MANAGAHA MARINE CONSERVATION AREA ANNUAL REPORT

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INTRODUCTION

The usefulness of protected area designation for Commonwealth of the Northern Mariana Islands (CNMI) Marine Sanctuaries is being addressed through annual or semi-annual surveys in the CNMI's no-take Marine Sanctuaries. The Managaha Marine Conservation Area (MMCA) comprises the largest no-take Marine Sanctuary in the CNMI. Having been established in 2000, the primary comparative survey data collected annually has been directed towards food fish groups that comprise the majority of reef fish harvested in near shore waters. In addition to the designation of no-take Marine Sanctuaries in the CNMI to enhance finfish resources, other regulatory protections have been enacted in recent years, including a December 2003 restriction on the use of gill, drag, and surround nets, as well as a ban on the use of scuba-spear fishing throughout the entire CNMI in 2003. The evaluation of the MMCA has been conducted on an annual basis through time, comparing years via a time series trend. In 2005 samples were also obtained from similar habitats outside of the MMCA to further assess its effectiveness as a no-take zone.

METHODS

The methodologies employed in the annual MMCA included 25 by 5 meter belt transects, as well as 10-meter diameter stationary point counts (SPC) to assess fish abundance and size frequency. Belt transects have been collected since 2000, while the SPC have been collected since 2004. Both methods are visually sensitive and are therefore conducted diurnally.

Belt transects (BT) were laid down in a random fashion following boat anchoring in a stratum. For each snorkel or dive a minimum of three transects were conducted in a varying sequential manner. Data from BT included numerical (since 2000) and size category (since 2004) observations. All fish observed while swimming along the BT were identified down to the level of species when possible, and each fish grouped into a size frequency category.

All analyses were conducted at higher taxonomic level categories such as family or subfamily, or by life history stages. Relative population estimation was conducted using a Stratified Random Sampling approach (Cochran 1977).

For year 2000, stratum weights were determined by simple proportional allocation of stratum size:

$$W_h = N_h/N$$

Where W_h is the stratum weight, N_h the stratum size, and N the sum of all strata. In subsequent years, allocation weights were optimally allocated, including stratum size and stratum variance:

$$W_h = \frac{N_h s_h}{\sum N_h s_h}$$

Where s_h is the estimated stratum variance. The sample size per strata was determined from the total sample size and the strata allocation weights:

$$n_k = W_h(n)$$

The unbiased estimate of the population mean was determined by:

$$\bar{y}_{st} = \sum^{L} (W_h) \bar{y}_h$$

The overall unbiased estimate of variance was determined as:

$$\hat{V}(\bar{y}_{st}) = \sum W_h^2 (\frac{s_h^2}{n_h})(\frac{N_h - n_h}{N_h})$$

The unbiased estimate of total population size was then calculated as:

$$\hat{Y} = N(\bar{y}_{st})$$

Bounds on the error of estimation were computed following Cochran (1977):

$$B = \pm 2\sqrt{\hat{V}(\hat{y})}$$

RESULTS

Data from the belt transects are presented in Figures 1-3 below. In Figures 1-3, relative population estimates of 12 food fish groups over time are provided from optimally allocated stratified random sampling, agglomerated from the four primary habitats where transect data has been demonstrated to be useful; the reef slope, lagoon deep patch reef, lagoon shallow patch reef/Acropora zone, and the mixed area (Trianni 1999a; 2003).

Lutjanidae. Relative population estimates of Lutjanidae in Figure 1 illustrate a significant increase in observations in 2007. Transect data indicate that the snappers have increased in relative abundance in the MMCA between the 2005 and 2007 surveys.

Lethrinidae. Relative population estimates of Lethrinidae in Figure 1 indicate a positive trend over time, with significant increases over the past three years. These increases in emperor relative population size are attributable to *Gnathodentex aurolineatus* and *Lethrinus harak* becoming more abundant since the inception of both the scuba-spear and net use prohibitions. Both species were landed in high numbers during the scuba spear fishery (Graham 1994; Trianni

1998), and *L. harak* has comprised as much as 60% of recent exemptions to the net use prohibition (DFW unpub. data). It can be considered that the increase in abundance of *L. harak* was due not only to the MMCA but also to the scuba spear and net use prohibitions as this species travels widely throughout the lagoon, whereas the increase in *G. aurolineatus* can be attributed primarily to the MMCA and the scuba spear ban.

