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VIRGINIA RECREATIONAL FISHING DEVELOPMENT FUND
SUMMARY PROJECT APPLICATION*

NAME AND ADDRESS OF APPLICANT:	**PROJECT LEADER (name, phone, e-mail):**
Virginia Institute of Marine Science P.O. Box 1346 Gloucester Point, VA 23062	Romuald N. Lipcius (804) 684-7330, rom@vims.edu
PRIORITY AREA OF CONCERN:	**PROJECT LOCATION:**
Habitat Improvement	Various VMRC Artificial Reef sites, such as Northern Neck, Poquoson, Gwynn's Island and Back River, and the Lynnhaven River, Virginia

DESCRIPTIVE TITLE OF PROJECT:

Enhancement and Sentinel Reefs for the Virginia Artificial Reef Network

PROJECT SUMMARY:

This proposal requests funds to continue the currently funded RFAB project to determine the optimal design of subtidal artificial fish reefs, and to develop a sentinel reef network for Virginia's artificial reef program. The purpose of the sentinel reef network would be to establish standard artificial reefs that would be deployed within Virginia's artificial reef systems, and serve as an indicator (i.e. canary in the coal mine) of the performance of the larger artificial reefs deployed by VMRC. The proposal is part of a larger project aimed at determining an optimal reef design to enhance recreational fish and fish prey production, and to assess habitat suitability and the prey base for recreational fish in a complementary proposal by Seitz.

EXPECTED BENEFITS:

Successful completion of this project will result in identification of an optimal reef design that enhances recreational fish production, and the utility of standardized sentinel reefs serving as performance indicators of Virginia's artificial reefs. Our group is working together with VMRC and CCA to determine the most effective means of implementing a network of artificial reefs that will serve as stable habitats providing food and shelter for recreational fish species. In addition, we will implement an educational outreach program to inform recreational fishers and the general public of the value of artificial reef networks. In the long term we hope to expand the project to all of Virginia's artificial reef sites to augment production of recreational fish and assess reef performance in a network of artificial reefs in the Virginia portion of Chesapeake Bay.

COSTS:

VMRC Funding:	$153,946
Recipient Funding:	$17,935
Other Funding Sources (please list) :	State/NOAA/ACoE
Total Costs:	$171,881

Detailed budget must be included with proposal.

Updated 4/27/06

***This form alone does not constitute a complete application, contact Sonya Davis at 757-247-8155 or sonya.davis@mrc.virginia.gov**

6.) **Estimated Cost and Justification**

	VMRC	VIMS
Salaries		
Lipcius, PI - 1 month	9,542	
Marine Scientist (BS level) - 12 months	35,700	
Fringe, 35% salaries; 7.65% waged	15,835	
Supplies		
SCUBA supplies and accessories ($4,800); Reef materials ($19,000); miscellaneous field supplies ($4,500); Software ($1400)	29,700	
Travel		
Metings and Field sites - ~275 miles RT @$.58/mile VIMS truck; tolls; Lodging; Per diem	5,500	
Vessel Rental		
Rental - $120/day x 24 days	2,880	
Subcontract		
Deployment of reefs on site	12,000	
Equipment		
Portion of underwater video monitoring system	12,000	
Facilities & Administrative Costs (25%)	30,789	17,935
Total	153,946	17,935

Personnel salaries are for the coordination and conduct of the work. As leveraging, the salaries of two other staff and two additional graduate students will be covered under other grants. We have applied the allowable 30% fringe for faculty and 7.65% for hourly staff. We request 24 days of boat time on a VIMS vessel (large privateer) for sampling the reefs ($2880) plus fuel (listed in supplies). Supply costs include reef building materials, sampling materials, some SCUBA gear that will be used in this project and in future projects, software for the video system, and miscellaneous supplies. Supplies also include vessel fuel at $50 fuel per day for 24 days. Travel includes trucks for trailering boats from the VIMS main campus to field sites at $0.58 per mile for 24 days. In addition, we request $12,000 to cover 25 % of the cost of an underwater video system critical to estimate fish production, and which will be used in subsequent years with additional artificial fish reefs. We have found the video system invaluable in assessing fish and invertebrate production on artificial reefs, and we will cover the remaining 75 % of the cost from other funding sources. The subcontract is for a small barge to deploy the reefs at the two locations. Indirect costs are charged at the rate of 25% with 20% match, with the exception of service centers and equipment.

