



Research Proposal

Artificial Reefs: a comparison between metal, concrete and natural structures for scleractinian coral recruitment and fish aggregation in the Gulf of Thailand

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Background

Coral reefs, and the associated fish community, arguably constitute one of the most productive and diverse marine ecosystems on Earth (Mulhall, 2009), the Gulf of Thailand being a major marine resource for the population of Thailand (Cheevaporn & Menasveta, 2003). Over the last decade, it has become obvious that human activities impact these systems negatively, and to the extent that 75% of all reefs are considered threatened (Hughes et al., 2003; WRI report, 2008). Recent research in the Gulf of Thailand hints to herbivore fish assemblages as key controlling factor of the benthic community, and ultimately of coral reef ecosystem services (Stuhldreier et al., 2015), implying that additional measures to preserve and increase herbivore fish stocks are crucial.

Artificial Reef Systems have been proposed as tools for coastal resource management and coral reef restoration, but studies of existing systems produced at best ambiguous results, ranging from deleterious effects on reef fish populations (Grossman et al., 1997), to positive effects on scleractinian coral recruitment (Tanner et al., 2006).

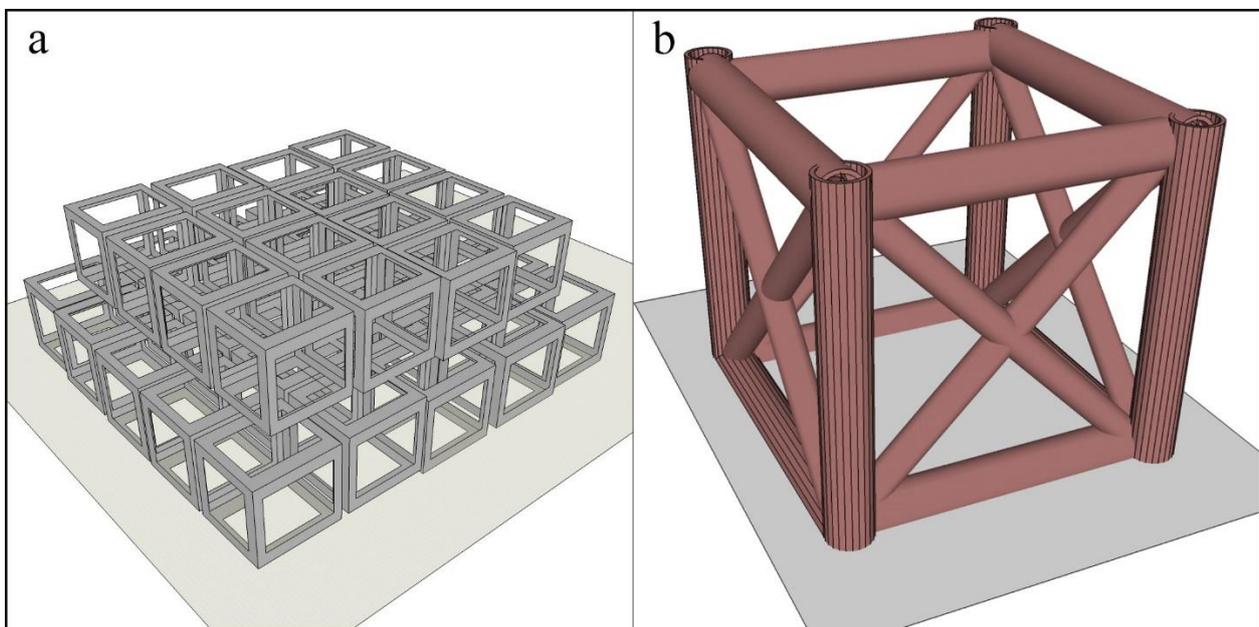


Fig. 1. Models of Artificial Reef Systems deployed in late 2013. (a) concrete cubes (b) metal structures altered from gas drilling platforms. (sketch is not to scale).

In late 2013, a total of 7 concrete structure sets (figure 1a), and 4 metal structures (figure 1b) were deployed at the island of Koh Phangan, lower Gulf of Thailand, with the goal of promoting fish stocks and coral propagation for the local fishing communities of Koh Phangan.

This study aims to investigate the effectiveness of said structures, with respect to scleractinian coral recruitment, fish aggregation and assemblage, and the acceptance, usefulness and benefit for the local key communities.

Key Questions

This study is proposed to answer the following key questions:

1. How do the different artificial structures compare to natural substrates, with respect to general invertebrate, and in particular, coral recruitment?
2. How do the different designs influence fish community and abundance, in comparison to natural structures?
3. Do the structures promote, or aggregate commercially important fish species?
4. Do the different designs provide stable, non-deleterious substrates for scleractinian coral growth?
5. Are the provided structures accessible, accepted and used by local key communities, as an alternative fishing location?

Materials and Methods

Study site:

This study will be conducted on the island of Koh Phangan, Gulf of Thailand (9.787220 N, 100.003739 E), located approximately 60 km from the mainland. A total of 7 concrete structure sets, and 4 metal structures were deployed in late 2013 (2556 BE), by a joint operation of the Department for Marine and Coastal Resources (DMCR) and the Petroleum Institute of Thailand (PTIT).

