Baseline Data for Evaluating Reef Fish Populations in the Florida Keys, 1979-1998

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September 1999
This group provided NOAA Technical Memorandum NMFS-SEFSC-427, September 1999.

EXECUTIVE SUMMARY

Reef fishes are an essential and conspicuous component of the South Florida Marine Ecosystem that support important commercial, recreational, and aesthetic fisheries. Fishes are the ultimate downstream integrators of environmental conditions and human activities. Factors that increase mortality, such as fishing, loss of habitat, and pollution are eventually reflected in adult population abundance, individual size and condition. Over the last two decades, the Florida reef tract ecosystems and Florida Bay undergone dramatic environmental changes from human and natural forces.
These changes are a general concern and the of an intensive effort to restore the ecosystem by altering the hydrology to a more natural condition. Fishes are a direct public concern and obvious measure of restoration success. Success of restoration and management changes should be reflected in fish communities in terms of the species composition, the size/age structure of fishes, in fisheries. Fishery resources are regulated by several state and federal agencies different levels of spatial protection. Understanding and modeling the dynamics of physical and biological processes of Florida and the Florida reef tract requires a good database on fish composition by habitat.

The Florida Keys National Marine Sanctuary (FKNMS) final management plan became effective on 1 July 1997 creating the planned network of 'no-take' marine reserves in North America. These reserves included 18 'no-take' Sanctuary Protected (SPAs) and one large 'no-take' ecological reserve. This action provides a unique research opportunity to examine the processes and effects of reserve protection at replicated sites of different size. An important goal of the FKNMS management is to evaluate changes resulting

from establishing no-take marine reserves five years after they became established. In addition, new ecological reserves are being proposed for the Tortugas region.

Biological data on reef fish biodiversity have been collected continuously since 1979 by highly trained and experienced divers using open circuit SCUBA and visual methods. Visual methods are ideal for assessing reef fishes in the Florida Keys because of prevailing good visibility and management concerns requiring the use of nondestructive assessment methods. Data were collected from randomly selected 7.5 m radius plots using a standard fishery independent, stationary plot method (Bohnsack and Bannerot 1986). Data collected show reef fish species composition, abundance (density per plot), frequency-of occurrence, and individual sizes of fishes at reef sites extending from Miami through the Tortugas. These data can be used to assess changes in reef fish communities in the Florida Keys as the result of changes in zoning, regional fishery management practices, and restoration efforts in Florida Bay.

This report provides a summary of a 20 year historical data base that will form the baseline for assessing future changes in reef fish communities in the FKNMS. A total of 263 fish taxa from 54 families were observed from 118 sites in the Florida Keys from 6,673 visual stationary plot samples from 1979 through 1998. The ten most abundant species accounted for 59% of all individuals observed. Ten species had a frequency-of occurrence in samples greater than 50% and only ten species accounted for 55% of the total observed biomass.

Bray-Curtis similarity analysis of 90 reef sites was conducted to analyze spatial distribution patterns. The analysis showed that reef sites clustered primarily between inshore patch reefs and offshore reefs irrespective of region. Within offshore reefs, Tortugas deeper reefs were distinguished from sites in the rest of the Florida Keys. In the main Keys, offshore reefs clustered into high relief forereef and low relief hard bottom habitats. Within habitat types, reef sites clustered primarily by geographical region.

Trophic composition of fishes differed greatly in terms of number of individuals and total biomass. Fishes were numerically dominated by planktivores (44%) followed by macroinvertivores (26%), herbivores (17%), piscivores (8%), microinvertivores (3%), and browsers (1%). In terms of biomass, piscivores (42%) dominated, followed by macroinvertivores (25%), herbivores (21%), planktivores (5%), browsers (4%), and microinvertivores (3%). Data collected from 1994-1997 form a baseline for assessing changes at study sites during the first five years of protection under the FKNMS management plan. Annual mean density (number of fish observed per plot sample) with 95% confidence intervals were calculated for selected species and projected through 2002 as a prediction of future performance based on the assumption of no changes in population parameters over time.

Since only one full year of data were available following the establishment of notake zones, it is premature to make conclusion about the impacts of marine reserves on changes in abundance or sizes of multispecies reef fish stocks. It is encouraging, however, that after only one year of no-take protection, the annual mean densities of exploited species in no-take sites were the highest observed for yellowtail snapper, combined grouper, and hogfish and the second highest for gray snapper compared to the baseline period. In comparison, similar uniform responses were not observed for the same species at fished sites nor for two species without direct economic importance (striped and stoplight parrotfish).

Sizes of reef fishes are also being monitored to assess population changes. Mean fish size in exploitable and nonexploitable phases for stocks of economically important species were examined as baseline statistics for evaluating future community changes in response to management actions. Because adult growth rates are relatively slow, size changes were unlikely to change much after only one year of protection and may lag other parameters.

Table 1. Mutton snapper density index (1994-2005) and upper and lower 95% Confidence intervals.

