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CLIMATE CHANGE, MARINE LIFE, AND LIVELIHOODS IN THE CENTER OF CORAL TRIANGLE

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CLIMATE CHANGE, MARINE LIFE, AND LIVELIHOODS IN THE CENTER OF CORAL TRIANGLE

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PREFACE

Coral Triangle is a triangular area of the tropical marine waters of Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste. This region is recognized as the global centre of marine biodiversity and a global priority for conservation. Indonesia is an archipelago within this region with high marine biodiversity living in different forms of marine habitats, such as coral reefs, seagrass beds, and mangroves. However, decline of different population of marine biota have already reported due to anthropogenic factor, overexploitation, and climate change.

In celebrating the 57th of Hasanuddin University and 25 years of Marine Science Education in Hasanuddin University, the Faculty of Marine Science and Fisheries proudly presents these International Conference and National Seminar. Under the conference theme of "Climate Change, Marine Life, and Livelihoods in the Center of Coral Triangle" will bring together various stakeholders to share ideas and communicate climate change issues and to increase public knowledge and awareness on climate change to the socio-ecological systems particularly in the coral triangle region.

This proceeding is published to disseminate some papers that have been orally presented within the conference conducted in Makassar at 11 September 2013. We hope that this proceeding will improve the understanding of various stakeholders such as scientists, policymakers, managers, industry and members of civil society on the importance of this coral triangle region.

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Investigation For Coral Reef Degradation Due To 'Ship Grounding'

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ABSTRACT

Threat of the coral reef ecosystem is still occur due to anthropogenic and natural causes. It is less known that the coral reef degradations had been caused by ship grounding due to navigational error or bad weather. Ship grounding can impact to the coral reef and shallow seabed ecosystems particularly change the bottom structure of habitat. Measuring the habitat damage can be investigated by diving methods namely Rapid Reef Assessment, Point Intercept Transect (PIT) and manta tow. Furthermore to estimate the type and wide of reef degraded can be investigated by on boat namely Run Video Camera, Deep Scan Sonar and submesible photographic Quadrat Transect. Selection of manual methods depending on oceanographic condisitions, depth of reef, ability of diver and equipment available. Ship grounding impact can be divided into three site categories are inbounding track, parking lot and the hull resting area. Many cases of it had impact in around inbounding track was 100% dead coral dominated by boulder fragments, in the parking lot was less than 70% of dead and injured coral and in the hull resting area were 95% of dead and injured head corals and 5% of sand coverage. The grounding ships was affecting to the on site coral reef condition and diversity. They always threatened by these accidents around the ship lines anytime. So we have to care and take a responsibility to rehabilitate the degradation of the coral reefs.

Keywords : *Coral reef, degradation, ship grounding*

INTRODUCTION

Degradation and the injury of the coral reefs can occur by many means, natural and anthropogenic, and from direct impact and cumulative nonpoint sources. Physical impact to coral reef include natural events such as hurricanes and thypoons, and injury from anchors, divers, boat hulls, destructive fishing techniques, dredging and coral mining, etc (Challenger, 2006). Most of coral reefs which are adjacent to urban setting are subject to on going large scale stressed due to anthropogenic activities (e.g., overfishing, sediment and nutrient run-off). They are less likely to be able to recover from the disturbances. Another type of human impact as a result of ship groundings, discrete sewage discharges and boat anchors. Various natural drivers of coral reef degradation such as ENSO-induced mass coral mortality, tropical cyclones (hurricanes, typhoons), earthquakes, tsunamis, hurricanes / typhoons, global warming (bleaching), predators (*Acanthaster planci*, *Drupella*), acidification, coral disease (Edwards and Gomez, 2007).

In many cases, ship grounding in Indonesia is not a special attention from scientists, coral reef managers and also diver. In the Indonesian environmental laws , there are chapters that explain the destruction of coral reef ecosystems by humans such as bombs, cyanide and "bubu' trap without mentioning the direct damage caused by the shipgrounding. More countries have had a clear legal instruments concerning the case of a shipgrounding accident on habitat of ecosystem. Even the case of marine pollution caused by oil spills has become one of the main focuses in the rescue marine biological resources . Ship grounding is a ship or boat accidents as the responsibility of the captain, the ship owner and the vessel insurances. As the federal states in USA have laws setting up the resource degradation (Deis and French, 1998) in the form of 'The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA 80 and a Act/1990 Oil Pollution (OPA/90).

