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COMBINING EDUCATION AND SCIENCE OUTCOMES: THE MARINE STUDIES PROGRAMME AND TUHUA MARINE RESERVE MONITORING

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ABSTRACT

Tūhua (Mayor Island) lies 35 kilometres off shore in the Bay of Plenty, New Zealand. It has a long history of Māori occupation and is of high cultural significance to these traditional owners. Tūhua was once world-renowned for big game fishing, but after incremental declines in local fish populations, in 1993 a no-take marine reserve was gazetted and has been the subject of annual marine monitoring surveys since that time. Continued monitoring has only been possible because of the creation of an innovative science/education partnership between the Tūhua Trust Board, representing the indigenous Māori owners of the island, the Department of Conservation (DOC), responsible for managing the reserve, and the Marine Studies Department of Bay of Plenty Polytechnic (BOPP). The Polytechnic's Marine Studies course is a successful undergraduate diploma/degree education programme, combining strong practical elements with academic rigour. Second year Marine Studies students and staff members undertake the marine monitoring surveys at Tūhua on an annual extended field trip. Managers expected the marine reserve would demonstrate growth in fish numbers in comparison to the adjacent less protected areas. However little change in key indicator species was apparent after ten years of protection and this precipitated a review of the methodology and marine management policies. Twenty years after protection, there are now clear differences. Interwoven with this hard science discourse are the perceptions of the students involved in the annual monitoring programme. On the extended monitoring field trip, the students and staff members live on the island for ten days in basic conditions and are immersed in a natural learning environment. Results of a series of questionnaires suggest that the students involved increase not only their skill sets but also have increased self-confidence, motivation and conservation awareness. Science and education outcomes have been successfully combined into a readily transferable model over twenty years at this ecologically and culturally significant island location.

INTRODUCTION

The waters around Tūhua (Mayor Island), our remote study site in north-eastern New Zealand, were once internationally renowned for diving and big game fishing (Prebble, 1971). However, over time harvesting severely depleted fish stocks (Jones and Garrick, 1991), prompting the establishment of two management areas: a no-take marine reserve and a complementary partially protected management area about the island.

No-take marine reserves are increasingly being adopted to protect and restore marine biodiversity (Babcock et al., 2010; Claudet and Franchetti, 2010; Halpern, Lester, and Kellner, 2009; Lester et al., 2009; Meyers and Worm, 2005; Russ and Alcalá, 2004). The efficacy of such reserves relies heavily on the degree to which extractive fishing is controlled within them (Byers and Noonburg, 2007; Denny and Babcock, 2004; Fenberg et al., 2012; Kritzer, 2004; Russ et al., 2008; Shears & Usmar, 2006).

Successful marine reserve management is also dependent on regular reporting of monitoring results and in remote marine reserves this is often a resource heavy undertaking. At Tūhua, an ambitious annual marine reserve monitoring programme has been achieved for over twenty years. This has been possible through a value-equal partnership between the Department of Conservation (DOC) who are charged with monitoring the reserve, the Tūhua Trust Board who represent the indigenous Māori owners and the Marine Studies Department of Bay of

Plenty Polytechnic, a locally based tertiary education provider. Trained second year Marine Studies students undertake the reserve monitoring for DOC at Tūhua during one of their extended field trips.

Bay of Plenty Polytechnic's Marine Studies programme is a very successful course of study that has been running for over twenty years in the coastal city of Tauranga, New Zealand. The programme consists of a two-year marine-focused diploma with an option to add an extra year of study to achieve a Bachelor of Science degree. This option attests to the academic rigour of the diploma, but what aspects of the course make the strongest impression on the students?

Informal feedback from graduates suggests that from their perspectives some of the essential ingredients of the programme appear to be related to experiential learning on extended field trips in both years one and two of their three year degree. These intensive field trips last for up to two weeks, revolve around scuba diving and entail working together to collect marine-related information. The inclusion of these field trips is a clear point of difference from the more conventional university models of undergraduate study in New Zealand, in which field trips are typically to local sites and of short duration.

