INTERNATIONAL POSITION STATEMENT AND EVALUATION GUIDELINES FOR ARTIFICIAL REEFS IN THE GREAT LAKES

edited by

John E. Gannon

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March 1990

The Great Lakes Fishery Commission was established by the Convention on Great Lakes Fisheries between Canada and the United States, which was ratified on October 11, 1955. It was organized in April 1956 and assumed its duties as set forth in the Convention of July 1, 1956. The Commission has two major responsibilities: first, develop coordinated programs of research in the Great Lakes and, on the basis of the findings, recommend measures which will permit the maximum sustained productivity of stocks of fish of common concern; second, formulate and implement a program to eradicate or minimize sea lamprey populations in the Great Lakes.

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INTERNATIONAL POSITION STATEMENT AND EVALUATION GUIDELINES FOR ARTIFICIAL REEFS IN THE GREAT LAKES

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GREAT LAKES FISHERY COMMISSION
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FOREWORD

In their Joint Strategic Plan for Management of Great Lakes Fisheries, the agencies primarily responsible for the welfare of Great Lakes fisheries recommended that the Great Lakes Fishery Commission create a habitat advisory capability to assist each lake committee in developing environmental objectives essential to achieving its fishery objectives. After the Habitat Advisory Board (HAB) was established in 1984, the Commission asked the Board to work on a wide range of habitat issues; e.g. to identify and address current and emerging habitat issues that may affect the achievement of fishery goals.

One of the issues identified was use of artificial reefs in Great Lakes fishery management. Artificial reefs have been employed in marine waters and in small freshwater lakes and reservoirs for many decades, but they have not drawn widespread attention for use in the Great Lakes until recently. Although artificial reefs have been acclaimed to be broadly successful, especially in marine waters, a review of artificial reef programs revealed an alarming lack of long-term assessment and evaluation of their effectiveness. Further, it became readily apparent that waste disposal, not fishery management, has been the principal driving force behind many artificial reef programs in marine waters.

Therefore, questions remain on the effectiveness of artificial reefs as a fishery management technique. What reef configurations built of which materials attract the most fishes in the most cost-effective manner? Do the reefs simply attract fish or do they also contribute to their production? Is there a potential problem of over-exploitation of vulnerable fish stocks through the deployment of artificial reefs?What type of materials are environmentally acceptable for artificial reef construction in the Great Lakes?

Because of these and other pertinent questions, HAB appointed an Artificial Reef Task Force in 1987 to examine the issue. The Task Force concluded that artificial reefs as a fishery management technique are unproven in the Great Lakes. Consequently, long-term evaluation of existing and future reef projects was recommended. Through the evaluation process scientific and socio-economic information will accumulate, and the value of artificial reefs for the management of the Great Lakes fishery resources can be assessed.

This document, the product of the Task Force's deliberations, has been endorsed by the Habitat Advisory Board, and was received by the Fishery Commission in May, 1988. It was then distributed to the Council of Lake Committees for review and comment. It was modified on the basis of comments received, and resubmitted to the Commission at its annual meeting in Montreal, May 1989. At that time, after seeing the visuals and hearing the presentation, Michigan asserted that the original title, "International Position Statement and Guidelines for Artificial Reef Development in the Great Lakes," implied a biased position favoring develop

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ment. This had not been the Task Force's intention, but there was agreement that the title and parts of the "Guidelines" section could be interpreted that way. The Commission agreed with the criticism and endorsed the report contingent on review and modification by the Task Force Chairman and Secret&at to insure that the report did not convey a pro-development Stance.

The report is divided into three sections-a position statement, evaluation guidelines, and a summary of recommendations. The position statement recognizes that use of artificial reefs as a fishery management technique is in its infancy in the Great Lakes and concludes that artificial reefs should be considered experimental and that they require comprehensive monitoring and long-term evaluation which includes ecological and socio-economic perspectives. The declaration is termed a "position statement" rather than a 'policy" because the jurisdictions, not the Commission, have the authority to make and implement habitat management policy.

The second section, evaluation guidelines for proposed and existing artificial reefs, describes how to measure progress toward fishery management objectives and determine the effectiveness of artificial reefs in fishery management programs. The guidelines define acceptable and unacceptable uses of artificial reefs, explain the differences between freshwater and marine reefs, describe monitoring and evaluation programs, and recommend methods for evaluating artificial reef proposals. Sources of information and guidelines for establishing a data base and coordinating research are recommended. One of the more important facets in artificial reef decisions, the institutional considerations, is well covered and should be helpful to government agencies, the beneficiaries, corporate sponsors, the general public, and regulators.

The third section, a summary of recommendations, addresses the role and responsibility of natural resource management agencies and jurisdictions, the Great Lakes Fishery Commission, and the US. Fish and Wildlife Service.

The Artificial Reef Task Force was chaired by John E. Gannon (U.S. Fish and Wildlife Service). The members were Ray Biette (Ontario Ministry of Natural Resources), David DeVault (US. Environmental Protection Agency), Robert Lange (New York State Department of Environmental Conservation), Jeffrey Reutter (Ohio State University), and Steven Ugoretz (Wisconsin Department of Natural Resources). Liaison members were the HAB Co-Chairman William Pearce (New York State Department of Environmental Conservation) and Carlos Fetterolf, Jr. (Great Lakes Fishery Commission). Janet Smith, (U.S. Fish and Wildlife Service) provided technical support Pat Bronkowski (Great Lakes Fishery Commission) gets credit for the fine word processing. Martha Walter reviewed the document for format and intent.

