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A New Method for Citizen Science to Monitor Coral Reefs in Thai Waters

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Abstract. Tourism is becoming more important economic in many countries, yet its continued expansion has led to concerns over environmental impacts. Tourist activities can cause a direct impact on the marine environment. The aim of this study was to develop a new coral reef monitoring method for citizen science in Thailand to assess coral reef conditions on a large scale, which supports coral reef management. The coral reef monitoring consists of at least 20 representative photos from each reef site. Each photo should be taken from top view of the coral reef, approximately 2 meters distance. All photos should not be taken overlapping. The coral reef fish monitoring consists of at least 3 minutes video recordings which should be taken from about 2 meters distance with 60° to the coral reef. The proposed method was conducted in both the Gulf of Thailand and the Andaman Sea, i.e., Rayong, Chumphon, Phuket, and Phang Nga Provinces for its validation. This study emphasizes that citizen science has an important and effective educational value. Tourism and diving business stakeholders should increase their commitments and efforts to the coral reef monitoring programs.

Keywords: citizen science, coral reef, monitoring, tourism, SCUBA diving

1. Introduction

The degraded coral reefs in Thailand and other reef sites in tropical countries require appropriate conservation and management strategies to enhance coral reef resilience (Yeemin et al. 2006; Bruno and Selig 2007. Phongsuwan et al. 2013; Sutthacheep et al. 2013; Sutthacheep et al. 2018). Collaboration among government agencies, non-government organizations and private sectors plays a major role on coral reef monitoring, conservation and restoration (Yeemin et al. 2012; Aswani et al. 2015; Obura et al. 2019; Licuanan et al. 2021). Citizen science is an important approach in monitoring coral reefs to enhance marine protected areas management (Lau et al. 2019). It is defined as participation in efforts to systematically collect and analyze data; test natural phenomena; and/or disseminate these activities by non-professional scientists, usually on an unpaid basis (Silvertown 2009). The citizen science may include different types of community-based monitoring projects, such as community members collecting and managing data and information (with or without expert participation), working in collaboration with experts to collect data and information, providing occasional/opportunistic information to scientists and/or managers, etc. (Great Barrier Reef Marine Park Authority 2013).

Developing appropriate methods and procedures for citizen-scientists to participate in coral reef monitoring is urgently needed. The methods and procedures should be simple and provide more interaction between the managers, scientists, local people, and the general public to benefit coral reefs (Turrini et al. 2018). Citizen science for coral reef research has been widely developed in many geographic locations and research objectives, particularly coral bleaching, reef mapping, and monitoring and threat reporting (Siebeck et al. 2006; Branchini et al. 2015; Roelfsema et al. 2016; Done et al. 2017; Bauer-Civiello et al. 2018; Lau et al. 2019; Licuanan et al. 2021). Non-government organizations and citizen scientists can implement replicable and cost-effective monitoring programs for different goals (Dickinson et al. 2010; Marshall et al. 2012; Jambeck and Johnsen 2015; Done et al. 2017). One of good citizen science practices is Reef Check activities in several countries. Reef Check is a not-for-profit,

registered charity with a few organizing members, a large volunteer group, and having a good governance framework. Training and coordinating SCUBA and snorkel volunteers to collect data sets on benthos, substratum, invertebrates, fish, and human impacts on reefs are important activities of the Reef Check programs (Done et al. 2017; Lau et al. 2019; Obura et al. 2019).

A good method for monitoring coral reefs by citizen scientists should be simple, available and inexpensive to perform and provide accurate data that are required for decision-making of managers (Licuanan et al. 2021). The data collected have to be readily validated (Burgess et al. 2016). A simple method can encourage more active volunteers who do not have the technical training and advanced skills, such as reef ecology, coral taxonomy, etc. The aim of this study was to develop the new coral reef monitoring method for citizen science in Thailand to assess coral reef conditions on a large scale, which supports coral reef management, based on the fact that most SCUBA divers have their underwater cameras for photos taking and video recording.

2. Materials and Methods

This proposed new method for citizen science to monitor coral reefs was designed, tested at several reef sites and validated by experienced marine ecologists. A team of SCUBA divers were assigned to take underwater photos from 1, 2, and 3 m distance, either directly facing the coral reef or at a slight angle to provide a general view of the reef (Figure 1).

The proposed method was conducted at several reef sites in both the Gulf of Thailand and the Andaman Sea, i.e., Rayong, Chumphon, Phuket, and Phang Nga Provinces (Figure 2) to test the appropriate distance for taking underwater photos. Video recordings (3 minutes for each) were also conducted for reef fish monitoring and testing the method accuracy.

