Preliminary field report on the impact of the MV Tycoon on the coral reef environment at Christmas Island

Preliminary report produced by Jean-Paul Hobbs[1]* and Justin Gilligan for Parks Australia and Regional Australia.
27 January, 2012.

[1] Oceans Institute, M470 , University of Western Australia, 35 Stirling Highway, Crawley WA 6009
* Author for correspondence: jean-paul.hobbs@uwa.edu.au

EXECUTIVE SUMMARY

This field report provides preliminary insights into the initial impact of the MV Tycoon on the coral reef environment of Christmas Island. Unfortunately, unfavorable weather conditions have significantly restricted fieldwork and only 3 of the 10 monitoring sites could be surveyed. Consequently, this limits the inferences that can be made from this study. Caution should be given to the accuracy of the following results given the limitations of the post-impact surveys.

The preliminary results can be summarised as:

1. There has been no observable change in live hard coral cover at the impacted site on the western side of Flyingfish Cove.
2. There has been no observable change in algae cover at the impacted site on the western side of Flyingfish Cove.
3. There has been no observable change in the total abundance or species richness of butterflyfishes at the impacted site on the western side of Flyingfish Cove.
4. There has been no observable change in the total abundance of angelfishes at the impacted site on the western side of Flyingfish Cove.
5. There has been no observable change in the abundance of anemones or anemonefishes at the impacted site on the western side of Flyingfish Cove.

When interpreting these results the following caveats must be applied:

1. This study is a preliminary assessment with limited ability to detect impacts. A comprehensive assessment of the impacts can only be achieved once all the monitoring sites have been surveyed.
2. This study examined the western side of Flyingfish Cove and due to the greater distance from the MV Tycoon and the role of local currents the immediate impact at this site is likely to be much less than that on the eastern side of Flyingfish Cove (to the east of the jetty).
3. Areas to the northeast of the MV Tycoon (e.g. Isabel Beach, Rocky Point) were not surveyed and may have experienced greater impacts than the western side of Flyingfish Cove because the plume was recorded travelling northward, rather than westward, from the ship.
4. Significant changes in benthic composition (e.g. coral and algal cover) can occur months and possible years after the initial impact.
5. Fish communities often exhibit lag effects following impacts and therefore the lack of an immediate effect should not be considered as no effect.
6. This study did not measure sub-lethal impacts (e.g. reduced growth and reproduction), which can have significant lag effects on populations.
7. This study only surveyed at 5 and 20 m depth. The impact on organisms inhabiting shallow waters (< 5 m) and intertidal areas is unknown, but may be high because pollutants were observed accumulating in these areas.

OBJECTIVE

The overall objective of this study was to determine the initial impact of the MV Tycoon on the coral reef environment at Christmas Island. This preliminary study focuses on the initial changes in benthic composition and fish populations following (= approximately 2 weeks after) the grounding of the MV Tycoon.

The specific aims were to determine changes in:

1. live hard coral cover
2. algal cover
3. coral death and health
4. abundance and species richness of butterflyfishes
5. abundance of pygmy angelfishes
6. abundance of anemones and anemonefishes

METHODS

This study takes advantage of data from a long-term monitoring program established in 2005 at Christmas Island. Based on this monitoring program, 10 survey sites were selected for this study (Figure 1); however, unfavorable weather meant that only 3 sites could be surveyed during the fieldtrip (19-27 January, 2012). This included one impact site on the west side of Flyingfish Cove (the area of reef immediately to the west of the jetty) and two control sites on the northeast coast (Ethel Beach and Ryan's Ravine). The survey methodology used in this study is the same as that used in the previous surveys.

Benthic composition

The benthic community on corals reefs is usually dominated by live hard corals; however, on impacted or degraded reefs, algae dominates the benthos. Therefore, to determine whether the benthic community changed following the grounding of the MV Tycoon (and subsequent release of hydrocarbons and phosphate) we examined live hard coral cover and algae cover. To quantify the benthic community (including hard coral and algae), the line-intercept method was used and points taken every 2 m on a 50 m transect tape. Three replicate 50 m transects were deployed at each of two depths (5 and 20 m).

Coral death and health

Corals can exhibit stress responses (e.g. bleaching) or become susceptible to disease following impacts. To determine if this was the case three replicate 30 x 4 m belt transects were conducted at each of two depths (5 and 20 m). Within these transects the number of bleached and diseased (white syndrome) colonies were recorded. The number of recently killed corals (identified by the presence of filamentous algae colonising an intact skeleton, and the absence of coral spat and other encrusting calcifying organisms) in each transect was also recorded.

Fish populations

Belt transects (50 x 5 m) were also used to determine if there were any changes in populations of reef fishes (due to death or continued avoidance of impacted areas) following the grounding of the MV Tycoon. Three replicate transects were done at each of two depths (5 and 20 m). Fish were counted whilst unwinding a 50 m tape and, once achieved, the benthic community was quantified, and coral death and health recorded (as described above), when winding the tape back in.

The fish surveys focused on 3 key groups. The first group was butterflyfishes (genus *Chaetodon*), which contain many coral-feeding species that usually experience population decreases following loss of coral cover. The second group was pygmy angelfishes (genus *Centropyge*). This territorial group feeds on filamentous algae and is common at Christmas Island. Butterflyfishes and angelfishes were studied because they usually exhibit population responses when coral reefs become degraded and shift from coral-dominated communities to algal-dominated communities.

