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Short Communication

Comparative Study of Point Intercept Transect (PIT) Method and Underwater Photo Transect (UPT) to Calculate Hard Coral Cover Percentage

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Abstract

Coral reef ecosystems are vulnerable to damage and extinction. Therefore, it is imperative that, as part of conservation, their conditions are monitored using straight forward or easy-to-use methods. The research was intended to compare the effectiveness of using Point Intercept Transect (PIT) and Underwater Photo Transect (UPT) methods in calculating percentage of hard coral covers. It was conducted at six sites in Karimunjawa Islands, Indonesia: Cemara Besar, Cemara Kecil, Taka Malang, Tanjung Gelam, Menjangan Besar, and Menjangan Kecil. At each site, photographs of coral reefs were taken in two ranges of depths, shallow (3–6 m) and deep (9–12 m), along the length of the predefined transects (100 m for PIT and 50 m for UPT). In UPT, the photos were taken using a 58 x 44 cm frame. Fifty photo frames were collected then processed using Coral Point Count with Excel extensions (CPCe) 4.1. The results showed that PIT and UPT produced different percentages of hard coral cover at each site, with the most significant difference found in deep waters of Menjangan Besar (45.27%) and the least one in deep waters of Menjangan Kecil (0.08%). Overall, the difference in percentage of covers was averagely 9.79 percentage points, which is still categorized into small. Both methods have their own advantages and disadvantages. However, UPT is preferable because its results can be reanalyzed, especially the identified coral reef species.

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1. Introduction

Coral reef ecosystems offer a myriad of ecological and economic benefits. The ecological benefits include providing habitats for a large variety of marine life, sites for foraging and spawning, and supports to other related organisms (Suharsono, 2008). Therefore, economically, healthy coral reefs and their live inhabitants can be a source of livelihood in, among others, capture fisheries. However, coral reef ecosystems are vulnerable to damage and extinction resulting from natural and anthropogenic factors (Sukmara *et al*., 2001; Sudiono, 2008; Prasetya *et al*., 2018). The natural factors are sea surface temperature rise, earthquakes, tsunamis, and acidification, while the anthropogenic factors may involve environmental pollution, unsustainable fishing (e.g., blast fishing and trawling), and water tourism that are not environmentally friendly (Bravo *et al*., 2021).

Regular monitoring is necessary to plan for and implement coral reef conservation efforts, create a guide for management actions (Flower *et al*., 2017), and map and measure changes due to ocean warming and human impacts (Licuanan *et al*., 2021). One of the methods commonly used to calculate the cover percent of hard corals is Line Intercept Transect (LIT), which uses the relative length of the coral observed (English *et al*., 1997; Facon *et al*., 2016). LIT is the standard method to measure hard coral cover and colony size that requires a diver to swim the length of the line transect and record the coral genus/genera beneath it. Although it is relatively easy to perform and simple, this data collection process has its drawbacks, e.g., LIT can be time-consuming when used in large-scale surveys. Moreover, there is a possibility of samplers missing small organisms if not conducted by an expert (Nakajima *et al*., 2010). Also, according to English *et al*. (1997), LIT is not suitable for mortality and recruitment studies. Besides LIT, several other methods that are often used to measure hard coral cover are Point Intercept Transect (PIT) (Dodge *et al*., 1982; Segal and Castro, 2001; Hill and Wilkinson, 2004) and Quadrat Method (Clua *et al*., 2006; Price and Harris, 2009).

Over time, methods to observe coral reefs are developing and differentiating. Some recently emerging methods incorporate and make use of photo and video analyses, such as Photo Line Intercept Transect (PLIT) or Underwater Photo Transect (UPT) (Nakajima *et al*., 2010) and Video Intercept Transect (VIT) (Ninio and Meekan, 2002). The photo-based method involves taking full-frame digital photographs from each quadrat placed along a benthic line transect (Hill and Wilkinson, 2004), while the video-based method uses a high-resolution camera to record objects along a line transect (Witman, 1992; Houk and Van Woesik, 2006). Photos and videos can then be analyzed in two ways: by using plots (to enable areal observation of the studied objects) and software or computer programs (to obtain percent coral cover with high accuracy) (Sweatman *et al*., 2001).