Proposal Submission to

Virginia Marine Resources Commission

By

THE VIRGINIA INSTITUTE OF MARINE SCIENCE
COLLEGE OF WILLIAM AND MARY

Enhancement and Sentinel Reefs for the Virginia Artificial Reef Network

Romuald N. Lipcius
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John E. Olney
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December 17, 2007

Enhancement and Sentinel Reefs for the Virginia Artificial Reef Network

P.I.: R.N. Lipcius

Co-P.I.: R.D. Seitz

1.) **Need**

1a.) **Introduction**

A comprehensive review and recent field investigations have demonstrated that the production of various recreationally valuable fish can be increased by different types of artificial reefs (Peterson et al. 2003). Enhancement occurs either through the provision of habitat and food for structure-dependent fish such as sheepshead and tautog (recruitment enhancement), or by increasing the availability of reef prey (growth enhancement) for transient fish such as black sea bass that use the reefs as a foraging ground. For example, the biomass of sheepshead was increased annually by 0.6 kg per 10 m^2 and that of black sea bass by 0.4 kg per 10 m^2 (Peterson et al. 2003). Artificial reefs can also enhance commercially valuable fish, as in the case in New Zealand where blue cod fishery landings increased by over 500 % in areas where oyster reefs were protected to provide habitat for blue cod (Cranfield et al. 2001). In general, the production of recreationally and commercially important fish has been augmented considerably by a diverse set of artificial fish reefs, including oyster reefs, even when such reefs also concentrate fish (Seaman 2000).

The effectiveness of alternative reef structures as excellent fish and invertebrate communities was evident in our examination of artificial reefs in the James River, in the lower Rappahannock River, and in Lynnhaven River. For instance, the abundance and biomass of Eastern oyster and hooked mussel on a concrete modular reef deployed at 7-9 m depths in the lower Rappahannock River were some of the highest recorded in Chesapeake Bay, averaging over 1,000 oysters and 10,000 mussels per m^2 of river bottom (Lipcius and Burke 2006). In addition, the habitat provided by the oysters and mussels supported a diverse assemblage of mud crabs, polychaete worms, small mollusks, reef fish, and other species that serve as potential prey for larger, recreationally valuable fish (Seitz et al. manuscript in preparation).

Our recent investigations have indicated that particular types of alternative oyster reefs (Figures 1 and 2) not only increase oyster abundance significantly (Lipcius and Burke 2006), but they can also enhance abundance of recreationally valuable fish such as sheepshead, black sea bass, and tautog. Specifically, various recreational fishers have caught these species near the alternative oyster reefs, and we have directly observed these fish on or near the alternative oyster reefs (personal observations by R.N. Lipcius and by D. Bushey of Commonwealth Pro-Dive). Numerous video and diver observations indicated that sheepshead, black sea bass, tautog, striped bass (rockfish) and other fish used the reefs as shelter or as foraging grounds. These observations are

consistent with the general conclusions by Peterson et al. (2003) on the utility of artificial reefs, including oyster reefs, in enhancing the production of recreational fish species.

With RFAB funding, we began a cooperative effort with M. Meier and J. Grist of VMRC to evaluate the effectiveness of different types of artificial reefs in enhancing the abundance and production of recreational fish and their prey on the reefs (e.g. oysters and mussels). Besides VMRC and VIMS, the effort also involves the Army Corps of Engineers—Norfolk District, Chesapeake Bay Foundation, Rappahannock Preservation Society, Lynnhaven Now, City of Virginia Beach and private citizens. We have also been interacting with the Coastal Conservation Association (CCA) and Charter Boat Captain's Association of the Northern Neck due to their interest in augmenting the production of recreational fish for Virginia anglers. The overall goal of this effort is to determine the optimal structure and placement of artificial reefs that will simultaneously maximize the production of fish, oyster and mussel. Some work has been conducted in the Rappahannock River, Lynnhaven River, and James River (Lipcius and Burke 2006, Burke and Lipcius manuscript in preparation, Seitz et al. manuscript in preparation, Lipcius et al. VIMS report in preparation).