Myripristinae & *Holocentrinae*. Relative population estimates of the subfamilies Myripristinae and Holocentrinae (family Holocentridae) in Figure 1 show a steady increase over time, in particular since 2002.

Mullidae. Relative population estimates of Mullidae from Figure 2 show an overall increase overtime, especially during the last two surveys. These fish are active benthic carnivores that feed in all nearshore habitats. There relative increase over time is most likely due to the net use restrictions.

Balistidae. Relative population estimates of Balistidae from Figure 2 show an overall increase overtime, with a considerable increase during the 2007 survey period.

Serranidae. Relative population estimates of Serranidae from Figure 2 show a high increase during the last survey, following increases in 2004 and 2005, following the low 2002 estimate. The primary source of grouper abundance over time is due to increases in the principal species *Cephalopholus urodeta*.

Nasinae. Relative population estimates of the Nasinae (Figure 2) show periods of high abundance and low abundance. These fish tend to favor continuous hard bottom habitats. The main influence on mean abundance and subsequent population estimates is attributable to various members of the genus *Naso* that tend to form roaming schools, thereby making observation within the confines of 125 meter square belt transect highly variable. The 2007 estimate was slightly greater than the 2005 estimate, although the trend in observations is slightly negative trend over time.

Sedentary Acanthurinae. This group is dominated by *Ctenochaetus striatus*, and *Acanthurus nigrofuscus*. Relative population estimates of this group indicate a significant increase during the past survey period, following increases in 2004 & 2005 (Figure 3). The increase of this group implies an increase in MPA functionality through better enforcement and the lack of harvesting and destructive fishing practices resulting in more undisturbed habitat.

Roving Acanthurinae. This group decreased in 2007 from the previous high years of 2004 & 2005, although the trend was still very positive (Figure 3). The convict tang, *Acanthurus triostegus*, increased dramatically in 2004 & 2005, over the survey period from 2000-2002. A large school of the convict tang that was observed during 2004 was not entirely included in the population estimate. Instead, the mean of all transects in 2004 from the shallow patch reef/Acropora zone, including that school, were used as a proxy for that transect and subsequent analysis in order to mitigate for the substantial variability resulting from that observation.

Initial Phase Scaridae. The relative population estimate of this group increased significantly during the last survey period (Figure 3). This followed the 2000-2005 survey period where mean abundances exhibited a decline from 2000-2002, followed by a slight increase in 2004 and a larger increase in 2005, which was still lower than the 2000 estimate. The continued increase in this group is suggestive of good recruitment years.

Terminal Phase Scaridae. The relative population estimate of this group indicated a significant increase during the last three survey periods, with the 2007 estimate being the highest in the time series (Figure 3). It has been documented from the scuba spear fishery that Terminal Phase Parrotfish are highly vulnerable to fishing pressure (Trianni 1998), and, therefore, the recent increase in these fish indicate an increased functionality of the MMCA, and also direct positive population growth as a result of the scuba spear fishing ban.

The comparison of samples taken from similar habitats within and outside of the MMCA is depicted in Figure 4. There was not a significant distinction between the size frequency structure in samples from within and outside the MMCA. Recruits were observed in more habitats inside the MMCA, and there were higher relative frequencies for smaller sized fish within the MMCA that outside of it. There was not an obvious difference with respect to larger size class fish. Overall numerical differences were significant, however, as t-Tests found more fish within the MMCA in the outer slope ($P = 0.004$) and in the shallow patch ($P < 0.000$) reef habitats. No significant differences were found in the mixed habitat (Figure 5).