Several studies have compared various methods of determining percent hard coral covers for accuracy and effectiveness. For example, Facon *et al*. (2016) compared two coral reef monitoring methods for the southwestern Indian Ocean islands, i.e., LIT and PIT. Lam *et al*. (2006) evaluated VIT and PIT methods for identifying and monitoring subtropical coral communities. However, no comparison studies have been conducted for the coral reef ecosystems at the research sites, i.e., Cemara Besar, Cemara Kecil, Taka Malang, Tanjung Gelam, Menjangan Besar, and Menjangan Kecil of Karimunjawa Islands. In addition, Leujak and Ormond (2007) found that the photo-based methods can facilitate monitoring coral reefs better than the conventional ones because even a non-specialist diver can assist in collecting photographs that will be analyzed in the laboratory for coral identification by experts. For these reasons, the current research was designed to compare Point Intercept Transect (PIT) and Underwater Photo Transect (UPT) at the six research sites. A method that is the easiest to use and has the highest accuracy will facilitate regular monitoring of coral reef conditions.

The research aimed to compare PIT and UPT for their effectiveness in calculating percentage of hard coral covers. PIT is a line transect method in which objects of observation are recorded at specific intervals along the transect (Wilkinson, 2000). Reef Check also employs PIT to determine the percentage of hard coral covers. In the current research, UPT refers to the method used by the Indonesian Institute of Sciences (LIPI) that involves making 58 x 44 cm quadrats along the predetermined line transects-termed quadratic ransects, from which photos are taken and then analyzed using Coral Point Count with Excel extensions (CPCe) software.

2. Materials and Methods

2.1 Study Area

The research was conducted in Karimunjawa Islands in Jepara, Central Java, in December 2019. Data were collected at six sites, namely Cemara Besar (S: 05˚ 48’ 14.3”, E: 110˚ 22’ 42.9”), Cemara Kecil (S: 05˚ 49’ 49.7”, E: 110˚ 22’ 32.4”), Taka Malang (S: 05˚ 49’ 11.9”, E: 110˚ 26’ 42.2”), Tanjung Gelam (S: 05˚ 50’