The Tūhua Marine Studies extended field trip discussed here can last for between seven and ten days, involves a degree of isolation from home and disruption to familiar routines, challenges the students in many ways and is subject to the vagaries of weather. Often logistical pressures are considerable and preparation extensive, teamwork and peer group trust is paramount, and individuals experience highs and lows over the course of the trips. As stated by Black Mountain Expeditions, 2009 (in D'Amato and Krasny, 2011) "Suspending the normal reality for students by transporting them away from their daily comforts opens the doors for transformative learning to occur". A series of questionnaires sought to investigate the effects on the students involved.

Although the marine reserve was established in 1993, annual monitoring of size and abundance of key reef fish revealed that only small change within the no-take reserve and marginal difference in biological parameters between management areas had occurred (Shears and Usmar, 2006; Young et al., 2006). One explanation was that fishing pressure was continuing within the reserve despite its status as a no-take reserve (Shears and Usmar, 2006; Young et al., 2006). In an attempt to counter this, active enforcement of compliance with fisheries regulations was introduced in 2008. This has been implemented through a range of measures which are underwritten by a firm commitment by management to support an increased staff presence in the reserve.

This paper details both science and education outcomes from the long term annual marine monitoring at Tūhua which are achieved through a collaborative partnership model which we believe is successful and transferable. We quantify some of the benefits gained during the period of active enforcement of reserve regulations for the recovery of a previously exploited fish species, Snapper, in the no-take marine reserve. We also outline some outcomes for the student surveyors who undertake the annual surveys in terms of personal and professional development. Interestingly linkages are also established between student involvement in marine reserve monitoring and their subsequent motivation to both share and act on conservation messages. We detail how the Tūhua monitoring partnership has made a positive difference at an individual, institutional and community level, including increasing understanding of marine environmental rebound following human induced depletions.

METHODS

The marine monitoring methods reported in this paper and incremental changes to the methodology since the establishment of the Tūhua Marine Reserve and partially protected area (Fig. 1) are outlined in detail in Young et al. (2006), Morrison and Gregor (2012) and Gregor (2013). The figures presented are drawn from Gregor et al. (in revision), Morrison and Gregor (2012) and Gregor (2013).

Essentially for the marine surveying results reported here, the study area was stratified by management area and into 0–10 and 10–20 depth bands. Ninety-nine locations were randomly selected and annual underwater visual census (UVC) was undertaken to record the mean number of fish per transect. Transects were 50 m long with a half cylinder of 5 m radius above and on either side of the divers. Acknowledging that UVCs may be affected by the reaction of fish to the presence of divers, baited underwater video (BUV) was also employed (Morrison and Gregor, 2012) to support and extend the UVC results.