All underwater photos were analyzed by marine biologists for the accuracy of providing figures of live/dead coral cover, coral composition, partial mortality, coral diseases, coral fragments, coral recruits, macrobenthic organisms, and threats.

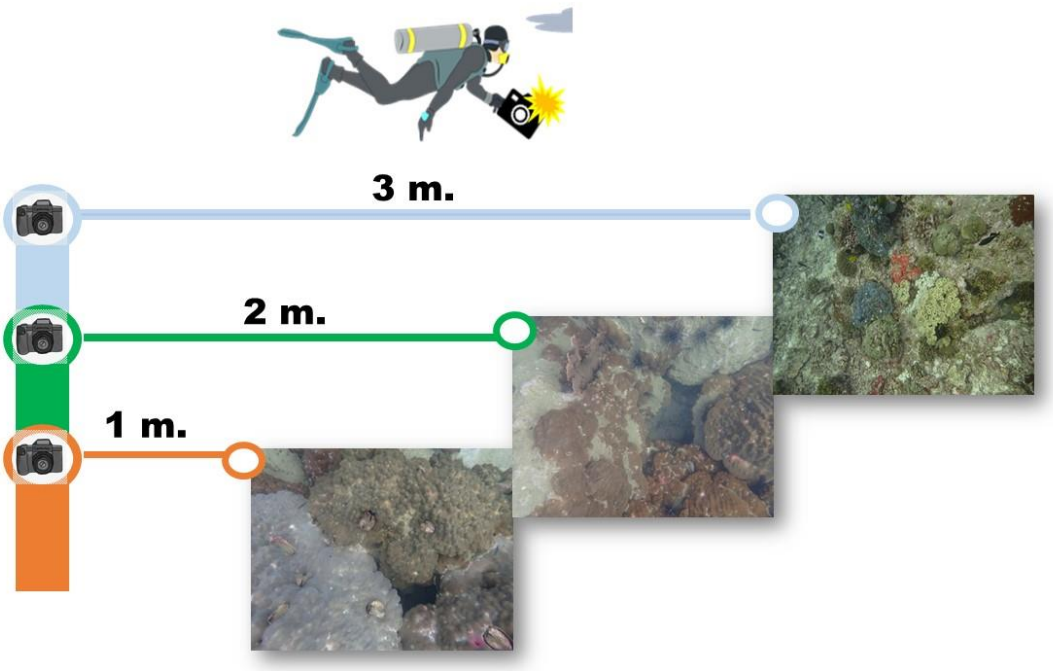

Figure 1. Underwater photos were taken from 1 – 3 m distance

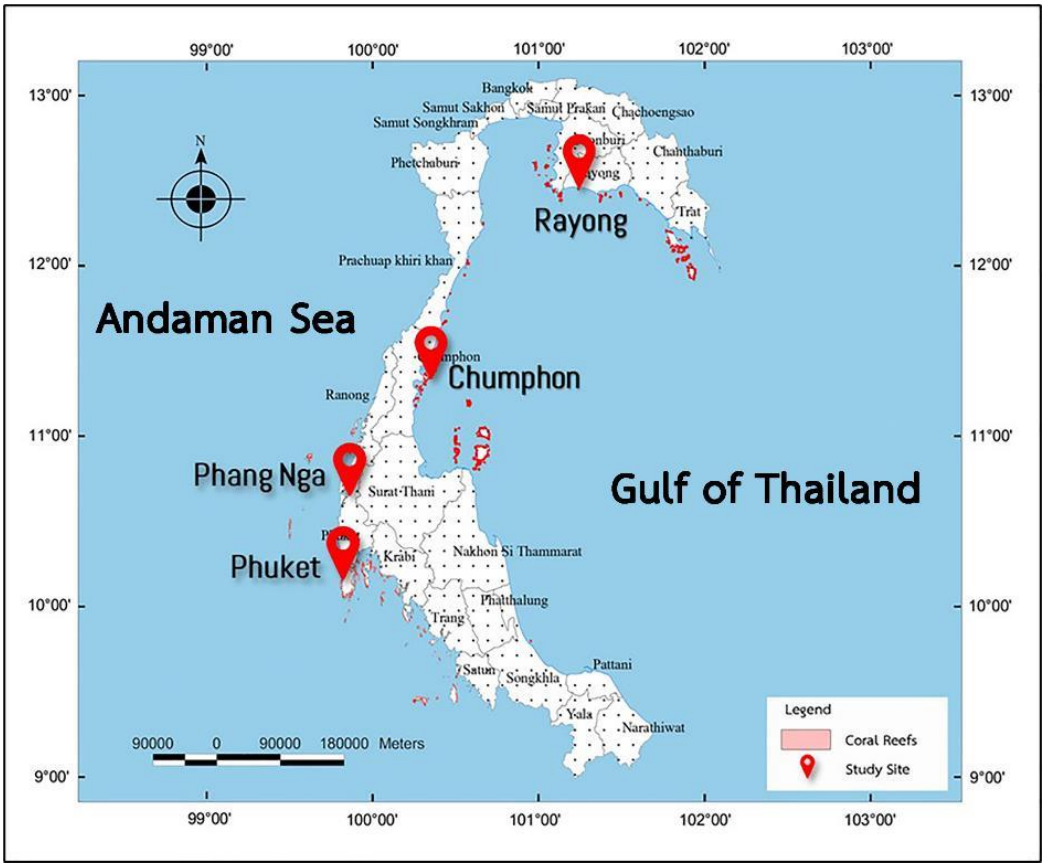

Figure 2. The study sites for testing the method in Thai waters

3. Results and Discussion

3.1 Coral reef monitoring

The underwater photos were taken from 1, 2, and 3 m distance (Figures 3, 4, 5) were analyzed for the accuracy of quantitative presenting of live/dead coral cover, coral composition, partial mortality, coral diseases, coral fragments, coral recruits, macrobenthic organisms and threats.

Percentages of accuracy of the underwater photos taken from 1 and 2 m distances were over 70% for the quantitative data of live/dead coral cover, coral composition, partial mortality, coral diseases, coral fragments, macrobenthic organisms and threats. However, the accuracy of coral recruits assessment was below 40% for all underwater photos. The percentages of accuracy of the underwater photos taken from 3 m distance were much lower than those from 1 and 2 m distances (Figure 6).

The underwater photos taken from 1 m distance provided the highest accuracy for all examined coral condition, however it may be high risk for coral damages caused by volunteer divers during their surveys. Therefore, the underwater photos taken from 2 m distance should be recommended for the new coral reef monitoring method for citizen science.