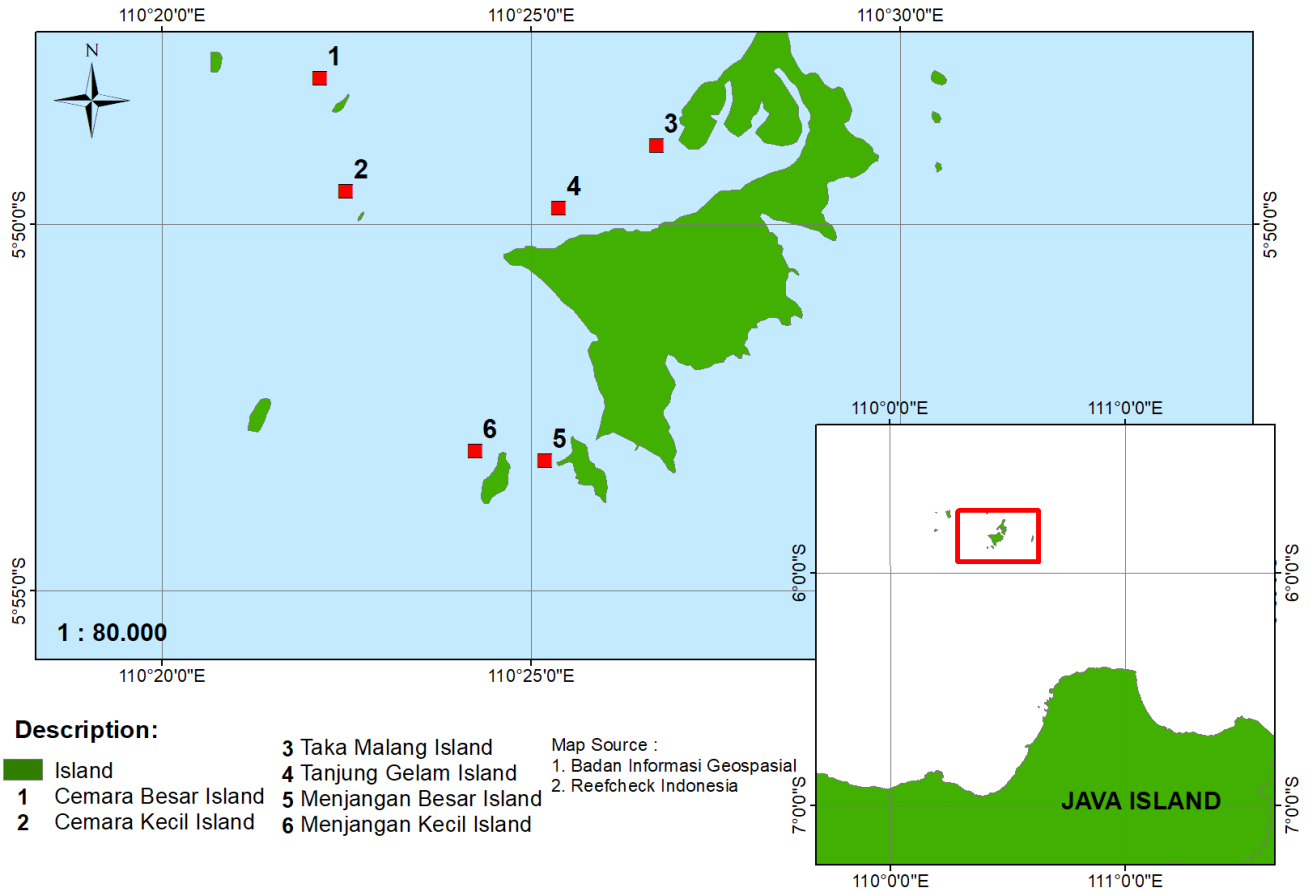

Figure 1. Map of Research Location

04.7", E: 110° 25' 24.3"), Menjangan Besar (S: 05° 53' 22.3", E: 110° 24' 21.6"), and Menjangan Kecil (S: 05° 52' 42.5", E: 110° 24' 58.5") (Figure 1).

2.2 Sampling Technique and Analysis

At each site, data were collected at two depths to represent shallow waters (3–6 m) and deep waters (9–12 m) along a 100 m transect installed according to English *et al.* (1997). In PIT, data were collected at 0.5 m intervals by taking into account the indicator organisms under the transect, i.e., coral reefs and various organisms in the vicinity. Similarly, data collection with UPT also used the same 0.5 m intervals, but the transect total distance was shorter, 50 m. In UPT, photos of coral reefs were taken along the transect path using a 58 x 44 cm frame, resulting in 50 photo frames. Afterward, for each photo, the data were processed in CPCe 4.1 on 30 point samples. These samples were automatically selected at random and then labelled with the code of the existing biota and substrate category. The data were collected by two people, tasked with installing the quadratic transects and taking photos. The UPT did not require particular underwater camera specifications; the higher resolution a camera has, the better the image quality is. To analyze the accuracy and effectiveness, the data derived using the two methods were compared at the same survey points.

Coral community structure was calculated according to English *et al.* (1997) using the formula below:

$$ni = \frac{li}{L} \times 100\ \%$$

ni : percentage of substrate cover
li : total length of each substrate
L : total length of the transect

3. Results and Discussion

The PIT and UPT methods generated different results for shallow and deep waters. In shallow waters (3–6 m), the slightest difference of 3.87 percentage points was found in Cemara Besar, where PIT and UPT produced 50.62% and 54.50% hard coral cover, respectively. On the contrary, the percentage of covers differed most significantly by 18.34 percentage points

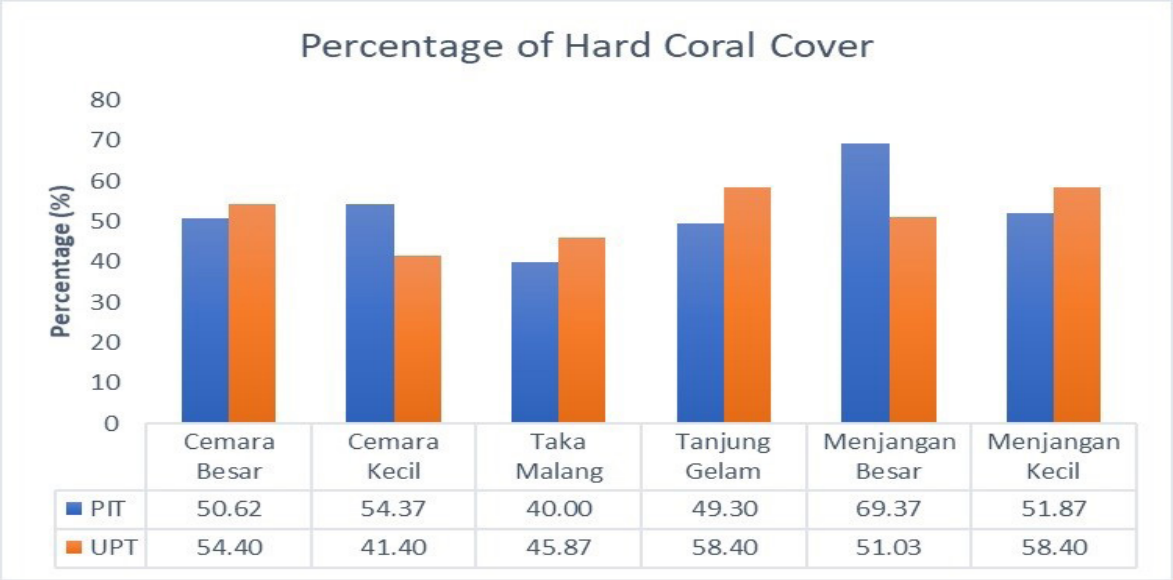

Figure 2. Percentage of hard coral cover representing shallow water (3-6 m) of each location

