nine nautical reef zone	**$777,000**
Converting ex-military equipment into artificial reefs	**$610,000**
Contracts for deployment of donated material	**$1,000,000**
5 Year monitoring program using SCUBA and ROVs	**$375,000 ($75,000/yr)**
Academic research on Reef Productivity (5 yr)	**$3,750,000 ($750,000/yr)**
Totals	**$12,483,500**

Figure 3.B: Location of Offshore Reef Zones permitted by the United States Army Corps of Engineers.



Conclusion

Artificial reef development started in Alabama in 1953 as a way for coastal fishermen to catch more fish and increase the economic productivity of the Gulf marine system. Little did people know, reef deployment would have a positive impact on the marine environment, as well as their pocketbook. Over the past sixty years, the State and the scientific community have significantly expanded their understanding of best practices related to reef development, selection of reef materials, and have a much deeper appreciation for the vital purpose artificial reefs play in protecting the ecological well-being of the northern gulf.

Alabama has long received national recognition for using artificial reefs as fishery management tools. However, the state must take strategic steps to address problems associated with a loss of reef habitat because many of the previously deployed reefs are at the end of their useable life. By enhancing the existing infrastructure and increasing connectivity between inshore, nearshore and offshore reef sites, Alabama can move its marine management into the future and engineer a state of the art artificial reef ecosystem. Without such action, the state's coastal waters will be unable to maintain the types of economic and ecological productivity they have been responsible for in past years.

The Alabama Reef Plan represents a comprehensive scientifically supported outline on how to engineer a marine ecosystem designed to accommodate numerous fish species at all stages of their lifecycle. It will protect the ecological well-being of the northern gulf while simultaneously driving economic productivity for the state of Alabama. This plan is a living document that will be updated with regularity.