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Foreword

This document was endorsed by the Great Lakes Fishery Commission at its May 1989 Annual Meeting. The Commission encourages agencies and jurisdictions to incorporate the elements of the position statement, as a minimum, into their own policies. In lieu of official policy development, the jurisdictions and agencies are encouraged to use the position statement and accompanying evaluation guidelines when reviewing artificial reef proposals for approval, modification, or disapproval.

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POSITION STATEMENT

Artificial reefs can be a tool for modifying habitat to achieve fishery management goals. Such goals include attracting and concentrating desirable species of fish, enhancing the productivity of fish and other aquatic organisms, and increasing habitat or rehabilitating its quality. To ensure safety and effectiveness, reefs must be constructed of environmentally acceptable materials and properly placed. They should only be constructed in the Great Lakes when there is clear benefit to fisheries without deleterious effects on the ecosystem or undue interference with other beneficial uses of the lakes. Under no circumstances should artificial reef development be used as a pretext for the disposal of terrestrial refuse into the aquatic environment.

I. Purpose

The purpose of this position statement is to guide the evaluation of artificial reef proposals in the Great Lakes so that any reefs built will enhance the fisheries and recreational uses of the lakes without adversely affecting natural resources or impeding other beneficial uses. This position statement sets minimum recommended standards for evaluating artificial reef proposals and lists the factors that should be considered in planning artificial reefs. Other relevant issues are summarized. The Great Lakes jurisdictions are encouraged to incorporate the elements of this position statement, as a minimum, into their own policy. In lieu of official policy development the jurisdictions and agencies are encouraged to use the position statement and accompanying guidelines when reviewing artificial reef proposals.

II. scope

A. This position statement specifically addresses artificial reefs but many elements are also applicable to incidental artificial habitats. Artificial reefs, natural reefs and shoals, and incidental artificial habitats as referred to in this document are defined as follows:

Artificial reef: An artiticial reef is a structure - floating, suspended or submerged - which is constructed and placed in the Great Lakes for the expressed purpose of attracting fishes and enhancing fishery resources and habitat. This document primarily refers to submerged reefs (also known as benthic or bottom reefs) because they are of most current interest in the Great Lakes. Floating artificial devices (FADS), moored structures that either float at the surface or are suspended in mid-water, are in more common usage in marine waters.

Natural reef: A natural reef is an elevated area of lake bottom having sharp relief, usually consisting of submerged bedrock outcrops and/or boulders, cobbles, and gravels. Reefs of high profile consist primarily of submerged bedrock outcrops, while in low profile structures boulders, cobbles, and gravels usually are predominant. Low profile structures are sometimes referred to as shoals.

Incidental artificial habitats: Incidental artificial habitats are structures such as breakwaters, piers, jetties, water intake cribs, and walls of confined disposal facilities (CDF) that are constructed for specific engineering purposes but also incidentally provide habitat for fishery resources.

B. This position statement applies to all Great Lakes waters but recognizes that artificial reefs should be excluded from spawning sanctuaries and other critically important areas to prevent over-exploitation of fish stocks. This exclusion does not apply to reef projects designed to enhance sanctuary areas.

C. This position statement also recognizes that artificial reef development as a fishery management technique is in its infancy in the Great Lakes. Consequently, all artificial reefs shall be considered experimental and require an appropriate monitoring and performance evaluation program that is scaled specifically to the size of each project.

D. This position statement shall be reviewed by the Great Lakes Fishery Commission (GLFC) for purposes of extension and/or revision after a period of five (5) years based on evaluation of research and monitoring results.

III. Authority

This position statement was developed under the authority of the Great Lakes Fisheries Convention between the United States of America and Canada, September 10, 1954, and is within the scope of the internationally accepted Strategic Great Lakes Fishery Management Plan of December, 1980, developed by the responsible natural resource management agencies. It is consistent with the document entitled, "Guidelines for Fish Habitat Management and Planning in the Great Lakes" of March, 1987, and recognizes of applicable environmental laws and policies in Canada and the United States, including but not limited to the Policy for Management of Fish Habitat (Department of Fisheries and Oceans, Canada), the Fisheries Act (Canada), the (U.S.) National Artificial Reef Plan and the (U.S.) National Fishing Enhancement Act, and the (U.S.) Fish and Wildlife Coordination Act.

IV. Policy and Management

It is recommended that all agencies and jurisdictions with natural resource management authority consider the following elements in developing artificial reef policy and in reviewing proposals for artificial reef construction:

A. Acceptable materials

No materials will be used for the development of artificial reefs until such materials have been proven to be environmentally acceptable (i.e., non-toxic and non-hazardous) by the responsible agency through environmental review procedures (environmental impact assessments, permit review etc.).

B. Notification

The jurisdiction or agency where an artificial reef is proposed will notify other jurisdictions on the same lake in the spirit of cooperation and coordination agreed upon in the "Strategic Great Lakes Fishery Management Plan." Such coordination and cooperation should include the Lake Committees and the Habitat Advisory Board because of their respective roles in establishing lakewide fish community and habitat goals.