The third group was anemonefishes. This group was chosen because they have an obligate relationship with anemones. This habitat specialisation not only increases their risk of extinction, but also increases their likelihood of exposure to pollutants. Anemonefishes show high site fidelity to their host anemone and therefore are unlikely to swim away to avoid pollutants. Furthermore, anemones have limited mobility (and therefore limited avoidance behavior), and if they die this results in decreases in anemonefish abundance. To detect changes in the abundance of anemones and anemonefishes, anemones that were tagged and surveyed previously in Flyingfish Cove were resurveyed after the MV Tycoon grounding. Tagged anemones included: *Cryptodendrum adhaesivum*, *Heteractis magnifica*, and *Stichodactyla mertensi*, and the study anemonefishes were: *Amphiprion clarkii*, *Amphiprion perideraion*, and *Amphiprion sandaracinos*. These are all the anemonefishes and host anemones that occur at Christmas Island.

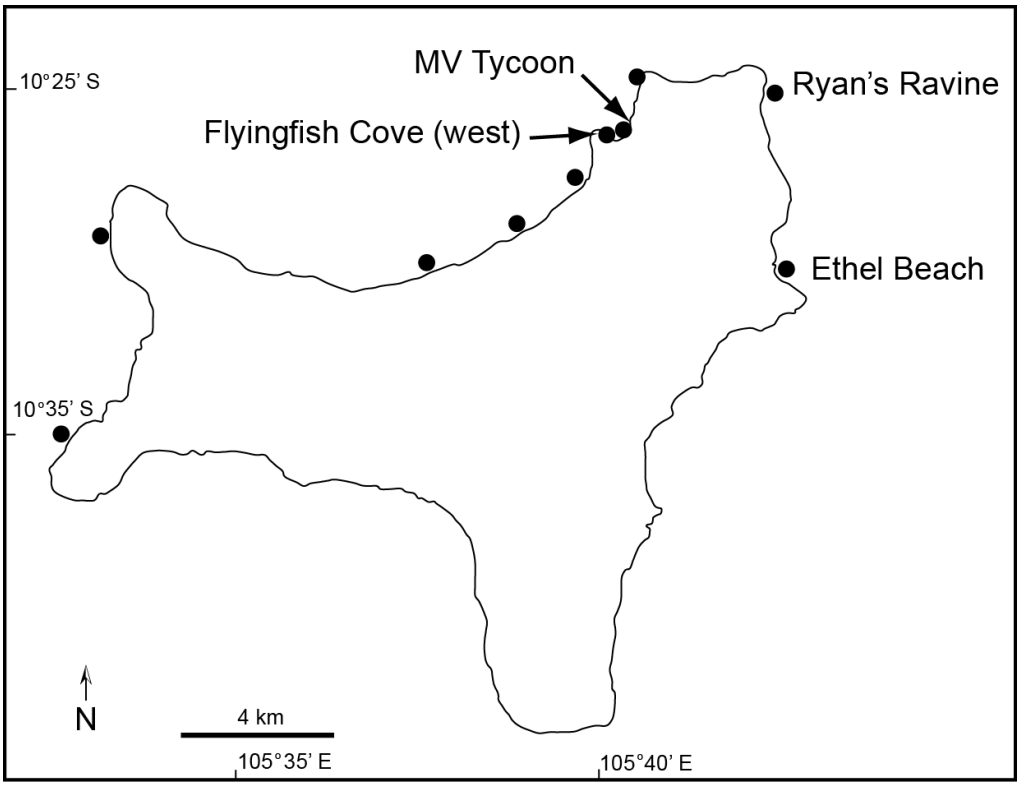


Figure 1: Map of the 10 monitoring sites at Christmas Island. The sites that were surveyed during this fieldtrip (January 2012) are named. The unnamed sites represent those that were not surveyed due to adverse weather. The position of the MV Tycoon wreck is indicated on the eastern side of Flyingfish Cove.

RESULTS

Benthic composition

There has been no obvious change in the cover of live hard coral at the western side of Flyingfish Cove following the grounding of the MV Tycoon (Figure 2). The apparent slight increase in live hard coral cover at the two control sites is probably due to random transect placement at these sites because a significant increase in coral cover is unlikely between the "late 2011" surveys in December 2011 and the "early 2012" surveys in January 2012.

There was also no obvious change in the algal cover at the western side of Flyingfish Cove (Figure 3). The majority (>99%) of the algae cover was short (< 10 mm), filamentous algae. The slight increase in the shallows (5 m) and slight decrease in the deep (20 m) in algal cover between 2011 and 2012 at the Flyingfish Cove site was similar to the fluctuations in the data at the control sites and probably represents sampling variation.

Coral death and health

There were no recently killed (i.e. died since the grounding of the MV Tycoon two weeks ago) corals within the transects at 5 and 20 m at the western side of Flyingfish Cove. Coral disease and bleaching were minimal and similar to pre-impact (December 2011) levels. At 20 m depth, 2 of 36 *Acropora* plates had coral disease (white syndrome), and of the 61 *Pocillopora* corals, 1 had disease (white syndrome) and the 1 was bleached. No other corals in the transects had visible signs of bleaching or white syndrome. There was no bleaching or white syndrome observed in corals during transects done at 5 m depth.

Fish populations

There was little change in the total mean density of *Chaetodon* butterflyfishes at the western side of Flyingfish Cove following the grounding of the MV Tycoon (Figure 4). The pre- and post-impact butterflyfish total mean density was also generally consistent at the control sites. There were also no noticeable changes in species richness of butterflyfishes between pre- and post-impact surveys at the impacted site (Flyingfish Cove) and the two control sites (Figure 5).