DISCUSSION

The MMCA has been successfully surveyed on an annual basis since 2000, with the exception of 2003 when inclement weather and logistical obstacles prevented sampling. In addition, the protracted Section 7 review process of the CNMI DFW 5-year plan (2007-2011) requested by the US Fish and Wildlife Service and carried out by the NOAA NMFS Pacific Islands Regional Office, resulted in the fiscal year 2007 DJ grant not becoming available to charge until March 2007, resulting in the loss of the first half of the 2007 fiscal year. As a result of this delay, all field sampling was delayed by several months, and the MMCA survey that has been historically conducted during the period November thru January, was delayed until June-July 2007.

A total of eleven of the twelve groups analyzed have shown increases in relative abundance over the time series (Figures 1-3). The institution of regular enforcement monitoring began in late 2002, which is believed to be directly attributable to the enhancement of reef fish resources within the MMCA. The institution of the regulatory restrictions on the use of gill, drag and surround nets in 2003 have also enhanced the MMCA and probably the entire lagoon in general, as these methods of harvest were most prevalent in the Saipan Lagoon. In addition, the ban on the use of scuba spear fishing on Saipan in 2003 has also improved the abundance of these food fish groups.

Continued annual surveys in the MMCA, as well as subsequent lagoon-wide surveys will provide a clearer understanding of the long-term influence of Marine Sanctuary designation (enforcement) and regulatory restrictions on certain fishing methods.

LITERATURE CITED

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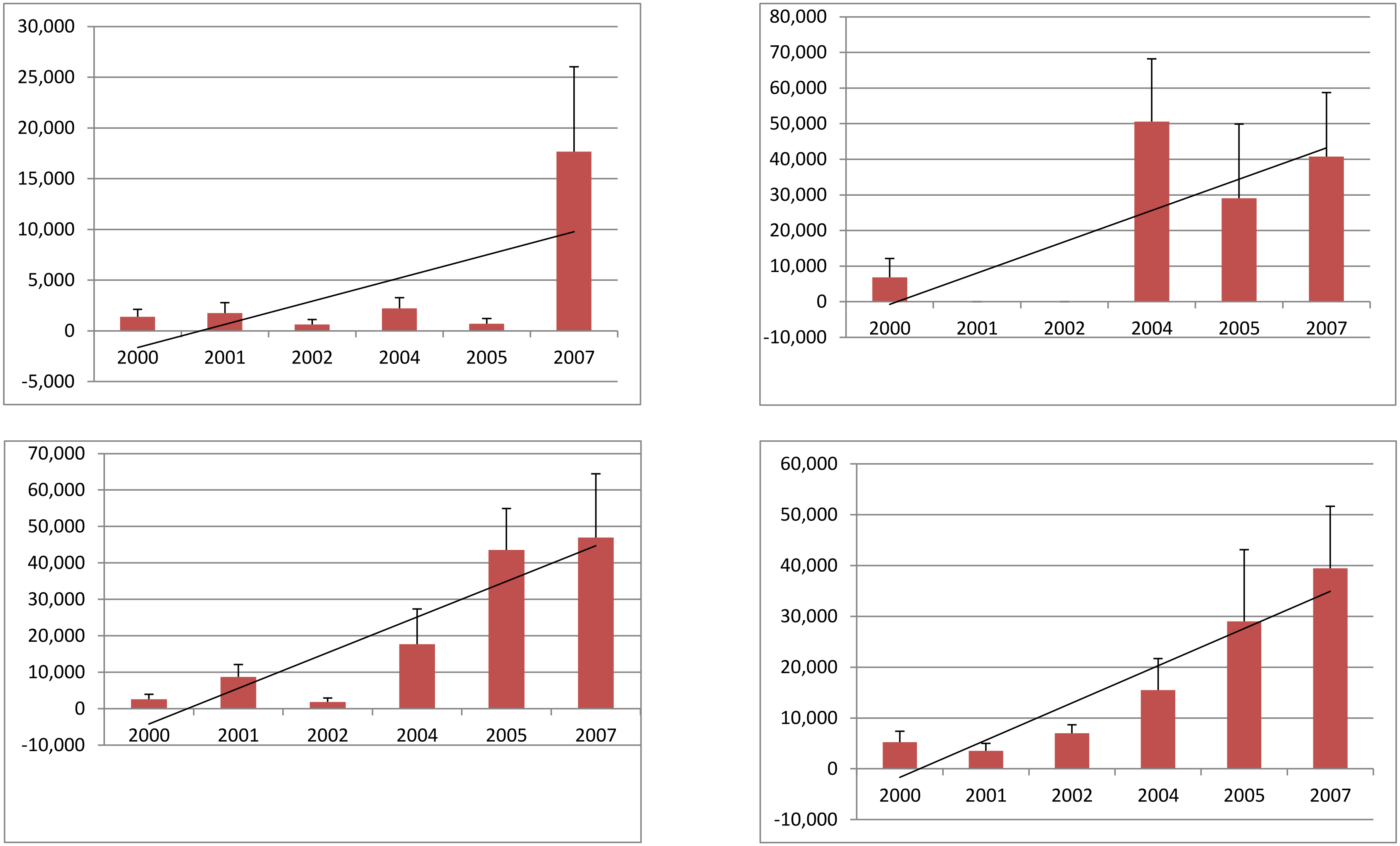