C. Natural reef survey and mapping

It is recognized that the primary impetus for artificial reef construction is to attract sport fish for the recreational fishery mainly in urban nearshore areas. However, some reefs may be developed specifically as attractants, while others may be developed for stock rehabilitation (i.e., increasing production by creating or enhancing spawning and nursery habitats). In both cases, an inventory of Great Lakes natural reefs is required to provide important information to be used in making decisions concerning the location and extent of artificial reef development necessary to achieve fishery management goals. On a case-by-case basis where a new artificial reef is being considered a natural reef survey and habitat map are required. Many of the natural reefs have already been mapped; therefore, this task will require integration and synthesis of existing information with some data gathering on unmapped reefs. This activity will serve to:

1. Determine the quantity and quality of existing natural reefs as they affect local and lakewide-riverwide fish community structure and their ability to meet approved fisheries management plans.

2. Determine whether an artificial reef would be desirable to meet specific management goals and objective.

D. Artificial reef evaluation

For approved artificial reef projects, the responsible natural resource management agencies should require appropriate pre- and post-construction evaluations scaled to the size of the project, including:

1. Preconstruction evaluation of the proposed site for artificial reef suitability, including factors such as substrate, current and sediment movements, ice conditions, temperature, water chemistry and existing biota

2 Pre-construction socio-economic evaluation of the proposed site, including an evaluation of potential use; an estimate of annual costs (capital, operating maintenance); an estimate of annual economic and social benefits (direct and indirect); and a comparison of costs to benefits of each proposed reef Such an evaluation should be tailored to the size of the project.

3. Preconstruction assessment of physical and chemical characteristics of the proposed reef material(s) and their environmental and biological acceptability.

4. Long-term, post-construction performance evaluation including physical, biological and socio-economic aspects, to determine whether the objectives of the reef have been met.

5. Project review to determine which changes, if any, should be incorporated into the design of proposed additional artificial reefs or restructuring of existing reefs.

EVALUATION GUIDELINES FOR PROPOSED AND EXISTING ARTIFICIAL REEFS

I. Background

A. Introduction

Any management technique or strategy used by a fishery manager should be part of a comprehensive, integrated management program focused on a set of carefully formulated goals and objectives. Goals and objectives should define the management program and drive the selection of specific techniques and strategies. Evaluation to measure progress toward objectives and to determine the effectiveness of techniques and strategies should be an integral component of the management program.

Construction of artificial reefs is a fishery management technique that can be used to achieve certain management objectives. As with any other management technique, the fishery manager must carefully weigh the potential benefits of artificial reefs against their limitations, liabilities, and costs in the context of specific objectives to decide whether implementation is warranted.

B. Acceptable Uses of Artificial Reefs

In a general sense, acceptable uses of artificial reefs include applications that are ecologically sound and are likely to result in the attainment of appropriate objectives. These objectives normally include sportfishing development, enhancement and rehabilitation of sport and commercial stocks through habitat improvements, and mitigation of habitat losses.

1. Sportfishing and Recreational Development. The uses of artificial reefs listed below would primarily focus on the capacity of reefs to concentrate fish, thereby making the fish more accessible to anglers. If the size of a fish population were limited by the absence or scarcity of the type of habitat an artificial reef could provide, then reef construction could contribute to increased production and geographic expansion of that population. However, this implicitly suggests some modification of the fish community that should be clearly identified as having a potential impact. In addition, the beneficial uses should outweigh undesirable impacts such as possible over-exploitation of fish due to their concentration in a known location. Beneficial uses include:

    a. Increase angler effort and success for selected species in specific areas, with a subsequent increase in economic benefit from sportfishery development. Artificial reefs may also serve to diversify local angling opportunities.

b. Redirect fishing pressure away from environmental@ sensitive areas (e.g., spawning and nursery grounds).

c. Improve fishing access for a wider segment of the angling public and enhance safety of recreational users by increasing use opportunities in close proximity to harbors of refuge.

d Increase recreational diving opportunities and other non-consumptive uses.

2 Fish Stock Rehabilitation and Enhancement. Other acceptable uses of artificial reefs involve rehabilitation of fish populations or protection of endangered, threatened, or over-exploited fish species they can be used to:

a. Increase fish production in areas naturally devoid of reefs where lack of such habitat can be clearly identified as a factor that is limiting fish production.

b. Restore habitat of species whose destruction by human or natural causes has contributed to a decline in their abundance.

c. Create or improve habitat in refuges established to concentrate over-exploited, threatened, or endangered fish stocks, affording appropriate -habitat and protection from fishing.

3. Habitat Mitigation. Finally, artificial reef construction may be used in rare instances as a replacement to mitigate the unavoidable destruction of natural reef habitat. In general, mitigation is not an acceptable use because artificial reefs cannot replace the productivity of the natural ecosystem.

C. Unacceptable Uses of Artificial Reefs

In general, applications that cannot be related to the management goals and objectives of a comprehensive fishery management program are unacceptable use of artificial reefs. These include:

1. Disposing of waste products as a sole or principal objective of reef construction.

2. Deliberately increasing fishing pressure or efficiency directed at species for which management objectives require decreased harvest

3. Attempting to increase production of certain fish species when there is no direct evidence that the absence or scarcity of reef habitat is a factor limiting production.

4. Placement that would place persons or property in danger (e.g., creation of a navigation hazard, attraction of anglers to offshore areas remote from access points, or concentration of anglers near commercial shipping lanes or dangerous currents).