There was no noticeable change in the total mean density of pygmy angelfishes (*Centropyge*) at the western side of Flyingfish Cove following the grounding of the MV Tycoon (Figure 6). Although no pygmy angelfishes were recorded in the post-impact (early 2012) surveys at 5 m depth on the western side of Flyingfish Cove (Figure 6b), this was also the case before the impact (late 2010 and late 2011).

Resurveying the tagged anemones at the western side of Flyingfish Cove revealed that no anemones had died in the two weeks following the grounding of the MV Tycoon (Figure 7). There were minimal changes in the abundance and size structure of anemonefishes inhabiting these tagged anemones following the impact (Figure 8).

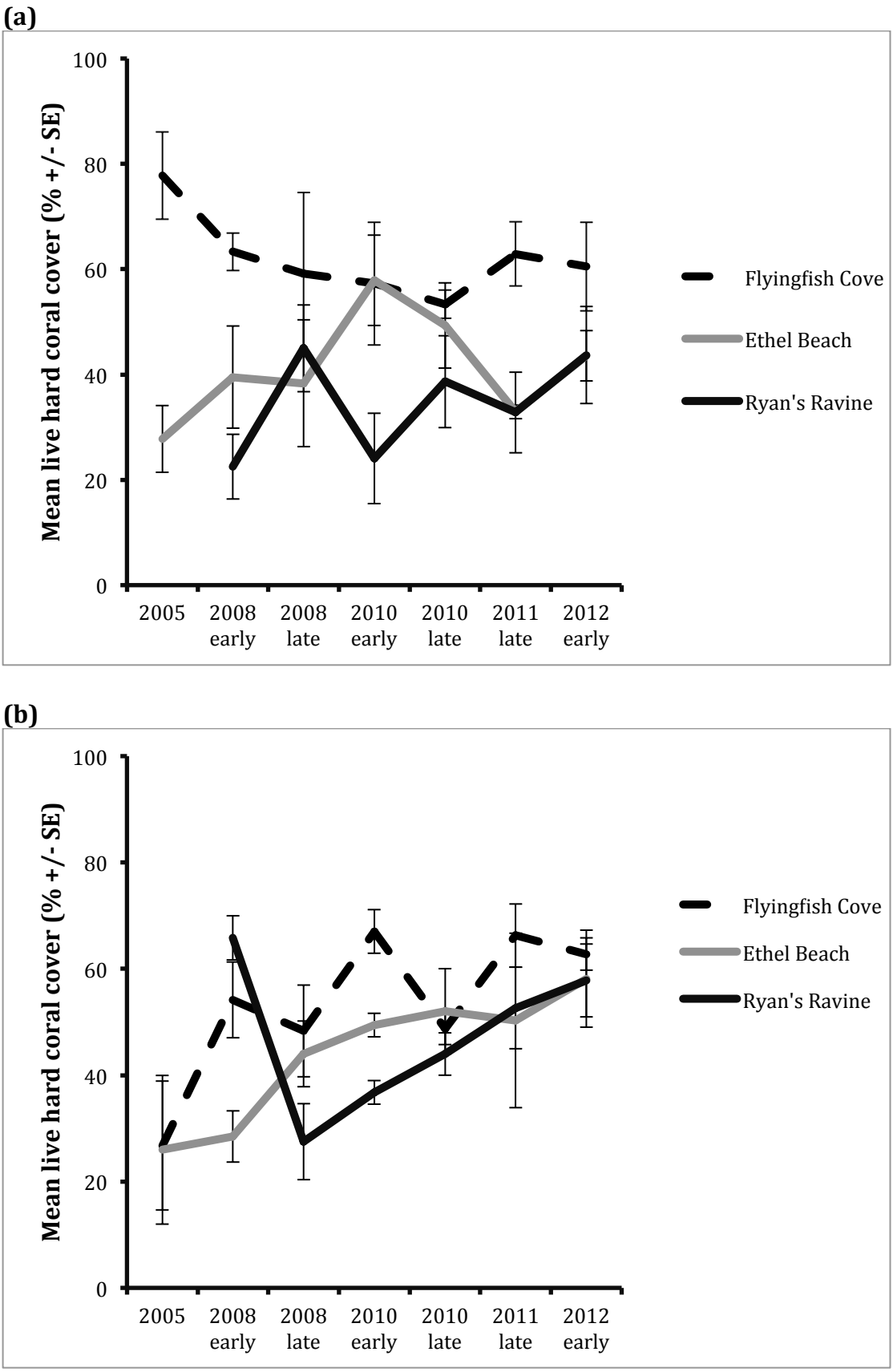


Figure 2: Mean live hard coral cover (% +/- SE) at the impacted (Flyingfish Cove) and control sites (Ethel Beach and Ryan's Ravine) at (a) 20 m and (b) 5 m depth. The post impact data is presented as "2012 early".