Ever since humans have first begun building boats, ships got grounded on coral reefs. Impacts of ship aground include dislodging and fracturing corals, pulverizing coral

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skeletons, displacing sediments from ground, and destroying the 3-D structural complexity of the reef (Jaap, 2000). Salvage operations usually add to reef damages, without counting damages by fuel and cargo slicking from the ruptured hull. This causes acute and long-lasting effects on regenerative processes of coral communities (Aronson, 1997). Resulting from low natural fusion levels of fragments to substrates, virtually complete removal of living coral colonies fragments may occur during subsequent storms (Bruckner and Bruckner, 2001). In Florida, boating is the primary cause for reef damage, mainly by ships colliding into reefs (Bruckner and Bruckner 2001; Lirman and Miller 2003); and literature therein; but see also cases from the Red Sea (Schuhmacher *et al* 2002). In the Florida Keys alone,>500 small vessel groundings are reported annually with, at least, 2-3 times that number unreported (Jaap, 2000).

Ship groundings on coral reefs often result in severe localized biological and physical damage, including the dislodgement of corals, pulverization of coral skeletons, displacement of sediment deposits, and loss of 3-dimensional complexity (Precht, 1998; Jaap, 2000; Precht et al.,2001; Precht and Robbart, 2006; Jaap *et al.*, 2006). Some of ship grounding crack the surface of coral reef, the framework generally becomes the stabilized and prone to subsequent mobilization and destruction. Reef rock can be destroyed and topography altered. Mobile reef rock can cause incidental injury to nearby animals and plants (Shutler *et al., 2006*). Increasingly more of these ship grounding incidents are involving insurance claims to pay for triage, assessment and quantification of the damage, restoration and subsequent monitoring, compensatory restoration (compensating the public for the interim loss of the resource from the time the injury occurred until restoration is complete), as well as punitive action. Scaling for compensation and restoration is based on assessing the extent of the injury and determining the time necessary for recovery to the pre-incident state (Andrews *et al.*, 2005).

Indonesia is having the largest coral reefs in Asia does not has a formal recording of acount of coral reefs damage due to ship grounding. As an archipelagos country, Indonesia like Filipina and the Caribean countries, has to have the formal rules and abig attention on it. For example, Phillipina have a good record of the ship grounding ' in Thubata Reef the conservation area . Various cases of ship grounding have a lot going on in the waters of the coral reef tropical countries such as in the Gulf of Mexico , the Red Sea , the Great Barrier Reef , Indonesia and the Philippines , Sri Lanka , and the Maldives and the Pacific islands .

Ecological assessment of biodiversity lost due to ship grounding can be identified eg. what species of organism is destroy, how many occurrences of 'ship grounding' around our coral reefs, how wide the destruction. Are there mechanisms or regulations we have for complaining and where will be given the information while we see the grounding ship ? Indonesian archipelago sprinkled with coral reef ecosystems often occurs ship grounding on a remote island reefs and will continue endangered.

Unfortunately, there are no reports and handling of restoration and rehabilitation of coral reefs after ship grounding . According to Miller, *et al* (1993) in Precht *et al* (2000) shipwreck is the factor of damage to coral reefs from anthropogenic very chronic and restoration should be pursued more quickly. This paper is focus primarily on injuries of coral reef structure resulting from direct physical impact of ship grounding, since little of the current understanding of coral reef injury from ship grounding within the case of one the large vessel incident in Spermonde Archipelago ship line. From this paper to all readers is hoped to pay attention to conserve the coral reef from anthropogenic impact namely ship grounding' especially.