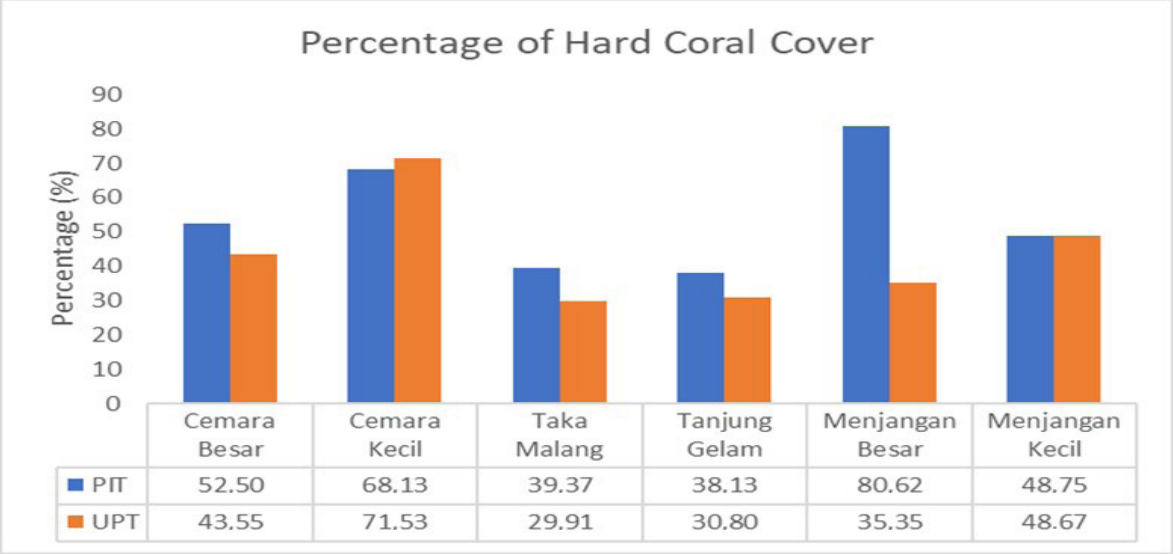

Figure 3. Percentage of hard coral cover representing deep water (9-12 m) of each location