5. Placement that would result in the destruction of fish or wildlife or of significant natural habitat.

6. Mitigating dissimilar habitat types (e.g., attempting to compensate the destruction of a wetland by constructing a reef), unless there is a clear and overriding benefit to fishery resources from the trade-off.

D. Differences between Freshwater and Marine Reefs

Freshwater and marine ecosystems differ considerably in their physical, chemical and biological characteristics. Several of these differences affect the relative probability of success of artificial reefs as a fishery management tool in these two environments.

In many marine waters, rich and diverse plant and animal communities include many species of fish that thrive on natural, physical substrates consisting of submerged bedrock. outcrops and coral reefs. These biological communities readily respond to artificial reef development. In contrast, freshwater natural reefs are generally limited to gravel shoals and submerged bedrock outcrops. These substrates are utilized by pelagic fish species for spawning. Comparatively few species are more sedentary, gathering near structures for more extended periods of time for shelter, food, etc. In contrast to the marine environment, considerably less diversity and biomass of fish and fish food organisms are associated with shoals and reefs in fresh water. Hence, a smaller pool of organisms is available for colonization of freshwater artificial reefs. On the evolutionary scale, freshwater communities are relatively young; there is no freshwater equivalent of a coral reef and its specialized and diverse biotic community. Consequently, the history of development and success of marine artiticial reef programs may not be fully transferable to freshwater environments.

When any item of terrestrial origin is placed purposefully or accidentally in fresh water it remains sparsely colonized by encrusting plants and animals. In contrast, such items are rapidly and extensively colonized in marine waters. For example, reef substrates

made from coal waste blocks (i.e., fly ash or a fly ash/scrubber sludge mixture in a concrete matrix) have been developed and tested for artificial reef applications in marine waters. Moreover, experimental work is now underway using oil ash, The comparatively high ionic constituents in marine waters and the high degree of biological colonization on these blocks appear to stabilize the block surfaces, thereby reducing chemical leaching and physical erosion. Consequently, such substrates are gaining acceptance as environmentally compatible for artificial reef development in marine waters. Although fewer tests of these materials have been conducted in fresh water, the available evidence indicates that chemical leaching and physical erosion of these materials may be more rapid in fresh water, thereby adversely affecting their environmental acceptability. More research is necessary to assess the environmental safety of using such waste products in the Great Lakes.

Experienced marine and freshwater anglers recognize that fishing is often better in the vicinity of submerged objects that provide some structure and vertical relief where the bottom otherwise appears to be flat and barren. It is unknown at this time in the Great Lakes whether the degree of attractiveness of artificial reefs to desirable species of fish will be high enough to justify the economic expense of constructing and maintaining the reefs. Consequently, monitoring and assessment of artificial reef sites in the Great Lakes before and after construction is recommended so that artificial reefs can be properly evaluated as a fishery management technique.

E. Monitoring and Evaluation

1. Artificial Reef Sites

Evaluation should be an integral component of fishery management. Utilization of any management technique or strategy (including artificial reefs) should be driven by objectives, and the effectiveness of the technique or strategy should be evaluated in the same context as the objectives are stated. Each new reef construction project should be monitored, scaled to the size of the project to evaluate whether the reef produced the expected results in fishery benefits.

Only a few artificial reefs have been constructed and evaluated in the Great Lakes, and existing data are insufficient to predict the effect of any new proposed reef. Consequently, all artificial reefs in the Great Lakes should be considered experimental. Permits for new artificial reef construction should routinely require an appropriate monitoring program until experimental requirements are satisfied

and predictive capability is attained. It is expected that the scale of monitoring programs necessarily will be proportional to the scale of the associated reef project

The monitoring should consist of the following components:

a. Pre-construction site evaluation to establish physical, chemical, and biological appropriateness for reef construction.

b. Pre-construction evaluation of the fish community present in the project area on a seasonal basis.

c. Preconstruction evaluation of potential effects of the proposed structure on littoral drift of bottom substrate.

d. Inspection and analysis of all reef materials prior to placement to insure the absence of toxic materials or potentially hazardous characteristics, such as protruding reinforcing rods.

e. Immediate post-construction mapping of the site to document placement of reef materials and reef configuration.

f. Seasonal post-construction monitoring of the fish community associated with the reef and of basic water quality parameters.

g. Annual post-construction monitoring of the reef to evaluate physical integrity and movement of reef materials especially with respect to ice damage and patterns of sediment deposition.

h. Seasonal post-construction monitoring of the reef for colonization by attached plants and macroinvertebrates for at least five years.

i. Socio-economic and cost-benefit monitoring and evaluation throughout the planning and development phases.

The preceding list is considered to be a generic monitoring program designed to provide information about the effects of reef construction. The resulting data may not by itself provide sufficient insight into whether the reef contributed to the attainment of fishery management goals and objectives. In most cases an evaluation program must be individually tailored to measure progress toward fishery management objectives as influenced by a specific reef project.

For example, if an artificial reef were constructed to address a management objective of increasing the size of a fish population, evaluation specifically must be directed at determining whether or not the fish population increased, not whether the reef attracted fish or whether fish spawned on or near it. Similarly, if a reef were constructed as part of a strategy to improve fishing or increase angler participation, evaluation should include measurements of change in the fishery such as effort, harvest, and catch rate.