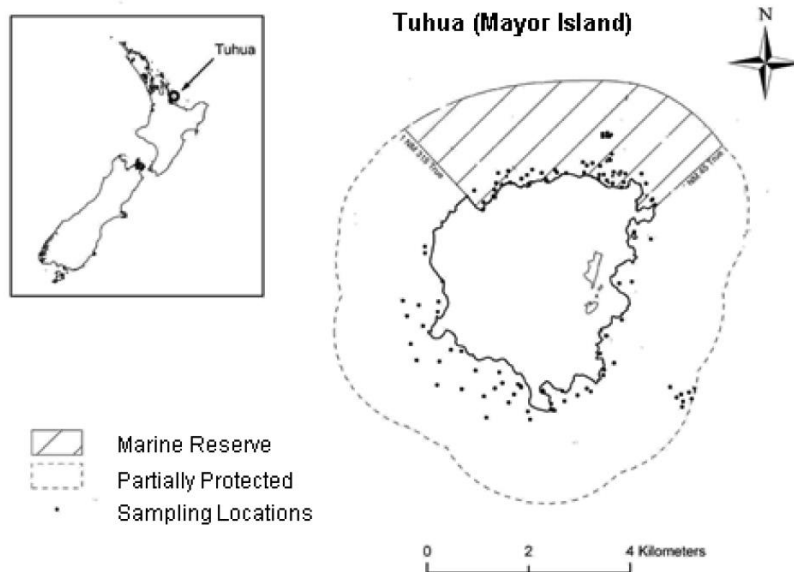


Fig. 1. Study area. Tuhua Marine environs, showing the no-take Tūhua Marine Reserve and the partially protected management area where some harvesting is allowed. The black dots represent sampling locations for the no-take marine reserve ($n = 38$) and for the partially protected management area ($n = 53$).

The study of the perspectives of staff and student surveyors involved in the collection of the marine survey data employs a qualitative interpretivist approach (D’Amato and Kransy, 2011) and uses a mix of both quantitative and qualitative data capture to explore this adventure-based experiential learning model. The aim was to understand how the programme worked from the perceptions of participants who had experienced it and recognise the “value and real meaning of these personal experiences” (Martin and Leberman, 2005). The survey instruments were a series of questionnaires that were developed specifically for exploring student perceptions of the Marine Studies extended field trips. Questionnaires were offered to students in year two of their study in 2012 and 2013. They were asked approximately thirty questions on a range of aspects relating to the extended field trips in which they had taken part, of which Tūhua was one. Total sample size for 2012 and 2013 combined was 83 respondents, which equated to 80 percent of the total possible respondents of those two year groups.

RESULTS

Monitoring results presented here focus on a key predatory species, snapper. In 2004, Baited Underwater Video (BUV) indicated no significant difference in snapper abundance between the marine reserve and partially protected management area. In 2008 enforcement of compliance with fisheries regulations was enhanced (passive changed to active compliance). Three years later, in 2011, of the 120 snapper recorded by BUV, 89 were in the no-take marine reserve and 31 inside the partially protected management area (Fig. 2). This reflected twelve times more snapper than were recorded in the reserve in 2004. Differences in snapper abundance between the two management regimes were statistically significant ($P = 0.0004$) in 2011. This backed up the results of UVC surveys and lent credence to the decision to enforce compliance with regulations in the no-take reserve.

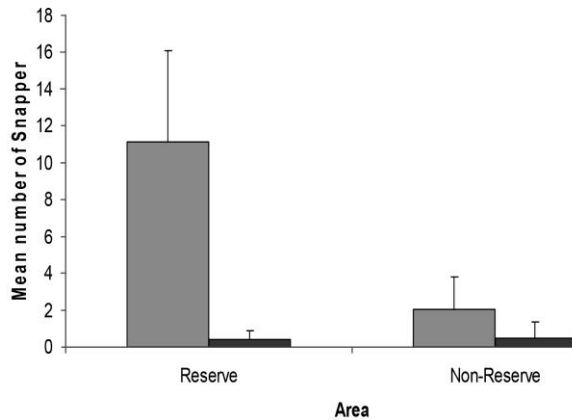


Fig. 2. Mean number of snapper inside and outside Tūhua Marine Reserve Recorded from 23 BUV drops in April 2011 and March 2004 (Morrison and Gregor, 2012). Error bars are the 95% confidence interval of the mean.