Species: mutton snapper
Life stage exploited phase, >=40 cm
n: primary units sampled (200 m x 200 m, 40,000 m2)
nm: second-stage units sampled (177 m2)
avdns: domain-wide mean density, number per 177 m2 (2-stage stratified random design)

year	nstrat	n	nm	avdns	se_dns	lw_95ci	up_95ci
1994	5	33	141	0.022	0.0117	0.0232	0.0232
1995	5	55	283	0.036	0.0152	0.0298	0.0298
1996	5	46	198	0.006	0.0042	0.0083	0.0083
1997	5	68	404	0.015	0.0057	0.0111	0.0111
1998	10	78	462	0.007	0.0034	0.0067	0.0067
1999	10	159	438	0.014	0.0077	0.0152	0.0152
2000	10	208	473	0.034	0.0105	0.0205	0.0205
2001	10	277	689	0.067	0.0162	0.0319	0.0319
2002	10	315	583	0.054	0.0108	0.0213	0.0213
2003	10	213	411	0.069	0.0196	0.0386	0.0386
2004	10	121	229	0.097	0.0378	0.0745	0.0745
2005	10	224	375	0.032	0.0095	0.0186	0.0186

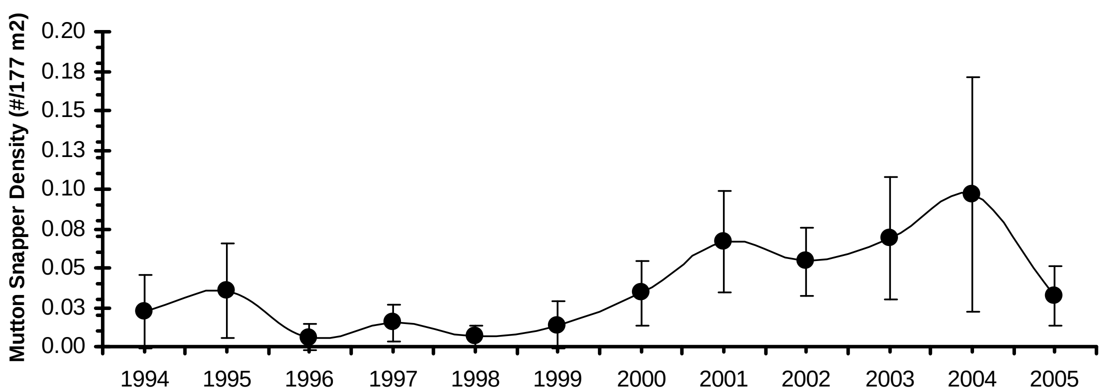

Figure 1. Annual density (Number of Fish / 177 m^2) and 95% C.I for mutton snapper.

Table 2. Mutton snapper mean length (mm) estimation (1994-2005) and upper and lower 95% Confidence intervals.

Species: mutton snapper
Life stage: exploited phase, >=40 cm
lbar: mean length in exploited phase
note 1: n is statistical sample size, based on average number of fish observed >=400 mm per 177 m2 point count, usually by a buddy pair of divers; actual number of fish observed is approximately double the n.
note 2: lower and upper SEs are somewhat asymmetrical due to log-transformation (and back-transformation) for estimation of lbar

Year	n	lbar (mm)	lw_se	up_se	lw_95ci	up_95ci
1994	3.0	500.2	64.2	73.7	204.4	144.8
1995	5.7	502.1	29.0	30.8	74.6	60.5
1996	1.0	600.0	0.0	0.0	0.0	0.0
1997	5.0	421.8	20.2	21.2	51.9	41.7
1998	4.0	479.1	58.3	66.4	161.8	130.4
1999	3.5	462.1	27.8	29.5	88.4	58.1
2000	16.8	459.7	18.8	19.6	39.8	38.4
2001	48.0	481.0	15.8	16.4	31.8	32.2
2002	100.2	504.5	7.8	7.9	15.5	15.6
2003	46.8	518.6	17.1	17.7	34.5	34.8
2004	34.0	491.4	18.4	19.1	37.5	37.6
2005	43.5	474.5	10.2	10.5	20.6	20.5
	Mean	**491.2**				

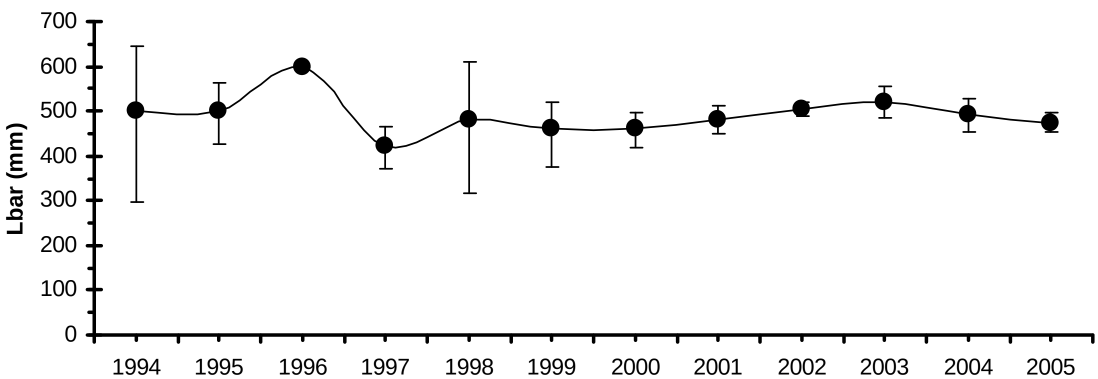

Figure 2. Mutton snapper mean length (mm) and 95% C.I by year.