2. Incidental Artificial Habitats

Breakwaters, piers, jetties, water intake structures, and walls of confined disposal facilities (CDF) are constructed primarily for specific engineering purposes, but they can provide incidental habitat for fish and fish food organisms. Such structures often become favorite sportfishing spots near Great Lakes cities. Some of the few documented cases of lake trout natural reproduction in Lake Michigan have occurred on rock deposited to protect power plant intake and outfall structures.

Incidental habitat creation is outside the scope of this document. However, it is a potential resource that should be considered. In this context, the Commission encourages the state, provincial, and federal regulatory and resource management agencies to use these guidelines to maximize the fishery habitat potential of incidental reef creation. These could include recommendations for construction materials and techniques which create desirable habitat, assistance in designing those structures, and recommendations for monitoring to determine whether those structures are providing a benefit to the fisheries.

In some cases, incidental habitat creation may be related to mitigation (see pages 6 & 7). The adverse impacts of structures built in the Great Lakes may be partially mitigated by modifications designed to enhance their fish habitat characteristics. Existing structures could also be evaluated to determine whether they have provided a fishery benefit, which factors are producing that benefit, and how to modify them to become more beneficial.

Consequently, it is recommended that incidental artificial habitats should be monitored by the permittees and permitting agencies to determine if fish and anglers are making use of them. If there is some basis to conclude that there are fishery benefits, the agencies and academic institutions could design studies to evaluate which factors are producing the benefits and how to apply those factors

to future incidental habitat projects and artificial reefs. This information could be entered into a data base (see page 15).

If they were implemented, these recommendations would provide an opportunity to gather information that may be important to our understanding of how artificial reefs perform in the Great Lakes without having to develop and fund costly experimental projects. Thus, an opportunity may exist to gain fishery benefits from projects that are going to occur anyway.

II. Evaluating Artificial Reef Proposals

The following guidelines should be applied by fishery management and regulatory personnel in their decisions on whether to endorse or approve reef proposals. Fishery managers should use these criteria in deciding whether to include an artificial reef component in their management plans for specific areas. Further, potential reef developers should use these guidelines in deciding whether to submit an artificial reef proposal for regulatory approval.

A. Site Suitability

1. Quantity of significant natural spawning, nursery, and foraging habitat at the proposed reef construction site.

2. Ability of substrate to support the mass of reef material.

3. Distance from potential hazards such as commercial shipping lanes or dangerous currents.

4. Potential to affect littoral drift negatively or become covered with sediment or damaged by wave action and ice.

5. Distance from fish stocks vulnerable to over-exploitation.

6. Potential to disturb shoreline residents/users.

7. Distance from wastewater discharges and amount of contaminated sediments in the vicinity.

8. General status of daily and seasonal water quality in project proposal area in relation to its ability to support the biotic community.

9. Distance from water intakes.

10. Existing or potential fishing quality in the site area.

11. Proportion of season proposed site is fishable due to weather conditions (recreational objectives only).

12 Proximity to significant access facilities for recreational users and shelter for small boats (recreational objectives only).

B. Material Suitability

1. Naturally occurring materials are preferable for reef construction.

2. Materials should not be an aquatic or human health threat (i.e., not mutagenic, teratogenic, nor toxic through acute, chronic, or bioaccumulative modes of action).

3. Material should retain long-term physical integrity.

4. Configurations should not create a hazard for scuba divers or unnecessarily tangle fishing tackle.

5. Minimal potential for dislodgement and/or transport by currents or ice.

C. Compatibility with Management Objectives

A reef should be designed to achieve management objectives by incorporating the fishery management strategies and habitat requirements of the desired species. For example, a reef built to create walleye spawning habitat must be shallow enough to satisfy spawning habitat preferences, while a reef built to attract walleye for daytime ‘angling must be in water that is deep enough to attenuate incident light.

Any proposal for reef construction that cannot demonstrate the role of the reef in a comprehensive fishery management program and its relation to specific fishery management objectives should be considered unacceptable, Factors to be considered:

Evaluation

1. A reef should not increase vulnerability to fishing for species for which a management objective of decreased harvest has been established

2 A reef intended as a refuge for spawning to enhance productivity of managed species or to protect threatened or overexploited species should be as remote from human disturbances as possible.

3. A reef intended to increase angler participation in a given area should be as convenient to good access and safe boating conditions as possible.

4. A reef intended to mitigate the loss of a natural reef should be roughly comparable in size, structure, siting, and function; and it should be within the range of the affected fish stock.

D. Compatibility with Lake Ecology

Building a reef which is compatible with lake ecology and underwater physical conditions will increase its probability for success. The extreme wave and current action in the Great Lakes and ice scour during winter limit the placement of artificial reefs. For target species frequenting nearshore waters, artificial reefs need to he sufficiently shallow to attract them but not so shallow as to be destroyed by physical processes. Deep water reefs generally should be placed where firm bottom support is present, The economic feasibility of placement of reefs in soft bottom sediments should be considered as much of the material will sink into the bottom and become unavailable as a fish attractant.

E. Compatibility with Particular Fish Species

Little is known about the design factors (materials, depth, size, configuration, etc.) that make artificial reefs most suitable for attracting particular freshwater fish species. It is recommended that research be conducted in the Great Lakes on natural shoals and reefs so that such factors can be better understood and incorporated into ecologically compatible artificial reef designs. Moreover, the importance of long-term evaluation of existing and proposed experimental artificial reefs cannot be overemphasized. Information from incidental habitat creation may also provide valuable guidance concerning design criteria

Evaluation

Limited research in the Great Lakes indicates that habitat diversity is correlated with species diversity, as is well known in stream ecology. A wide range of material SIZES (pebbles, gravels, and cobbles) provides microhabitats that enhance benthic productivity, thereby sustaining an excellent forage base for fishes. Similarly, large boulders and vertical relief provide macro-habitats, enhancing fish attraction, presumably for shelter.