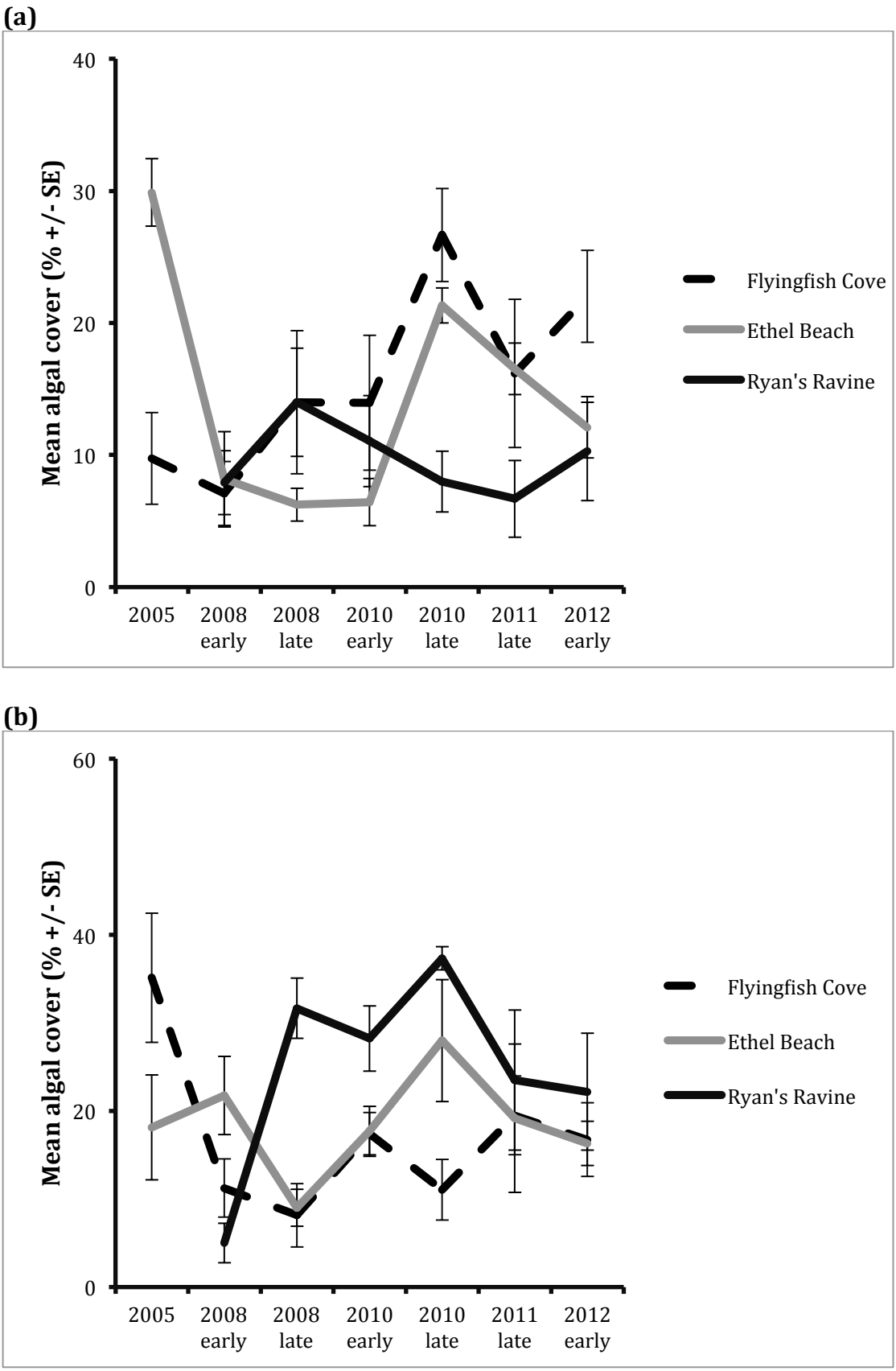
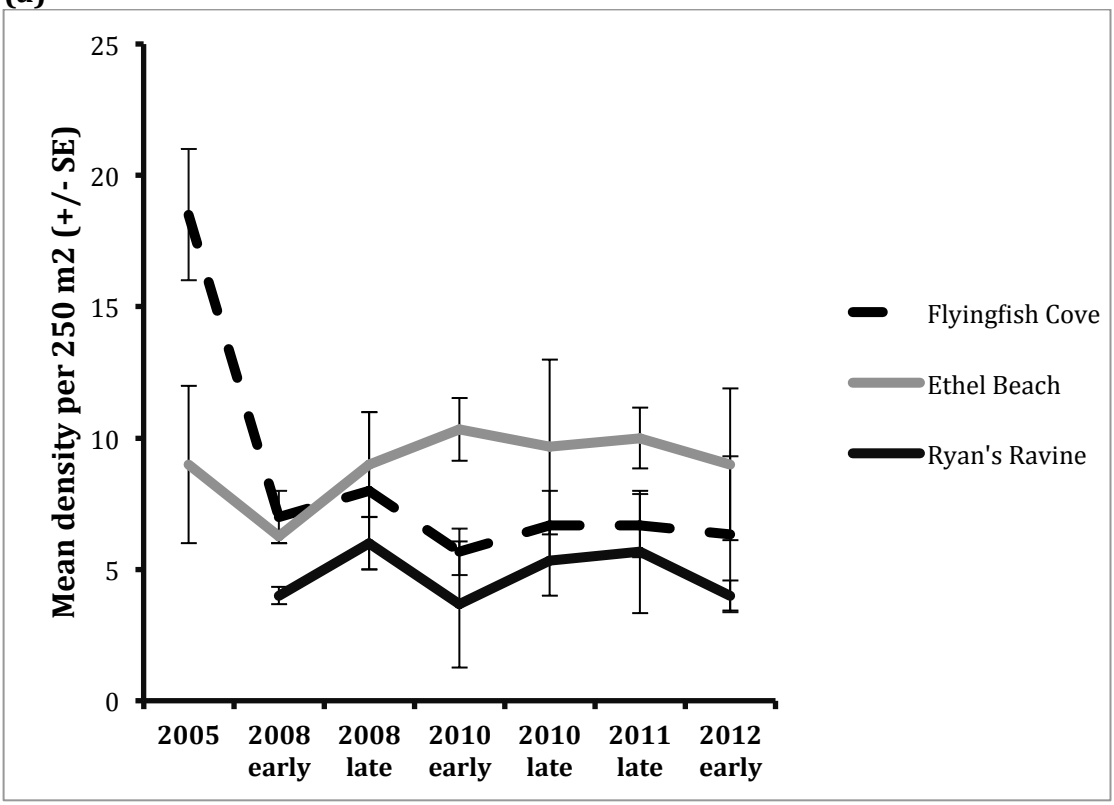