Figure 1. Belt Transect relative population estimates with error bounds derived from stratified random sampling. Clockwise from top left: Lutjanidae; Lethrinidae; Myripristinae; Holocentrinae.

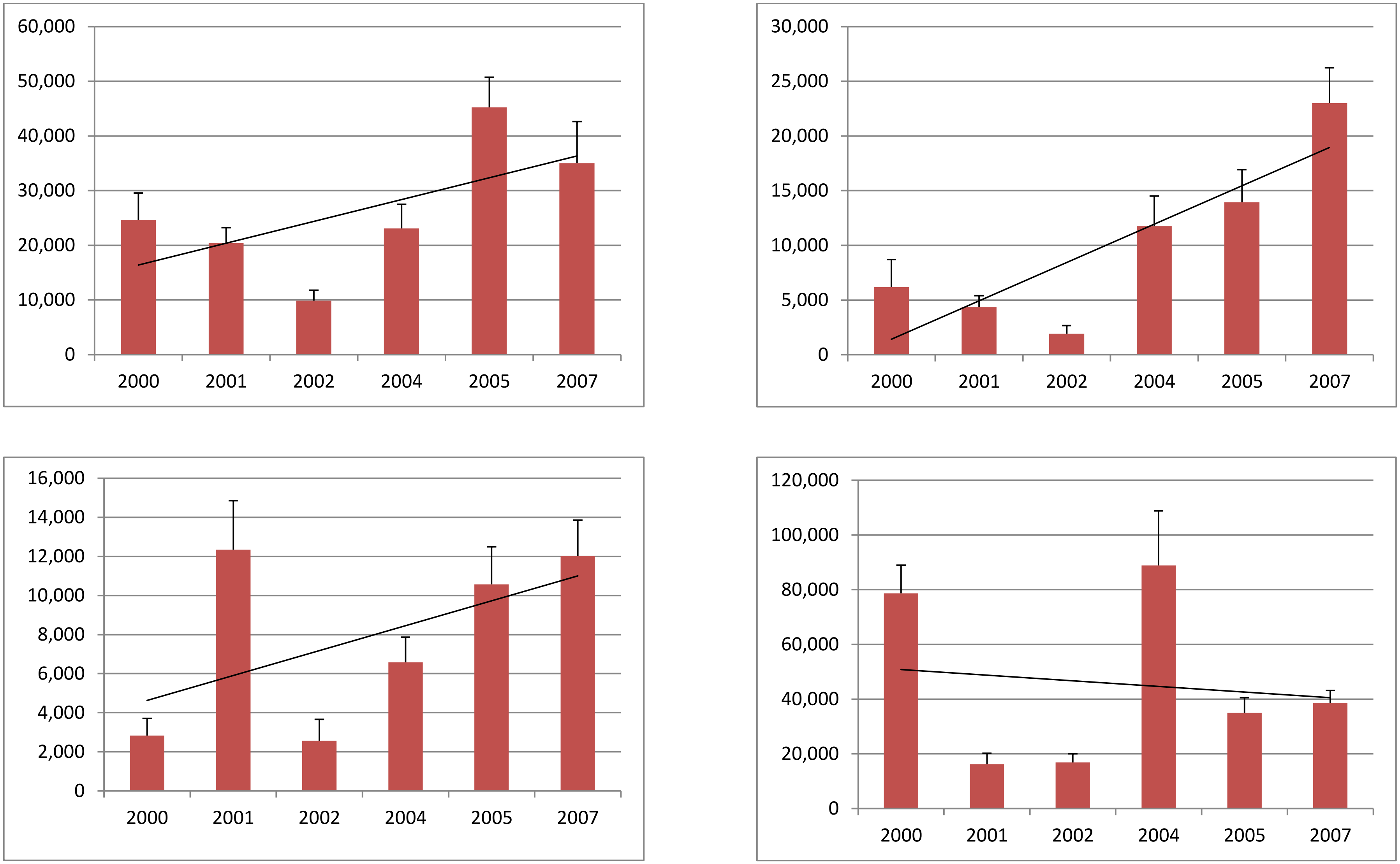

Figure 2. Belt transect relative population estimates with error bounds derived from stratified random sampling. Clockwise from top left: Mullidae; Balistidae; Nasiane; Serranidae