A proposed new method for citizen science to monitor coral reefs

- Monitoring sites on a reef should be selected to encompass the reef zones and different sides of an island.
- Diving at the reef zone of coral reefs or underwater pinnacles.
- Photos should be taken at the dive computer/depth gauge.
- At least 20 photos should be taken from about 2 m distance above the reef as representatives of each reef site. Photos should not capture the same scene or overlapping.

- Photos should be taken either directly facing the reef or at a slight angle to provide an overall reefscape view.
- Photos should be submitted for analyzing by scientists through Facebook: MBRG Ramkhamhaeng University.

An infographic of a proposed new method for citizen science to monitor coral reefs in Thai language is given in Figure 7.

Coral reef monitoring guide for citizen science

- Always check your distance from the reef before taking a photo.
- Always take photos of the dive computer to indicate water depth.
- Try to avoid overlapping parts of each image.
- No close-up photography.
- Do not shoot photos in rocky or sandy areas without coral reefs.
- If coral reefs are on the cliffs, shoot photos away from the cliff by keeping a distance of 2 meters.

An infographic of coral reef monitoring guide for citizen science in Thai language is shown in Figure 8.

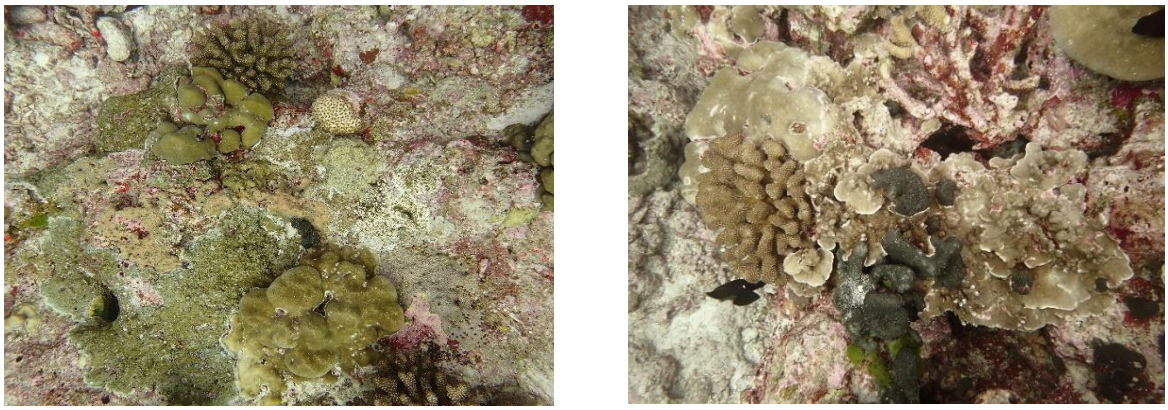

Figure 3. Underwater photos were taken at 1 m distance.

