ARTIFICIAL REEFS IN BRITISH COLUMBIA, CANADA

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Abstract

The Artificial Reef Society of British Columbia (ARSBC) is a Canadian non-profit society dedicated to the enhancement of the British Columbia marine environment and to the advancement of sport diving through public education and the creation and preservation of artificial reefs. ARSBC was founded in 1986 and is a membership-driven organization. ARSBC has successfully completed five artificial reef projects: G.B. Church (Aug. 10, 1991; Portland Island, Sidney); HMCS Chaudiere (Dec. 5 1992; Kunechin Pt., Sechelt); HMCS Mackenzie (Sept. 16, 1995; Rum Island, Sidney); HMCS Columbia (June 22, 1996; Maud Island, Campbell River); HMCS Saskatchewan (June 14, 1997; Snake Island, Nanaimo). Video highlights of the Saskatchewan sinking will be presented.

A limited assessment of the attached biological community has been completed. Within months, the outer hull becomes extensively encrusted with estimates of several hundred individuals per m^2. By 2.5 years, close to 100 species including invertebrates (62), fish (20) and algae (14) have colonized the reefs. The dominant group among the invertebrates is crustacean with 17 species.

We have demonstrated that sinking decommissioned military warships can stimulate economic activity in local coastal community in excess of $1 million dollars (CDN) annually if properly promoted. The eco-tourism draw adds to the local mix of economic activities so that local coastal communities are not solely dependent on one company or one natural resource. In addition, due to the success of their projects, ARSBC has been asked to assist other nations in creating ecologically-responsible artificial reefs in the Caribbean, Indian Ocean and offshore of California.

I. Background Information

A. History and Purpose of the Organization

The Artificial Reef Society of British Columbia (ARSBC) is a Canadian non-profit society dedicated to enhancement of the marine environment and to the advancement of sport diving through public education and the creation and preservation of artificial reefs. Founded in 1986, the ARSBC is a membership-driven volunteer organization. In the past 6 years, the ARSBC has sunk five ships as artificial reefs.

The efforts of the ARSBC grew out of the realization that historical shipwrecks were being damaged by recreational divers. To relieve the pressure and potential damage on these shipwrecks and to create local economic activity for remote coastal communities, the society developed a comprehensive plan to create and enhance awareness of premier scuba dive destination through artificial reef development.

Five artificial reefs in British Columbia that have been created by the activities of the ARSBC (Table 1).

Table 1. Artificial Reefs in British Columbia deployed by the ARSBC.

Ship	Date	Location
G.B. Church	Aug. 10, 1991	Portland Island, Sidney
HMCS Chaudiere	Dec. 5, 1992	Kunechin Pt., Sechelt
HMCS Mackenzie	Sept. 16, 1995	Rum Island, Sidney
HMCS Columbia	June 22, 1996	Maud Island, Campbell River
HMCS Saskatchewan	June 14, 1997	Snake Island, Nanaimo

B. Ship Preparation

Sinking of a ship is the climatic signal for the start of an artificial reef creation program. After acquiring a decommissioned warship, the Society spends at least 7 months and 75 man-months preparing a vessel for the sinking event. Preparation includes removal of residual hydrocarbons and other possible contaminants (e.g. lubricating oils); removal of wire and other objects that potentially could ensnarl a diver, closing off access to restricted compartments such as the boiler room; securing or removal of doors; as well as rendering the vessel "diver safe" by opening holes in the exterior so that ambient light is allowed to penetrate the reef every 20 m.

Materials that would be hazardous or toxic to marine organisms such as mercury, PCB, hydrocarbons and other liquids including refrigerants, are removed from the ship before the sinking. This process is confirmed by the materials in the "Hazardous Substance Material Disposal Portfolio" prepared for the ships by the Canadian Navy and by the inspection process of Environment Canada prior to issuance of ocean dumping permits under the Canadian Environmental Protection Act.

Detailed site surveys map the bottom to determine the location

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of baseline and orientation of ship within the site. This information is helpful in planning the sinking and placement on the bottom asides being a legal requirement.

The ships are sunk in a controlled manner. Usually, 8 to 10 charges are placed in the bowel of the ship. The object is to flood the lower parts of the ship as quickly as possible to ensure that the ship sinks on target. Over the last four sinkings, the sinking times have decreased dramatically from about 18 minutes for the Chaudiere to under 3 minutes for the Saskatchewan. This evolution has resulted in ships reaching the bottom nearly upright with a slight list to port as was the case with the *Saskatchewan.*

All sites are marked with a buoy system to clearly identify the location of the reef and facilitate tie-up moorings. Over the vessel center is an isolate danger buoy. Cautionary buoys mark the fore and aft of the reef. A pair of private mooring buoys sit on each side of the reef for ease of dive charter operators.

II. Biological Assessment

In planning an artificial reef creation program, potential environmental impacts affecting the biological and ecological community need to consider the living environment, trophic relationships, life stages, rare and endangered species, special populations or communities and indigenous or endemic species.

Impacts arising during emplacement phase and the operation as an artificial reef are summarized in Table 2 and have been adequately discussed in other publications (for example, Tortell 1993).

Existing benthos (bottom-living animals) in an area equal to the footprint of the vessel, in the case of a destroyer approximately $\leq$ 4,600 m^2, will be permanently smothered. This impact is offset by the additional surface area available for colonization of marine plants and invertebrates created by the artificial reef structure. The larger the ship in surface and interior area the more additional surface area available for habitat.

Turbidity will be a minor immediate consequence of the emplacement and is a function of the density and size of surface sediment at the proposed site. Turbidity arising from emplacement will generally be transitory and usually is not expected to lead to any direct or indirect impacts.