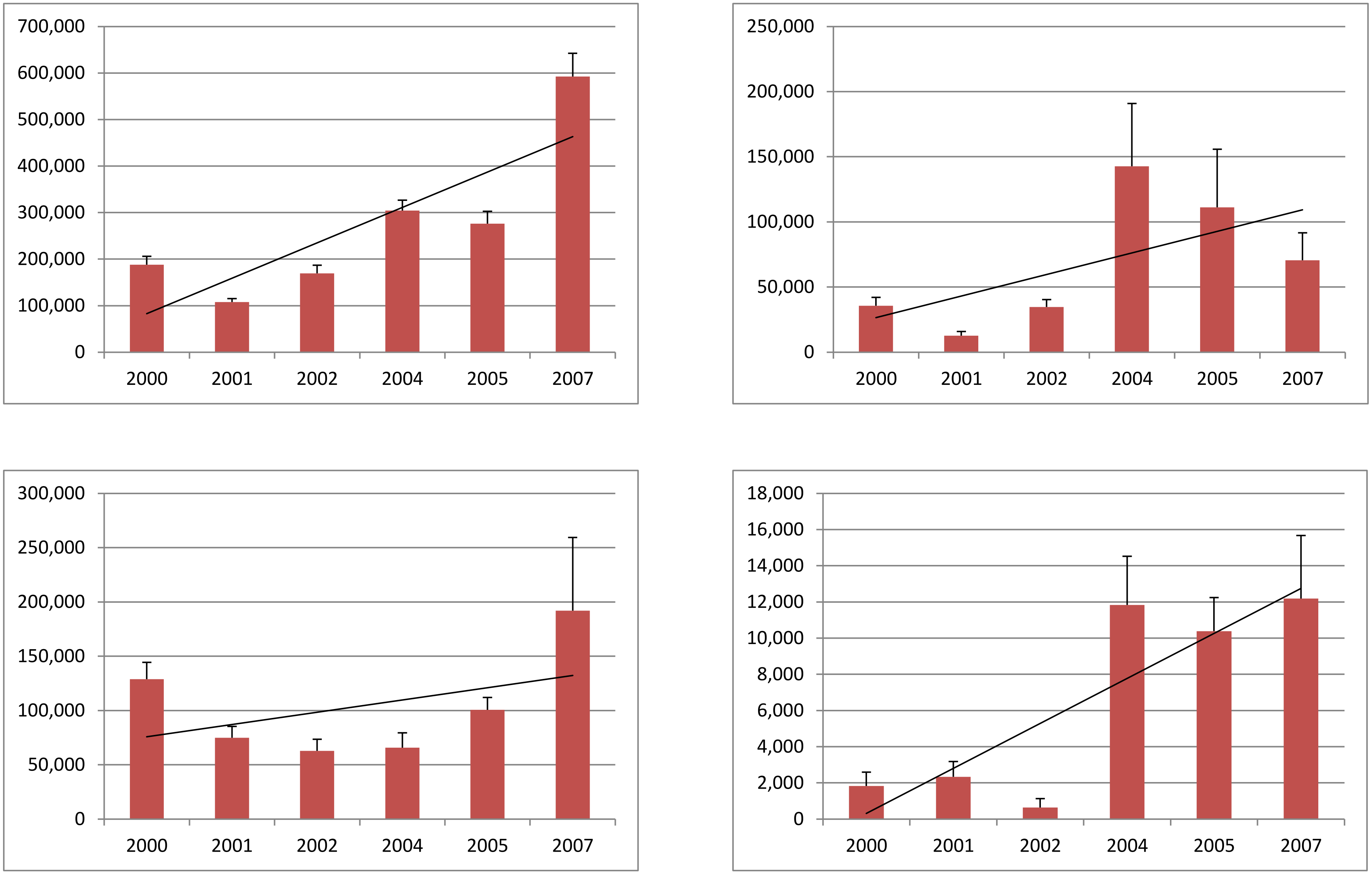

Figure 3. Belt transect relative population estimates with error bounds derived from stratified random sampling. Clockwise from top left: Sedentary Acanturinae; Roving Acanthurinae; Terminal Phase Scaridae; Initial Phase Scaridae.