Figure 3: Mean algal cover (% +/- SE) at the impacted (Flyingfish Cove) and control sites (Ethel Beach and Ryan's Ravine) at (a) 20 m and (b) 5 m depth. The post impact data is presented as "2012 early".

(a)



(b)

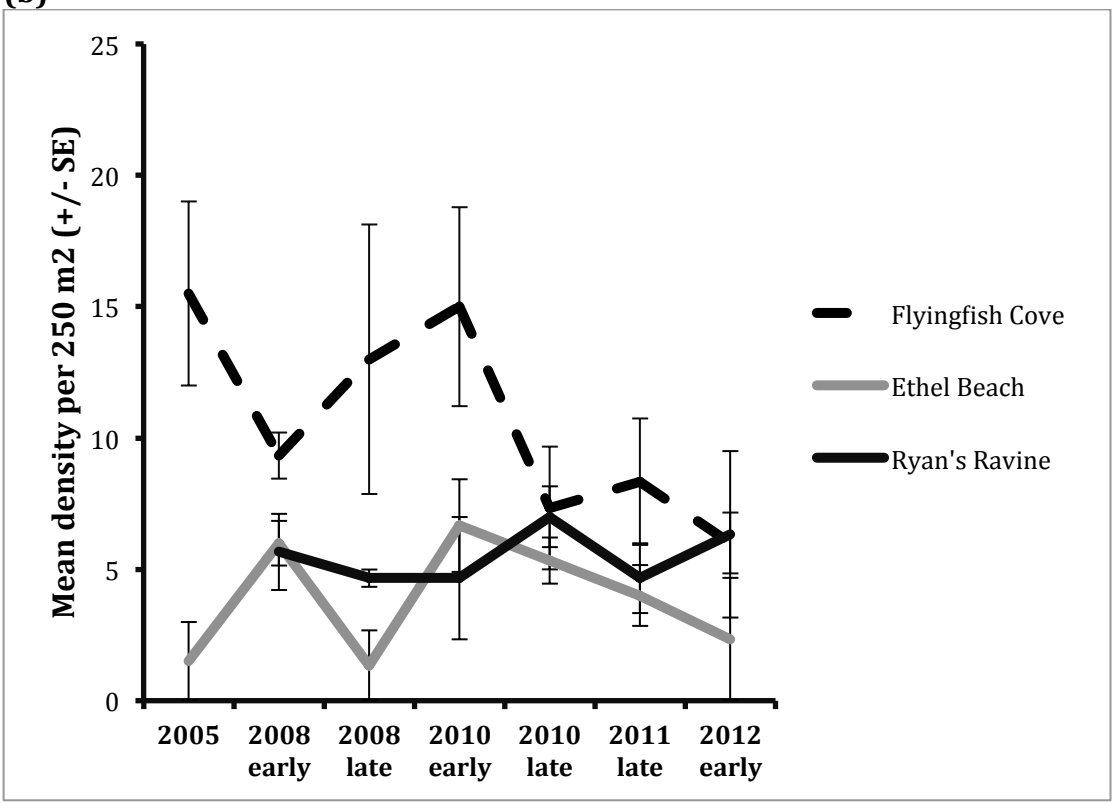


Figure 4: Mean total density of all *Chaetodon* butterflyfishes (per 250 m^2 +/- SE) at the impacted (Flyingfish Cove) and control sites (Ethel Beach and Ryan's Ravine) at (a) 20 m and (b) 5 m depth. The post impact data is presented as "2012 early".