Changes in the erosion or accretion at the proposed site can vary depending on placement, orientation and water depth. In British Columbia, because of the size of the ships, the proposed sites have water depths of approximately 40 m (120 ft.). Alteration of the current velocities is expected. However, the influence is proximate to the artificial reef.

Table 2. Potential negative impacts of artificial reefs [1].

Phase	Activity	Impact/Consequence
Emplacement		
	Loading	Noise
	Transport	Obstruction to navigation
	Seabed Emplacement	
		Smothering of benthic organisms
		Turbidity
Operational		
	Physical structure	
		Smothering of benthic organisms
		Alteration to current velocity, turbulence
		Bathymetry altered
		Erosion/accretion
		Obstruction to navigation and trawling; rerouting
	Materials employed	
		Leaching of contaminants
		Breaking loose, beach and Seabed littering
		Fish tainting, toxicity
	Reef simulation	
		Altered ecology
		New predators and competitors
		Barrier to migration routes
		Aggregation; maybe depletion elsewhere

[1] Adapted from UN FAO Review (Tortell, 1993).

During the last three sinkings, no evidence of a surface sheen from hydrocarbons (or other contaminants less dense than seawater) was detectable.

Environmental monitoring of *Chaudiere*, to date, has shown no significant negative impacts (Ellis, 1993; Kim, 1994). There is no expected long-term negative impact arising from these structures on the seabed.

A. Reef Simulation

Regarding reef simulation impacts, it is difficult to speculate without biological data on the significance of these suggested impacts. However, it is highly unlikely that the reef sites selected will block any known migration routes. Additionally, given the high biological diversity within the Georgia Strait,

negative ecological consequences, if any, will be minor.

A baseline study has been initiated for the *Saskatchewan* project by local community divers and follow-up studies are to be preformed to examine the change in benthic fauna at the *Saskatchewan* reef site. Having reviewed background materials and site-specific characterization details, no damage to fish habitat is anticipated.

After examination of scientific literature including the proceedings of the Third, Fourth, and Fifth International Conference on Artificial Habitat for Fisheries, we have yet to see data suggesting that scuttling a ship, in the manner in which the ARSBC does, is in any way harmful to the environment. Artificial reefs do not replace the existing natural habitats, but augment the physical structure of the water column allowing added sites for colonizing organisms to settle. A basic tenet of marine ecology is that any structure, whether natural or man-made, placed in the marine environment will, given time, become encrusted with organisms.

We must point out as indicated in a National Research Council review on restoring and protecting marine habitats (NRC 1994) that current research is being directed on the question of the structure and function of artificial reefs within the aquatic ecosystem.

A systematic monitoring program designed to evaluate the "performance" of the artificial reef should be established with support from other agencies to ensure that the mandate of the Society "to enhance the marine environment through creation and preservation of artificial reefs" is accomplished. We would suggest that this information be disseminated to the marine science community.

An assessment of the attached biological community has been completed for one artificial reef, *G.B. Church*. Within months, the outer hull becomes extensively encrusted with estimates of several hundred individuals per m^2. By 2.5 years, close to 100 species including invertebrates (62), fish (20) and algae (14) have colonized the reefs. The dominant group among the invertebrates is crustacean with 17 species (Subsea Enterprises Inc., 1994).

While circumstantial evidence and haphazard visits to the artificial reefs have indicated relatively rapid colonization, to date, no systematic approach has been undertaken to assess the ecological role of the artificial reefs. The Pacific Northwest is noted for the high biological diversity in its coastal waters. Yet, studies on artificial reefs are generally restricted to tropic and temperate latitudes. To the best of our knowledge the studies reported herein on artificial reefs represent the only one preformed in waters of our latitude.

III. Economic Assessment

The creation of an artificial reef can attract divers and generate significant revenue to the local coastal economy. We have demonstrated that sinking decommissioned military warships can stimulate economic activity in local coastal community in excess of $1 million dollars annually, if properly promoted. The eco-tourism draw adds to the local mix of economic activities such that local communities are not solely dependent on one company or one natural resource. However, to be a sustaining activity, the artificial reefs must be ecologically sound.

IV. Future Opportunities

While the ARSBC is primarily active in waters of the North East Pacific, the Society is in the enviable position of being asked by interested parties to provide advice and expertise toward development and execution of environmentally-sound artificial reef programs elsewhere. The experience gained over the past five sinkings is now being recognized as others attempt to start artificial reef creation programs.

The Society continually evaluates its artificial reef creation program effectiveness and incorporates new findings into future artificial reef development planning. Current research projects underway include examination of effect of ship's paint on recruitment and settling pattern of marine invertebrates and fishes and rate of colonization on various substrates including steel and aluminum. In addition, an experimental attempt to increase the complexity of the ship's exterior surface has been initiated to encourage rapid utilization by motile animals.

British Columbia artificial reefs are not designed as fish aggregating devices for fishing, but as additional supplemental habitat with the benefit primarily to divers and the marine environment. Plans are underway to make each artificial reef site a "no take" zone for scientific purposes.

As more naval ships are decommissioned, information on their use as artificial reefs is critical in deciding the fate of literally hundreds of military vessels. Because of the initial successes of our program, nonprofit groups from several countries (Australia, Barbados, France, Mexico and United States) have sought our advice in establishing similar artificial reef creation programs in their countries.

Acknowledgment

Funding for the acquisition of naval vessels was initiated with a loan from the Western Economic Diversification Fund of the Canadian Government. The Society receives assistance in human resources from a federal government program (Human Resource Development).

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