

CHAPTER 7: HYPOTHESIS TESTING

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Introduction

Some specific issues arose during the EIS process which were amenable to relatively short-term studies. It was recommended that some of these projects be conducted as post-graduate research studies. Barrier Reef Holdings offered logistical and financial support to carry out the projects.

Two other studies were not suitable as post-graduate projects. The actual dispersal of the brine plume was monitored on a contractual basis during the operations of the floating hotel, while a study on the effects of increased recreational fishing on fish stocks of John Brewer and adjacent reefs was intended to be carried out by a log-book scheme which did not eventuate due to the closure of the hotel.

The effects of bird droppings on lagoonal water quality

The floating hotel and associated structures provided additional roosting areas for a number of birds which, in turn, might have led to the localised enrichment of lagoon waters by their droppings, particularly in respect of phosphates and nitrates. On sand cays in the Great Barrier Reef, bird droppings may lead to enriched nutrient groundwater outflows which, in turn, may lead to narrow zones of enhanced algal growth (particularly of the green alga *Enteromorpha flexuosa*).

The objectives of this project were:

- to assess the level of bird usage and droppings on surfaces of the floating hotel and associated structures;
- to determine the level of nutrient leaching from such surfaces;
- to assess the likelihood and level of enrichment of lagoonal waters around the floating hotel and associated structures as a result of leaching of bird droppings; and
- to determine the effect of any such enrichment on the growth of fouling and other associated organisms around such structures.

It was found (M. Howland, unpubl. report) that the presence of the resort and associated structures led to a slight increase (approximately 5%) in the number of birds although the data in Figure 7.1 suggests this may have been due to seasonal variation. A longer time span would be required to identify real trends in bird numbers. Seabirds were generally limited to the pontoons situated around the resort.

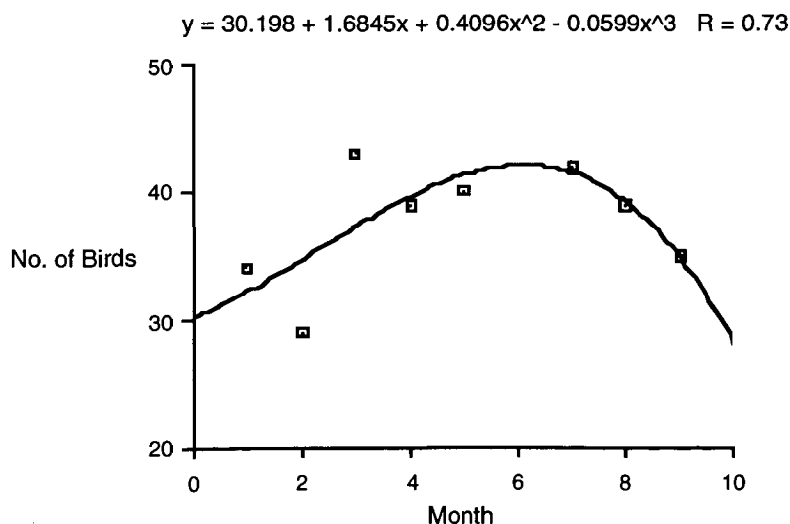


Figure 7.1. Average bird numbers from June 1988 - February 1989

Wastes produced by these birds equated to around 240 kg of faecal material entering the lagoonal waters or accumulating on roosting surfaces annually. The average nutrient (Nitrogen and Phosphorus) concentrations of this material are 13% Nitrogen and 2.8% Phosphorus (by weight) respectively. Given the volume of the John Brewer lagoon to be approximately $7 \times 10^7 \text{ m}^3$ at mid tide and flushing rates in the order of 80% every five days (Parnell, 1986), the calculated average nutrient increase in the lagoonal waters were around 1.2×10^{-6} ppb Phosphorus and 5×10^{-6} ppb Nitrogen respectively, which was far below the natural variability of these parameters and below any detectable limit either analytically or biologically.

The accumulation of bird droppings on pontoon surfaces necessitated regular cleaning (usually by pressure hose) for aesthetic and health reasons. To ensure the best possible dilution and removal of the faecal material (washed directly into the lagoon), cleaning during ebbing spring tides was recommended.