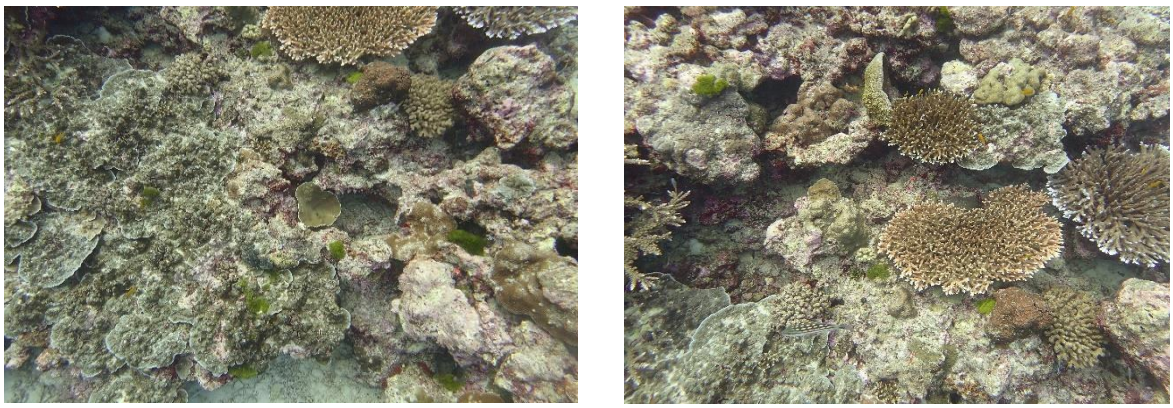

Figure 4. Underwater photos were taken at 2 m distance

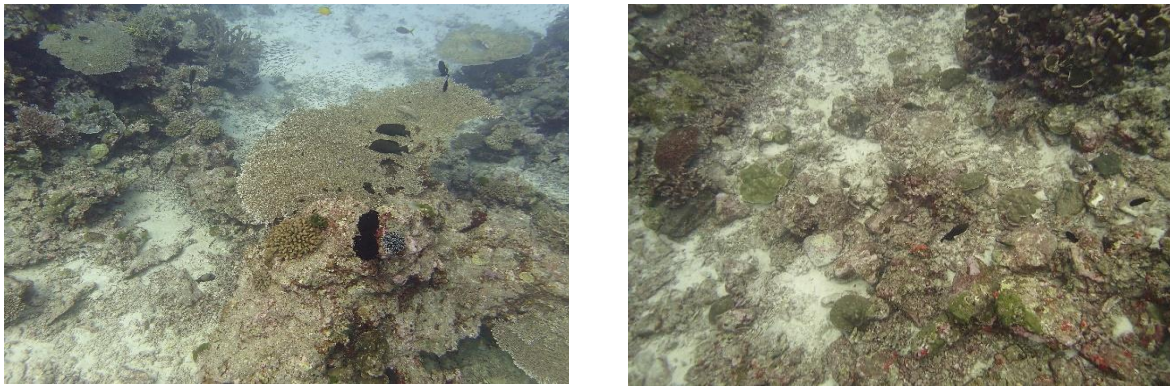

Figure 5. Underwater photos were taken at 3 m distance

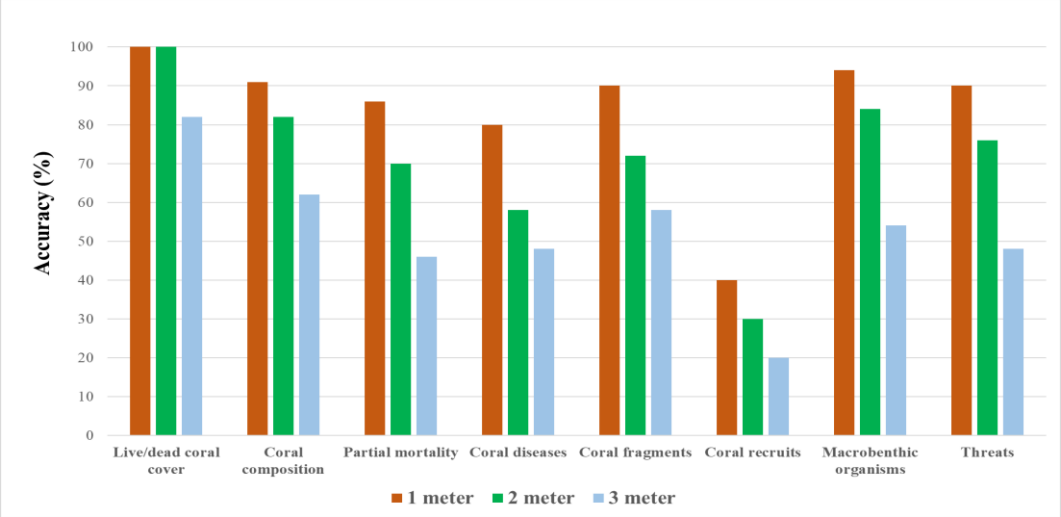

Figure 6. Accuracy of underwater photos taken from different distances for analyzing coral reef conditions

Figure 7. A proposed new method for citizen science to monitor coral reefs in Thai language for volunteer divers

Figure 8. Coral reef monitoring guide for citizen science in Thai language for volunteer divers

3.2 Coral reef fish monitoring

The underwater video recordings taken from 2 m distance (Figure 9) were analyzed for the accuracy of quantitative data compared with results from the Fish Visual Census method (English et al. 1997). This method for coral reef fish monitoring showed a new approach for citizen scientists to collect reef fish data in Thai waters.

A proposed new method for citizen science to monitor coral reef fish

- Diving at the reef slope zone of coral reefs or underwater pinnacles.
- Photos should be taken at the dive computer/depth gauge.
- Underwater camera should be set at 60° to the coral reef.
- At least three minutes of video recording from an underwater camera should be conducted from about 2 m distance above the reef to survey reef fishes. The divers should swim slowly for taking video recordings.
- Video recordings should be submitted for analyzing by scientists through Facebook: MBRG Ramkhamhaeng University.

An infographic of new method for citizen science to monitor coral reef fishes in Thai language for volunteer divers is showed in Figure 10.

Coral reef fish monitoring guide for citizen science

- Always check your distance from the reef before taking a video recording.
- Always take pictures of the dive computer to indicate depth.
- Do not swim too fast.
- Try to keep the underwater camera in the same position while recording video.

An infographic of coral reef monitoring guide for citizen science in Thai language is given in Figure 11.

3.3 Training of volunteers for using a new method for citizen science

All volunteers were SCUBA divers from the Save Our Sea, a non-government organization for environmental protection, who have at least Advanced Open Water Diver certificate. The training took place at reef sites in the Andaman Sea and consisted of lectures and interactive discussions about a new method for citizen science to monitor coral reefs and reef fish (Figure 12). There were several recommendations from the volunteer divers, such as how to avoid overlapping of photographs, guidance for a group of divers to take photos, best practices for taking photos with bias mitigation, improving facilities to receive a big data set, etc.