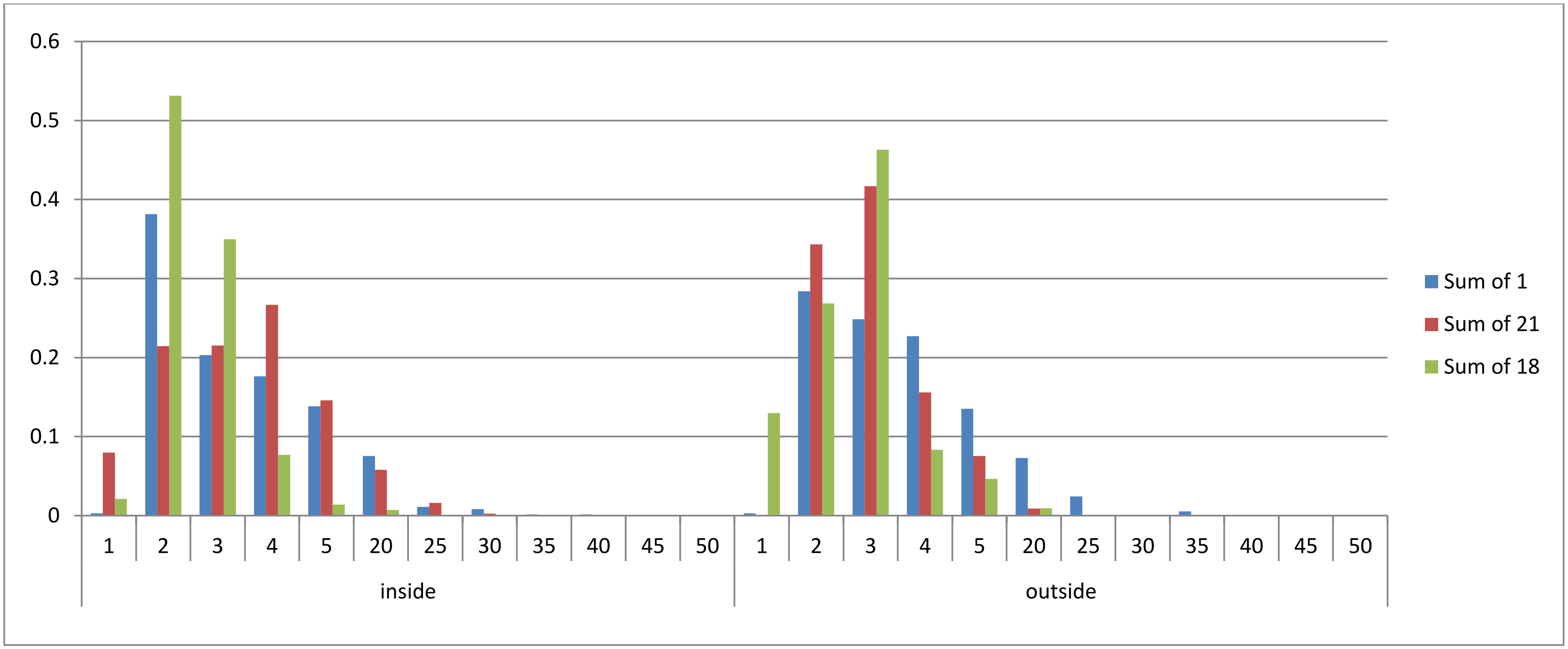

Figure 4. Relative percentages of size categories for reef fish observed from habitat type inside and outside of the MMCA during 2005 survey, for habitat types 1 = outer reef slope, 18 = mixed area, 12 = shallow patch reef/Acropora zone. Size categories: 1 = 1-2 TL cm, 2 = 2-5 