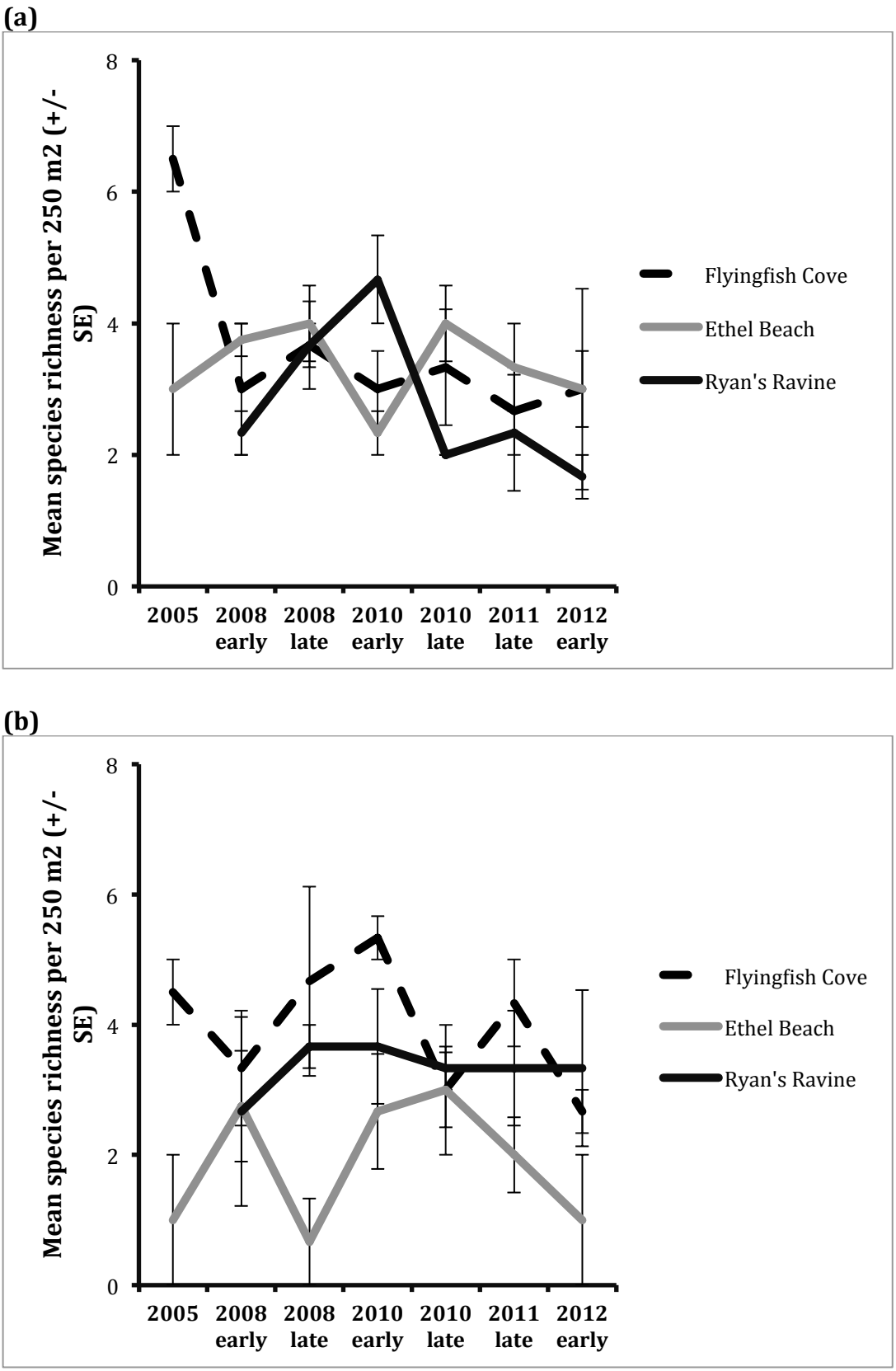


Figure 5: Mean species richness *Chaetodon* butterflyfishes (per 250 m^2 +/- SE) at the impacted (Flyingfish Cove) and control sites (Ethel Beach and Ryan's Ravine) at (a) 20 m and (b) 5 m depth. The post impact data is presented as "2012 early".