Figure 9. A photo captured from a video recording at 2 m distance

Figure 10. A proposed new method for citizen science to monitor coral reef fish in Thai language for volunteer divers

Figure 11. Coral reef fish monitoring guide for citizen science in Thai language for volunteer divers

Figure 12. Marine ecologists worked in collaboration with volunteer SCUBA divers to introduce a new method for citizen science to monitor coral reefs and reef fish

The new method for citizen science to monitor coral reefs is relatively simple and available because most volunteer SCUBA divers, dive leaders, and dive instructors have their own underwater cameras. However, turbid waters at some reef sites may inhibit using this new method for citizen science. The photos that are taken from underwater cameras have lower resolution and typically have a greenish-blue cast, limiting the taxonomic identifications of marine benthic organisms (Licuanan et al. 2021). Coral reefs in Thailand are high biodiversity as they locate in the Indo-West Pacific region, therefore clear underwater images are required for data analyses (Vo et al. 2013; Huang et al. 2015, 2016, 2018; Heery et al. 2018). A modified method to monitor coral reefs under specific conditions should be developed.

This study emphasizes that citizen science has an important and effective educational value for coral reef conservation and management. Tourism and diving business stakeholders should increase their commitments and efforts to the coral reef monitoring programs. Further studies should concentrate on more frequent monitoring and more up-to-date information of coral reef conditions, developing new educational methods for coral reef conservation and management, encouraging the civic sector for better understanding of scientific methods, strengthening scientists to become more aware of the priorities that society needs, and providing more information source for coral reef management agencies. This study also provides further information to relevant organizations responsible for coral reef management in Thai waters.

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