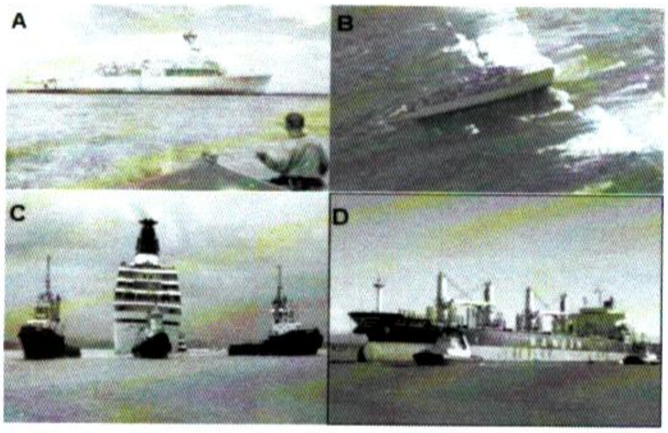


Figure 1. Ship accident grounding on reef around the world. A&B. US Navy ship on Tubatha Reef Phillipines; C. The 188 m Norwegian Crown cruise on patchreef of Bermuda (Jones, 2007); D. Hanjin Istambul Ship on reefs.

MATERIAL AND METHODS

Survey Methodology

The survey reported here employed 5 complementary methods, first - based on manual diving by RRA (Rapid Reef Assessmen) and PIT (Point Intercept Transect) methods (Figure 2), second and third - based on acoustic methods.

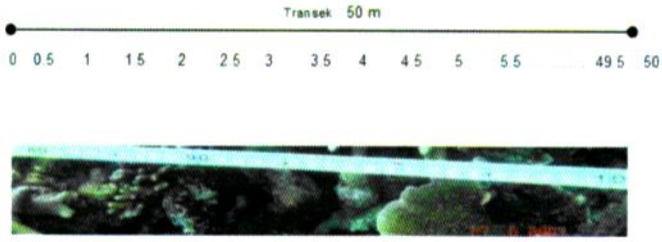


Figure 2. Transect tipe for Point Intercept Transect (PIT) method that laid on helthy coral reef and on the degraded reef by ship grounding.

Manual Diving using PIT Method

Diver and the buddy were diving on the 8 m depth of patch reef which impacted of the ship grounding to made a preliminary observation. From this result, we had an overview of the degradation of reef and made a certain the sites to lay the line Point Intercept Transect (PIT). Point Intercept Transect Method was developed by English (1994), McManus (1997); Manuputy and Juwariah (2009). This method is simple to apply where each of 0.5 m should be noted one component of coral reefs substrate (listed below) as long as 50 m each. About three sites of transects were laid 50 meters on the reef which impacted by ship grounding and on the adjacent. The type and shape of the degraded substrate were identified and analysed based on special category (Table 1). So, all of these category were divided to be four general category of coral coral injury and degraded substrate, eg. killed benthic substrate, damage-corals, damage to substrate-waves, dan damage to substrate-backwash. But in the Point Intercept Transect and the Line Intercept Transect, the general cateries of substrate be analysed are Life

Coral, Dead Coral, other Biotic and Abiotic (sand, silt, rock). Here the bottom substrates categories which impacted by destruction (Table 1)

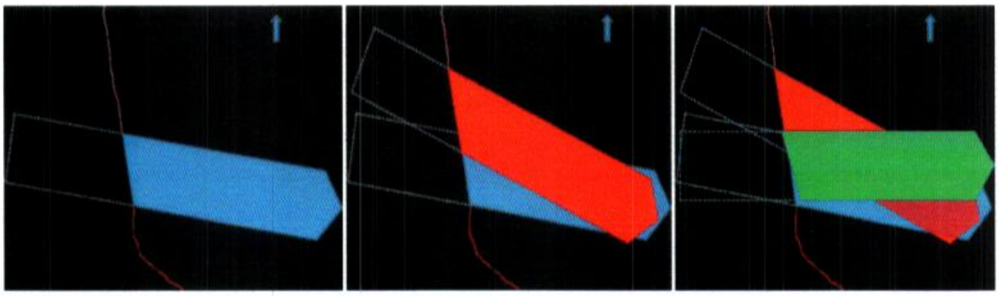
Table 1. Categorisation of substrat that have impacted by ship grounding.