This proposal requests funds to continue the currently funded RFAB project to determine the optimal design of subtidal artificial fish reefs, and to develop a sentinel reef network for Virginia's artificial reef program. The purpose of the sentinel reef network would be to establish standard artificial reefs that would be deployed within Virginia's artificial reef systems, and serve as an indicator (i.e. canary in the coal mine) of the performance of the larger artificial reefs deployed by VMRC. The proposal is part of a larger project aimed at determining an optimal reef design to enhance recreational fish and fish prey production. The other critical element of the project concerns habitat suitability and the prey base for recreational fish on these artificial reefs, which is presented in a complementary proposal by Seitz. Ultimately, we seek to determine which of various artificial reef types provides the most suitable shelter and feeding area for recreationally important fish and their prey. We will incorporate our findings with those of the complementary project by Seitz on the prey base for recreational fish species, and subsequently provide recommendations on the optimal reef design to increase recreational fish production in a network of artificial reefs throughout the waters of the Virginia portion of Chesapeake Bay. This project therefore falls under the category of Habitat Improvement.

1b.) **Accomplishments**

Under the current RFAB grant we have accomplished the following:

- **Deployment of 12 artificial reefs (Figure 3) at the Northern Neck and Poquoson reef sites of VMRC.**
- **Assessment of quality of artificial reefs and habitats at the Northern Neck and Poquoson reef sites.**
- **Determination of reef sites for deployment of 6 artificial reefs in Broad Bay and Linkhorn Bay of the Lynnhaven River (Figure 4).**
- **Collaboration with M. Meier and J. Grist of VMRC and R. Seitz of VIMS on habitat assessment and optimal reef structure of Virginia's artificial reefs.**
- **Identification of a readily available artificial reef (Figure 5) for comparison with the deployment reef (Figure 3) at artificial reef sites. This was accomplished in collaboration with M. Meier.**

2.) **Objectives**

A) Evaluate recreational fish production on alternative artificial reefs at Northern Neck reef, Poquoson reef, in the Lynnhaven River, and at additional VMRC reefs to be determined in consultation with VMRC and recreational fishers.

B) Establish sentinel reefs at Northern Neck reef, Poquoson reef and at additional VMRC reefs to be determined in consultation with VMRC and recreational fishers.

C) In conjunction with the prey base and food web information from the complementary project by Seitz, determine the optimal reef type for maximizing recreational fish production and prey abundance.

3.) **Expected Results or Benefits**

Successful completion of this project will result in identification of an optimal reef design that enhances recreational fish production, and the utility of standardized sentinel reefs serving as performance indicators of Virginia's artificial reefs. Our group is working together with VMRC and CCA to determine the most effective means of implementing a network of artificial reefs that will serve as stable habitats providing food and shelter for recreational fish species. The recreational fishing community is expected to profit from the enhancement of fish production. In addition, we will implement an educational outreach program to inform recreational fishers and the general public of the value of artificial reef networks. We have also communicated with J. Travelstead

and M. Meier of VMRC's Fisheries Division to make sure that the artificial reefs are consistent with VMRC's philosophy on creation of artificial fish reefs. Finally, in the long term we hope to expand the project to all of Virginia's artificial reef sites to augment production of recreational fish and assess reef performance in a network of artificial reefs throughout the Virginia portion of Chesapeake Bay.

4.) **Approach**

Reef structures will continue to be deployed between April and November 2008 to allow for colonization by fish in the spring and summer, and by oysters, mussels, crabs, and other fish prey in summer and fall. Abundance of fish (this project) and invertebrate prey (Seitz project) will be quantified in May, August and November 2008. Fish production will be quantified with a combination of an underwater video system, direct diver observations, and selective capture of fish with circular nets used previously by us to sample artificial shelters in other locations. Most of the observations will be conducted with the video system, and verified with periodic diver observations and net sampling. These observations will give us direct measures of fish recruitment and foraging at each of the reef types. In addition, we will sample recreational fish at each location by enlisting the assistance of local recreational anglers through our contacts with Lynnhaven Now and the Coastal Conservation Association.