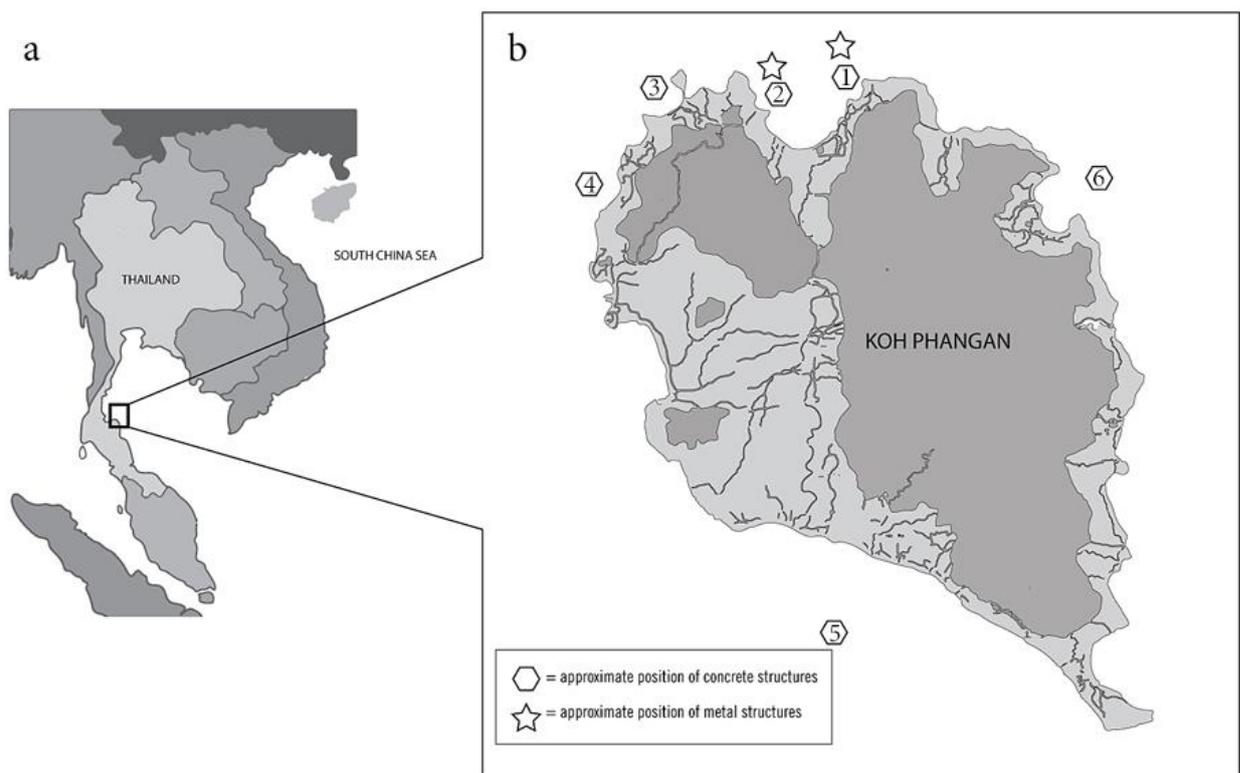


Fig. 2. Study site. (a) Location of Koh Phangan ((9.787220 N, 100.003739 E) in the south western Gulf of Thailand. (b) Stars indicate approximate position of metal artificial reef structures, hexagons indicate approximate positions of concrete structure sets.

The metal structures, which were modeled after gas drilling platform support structures for testing purposes, are situated in the bay of Chaloklum, on the northern coast of Koh Phangan. The concrete structure sets were placed in the bays of Haad Khom (1), Chaloklum (2), Mae Haad (3), Haad Yao (4), Ban Thai (5) and Thong Nai Pan (6), which are of high touristic value, but are also intensely used for line fishing, and small seine- and gill-netting operations.

Additionally, two concrete structure sets were deployed at Sail Rock (Hin Bhai, 9.952054 N, 99.989657 E), which is known for aggregating large numbers of pelagic, commercially important species, and is also one of the main recreational scuba diving attractions in the area.

Survey designs:

To observe differences in scleractinian coral, and other sessile invertebrate recruitment, photo quadrat transects will be carried out on the substrate in 0.5 m intervals, using a 0.15 m x 0.15 m pvc frame. The resulting images will be processed with CPCe 4.x (Kohler et al., 2006), calculating surface cover, Shannon Diversity, and Species Richness. To assess differences in fish aggregation, underwater visual census (roving diver techniques, Schmitt et al., 2006) and timed video transects will be conducted. The resulting data will be used to carry out a Simple Biomass-Based Length-Cohort Analysis (Zhan et al., 2010), and to calculate Shannon Diversity and Species Richness.

Manipulation Experiments:

To calculate general, and specific sessile organism recruitment, 3 areas of 1 m length per structure will be cleared of all growth, and surveyed bi-monthly using photo quadrats, and tapeline to measure differences in diameter or height. Organisms from natural structures will be transplanted to adjacent locations.

Physico-chemical parameters:

To reduce distortion in the analyses, general physico-chemical parameters will be measured; pH, DO and Salinity with multi parameter portable meters; temperature and light using HOBO pendant loggers; turbidity with secchi disks; PO⁴⁻ and NO_x with spectro-photometric methods.

Acceptance as alternative fishing location:

To gauge the acceptance, accessibility, and usefulness of the different locations, multiple choice paper surveys will be distributed in the local key communities of Koh Phangan. Additionally, wherever possible, visual inspections of catch landings and vessel density (expressed as boats per location per day) shall be conducted.

Envisioned Timeframe

As data has already been collected from the deployment of the structures onward, and data from natural substrates from Koh Phangan is already available, the study is planned for a duration of 6 months, from February to July 2015. Studies will be conducted bi-monthly on 3 concrete, 3 metal, and 3 natural structures. Background parameters will be studied in 4 different locations: Control site 1, Chaloklum, Mae Haad and Sail Rock.

Funding:

As most of the surveying is carried out in the form of underwater visual censuses, the majority of the data can be collected in the normal frequency of the DMCR's and CORE sea's monitoring schedule; printed surveys can be distributed on Koh Phangan through the local Amphoe; and should not generate any extra costs.

Additional funds would be required for boat trips, nutrient measurements and additional data loggers.

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