Seabirds were noted only to frequent pontoons which were not regularly used by the resort, hence the regular use of these pontoons (as was done with the watersports pontoons) with the possible repositioning nearer the resort itself may have alleviated potential problems. The exception to this was the helipad which often had up to 200 terns roosting there despite regular usage, leading to the danger of collisions between helicopters and birds. Resort staff found a workable bird deterrent by the use of small plastic cachets containing mothballs placed around the pontoons. This method appeared both cheap and effective.

On the basis of this study, it would appear that the positioning of the resort within the lagoon at John Brewer Reef had no adverse effects on water quality by increasing bird usage of the area. Some minor operational problems existed, but these were overcome by the use of bird deterrents and sensible cleaning practices.

The effects of light and shading on pelagic organisms

Lights under the water or shining directly onto the water surface can attract fish and squid. Planktivorous fish such as antherinids and clupeids are not noticeably affected but when schools of these species aggregate, other species such as garfish (hemirhamphids), longtoms (belonids) and squid usually appear, either as a direct result of the light or in response to the schools of baitfish. Such artificial aggregations of fish as a result of lighting and the subsequent arrival of predators, can alter the predator-prey relationship that exists between these groups of species.

The objectives of the study were:

- a. to assess the extent to which the prey and predator species may be affected by lighting, particularly in relation to their attraction to light;
- b. to assess the extent to which prey species may be affected by lighting, particularly in relation to increased predation; and
- c. to compare the composition of such light-induced aggregations with similar aggregations in the absence of light.

The study compared the fish community structure under the resort and from five control patch reefs, between June and November 1988 (K. Weaver, unpubl. report). Data were analysed at the family level using multi-variate techniques. The resort appeared to act as an aggregation device for many species, with species richness greater under the resort than in equivalent sized control sites. In addition, a number of species were present at the resort but not at control sites.

A major factor appeared to be the substrate type under the resort, which provided additional habitat favourable to territorial fish. The differences between the sites were considered to be attributable to differences in the nature of the substrate, rather than to any differences in lighting caused by shading by the resort structure.

The effects of underwater noise on fish populations

The EIS identified underwater noise and vibrations as having a potential to affect a number of reefal organisms, particularly fish.

The objectives of this section of the study were:

- a. to assess the effect of constant and periodic underwater noise and vibration on reefal organisms, particularly fish;
- b. to determine the extent to which these organisms can accommodate such noise levels; and
- c. to determine the extent to which any noise-induced avoidance behaviour is counteracted by regular feeding activities.

Recordings of underwater noise were made at 50 sites within the sphere of influence of the resort-generated noise, and up to 1 km from the reef (R. McCauley, unpubl. report). No assessment of the effect of noise on fish numbers was possible as the fact that fish were attracted by daily fish-feeding (generally associated with propeller noise) seemed to counteract any tendency towards their possible avoidance of noise.

Dispersal of the brine plume

Performance characteristics of the desalination plant indicated that the salt concentrations in the left-over brine would be increased from approximately 3.5% to 4.7% (van Woesik et al, 1989). With constant operation, this resulted in a 225 m³/day discharge of 4.7% brine solution. In addition to increased salt levels, the brine effluent would contain organic flocculants and anti-scalants at low concentrations. It was predicted that the brine plume was not likely to extend for more than a few metres from the point of discharge (Parnell, 1986) and the teleost fish were likely to avoid this particular area. The extent and dispersion characteristics of the brine plume were established on the basis of fluorescent dye studies in March and April 1989.

The objectives of this section of the study were:

- a. to validate the actual extent and dispersion characteristics of the brine plume; and
- b. to investigate the possible effects of its constituents (e.g. high salt concentration, flocculants and anti-scalants) on a range of selected organisms.

The results of the study indicated that only small increases in salinity were initially detected within 12 m of the outfall, and dispersion and advection of the brine was relatively rapid. An advection axis of approximately 320 degrees was observed during the prevailing SE winds, and above ambient salinities were very small along the advection axis. Increases in salinity above ambient of more than 0.001 ppt were unlikely for extended periods and there was no evidence that the brine solution accumulated on or near the floor of the lagoon.

The first coral community to be under the influence of the brine was a small aggregation of corals, rising from the bottom of the sandy lagoon to approximately low water level approximately 100 m east of the resort. The above ambient salinities were very low and, on the basis of experimental studies, these concentrations are not stressful to corals.