BENTHIC TAXONOMY ASSESSMENT

ReefCloud Training - Cu Lao Cham MPA

Australian Insitute of Marine Science

Introduction

This report summarises an assessment of trainees' accuracy in identifying benthic taxa from images during a training course on Coral Reef Monitoring using ReefCloud. The Australian Institute of Marine Science developed and taught the training to upskill scientists and reef managers in monitoring coral reefs and contribute to standardising coral reef monitoring worldwide.

During the training, participants were tasked to identify benthic taxa from a selection of images previously annotated by AIMS scientists. This task was done before and after AIMS's training on genus-level taxonomy.

Methodology

The training was delivered in Cu Lao Cham for two days to 14 participants from the following institutions across Vietnam:

- Management Board of Cu Lao Cham Marine Protected Area
- Ly Son Marine Protected Area Authority
- Management Board of Bach Long Vi Marine Protected Area
- Management Board of Con Co Marine Protected Area
- Hue University
- Institute of Oceanography

The results below show the average accuracy of trainees in identifying benthos when compared against AIMS annotated images. Each participant was tasked with labelling the taxonomic identity of 5 points per image across ten images. To label each point, trainees were provided with a labelset that describes a taxonomic library of common benthic taxa in coral reefs (see Appendix 1).

A dedicated training was tailored to the images collected from Cu Lao Cham during practical training sessions, and the following training resources were used to facilitate the training:

- Coral Finder
- PowerPoint presentations developed for this training, Available Here.

Accuracy (Equation 1) estimated by comparing all trainee's annotations to AIMS data. Accuracy is calculated per label as the total number of True Positive classifications against the total number of points annotated by AIMS for the given label.

$$Acc_{\text{(label)}} = \frac{\text{TP}_{\text{(trainee)}}}{\text{Total}_{\text{(AIMS)}}} \times 100 \quad (1)$$

Accuracy measures how often trainees predicted the outcome correctly relative to the total number of predictions by AIMS, where **True Positive (TP)** is the number of points correctly classified by the trainees.

Results and Interpretation

Overall Accuracy among trainees

The figure below (Figure 1) displays the overall capacity of correctly identifying benthic taxa before and after the training. For ecological interpretation, this figure is divided into two pannels based on the taxonomic resolution: A) Genus-level taxonomy and B) Aggregated taxa into functional groups (e.g., Hard Coral, Soft Coral, Macroalgae, Turf Algae, Other Invertebrates, etc)

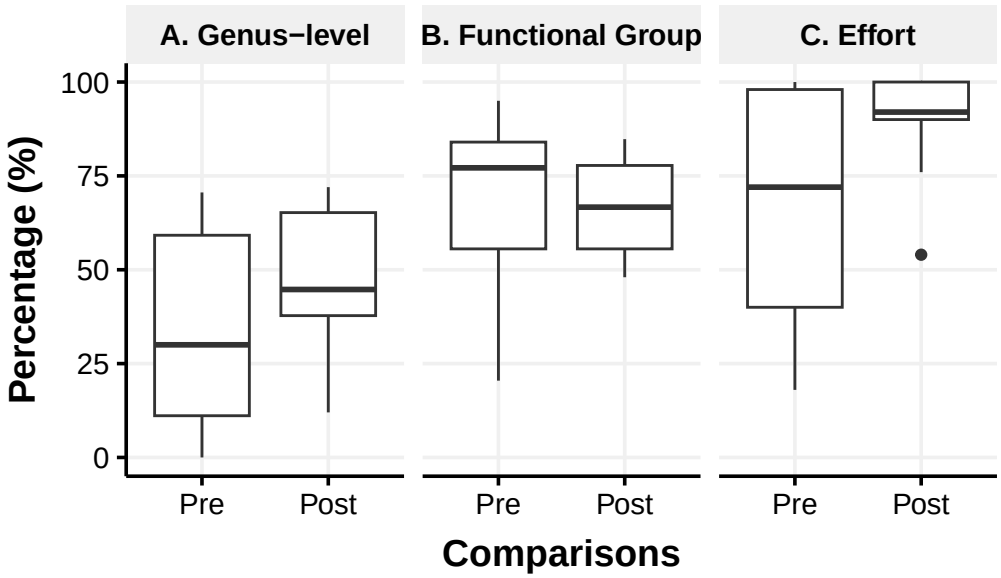

Figure 1: Overall accuracy (F1 Score) calculated before (Pre) and after (Post) the training. Panel C show the percentage of points annotated to show potential changes in sampling effort before Pre and Post