Production will be calculated by using published length-weight relationships. Although the fish information will not be specific to each reef type, the total production of the reef system will be ascribed to the reef types by partitioning the production according to the video and diver observations. The video system is a proven means of sampling fish under low visibility, as is diver observation. In the spring and summer, we will refine the net sampling method and cross-validate it with the video and diver methods. The abundance of fish on the various reef types will be analyzed statistically to determine which reef type is optimal in enhancing fish production.

This project will be a collaboration among several entities and personnel, and leverage various sources of funding to decrease the cost to VMRC and the state:

VIMS—R. Lipcius will coordinate the project and interact with R. Seitz on the complementary food web/prey availability project, and with H. Wang, J. Shen and M. Sisson on the existing hydrodynamic models for the lower Chesapeake Bay. R. Burke, a doctoral student at VIMS, will aid in coordination of the effort and use a portion of the information for thesis research. A substantial portion of the graduate student costs is covered by other grants.

ACoE—D. Schulte and C. Seltzer of the Norfolk District are actively engaged in the project and funded a portion of the pilot study for this proposal. In addition, the ACoE may be able to provide further funding for the construction of the reefs, offsetting the cost to VMRC and the state.

CBF—T. Leggett and C. Everett of the foundation's Virginia office are collaborating on the project.

Lynnhaven Now—This private-citizen group is facilitating interactions with homeowners, and providing an avenue of external private funding for the project.

City of Virginia Beach—The city is providing a boat slip at the city marina, and will fund some of the expenses of the project.

CCA—We are working with representatives of CCA and Charter Boat Captains to advise on sites for the artificial reefs.

VMRC—Lipcius is working directly with M. Meier in the Fisheries Division to ensure that the proposed reef systems are in agreement with the goals and needs of the artificial reef program at VMRC.

NOAA—The Chesapeake Bay Office has funded some of the pilot studies conducted with the Rappahannock River artificial reefs.

5.) **Location**:

The study sites are mainly VMRC's reef sites, such as Northern Neck reef and Poquoson reef. Additional reef sites will be selected upon discussion with M. Meier, CCA and the Charter Boat Captain's Association. In addition, some reefs will be located in the Lynnhaven River system (Figure 4). As we expect the reefs to be colonized by oyster, mussel, crabs and marine worms, we will request that VMRC declare these reefs as oyster sanctuaries so that the integrity of the reef structure for recreational fish is not disrupted.

References

Cranfield HJ, Carbines G, Michael KP, Dunn A, Stotter DR, Smith DJ (2001) Promising signs of regeneration of blue cod and oyster habitat changed by dredging in Foveaux Strait, southern New Zealand. NZ J Mar Freshwater Res 35:897-908

Downing JA, Rigler FH (Eds). 1984. A manual on methods for the assessment of secondary productivity in fresh waters. Blackwell Publishers.

Lipcius RN, Burke R (2006) Abundance, biomass and size structure of eastern oyster and hooked mussel on a modular artificial reef in the Rappahannock River, Chesapeake Bay. VIMS Special Report in Applied Marine Science and Ocean Engineering No. 390

Peterson CH, Grabowski JH, Powers SP (2003) Estimated enhancement of fish production resulting from restoring oyster reef habitat: quantitative valuation. Mar Ecol Prog Ser 264:249–264

Seaman WS Jr (2000) Artificial reef evaluation with application to natural marine habitats. CRC Press, Boca Raton, FL.

Figure 1. Upper 3 layers of an alternative oyster reef that increased oyster density significantly (~1000 oysters m^{-2} of river bottom) and also enhanced recreational fish abundance (Lipcius and Burke 2006).

Figure 2. Close-up view of the alternative oyster reef, showing the diverse benthic community as well as the spaces that afford shelter and foraging areas for recreational fish species. Within the reef there were numerous fish and invertebrate prey, such as mud crabs, which are commonly eaten by structure-dependent (e.g., sheepshead) and transient (e.g., black sea bass) recreational fish (Seitz et al. manuscript in preparation). In the reefs that will be used in this project, the spacing of some of the layers will be increased to provide optimal shelter spacing and foraging areas for recreational fish.

Figure 3. Constructed artificial fish reef. Twelve have been deployed at two VMRC reef sites, Northern Neck and Poquoson.