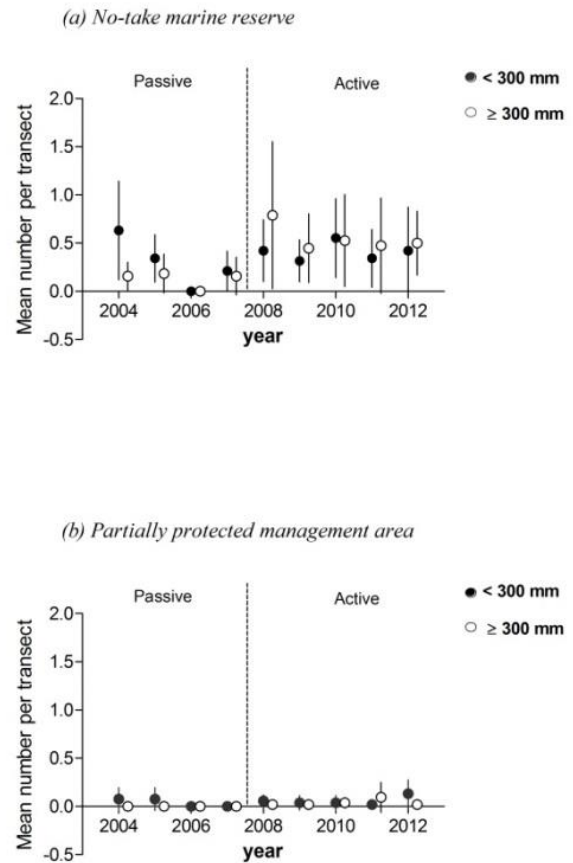


Fig. 3. Changes in yearly mean number over time of snapper < 300 mm (black circles) and snapper \geq 300 mm (open circles) in (a) the no-take marine reserve, and (b) the partially protected management zone. Error bars are the 95% confidence interval of the mean. (Gregor et al., in revision).

When examining the data in more detail over time, there were clear differences between management areas with active compliance from 2008. However mean number of snapper < 300 mm and legal-sized snapper did not continue to increase in the active compliance enforcement period in the no-take marine reserve as had been expected (snapper <300 mm $R^2 = 0.002$, $P = 0.91$; legal-sized snapper $R^2 = 0.40$, $P = 0.25$) (Fig. 3). Rather, after an initial increase in mean number immediately following active compliance enforcement, numbers of snapper <300 mm and of legal-sized snapper appeared to stabilise.

A short selection of results from the broad-ranging student questionnaires on extended field trips are presented here, of which Tūhua is one. When asked about the relevance of the extended field trips to their course of study, 100% of respondents said they were relevant. Of these 75% considered them very relevant (Fig. 4).

When asked to comment on aspects of the trips that had inspired or challenged them, students stated they were inspired by a wide range of features of the field trips (Fig. 5). Personal development and personal achievement rated very highly followed by aspects of the environment and marine life.

A large proportion of the respondents perceived that the field trips had played a positive role in motivating them to act on and share the marine conservation message (Fig. 6). Motivation to act had either been increased or greatly increased by the field trips for 73% of respondents and 84% said their motivation to share the conservation message had either been increased or greatly increased by the field trips.

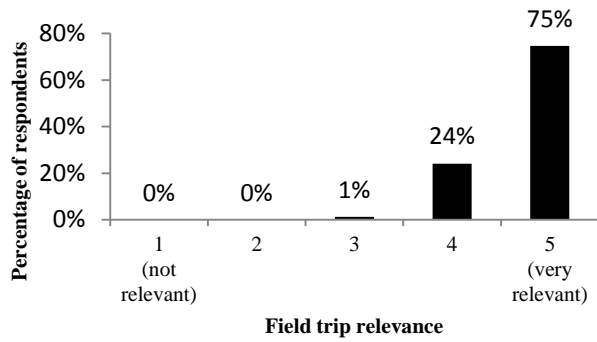


Fig. 4. Relevance of the extended field trips to the course of study (n=83).

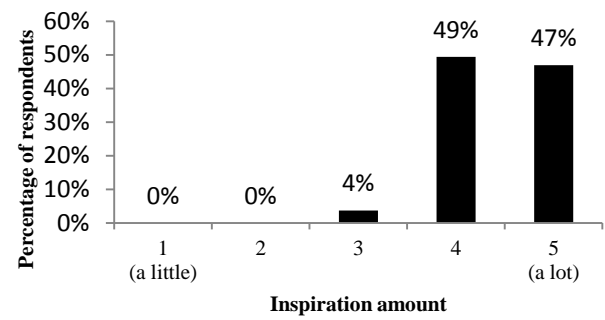


Fig. 5. Amount of inspiration that respondents felt over the course of the field trip (n=81).