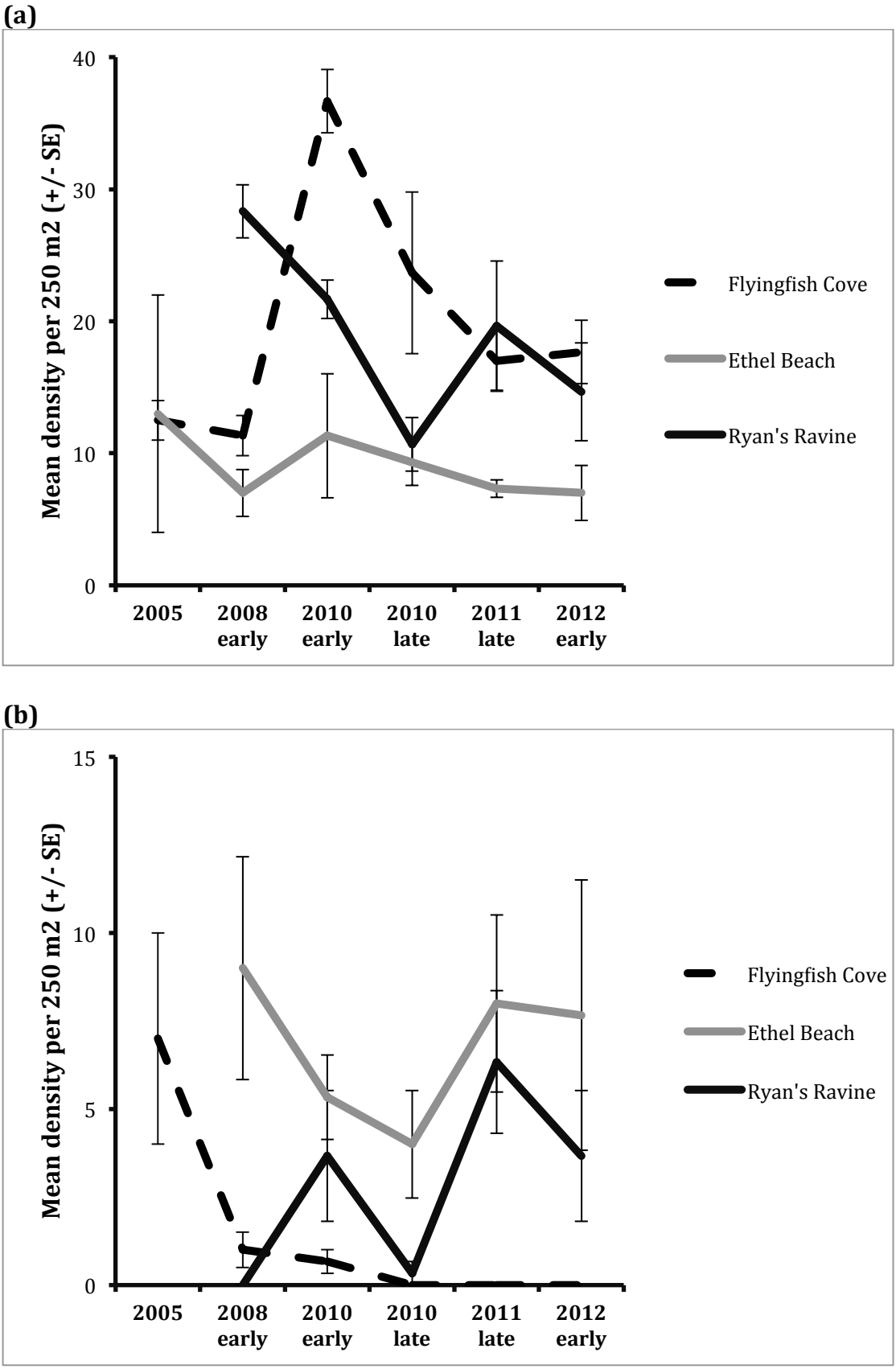


Figure 6: Total mean density (per 250 m^2 +/- SE) of pygmy angelfishes (*Centropyge*) at the impacted (Flyingfish Cove) and control sites (Ethel Beach and Ryan's Ravine) at (a) 20 m and (b) 5 m depth. The post impact data is presented as "2012 early".

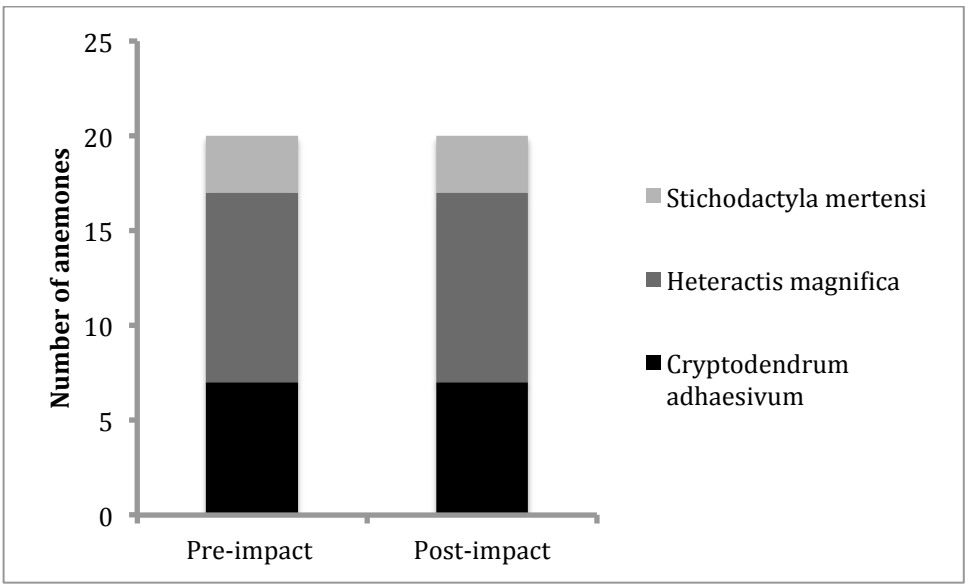


Figure 7: The number of tagged anemones at the western side of Flyingfish Cove present in surveys before (December 2011) and after (January, 2012) the grounding of the MV Tycoon.

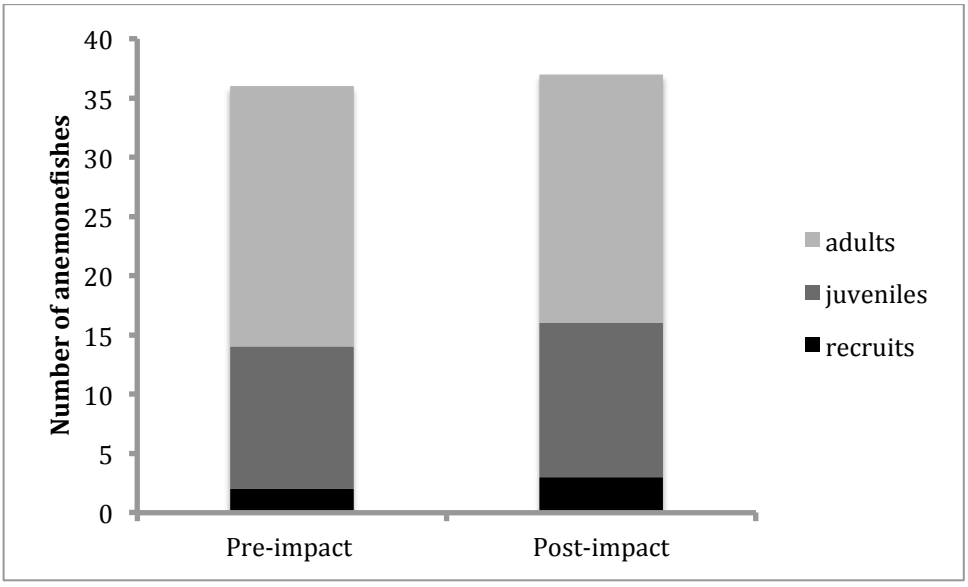


Figure 8: The number of anemonefishes present on tagged anemones at the western side of Flyingfish Cove. Surveys were conducted before (December 2011) and after (January, 2012) the grounding of the MV Tycoon. Different life stages are shown (new recruits = < 2 cm Total Length, juveniles = 2 – 5cm TL, adults = > 5 cm TL).