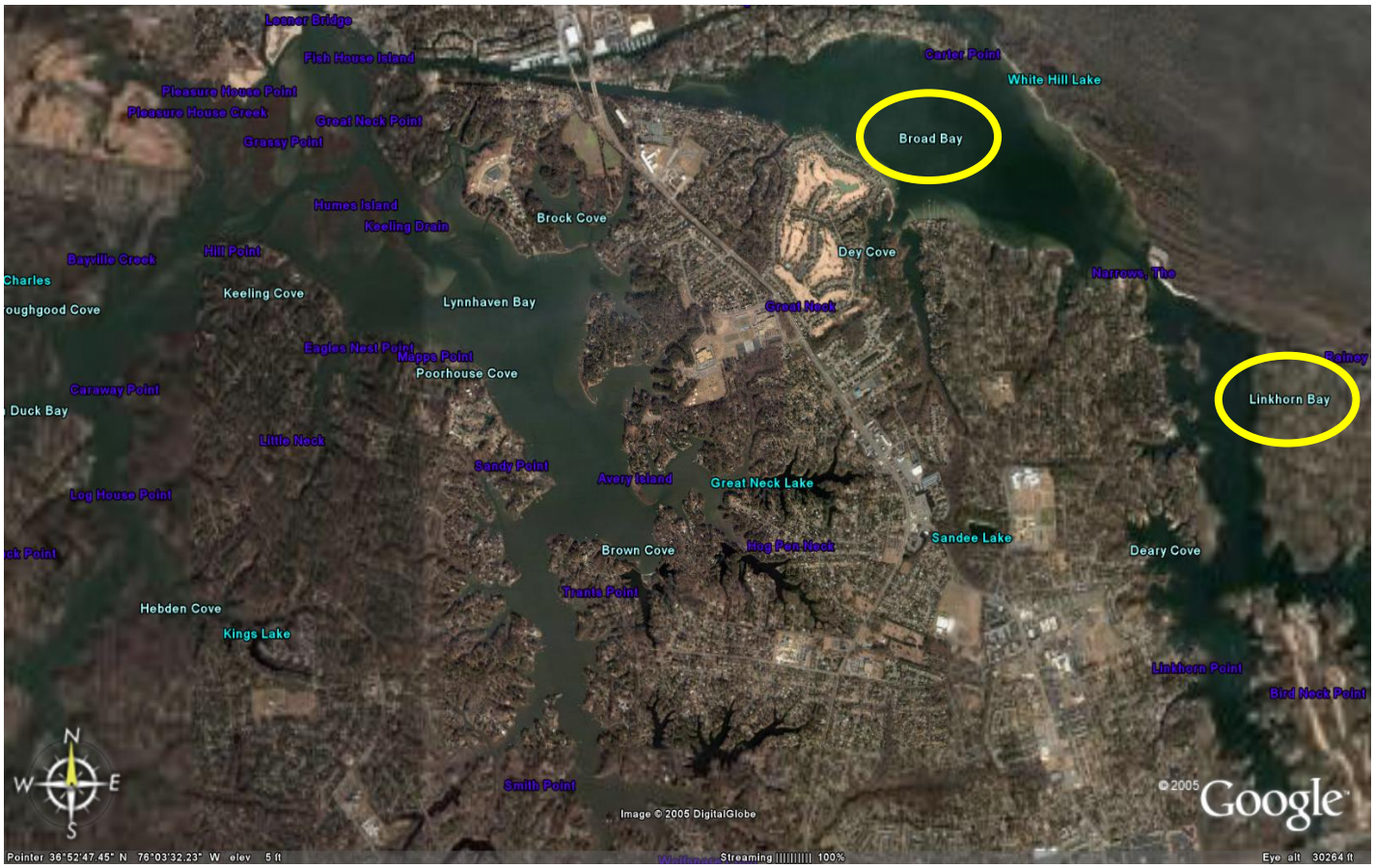

Figure 4. Locations of reef sites in Broad Bay and Linkhorn Bay within the Lynnhaven River system.

Figure 5. New artificial fish reef constructed by Reefmaker which will be deployed at the Northern Neck and Poquoson reef sites, as well as others t be determined in consultation with VMRC and recreational fishers. Note: The spacing between reef layers will be increased in alternating layers to provide suitable shelter for larger fish.