DAMAGE SUBSTRATE CATEGORY			
KILLED BENTHIC		**DAMAGE TO SUBSTRATE-WAVES**	
Hard coral – damaged	LCD	Overall damage - Reef	ODAM
Recently killed coral	RKC	Slope erosion	CRE
Coral life forms - damaged	CLF	Rubble piling/movement	RBP/M
Filamentous algae - damaged	FAG	Loose rocks < 50 cm	R<50
Thick turf/ fleshy algae - damaged	TAG	Loose rocks > 50 cm	R>50
Rock/ Bare surface	RC	Boulders > 1M	BLD
Rubble	RB	Scars/ exfoliation	SCR
DAMAGE-CORALS		Cracks	CRCK
Overall damage	CDMA	**DAMAGE TO SUBSTRATE-BACKWASH**	
Up-turned coral	UPC	Silt smothering live coral surface	SILC
Broken coral	BCC	Silt on reef surface/ sand pockets	SIT
RKC – standing	RKC-S	Debris-stone/ solid	DBS
RKC – upturned	RKC-U	Debris-vegetables / sea-grass	DBV
Coral life forms - damaged	CLF-D	Debris-litter	DBL

RESULT AND DISCUSSION

Ship Grounding Stages

Predicted movement of the ship between grounding to refloating. **A** – shows the vessel at a heading of 99 and grounded from the bow to cargo hold 4 (solid blue colour) the ungrounded stern of the vessel is shown by a dashed blue line. **B** – shows the vessel at a heading of 114 representing the maximum swing to port whilst the vessel remained aground and after the failed refloating attempt on the 16 October. Note this may have resulted in an increase in both the area of damage and amount of hull in contact with the underlying reef (solid red colour). **C** – shows the hull at a heading of 90 corresponding to being refloated stern first that may have further increased the area of damage (solid green colour) (Tissier, 2010).



A. In Bound Track Area B. Hull Resting Area C. Parking Lot Area

Figure 3. Simulation of ship grounding stage on : (A) inbound track area, (B) hull resting area and (C) the parking lot area (Tissier, 2010).

Ship groundings on coral reefs often result in severe localized biological and physical damage, including the dislodgement of corals, pulverization of coral skeletons, displacement of sediment deposits, and loss of 3-dimensional complexity (Jones, 2007). Coral reef destruction in the Spermonde Archipelago due to ship grounding have an impact on the single patch reef ecosystems in the outer of Lanjukang Island. From the observation using the PIT method showed that about 70-100% of coral reefs have been damaged (Figure 3). Coral reefs damage based on ship grounding impact were divided into four locations, namely adjacent to healthy reef, the inbound track , hull resting area and the parking lot area. The worst damage occurred in many parts of the location of the grounding. But at the location adjacent to the reef healthy and parking lot areas are still found living coral, coral proficiency level of a group of soft corals and small coral colonies sheltered between the large dead coral boulder. Sand coverage were only seen in the adjacent to healthy reef, inbound track and in the parking lot area. These sand settled in the small hole and space between the life coral and the hole in the parking lot. But on the flat destruction reef, the sand was swept by strong current through the channel between Lanjukang and lankai Island. The life coral colonies were difficult to find except in the edge of a dead hard bottom in the parkinglot and adjacent to healthy reefs.

Figure 4. Substrate of coral reef degradation coverage in the ship gounding sites.

Coral Colonies Injury and Reef Degradation

The coral colonies injured due to ship grounding may classified as in Table 1 above. Based on field observation using the PIT and RRA (Reef Rapid Assessment) on the grounding site, here we classified the injury habitat of coral reef related to the ship's activity during and after grounding could be reconstructed. The primary injury zones were categorized as follows :

a. Inbound Track

This zone include all of the scars generated on coral spurs and soft-hard bottom along the inbound path of the ship. The soft bottom are one thiny sand layer about 5-8 cm thick, under these is the hard bottom substrate of massive limestone. In the other site, the inbound track subtrates are dominated by the framework of limestone exposed in the shallow valley line due to propeller action in the stern grounding area. The ajacent of the inboud line are the healthy coral reef as signed by the life coral and other reef orgaisms. The reef habitat assessment showed that 95 % dead coral and 5 % sand (Fig. 6). But the good condition of coral reef which were not impacted to the adjacent reef.