Other factors to consider are the physiological requirements of the target species. Certain species of fish have known optimum temperature tolerance ranges and tolerances to hypolimnetic dissolved oxygen depletion. Artificial reef placement criteria should also include water quality and other physiological requirements of the target species. Such considerations should include seasonal changes in temperature and water quality and life cycle features of the target species which influence their seasonal distribution and movements.

III. Sources of Information on Great Lakes Artificial Reefs

A Existing Data Sources

The Artificial Reef Development Center (ARDC) supported by the Sport Fishing Institute, is the main national forum and clearinghouse for information about artificial reefs in North America However, most of the information available from the ARDC concerns marine projects.

The ARDC provides literature reference services and profiles of all permitted artificial reefs, as well as a list of the names of individuals involved in artificial reef development. Research and education are two other functions of ARDC. They publish technical reports and other materials relevant to artificial reef development. The ARDC can be reached at 1010 Massachusetts Ave., N.W., Washington, D.C. 20077 (phone 202-898-0770).

The U.S. Fish and Wildlife Service's National Fisheries Research Center-Great Lakes produced an unpublished annotated bibliography (July, 1987) of articles related to artificial reef development in the Great Lakes. The Research Center can be reached at 1451 Green Road, Ann Arbor, MI 48105 (phone 313-994-3331).

More recently, the Wisconsin Department of Natural Resources assembled a computerized data base on artificial reefs, including incidental habitats, in the Great Lakes. This is being done in conjunction with development of a State policy on artificial habitat in Wisconsin's Great Lakes waters. The Wisconsin data base includes information on the location, materials, design, placement, sponsors, cost, target species, and purposes for each project. For more information on the data base contact Wisconsin Department of Natural Resources, Box 7921, Madison, WI 53707, (phone 608-266-6673).

B. Establishing a Data Base

As more reef projects are proposed for the Great Lakes, the need will increase to provide information to reef sponsors, regulatory agencies, concerned citizens, fishing and environmental groups and others. A well organized data base would also be useful for monitoring existing projects to learn what makes an artificial reef succeed or fail. Data on fish use of deliirate and incidental artificial reefs can be very useful in improving future designs to maximize their effectiveness.

It is recommended that a continuing effort be made to collect relevant data on artificial reef projects in the Great Lakes. These data should be assembled into a clear, standardized format that allows easy access and comparisons between projects. Additional information related to other freshwater artificial reefs also should be included.

The Artificial Reef Development Center (ARDC) has expressed interest in expanding its data base to include Great Lakes data. It would be a logical development for the Great Lakes Fishery Commission to work with the ARDC, the U.S. Fish and Wildlife Service and other Great Lakes agencies to develop a standardized format and retrieval system that would be available to the Great Lakes resource management agencies and the Federal agencies. In addition, it is recommended that the U.S. Fish and Wildlife Service continue to assemble its bibliography on artificial reefs in the Great Lakes. The possibility of computer interfacing for the data base and for the bibliography should also be evaluated.

Arrangements for U.S. and Canadian federal agencies, the States and Province of Ontario to share information also should be investigated. Either a centralized repository for collected papers, or the interlibrary loan system could facilitate the exchange of information among and between agencies, academic institutions and the private sector (e.g., utilities). The Sea Grant programs of the Great Lakes States may also be a valuable resource in assembling and exchanging data on artificial reefs.

Finally, it is recommended that persons working on artificial reef projects in the Great Lakes make use of existing forums such as fish and wildlife conferences and international artiticial reef conferences to share information and experience. A freshwater artificial reef interest group could schedule meetings for this purpose during the annual conferences.

All of these recommendations could serve as coordinating forces to help those interested in Great Lakes artificial reefs make the most effective use of time, money and resources.

C. Coordination of Research

Currently, several institutions are independently investigating artificial reefs in the Great Lakes. These include government agencies, academic institutions (often through the National Sea Grant College Program), and private entities such as utilities. This raises the possibility of duplicative efforts with the associated waste of time and resources.

In addition, it is possible that basic questions about natural and artificial reefs are being neglected in favor of applied research more directed toward public relations and economic benefits. Projects that gain publicity or are popular with local anglers should not be substituted for systematic inquiry. Although university-based research is providing short-term information on the utilization of artificial reefs, government agencies clearly have a role to play in long-term monitoring, research, and assessment of artificial reefs.

Delineating the basic questions that need to be answered and coordinating research activity would begin to address both of these problems. The International Association for Great Lakes Research (IAGLR), the Science Advisory Board (SAB) of the International Joint Commission and/or the Board of Technical Experts (BOTE) of the Great Lakes Fishery Commission would be appropriate bodies to define research needs. The GLFC, through its existing committee structure should take the role of research coordinator, or encourage some other broad-based agency to do so. This coordination should include identifying the issues, setting priorities for research, and acting as a clearinghouse for research data and a ‘broker” between researchers and funding sources. The GLFC itself could, fund priority research.