DISCUSSION

There was no noticeable change in the benthic community at the survey site on the western side of Flyingfish Cove. Furthermore, we did not observe any recently killed corals and there were little visible signs of stress (bleaching and white syndrome disease) in corals between 5 and 20 m whilst doing the surveys. Collectively, this indicates that there has been no immediate change in the cover of live hard coral between 5 and 20 m on the western side of Flyingfish Cove. Mortality of corals in the shallows (< 5 m) and intertidal zone was not investigated (due to adverse weather) and may be high given that the hydrocarbon pollutants were seen to accumulate in these areas. The lack of observed coral mortality on the western side of Flyingfish Cove does not mean that the coral at this site has not been impacted. Sub-lethal effects (e.g. reduced mortality, growth, immunity) may have occurred and these effects may not be visible until months or even years after the impact. Future monitoring of growth rates, reproduction, and disease outbreaks would be necessary to detect such impacts.

The lack of immediate mortality or visible stress in corals at the western side of Flyingfish Cove indicates that corals at this site were not exposed to lethal doses of pollutants. Exposure (concentration and time) is likely to have been reduced due to the effect of outgoing currents ("rips") at the jetty and boat ramp situated in the middle of the Cove. These currents would have directed pollutants out to sea (northward) and thereby inhibited the continued westward movement of pollutants from the MV Tycoon on the eastern shore to the western side of the Cove. This effect is clearly illustrated in the photograph on the first page of this report. The reef area immediately to the left (west) of the jetty is the west Flyingfish Cove survey site. Furthermore, the large swell and waves over the past two weeks would have facilitated large movements of water leading to reduced exposure time and facilitating the dispersal of pollutants.

Not only would these currents minimise the exposure of corals on the western side of the Cove to pollutants, but it would also minimise the residence time of phosphate. There was no evidence of an immediate algal outbreak following the release of phosphate from the MV Tycoon. This could be because residence time was too low, or because the form of phosphate from the MV Tycoon was not available or not able to be readily utilised by the algae. Further monitoring of algae outbreaks is required, and determining the composition of phosphate that was on the MV Tycoon will help to understand and predict the likely impacts.

There were no noticeable changes in butterflyfish and angelfish populations on the western side of the Cove two weeks after the MV Tycoon ran aground. This is not surprising given there were no noticeable changes in the resources they rely on (corals and algae, respectively). However, fish populations could have decreased if they were directly affected by the hydrocarbons and phosphate. But there was no evidence of this at the survey site because fish abundances remained similar to pre-impact surveys. Fish could potentially move to avoid pollutants; however, there was no mortality or changes in abundance observed in benthic organisms (e.g. corals, anemones) or fishes with high site fidelity (e.g. anemonefishes). This indicates that exposure to pollutants at the western side of

the Cove was not sufficient to cause immediate death in the study fishes. Mortality rates are unknown for fishes present at Christmas Island that were not part of this study (> 500 species). In addition, it is unknown whether the study fishes have suffered sub-lethal effects, accumulated toxins or will die in the future as a result of this impact. Further monitoring and ecotoxicology studies are required to determine these impacts. Ecotoxicology studies have not yet been performed and should be considered a priority, particularly to determine whether species targeted for seafood are fit for human consumption.

Based on the surveys on the western side of the Cove and observations made by other people along the Cove shoreline, there appears to be a lack of evidence indicating that significant mortality has occurred to coral reef organisms in the two weeks following the grounding of the MV Tycoon. It is still possible that significant mortality has occurred but has gone undetected because organisms did not wash ashore (e.g. species that are negatively buoyant or do not have swim bladder) or have not been monitored. Also the worst affected areas (east of jetty) and habitats (shallows and intertidal) are yet to be surveyed. Furthermore, the impacts on populations may not be visible until into the future when delayed mortality and sub-lethal effects take their toll. Finally, the ongoing leaking of pollutants into the surrounding waters (evidenced by the photograph on the first page of the report taken on the 27th of January) means that immediate mortality is likely to occur in the future to those organisms that face continued exposure.

Limitations

At best, this report provides a preliminary indication of the effects of the MV Tycoon. This study only examined population level impacts at 5 and 20 m depth, and the majority of monitoring sites were not surveyed (due to bad weather). An adequate assessment of the impacts of the MV Tycoon on the coral reef environment of Christmas Island would require a more comprehensive monitoring program.

Recommendations

The overarching recommendation is for a more thorough assessment of the impacts of the MV Tycoon on the coral reef environment. For an impact study of the Island's coral reef environment to be considered adequate it would need to include the following:

- Completing the initial impact assessment at all monitoring sites, particularly areas (east side of Flyingfish Cove, Rocky Point) and habitats (shallows < 5 m and intertidal) likely to be have received the greatest impact.
- Ongoing monitoring of populations of key groups (including those assessed in this report) to quantify delayed mortality and sub-lethal effects (e.g. 2 weeks, 2 months, 6 months and 12 months).
- Ecotoxicology of key species, such as: habitat forming species (e.g. corals); ecologically important species (e.g. urchins); target species (e.g. fish and crayfish). Testing whether seafood in the Cove is fit for human consumption should be a priority.
- Ecotoxicology of key habitats, e.g. water, sediment, reef matrix, to determine ongoing impacts and how recovery will be affected.

While this study focuses on coral reefs, investigation of other important groups (e.g. crabs and seabirds) that are affected by impacts in the marine environment should also be undertaken.