The results show Blah, Blah Blah

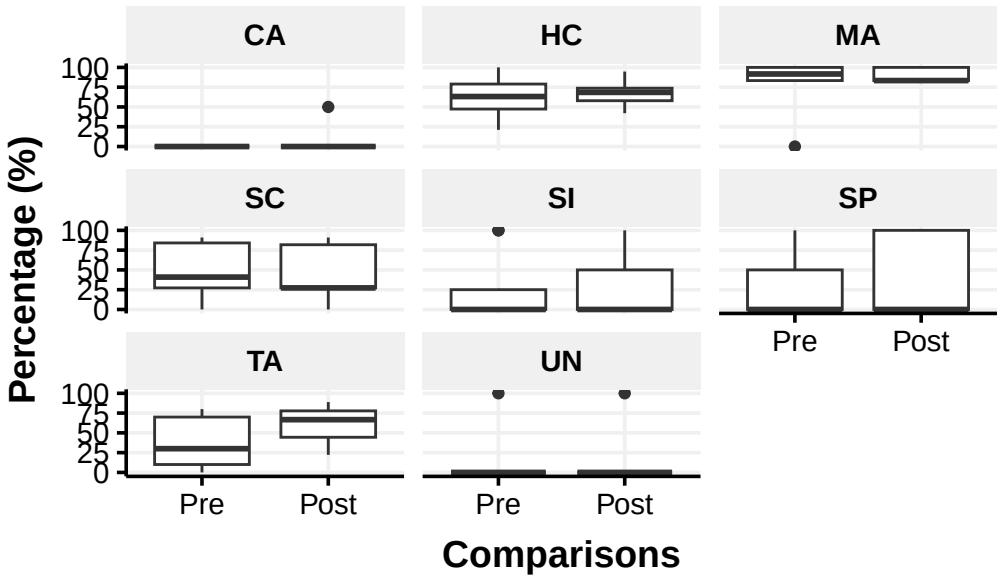

Figure 2: Accuracy of taxonomic identification calculated before (Pre) and after (Post) the training for labels aggregated to high-level functional groups. Each panel shows the calculated accuracy when aggregating genus-level annotations to functional groups (CA = Coraline Algae,Hard Coral = HC, MA = Macroalgae, SC = Soft Coral, SI = Sessile Invertebrates, SP = Sponges, TA = Tuef Algae and UN = Indeterminate or Unknown

