

Impacts of gold mine waste disposal on the sustainability of deep slope fish communities in a pristine tropical oceanic system

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Introduction

An open cut gold mine has operated since 1997 on Niolam Island, one of four volcanic sea mountains (referred to as the Lihir Island group) situated in Papua New Guinea's New Ireland Province. Two types of waste are disposed into the marine environment: (i) the excavated overburden dumped into deep near-shore ravines and (ii) discharge of heavy metals in the tailings slurry down the deep slopes via a pipeline at 128 m depth. However, very little quantitative information was known of the direct impact of this waste disposal on the deep slope fish communities. Furthermore, these deep slope fishes are an important marine resource for the artisanal fishery and their life history characteristics (slow growing, long-lived species with low natural mortalities) make them unlikely to sustain any significant mortalities from mine impacts or increased exploitation. As part of a larger project, the aims of this study were to assess the direct impacts from the mine waste disposal on the abundance of deep slope fish communities and to assess their vulnerability to anthropogenic mortality including mine impacts and fishery pressure.



Excavated mine overburden being disposed of into deep near-shore ravines off Niolam Island.



Local fisherman targeting deep slope fishes near-shore of Niolam Island.

Methods

A three-year dropline survey commenced in 1999 with sampling stratified by year (1999, 2000, 2002), depth (20-50 m, 51-120 m, 121-200 m, 201-350 m) and regions dictated by a spatial model (adjacent to the mine site, neighbouring regions north and south of the mine site and distant from the mine). Mine impacts were measured by comparing the probability of catching deep slope fish and comparing catch rates of total fish and individual species between regions using a General Linear Model (S-Plus). Biological data were also collected on the age and growth of these deep slope fishes in order to undertake an assessment of their population status.

Dropline sampling of deep slope fishes around the Lihir Island group.

Lihir Environment vessel undertaking deep slope dropline survey.



Results

Catch and biological data on 975 fish from 98 species were collected from a total of 458 stations fished during this study. The majority of species were from the families; Lutjanidae, Serranidae, Carangidae and Lethrinidae and made up 93% of the catch by weight. The probability of catching deep slope fish, and the total numbers of fish caught was significantly lower at sites adjacent to the mine than the neighbouring regions to the north and south of the mine; with the highest probability in regions distant from the mine. Nine of the 17 most common species had lowest catch rates at sites adjacent to the mine, while three species had highest catch rates adjacent to the mine. Only one species had highest catch rates in the neighbouring region to the north of the mine site, while four species showed no difference between sites (Fig 1). Species with highest catch rates adjacent to the mine included the trevally, *Caranx tille*, and the snappers, *Lutjanus argentimaculatus* and *L. timorensis*. These species tend to be reef associated for the sizes caught during this study, but appear to prefer the habitat provided by the more turbid waters near the mine. Two of the species with lowest catch rates adjacent to the mine (Comet grouper, *Epinephelus morrhua* and Goldband snapper, *Pristipomoides multidens*) had highest catch rates in the partially affected area to the north of the mine. Like most deep slope fishes,