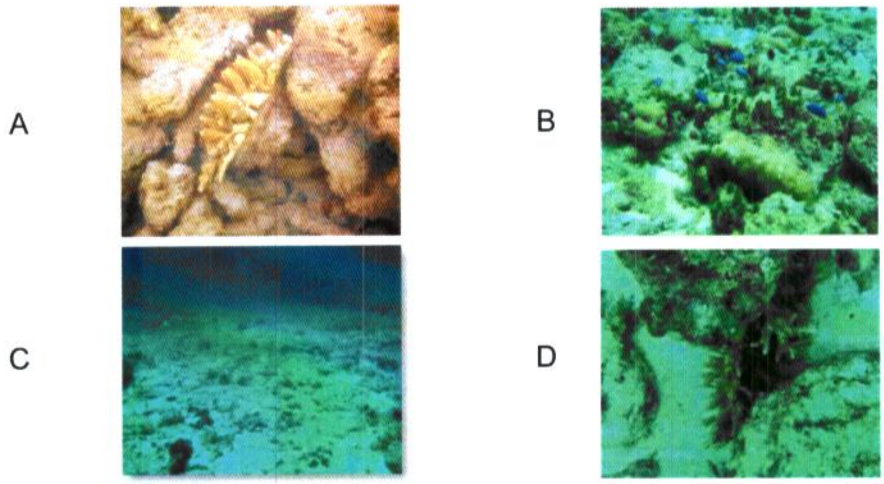


Figure 5. Kinds of coral injury and destruction of coral reef due to ship grounding. A,D=Upturned coral (UPC), B = Coral lifeform damage (CLD); C = Overall damage (ODMA).

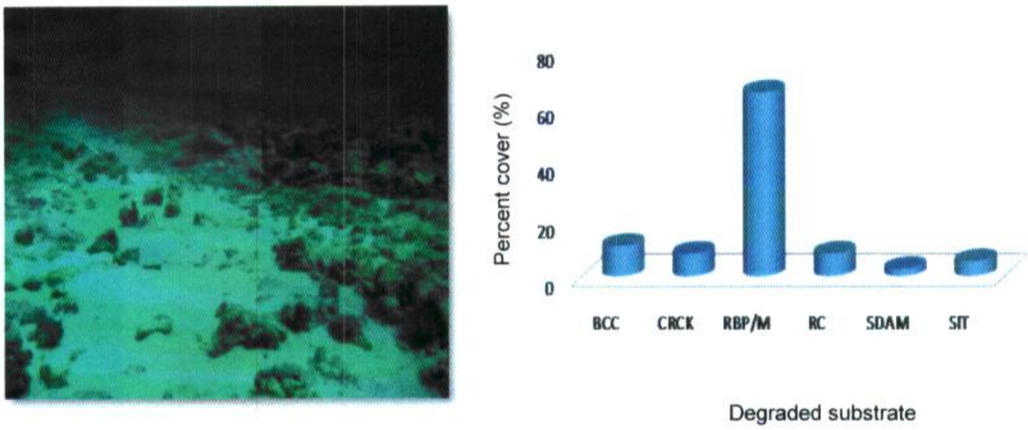


Figure 6. The soft and hard substrate of reef in line of inbound track of ship grounding. The left was compisited by sand and rock boulder that had sandy valley and in the right picture was composited by rock boulder in adjacent of the healthy reef.

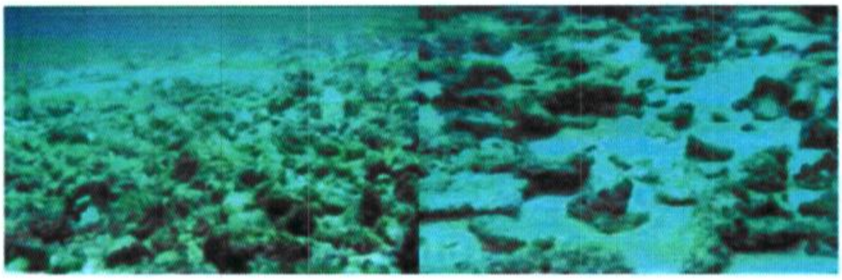


Figure 7. Showing the rubble and dead coral of 100% on the ground hull resting area which had sat by ship grounding for 11 days.

b. Hullresting Area

This site was the first worst impacted of the ship grounding. All of the reef substrates were destroyed to be flat base rocks. Because the significant impacted on these area that even within a time frame 11 days the cargo ship sat on the reef