IV. Institutional considerations

A. Role of the Governmental Agency

Artificial reef development is not a proven fishery management technique in the Great Lakes. That is why this document stresses the importance of evaluating existing reefs and carefully planning and assessing new ones. Assuming an artificial reef already exists or is far along in the planning process, this section addresses policy and regulatory matters that require consideration.

Because of the experimental nature of artificial reefs, the governmental agency should assume the long-term responsibility for the project- This can be accomplished if the agency itself is the permittee or if the agency acts as co-sponsor and assumes long-term legal responsibility for the project

B. Role of the Beneficiary

Assuming reef projects have been approved consistent with these criteria, local beneficiaries should assist whenever possible in the process of determining the most appropriate location and design of artificial reefs. Fishing organizations may provide the financial support to purchase reef materials and assist in their placement. Such groups also may place, maintain, and remove appropriate navigational aids. Contracting for reef construction can be done by private organizations with the cooperation and approval of the responsible agency. Under no circumstances should a local group undertake development and implementation of an artificial reef program without guidance and approval by the responsible governmental agency.

C. Role of the Corporate Sponsor

Corporations could be encouraged to donate materials and financial support to approved reef programs or to construct approved reefs. In recognition of significant donations, corporations could name the reef or reefs.

The research required to demonstrate and assure the safety and permanence of alternative materials (e.g., coal or oil waste blocks) should be the primary responsibility of the sponsoring company.

D. Role of the General Public

It is important that the public understand the rationale behind this artificial reef position statement and criteria and its intent to guide artificial reef development toward meeting fishery management goals. This will encourage constructive comment and public support.

The general public should support development of all phases of approved local artificial reef projects with a course of development that is based on scientific evidence and fishery management goals. Clubs and other organizations may want to develop, publicize, and coordinate donation efforts. The public, in cooperation with the responsible agency, also should be encouraged to participate in monitoring and evaluating the project, both in the design and data collection phases.

E. Regulation of Artificial Reef Projects

The Great Lakes Fishery Commission recognizes that action by the Great Lakes States and the Province of Ontario must be taken within the constraints imposed by their laws and regulations. The Commission encourages each Great Lakes State and the Province of Ontario, in concert with its respective federal government, to develop its own policy for evaluating artificial reef projects in the Great Lakes. The policy should be consistent with the Commission's position statement and to provide a common approach to artificial reef evaluation.

F. Responsibility and Liability

Artiticial reefs can potentially injure persons, property and natural resources. The risks include:

1. Injuries to personnel handling the reef materials.

2 Damage to vessels transporting reef materials.

3. Damage to fishing gear.

4. Damage to vessels in transit over the reef

5. Injury to users of the reef, including recreational divers.

6. Decomposition or movement of reef material to an unauthorized location.

7. Damage to the environment caused by toxic residues from reef materials, or from disturbed contaminated sediments.

8. Change in aquatic organisms or incidental killing due to explosions (e.g., purposeful sinking of barges or ships) or other physical activities associated with placement of reef materials.

9. Risks to human health concerns from consuming potentially contaminated fish.

To date, there have been no reported cases of liability imposed from injuries associated with artificial reefs. Likewise, salvage and removal of artificial reef structures have not occurred. Should reefs have to be salvaged and removed for whatever reason, the responsibility for such removal should be clearly stated prior to placement. Each level of government (federal, provincial, and state) should evaluate the liability and responsrbility issues in respect to artificial reef construction in the Great Lake?.

G. Access to Artificial Reefs

When fishery management and safety considerations allow, the builders of artificial reef habitats should be encouraged to provide public access as appropriate for fishing activities. Where feasible, such as artificial reefs near breakwaters, access for handicapped people should also be provided. These opportunities should be communicated to the angling public through state or provincial resource management agencies, fishing organizations, and the news media. The Great Lakes Fishery Commission, in cooperation with resource management agencies and educational institutions, should consider working with sportfishing groups to develop a basinwide list of accessible artificial reefs designed for sportfishing use. The list would include maps, charts, and other information that would allow anglers to make safe and beneficial use of those opportunities.

SUMMARY OF RECOMMENDATIONS

Based on the discussion in this document, the following list of recommendations is directed to the appropriate agency for action.

I. Natural Resource Management Agencies and Jurisdictions

A The Great Lakes Fishery Commission encourages each Great Lakes State and the Province of Ontario, in concert with its respective federal government, to develop its own artificial reef policy. The policy should be consistent with the Commission's position statement and evaluation criteria and thus provide a common approach to artificial reef assessment in the Great Lakes (page 1).

B. The following principal considerations should be taken into account in developing an artificial reef policy and in reviewing proposals for artificial reefs (pages 3-4).

1. Acceptable materials: No materials will be used for the development of artificial reefs until such materials have been proven to be environmentally acceptable by the responsible agency through environmental review procedures.

2. Notification: The jurisdiction or agency where an artificial reef is proposed will notify other jurisdictions on the same lake and the Commission.

3. Natural reef survey and manning: An inventory of Great Lakes natural reefs is required to assist the decision-making process concerning the location and extent of proposed artificial reefs.

4. Artificial reef evaluation: For approved artificial reef projects, pre- and post-construction evaluations of the artificial reef site, scaled to the size of the project, are required to assess whether the objectives of the reef have been met from both ecological and socio-economic viewpoints.