TL cm, 3= 5-10 TL cm, 4 = 10-15 TL cm, 5 = 15-20 TL cm, with remaining categories representing actual estimated sizes.

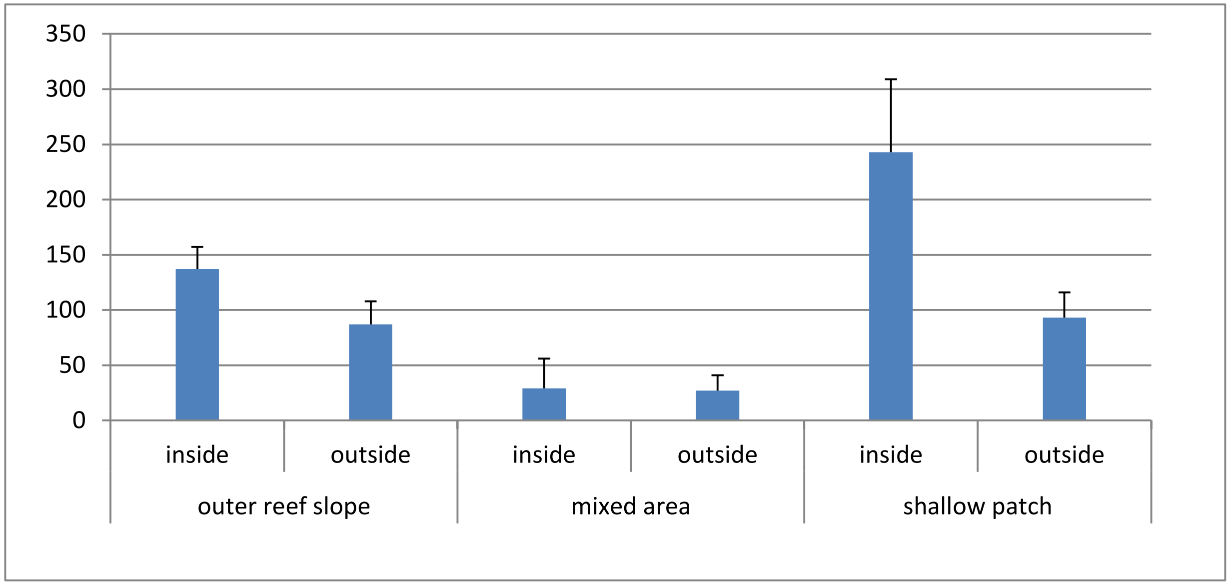

Figure 5. Mean and 95% confidence intervals of belt transect total mean fish density for samples from three habitats taken 'inside' and 'outside' of the MMCA.