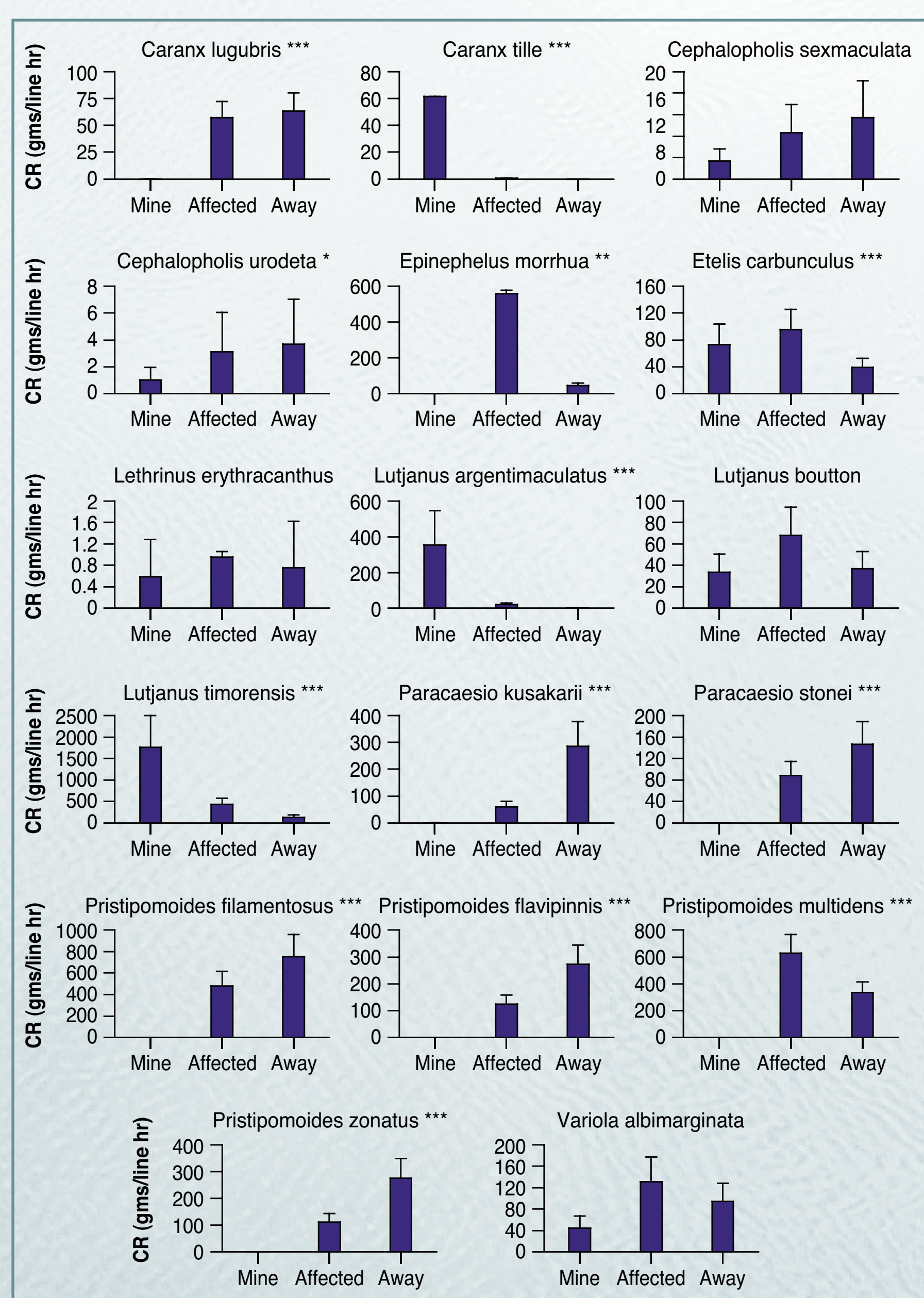


Figure 1. Catch rates ± 1 s.e. (gms/line hr) for the common deep slope species analysed using regions assigned by the spatial model. Statistically significant differences in catch rates are indicated by * ($p < 0.05$), ** ($p < 0.01$), *** ($p < 0.001$).



Preparing to process catch from the deep slope dropline survey.

the species around the Lihir Island group are also long lived and relatively slow growing, reaching at least 35 years. However catch rates were low; 1.383 ± 0.157 kg/line hr. Total biomass of deep slope fishes around the islands was estimated at 17.5 metric tonnes.

Conclusions

The direct impacts of mine waste disposal on the deep slope fish communities appear to be relatively localised. Total fish catches and mean catch rates of most species were significantly lower at sites closest to the mine waste disposal area and either not significantly different between neighbouring and distant regions or higher, in some cases several orders of magnitude, in the region adjacent to the mine (north and south). The reduced abundances of deep slope species around the mine site may be caused by deep slope habitat destruction, elevated turbidity levels or pollution from toxic tailings. However, it is unlikely that the reduced abundances were caused by the latter as several species showed preference for this disturbed region.

Overall catch rates were low compared to commercial and exploratory survey catches in other tropical Pacific areas, including elsewhere in PNG. The local people of the Lihir Island group also utilise the deep slope fishes to supplement their diet. As the human population on these islands is steadily growing due to mining operations, there is increasing fishing pressure on these resources. Given their already low biomasses and vulnerable life history characteristics coupled with the limited deep slope habitats and relative isolation of the Lihir Island group, these deep slope species would be highly susceptible to both mine and increased fishing impacts. Moreover, once these populations are adversely impacted they are unlikely to recover for many years. This highlights the need to also incorporate indirect mine impacts in future assessments and predictions of mine impacts on the deep slope fish populations.



Species commonly caught in the deep slope dropline survey; *Etelis carbunculus*, *E. coruscans*, *Lutjanus timorensis* and *L. argentimaculatus* (Lutjanidae).



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