C.' Breakwaters, piers, jetties, water intake structures, and walls of combined disposal facilities (CDF) are primarily constructed for specific engineering purposes but they often provide incidental habitat for fish and fish food organisms. Such incidental habitats should be monitored to evaluate what factors are creating beneficial habitat so that such information can be applied to future incidental habitat projects and artificial reefs (page 10).

Summary of Recommendations

II. Great Lakes Fishery Commission

A This position statement shall be reviewed by the Commission for Purposes of extension and/or revision after a period of five years based on evaluation Of research and monitoring results (page 2).

B. The Commission should work with the resource management agencies to develop guidelines to maximize the fishery habitat potential from incidental habitat creation (pages 10-11).

C. The Commission should provide the catalyst within the Great Lakes community to: a) develop a data base; b) develop a basinwide list of artificial reefs, and c) define issues and research priorities on artificial reefs in the Great Lakes (pages 14-16).

III. U. S. Fish and Wildlife Service

A. The National Fisheries Research Center - Great Lakes is encouraged to periodically update its bibliography on Great Lakes artificial reefs (pages 14-15).

SPECIAL PUBLICATIONS GREAT LAKES FISHERY COMMISSION

79-I Illustrated field guide for the classification of sea lamprey attack marks on Great Lakes lake trout. 1979. E.L. King and T.A. Edsall. 41 p.

82-I Recommendations for freshwater fisheries research and management from the Stock Concept Symposium (STOCS). 1982. A.H. Berst and G.R. Spangler. 24 p.

82-2 A review of the adaptive management workshop addressing salmonid/lamprey management in the Great Lakes. 1982. Edited by J.F. Koonce, L. Greig, B. Henderson, D. Jester, K. Minns, and G. Spangler. 40 p.

82-3 Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage. 1982. Edited by N.A. Auer. 744 p.

83-1 Quota management of Lake Erie Fisheries. 1983. Edited by J.F. Koonce, D. Jester, B. Henderson, R. Hatch, and M. Jones. 39 p.

83-2 A guide to integrated fish health management in the Great Lakes basin. 1983. Edited by F.P. Meyer, J.W. Warren, and T.G. Carey. 262 p.

84-1 Recommendations for standardizing the reporting of sea lamprey marking data. 1984. R.L. Eshenroder and J.F. Koonce. 21 p.

84-2 Working papers developed at the August 1983 conference on lake trout research. 1984. Edited by R.L. Eshenroder, T.P. Poe, and C.H. Olver.

84-3 Analysis of the response to the use of "Adaptive Environmental Assessment Methodology" by the Great Lakes Fishery Commission. 1984. C.K. Minns, J.M. Cooley, and J. E. Forney. 21 p.

85-1 Lake Erie Fish community workshop (report of the April 4-5, 1979 meeting). 1985. Edited by J.R. Paine and R.B. Kenyon. 58 p.

85-2 A workshop concerning the application of integrated peat management (IPM) to sea lamprey control in the Great Lakes. 1985. Edited by G.R. Spangler and L.D. Jacobson. 97 p.

85-3 Presented papers from the Council of Lake Committees plenary session on Great Lakes predator-prey issues, March 20, 1985. 1985. Edited by R.L. Eshenroder. 134 p.

85-4 Great Lakes Fish disease control policy and model program. 1985. Edited by J.G. Hnath. 24 p.

85-5 Great Lakes Law Enforcement/Fisheries Management Workshop (Report of the 21, 22 September 1983 meeting). 1985. Edited by W.L. Hartman and M.A. Ross. 26 p.

85-6 TFM vs. the sea lamprey: a generation later. 1985. 17 p.

86-l The lake trout rehabilitation model: program documentation. 19%. CJ. Walters, L.D. Jacobson, an G.R. Spangler. 32 p.

87-l Guidelines for fish habitat management and planning in the Great Lakes (Report of the Habitat Planning and Management Task Force and Habitat Advisory Board of the Great Lakes Fishery Commission). 1987. 15 p.

87-2 Workshop to evaluate sea lamprey populations "WESLP" (Background papers and proceedings of the August 1985 workshop). 1987. Edited by B.G.H. Johnson.

87-3 Temperature relationships of Great Lakes fishes: A data compilation. 1987. D.A. Wismer and A.E. Christie. 195 p.

88-l Committee of the Whole workshop on implementation of the Joint Strategic Plan for Management of Great Lakes Fisheries (reports and recommendations from the 18-20 February 1986 and 56 May 1986 meetings). 1988. Edited by M.R. Dochoda. 170 p.

88-2 A proposal for a bioassay procedure to assess impact of habitat conditions on lake trout reproduction in the Great Lakes (Report of the ad hoc Committee to Assess the Feasibility of Conducting Lake Trout Habitat Degradation Research in the Great Lakes). 1988. Edited by R.L. Eshenroder. 11 p.

88-3 Age structured stock assessment of Lake Erie walleye (Report of the July 22-24, 1986 Workshop). July 1988. Richard B. Deriso, Stephen J. Nepszy, and Michael R. Rawson. 12 p.

88-4 The International Great Lakes sport fishery of 1980. September 1988. Daniel R. Talhelm. 70 p.

89-1 A Decision Support System for the Integrated Management of Sea Lamprey. Joseph F. Koonce and Ana B. Locci-Hernandex. 1989. 73 p.

90-l Fish Community Objectives for Lake Superior. edited by Thomas R. Busiahn. 1990. 23 p.