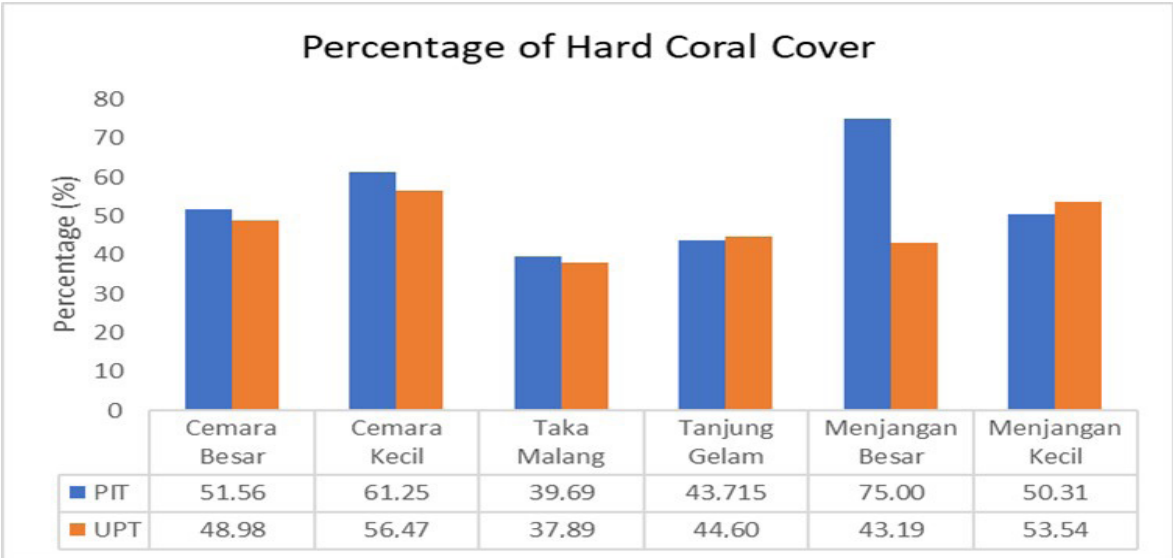

Figure 4. Average percentage of hard coral cover of all locations

in Menjangan Besar (PIT = 69.37%, UPT = 51.03%) (Figure 2). Overall, the applications of PIT and UPT at shallow depths resulted in an average difference of 9.43 percentage points. Spatially, PIT produced higher percentages of hard coral covers than UPT at four sites: Cemara Besar, Taka Malang, Tanjung Gelam, and Menjangan Kecil.

In deep waters (9–12 m), PIT and UPT produced similar percentages of hard coral cover in Menjangan Kecil, 48.75% and 48.67%, indicating the narrowest difference of 0.8%. However, both methods also produced contrasting results in Menjangan Besar, 80.62% and 35.35%, creating the largest difference of 45.27% (Figure 3). Overall, the percentages of hard coral cover in deep waters that were estimated using PIT and UPT were different by, on average, 12.42 percentage points. UPT produced higher percent covers than PIT at five sites: Cemara Besar, Taka Malang, Tanjung Gelam, Menjangan Besar, and Menjangan Kecil. These findings are inversely proportional to the percentage of covers identified at shallow depths.

For all sites and depths, the derived percentage of covers were the least significantly different in Tanjung Gelam, with PIT and UPT producing 43.715% and 44.60%, respectively, or a difference of 0.88 percentage points. On the contrary, the most significantly different results were detected in Menjangan Besar, with PIT and UPT producing 75% and 43.19% hard coral covers or a difference of 31.81 percentage points (Figure 4). On average, the difference in percent cover for all sites and depths was 9.795 percentage points. Such difference is considered small according to Nakajima *et al.* (2010), who, after comparing PLIT (Photo Line Intercept Transect) and PHOTS (Photo-Quadrat Method), found and considered 8 percentage points a slight difference. It means that both methods can be reliably used to monitor coral reef conditions continuously.

The current research compared the uses of PIT and UPT to calculate the percentage of hard coral covers. Based on Nakajima *et al.* (2010), a 0.5 x 0.5 m quadratic transect in UPT is favorable because the images obtained are relatively detailed and bright compared with a 1 x 1 m quadratic transect (cf. Leujak and Ormond, 2007). When a transect is divided into smaller quadrats, the shooting distance between them will be closer and result in better photo quality, allowing for easy object identification. However, suppose the coral reefs are massive and unevenly distributed. In that case, a close shooting distance can cause some coral colonies to appear blurry or too small in the photos, making them difficult to distinguish. To minimize such drawbacks, additional field notes are needed.

Differences in the analysis results are attributed to differences in the transect length observed. PIT was applied to the research sites with a 100 m transect, whereas UPT was with a 50 m transect. In addition, using PIT means only collecting data along with transect, but with UPT, researchers are allowed some room to also consider the area covered in the photographs. Further, thirty random points are automatically selected and digitized onto each photo, for which reason the derived percentage covers are relatively representative of the actual condition at the research site. Another difference lies in the analysis technique: the data derived using PIT are analyzed in the field, whereas UPT involves digital data analysis using a computer program. Theoretically, the analysis results from using the two methods should not be much different (Nakajima *et al.*, 2010). Nevertheless, several other studies have also reported that PIT produces a higher percentage of live coral reefs than LIT and Quadrat Transect (QT) (Wahib and Luthfi, 2019; Fadillah *et al.*, 2021).

4. Conclusions

The percent hard coral covers estimated using Point Intercept Transect (PIT) and Underwater Photo Transect (UPT) on average differ by 9.79 percentage points, which can be categorized into a small difference. It shows that PIT can estimate the percentage of hard coral cover more straightforwardly and efficiently in terms of time and cost compared with UPT. However, UPT provides more accurate identification results because the data collection and analysis can be performed separately, i.e., the photographs can be taken in the field by non-specialist divers and are then brought to researchers with more expertise in hard coral identification. This way, the photographs and the analysis results can be re-examined to achieve high accuracy.

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Author's Contribution

Johan Danu Prasetya; research idea, drafted the manuscript, collected and analyzed the data, and designed the figures. Dian Hudawan; drafted the manuscript, designed the maps

Conflict of Interest

We declare that we have no competing interests.

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