

INTERDECADAL CHANGE IN REEF FISH POPULATIONS AT  
FRENCH FRIGATE SHOALS AND MIDWAY ATOLL,  
NORTHWESTERN HAWAIIAN ISLANDS: STATISTICAL  
POWER IN RETROSPECT

*E. E. DeMartini, F. A. Parrish and  
J. D. Parrish*

ABSTRACT

Reef fish faunas were compared between surveys conducted more than a decade apart at each of two isolated and nearly pristine oceanic atolls (French Frigate Shoals [FFS] and Midway Atoll) in the northwestern Hawaiian Islands. Species composition, assemblage structure (density rankings), and population densities were compared to test the hypothesis that reef fishes had declined during a period of lower oceanic productivity in the central North Pacific. Within each of two principal habitats (barrier and patch reefs) at each atoll, species composition and rank densities differed little between sampling periods. Densities, however, generally declined by about one-third for many numerically dominant species and for taxa pooled into functional categories (trophic levels, feeding guilds). Patterns of temporal change were partly confounded by distributional shifts between barrier and patch reef habitats at FFS, perhaps reflecting indirect effects of storm disturbance on benthic algal habitat. Such effects, together with related changes in climate and oceanic productivity on an interdecadal time scale, might have been responsible for the apparent declines in reef fish densities at both atolls. Temporal patterns were clearer at Midway Atoll, where changes in benthic algae were not evident. Our observations indicate that the statistical power necessary to detect changes in the population densities of reef fish species that exhibit large temporal fluctuations in numbers, particularly on oceanic islands, is generally low. Power to detect twofold changes may be adequate, however, if taxa are pooled into functional categories.

Patterns of temporal change in the abundance of fishes on tropical coral reefs remain poorly understood despite a multitude of studies that have addressed several indirectly related issues. To date, most evaluations of temporal and spatial variation in reef fishes have been nonparametric comparisons of rank abundance (Jones and Thompson, 1978), multivariate characterizations of composition (Bortone et al., 1986), or comparisons of sampling methods (Bortone and Kimmel, 1991). Few studies (Thresher and Gunn, 1986; Lincoln Smith et al., 1991; Green and Shenker, 1993) have attempted to estimate the statistical power necessary to detect temporal or spatial differences in density or abundance, particularly at the species level. Yet the ability to estimate population size (or an adequate index of abundance) is clearly important for studies of stock dynamics. This would seem especially applicable to the majority of species with pelagic larval dispersal, whose temporally fluctuating local populations often, but not always (Sale, 1990), reflect variable recruitment (Doherty and Williams, 1988; Sale, 1991).

Most studies of reef fish assemblage and population structure have focused on the faunas of continental reefs. Time series abundance data are conspicuously lacking for fishes at isolated oceanic islands. Because of the relative isolation of such islands and the implications of isolation for planktonic dispersal, the faunas of archipelagos such as the Hawaiian Islands may be particularly subject to recruitment limitation (Hourigan and Reese, 1987). If so, the temporal patterns of isolated island faunas may be especially dynamic (Myers and Pepin, 1994).

For the above reasons, we conducted temporal comparisons of fishes in shallow-reef habitats at two isolated oceanic atolls (French Frigate Shoals [FFS] and