Gap Analysis for the Application of Artificial Reefs as Habitat Restoration

Análisis de las Deficiencias de la Aplicación de los Arrecifes Artificiales como la Restauración del Hábitat

L'analyse des Écarts pour L'application de Récifs Artificiels comme la Restauration de L'habitat

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EXTENDED ABSTRACT

Artificial reef construction is frequently promoted as a habitat restoration technique to benefit reef fisheries, despite limited scientific understanding of the value of such activities for fisheries production or in achieving habitat functions. Gaps in existing literature and ongoing research programs limit consideration of artificial reef projects to well understood applications benefiting human uses (diving, recreational fishing) or epifaunal communities and associated cryptic fish species (e.g., blennies, gobies) living in these communities. This review does not consider potential artificial reef applications in living shorelines, oyster reef restoration, coral reef restoration, or artificial reef placement in waters beyond the continental shelf. Public controversy persists regarding the role of artificial reefs in supporting reef fisheries production and in their function as a habitat (Powers et al. 2003, Shipp and Bortone 2009, Cowan et al. 2010, Cowan 2011). Artificial reefs can provide shelter and access to surrounding foraging areas for larger resident fishes and temporary foraging sites for larger migratory fishes, but there are scientific uncertainties around the question of whether artificial reefs serve to enhance production or merely aggregate individuals from surrounding areas, thus making them more susceptible to fishing mortality. Literature suggests that artificial reefs do not function exclusively as attractors or producers; instead, they can have some combination of attraction and production qualities, which vary in relation to factors such as site fidelity, movement within and between reef complexes, management regimes, and interspecies interactions (Addis et al. 2009, Bohnsack 1989). Literature is currently not sufficient to identify impacts to stocks of commercially and recreationally significant species on artificial reefs that are not managed for over-exploitation, regardless of whether the reefs increase fish production or simply attract fish from other areas.

Artificial reef function is dependent on target species, design and composition, and location (Bohnsack 1989, Grossman et al. 1997). Purpose, design, placement, and management considerations are critical to project viability, and the many different types of reef structures, each having unique functional qualities, make universal evaluation impossible. The same reefing technique or material can have significantly different impacts in different locations, making universal evaluation even more problematic. There is scientific consensus that the function of a proposed artificial reef is dependent on considerations including profile, materials, rugosity, design features, size, depth, bottom type, oceanography, and surrounding habitat features. The ecosystem service values (ESVs) of discreet components of artificial reef communities (e.g., non-targeted fish species, targeted fish species, epifauna, sessile organisms) and, in some cases, whether the ESVs provided by artificial reefs outweigh the ESVs of pre-existing habitats have not been fully evaluated. It is unclear if artificial reef design can be optimized for specific ecosystem management goals, and whether target goals can ever be achieved using certain construction materials, designs (e.g., high vertical relief reefs vs. low relief rubble) and locations (e.g., shallow nearshore vs. deeper offshore). Research has not indicated structured reef habitat limitation (hard bottom or vertical relief) as a factor in fish production on the continental shelf in the Gulf of Mexico. If hard bottom is not a limiting factor, then adding additional hard bottom surfaces will not likely increase fishery production, and in some areas, impacts to protected species such as Gulf sturgeon that rely on soft bottom habitat, also must be considered. Reef placements in new areas can create user conflict between extractive and aesthetic users of the same reef. Time required for an artificial structure to reach maturity, projected times to full function, and project life can be dramatically compromised by shifts in environmental conditions (e.g., temperature, storms, droughts, freshwater input pulses, higher salinities). Significant differences have been noted between natural and artificial reefs in fouling and fish community structures (Embesi et al. 2013, Patterson 2013, Kingon 2013). Especially in a hurricane-prone environment, projects should determine if materials are stable, if they endure on soft bottoms, and if artificial reef materials might break up to become hazards to navigation, fishing gear hazards, or projectiles that damage sensitive habitats.

Artificial reef projects may yet present opportunities to achieve specific goals. Assemblage recovery or compensation for damaged reefs could be accelerated by building artificial reefs in no-take areas.This may resolve some questions related to the productive value of artificial reefs, but fishing stakeholder groups may object if management plans for artificial reefs include prohibitions such as closed areas, gear restrictions, limited access, or fishing bans. Artificial reefing projects could also make up for lost fishing area in MPAs that limit or restrict fishing by building artificial reefs in areas with better fishing

access. Projects could divert pressure from heavily fished reefs and natural reefs to adjacent areas, or improve fishing by building artificial reefs in areas with limited fishing habitat. Artificial reefs could alleviate critical life history bottlenecks when habitats limit adult populations size (i.e., by providing juvenile habitats for habitat limited species), and artificial reefs closed to fishing could provide critical habitat for spawning adults for recruitment limited or overfished species. Artificial reefs could also be built as science reference or control areas to assess population responses and recovery in the absence of fishing. Artificial reef projects intended to enhance fisheries production or fulfill other habitat functions should clearly identify and articulate project purposes to determine if an artificial reef is the appropriate and most effective restoration action, should be properly designed and sited to meet the stated purpose, and should incorporate robust management and monitoring plans to demonstrate that the purpose is being met, or to adaptively respond if the purpose is not being met.

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