Accuracy for benthic taxa at the highest resolution

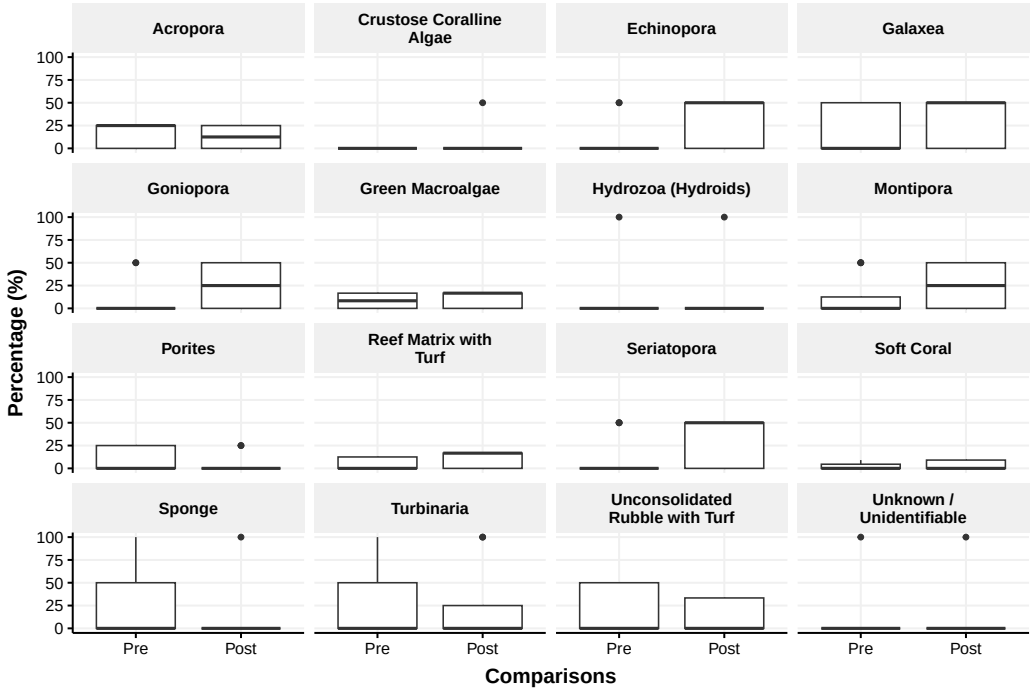

Figure 3: Accuracy of taxonomic identification calculated before (Pre) and after (Post) the training for labels at the highest taxonomic-level recorded. Each panel shows the calculated accuracy for detected taxa

Most confounded taxa

Comparing the indentifications between trainees and AIMS, we calculature the propobability of miss classifications across all taxa (i.e., False Possitives and False Negatives) using a confusion matrix. The confusion matrix allows to calculate the probability of confusion across labels. From this, we identified the most commonly confused or mistaken classification for a given taxa (Table 1). Looking through Table 1 you can identify common mistakes that will help improving the accuracy of classifications using the reference materials.

Table 1: Commonly confused label per taxa after completing the training

Taxa	Often Confused With...
HC	
Seriatopora	Millepora (Fire coral)
Galaxea	Plesiastrea
Isopora	Seriatopora
Plesiastrea	Seriatopora
Dipsastraea	Seriatopora
Acropora	Isopora
Goniopora	Astreopora
Alveopora	Seriatopora
Astreopora	Seriatopora
Turbinaria	Isopora

Echinophyllia	Seriatopora
Echinopora	Echinophyllia
Pachyseris	Seriatopora
Pectinia	Seriatopora
Podabacia	Seriatopora
Porites	Reef Matrix with Turf
Montipora	Isopora
Stylophora	Seriatopora
Other Poritidae	Seriatopora
Acanthastrea	Seriatopora
Platygyra	Seriatopora
Oulastrea	Seriatopora
Pocillopora	Seriatopora
BL_HC	
Acropora Bleached	Seriatopora
SC	
Soft Coral	Goniopora
Lobophytum	Seriatopora
Sarcophyton	Seriatopora
Other Sarcophytidae (Alcyoniidae)	Seriatopora
SP	
Sponge	Encrusting Sponge
Encrusting Sponge	Seriatopora
SI	
Millepora (Fire coral)	Seriatopora
Actinaria (Anemones)	Seriatopora
Hydrozoa (Hydroids)	Crinoidae (Feather Stars)
MA	
Green Macroalgae	Brown Macroalgae
Brown Macroalgae	Seriatopora
TA	
Reef Matrix with Turf	Brown Macroalgae
Unconsolidated Rubble with Turf	Reef Matrix with Turf
CA	
Crustose Coralline Algae	Echinopora
MI	
Crinoidae (Feather Stars)	Seriatopora
SS	
Sand	Seriatopora
UN	
Unknown/Unidentifiable	Goniopora

Recommendations

- The taxonomic identification of coral reef benthos only improves with practice. We recommend continuing to identify taxa from images and collaborating with experts in your region to validate annotations and improve accuracy.
- Revisit your accuracy scores over time using the code provided.
- Annotate images from different habitats to improve your identification skills. Coral reef benthos vary in appearance (e.g., shape, colour, size) across different habitats (e.g., inshore, offshore, turbidity, wave exposure).
- Revisit your annotations with colleagues at your institution. Often, taxonomic identification from images improves by revisiting the classification among your group, which will provide different perspectives.
- Defining a threshold for expected accuracy to ensure the ecological integrity of monitoring is difficult and case-specific. However, we recommend maintaining an overall taxonomic accuracy of over 80% to provide a robust assessment of change in coral reef benthic communities over time. Such accuracy should be evaluated regularly to maintain the value of monitoring data in informing management actions.
- Depending on the purpose of monitoring, i.e., the essential questions from management that monitoring is intended to answer, the taxonomic identification from images should be refined to ensure high accuracy in the identification of critical taxa. For example, suppose local management plans aim to preserve the condition of ecosystem engineers of coral reefs to maintain ecological resilience. In that case, special attention should be paid to the accuracy of the taxonomic identification of hard corals. Alternatively, management authorities may be concerned about invasive species. Therefore, monitoring should maintain high accuracy in identifying those potential threat species.