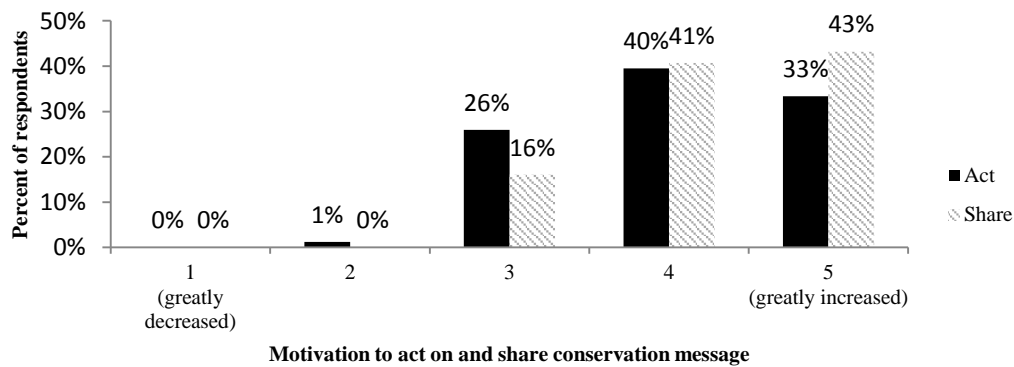


Fig. 6. Field trips effect on respondents' motivation to act on and share the marine conservation message (n=81).

DISCUSSION

This paper intertwines two major themes. The primary theme is the science of marine reserve monitoring at Tūhua, while the secondary theme examines the educational and personal outcomes of extended field trips for the students who undertake the monitoring. This paper has outlined a small number of the key result areas of this twenty year research partnership and strived to highlight the value of partnerships and working together through presentation of these indicative results.

The abundance of the key predatory species, snapper, appears to have increased in the marine reserve following the change to active compliance enforcement. However inter-annual variability remains high and the response trajectory has not continued to increase as expected. The marine reserve monitoring over the last twenty years has provided significant challenges in terms of understanding the ecological processes involved and this is by no means complete. Obtaining this detailed picture of species recovery in the marine reserve has only been possible through the support and hard work of the students and staff members of the Bay of Plenty Polytechnic with the assistance of the Department of Conservation and the Tūhua Trust Board. This unique science and education partnership has stood the test of time and achieved significant gains in terms of advancing understanding of the marine environment as outlined in the results.

Empirical evidence has driven management decisions and precipitated bold moves to support understanding of underlying processes involved with rebound in species assemblages at Tūhua. The effective feedback loop between evidence and management action has worked well and provides a useful template for other marine protected areas. Knowledge of the development of the marine reserve has been promulgated throughout the science and general community through publications, workshops and public presentations of results.

The students involved in the monitoring at Tūhua have also gained considerable benefit from their participation in the partnership. They have increased their knowledge and skills and gained self-confidence and motivation. They have been immersed in spectacular environments with skilled and experienced staff members and have had the opportunity to challenge themselves in a model of learning that is founded on outdoor and adventure experiential learning. This model also draws on aspects of environmental education and students return

to the mainland from these extended trips with greater environmental knowledge and conservation awareness. They also have enhanced motivation to share and act on marine conservation messages.

The Tūhua project has had widespread and positive effects on the students and staff members involved. The partners all support a future that involves continuity of the annual monitoring to address some of the outstanding ecological questions. These are being incrementally worked through to improve understanding of the Tūhua Marine Reserve and ultimately the wider marine environment.

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