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substrate. In particular Those are have been directly affected by hull resting of the cargo ship, so the all lifeform of corals and other biotas has been largely affected in the highes term. This means is that only those areas directly impacted through contact with the ship"s hull and to a lesser extent displaced rubble displaced immediately adjacent to these areas remain damaged. There were not living organisms can stand to living on these area, so had 100% dead coral appeared in this hullresting area (Figure 7).

c. Parking Lot Area

This site was the second worst impacted of the grounding in the parking lot area. There were not live coral found, these lime stone flat more than 10 hectare of substrate. Most of broken limestone or coral substrate called rubble in the form of large boulder were more than 25 cm. Boulder were proficiency of derived from massive corals split into fraction size > 25 cm which tend to be unstable (RBP / M). Sand (SIT) to be around the damage, as a result of currents that are stuck in a hole or groove between coral colonies that live close vicinity to the dead coral.

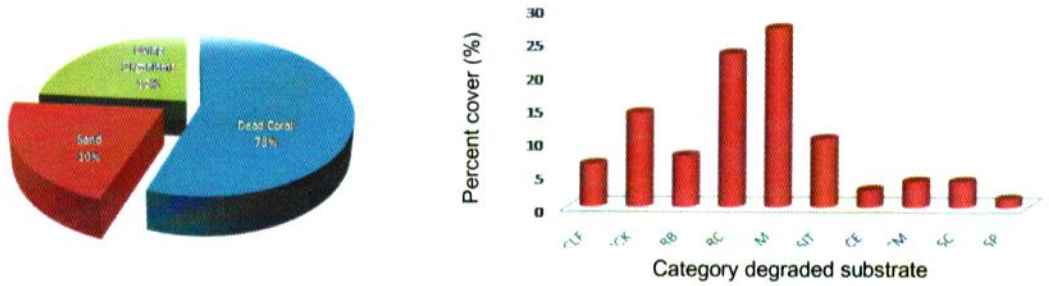

Figure 8. Showing the coverage of substrate on parking lot area

Severe Coral Reef Impact

The grounding of boats and ships is a widespread occurrence affecting severe aspect of scale of biological and physical damage, eg. the biodiversity of coral reefs, dislodgement of corals, pulverization of coral skeletons, displacement of sediment deposits and loss of 3-dimensional complexity (Precht, 1998; Jaap, 2000; Precht, *et al.*, 2001; Precht and Robbart, 2006; Jaap, *et al.*, 2006). Injury to coral reefs by groundings can range from relatively minor injuries to the degradation of the structural complexity of the reefs.

Between 500 and 600 vessel groundings are reported in the Florida Keys National Marine Sanctuary. Annually and approximately 60–90 of the groundings have involved injuries to coral reef habitat (Andrews, *et al.*, 2005). In Apo Reef Natural Park, a ship grounding incident in 2003 occurred in which according to the coral reef survey, a total of 225 species of fish representing 30 families were intercepted. The grounding caused reef damage in 2,910 m^2. Restoration costs using the coral transplantation method were estimated at PhP 38,260,5215 or close to PhP 13,000 m^2. This became the basis of the fines imposed on the ship owner to settle the damages they caused in the Park (Rosales, 2006).

In the summer of 2006 a cruise ship struck a coral reef in Bermuda. The AF paint used on the ship was Intersmooth 460 (International Marine Coatings) a Tributyltin

(TBT)-free self polishing copolymer with copper oxide and zinc pyrithione as primary and secondary biocides (Jones, 2007)

Increasingly more of these ship grounding incidents are involving insurance claims to pay for triage, assessment and quantification of the damage, restoration and subsequent monitoring, compensatory restoration (compensating the public for the interim loss of the resource from the time the injury occurred until restoration is complete), as well as punitive action. Scaling for compensation and restoration is based on assessing the extent of the injury and determining the time necessary for recovery to the pre-incident state (Andrews *et al.*, 2005).

The recovery of reefs from ship-groundings is often very slow and in many cases may take decades (Precht, 1998). While many studies have assessed the physical damage of large ship-groundings (Negri, *et.al.*, 2002). The grounding ship has the potential to impact on the recruitment of invertebrates to the damaged site, therefore slowing subsequent ecosystem recovery.

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