APPENDIX TWO

FISH BIOMASS CONVERSION EQUATIONS

BY

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INTRODUCTION

Fish abundance determined from the AGRRA belt transects has been reported throughout this volume as density estimates (number of individuals/100m^2). Most investigators using the AGRRA protocol have utilized a consistent methodology for censusing fish so that abundance estimates reported as density are especially useful in making regional comparisons of fish abundance. In some instances, however, where individual species within the reported taxa have widely varying morphologies, biomass (weight) may be a more representative measure of fish abundance. Biomass is an important attribute of populations that may be of interest to ecologists and resource managers since it provides insight into the trophic structure of the community and the production capacity of a reef (Bohnsack and Harper, 1988; Anderson and Neumann, 1996). Some of the authors in this volume have chosen to present their fish abundance results as biomass (grams/100m^2). Fish weight was estimated using previously established length-weight relationships for Caribbean fishes (Table 1).

METHODS

Fish weight was calculated using the power function: $W = aL^b$, where W is the weight (grams), L is the length (cm), and a and b are parameters estimated by linear regression of logarithmically transformed length-weight data. The parameters a and b shown in Table 1 were adjusted for unit length from linear regressions performed on fish lengths (mm) reported previously in the literature. Most of the length-weight relationships were determined from southern Florida specimens (Bohnsack and Harper, 1988), with exceptions as noted from Bohnsack and Harper (1988), Bullock et al. (1992), Claro and Garcia-Arteaga (1994), and Letourneur et al. (1998).

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REFERENCES

Anderson, R.O., and R.M. Neumann
1996. Length, weight, and associated structural indices. Pp. 447-482. In: B.R. Murphy and D.W. Willis (eds.). *Fisheries Techniques*. Second edition. American Fisheries Society. Bethesda, MD.

Bohnsack, J.A., and D.E. Harper
1988. Length-weight relationships of selected marine reef fishes from the southeastern United States and the Caribbean. *NOAA Technical Memoir* NMFS-SEFC-215, 31 pp.

Bullock, L.H., M.D. Murphy, M.F. Godcharles, and M.E. Mitchell
1992. Age, growth, and reproduction of jewfish *Epinephelus itjara* in the eastern Gulf of Mexico. *Fishery Bulletin* 90:243-249.

Claro, R., and J.P. García-Arteaga
1994. Crecimiento. Pp. 321-402. In: R. Claro (ed.), *Ecología de los Peces Marinos de Cuba*. Instituto de Oceanología, Academia de Ciencias de Cuba and Centro de Investigaciones Quintana Roo (CIQRO) México.

Eschmeyer, W.N. (editor)
1998. *Catalog of Fishes*. Special Publication No. 1 of the Center for Biodiversity Research and Information, California Academy of Science, San Francisco, CA. Volumes 1-3, 2905 pp.

Letourneur, Y., M. Kulbicki, and P. Labrosse
1998. Length-weight relationships of fish from coral reefs and lagoons of New Caledonia, southwestern Pacific Ocean: an update. *Naga*, ICLARM Q. 21(4):39-46.

Table 1. Length-weight relationships for the AGRRA fishes.

Scientific name	Common name	*a*	*b*	Comments[2]
Acanthurus bahianus	Ocean Surgeonfish	0.0237	2.9752	
Acanthurus chirurgus	Doctorfish	0.0040	3.5328	
Acanthurus coeruleus	Blue Tang	0.0415	2.8346	
Aluterus scriptus	Scrawled Filefish	0.8230	1.8136	
Anisotremus surinamensis	Black Margate	0.0059	3.3916	
Anisotremus virginicus	Porkfish	0.0148	3.1674	
Balistes vetula	Queen Triggerfish	0.0267	2.9903	
Bodianus rufus	Spanish Hogfish	0.0144	3.0532	
Cantherhines macrocerus	Whitespotted Filefish	0.0562	2.6534	
Cantherhines pullus	Orangespotted Filefish	0.0684	2.5632	
Canthidermis sufflamen	Ocean Triggerfish	0.0176	3.0554	
Caranx ruber	Bar Jack	0.0074	3.2370	
Centropyge argi	Cherubfish	0.0601	2.6920	* No data available for species; used *Centropyge tibicen* as model (**4**)
Cephalopholis cruentata[1]	Graysby	0.0135	3.0439	(was *Epinephelus cruentatus)*
Cephalopholis fulva[1]	Coney	0.0175	3.0000	(was *Epinephelus fulvus*); * St. Croix data used: n=1644, a=0.0175, b=3.0 (**1**)
Chaetodon aculeatus	Longsnout Butterflyfish	0.0220	3.1897	* No data available for species; used *Chaetodon capistratus* as model
Chaetodon capistratus	Foureye Butterflyfish	0.0220	3.1897	
Chaetodon ocellatus	Spotfin Butterflyfish	0.0318	2.9838	
Chaetodon sedentarius	Reef Butterflyfish	0.0252	3.0760	
Chaetodon striatus	Banded Butterflyfish	0.0222	3.1395	
Epinephelus adscensionis	Rock Hind	0.0111	3.1124	* No data available for species; used *Epinephelus guttatus* as model
Epinephelus guttatus	Red Hind	0.0111	3.1124	
Epinephelus itajara	Jewfish	0.0131	3.0560	* Gulf of Mexico data used; n=66, a=0.0131, b=3.056 (**2**)
Epinephelus marginatus	Dusky Grouper	0.0065	3.2292	* No data available for species; used *Epinephelus striatus* as model
Epinephelus morio	Red Grouper	0.0123	3.0350	
Epinephelus striatus	Nassau Grouper	0.0065	3.2292	
Haemulon album	White Margate	0.0167	3.0423	
Haemulon aurolineatum	Tomtate	0.0100	3.2077	
Haemulon carbonarium	Caesar Grunt	0.0147	3.0559	
Haemulon chrysargyreum	Smallmouth Grunt	0.3971	2.1567	
Haemulon flavolineatum	French Grunt	0.0127	3.1581	
Haemulon macrostomum	Spanish Grunt	0.0244	3.0295	
Haemulon melanurum	Cottonwick	0.0226	2.9527	
Haemulon parra	Sailors Choice	0.0199	2.9932	
Haemulon plumieri	White Grunt	0.0121	3.1612	
Haemulon sciurus	Bluestriped Grunt	0.0194	2.9996	
Haemulon striatum	Striped Grunt	0.0175	3.0990	
Holacanthus bermudensis	Blue Angelfish	0.0319	2.8994	
Holacanthus ciliaris	Queen Angelfish	0.0337	2.9004	
Holacanthus tricolor	Rock Beauty	0.0428	2.8577	
Lachnolaimus maximus	Hogfish	0.0203	2.9880	
Lutjanus analis	Mutton Snapper	0.0162	3.0112	
Lutjanus apodus	Schoolmaster	0.0194	2.9779	

Lutjanus cyanopterus	Cubera Snapper	0.0151	3.0601	
Lutjanus griseus	Gray Snapper	0.0232	2.8809	
Lutjanus jocu	Dog Snapper	0.0308	2.8574	
Lutjanus mahogoni	Mahogany Snapper	0.0429	2.7190	
Lutjanus synagris	Lane Snapper	0.0295	2.8146	
Melichthys niger	Black Durgon	0.0562	2.6534	* No data available for species; used *Cantherhines macrocerus* as model
Microspathodon chrysurus	Yellowtail Damselfish	0.0239	3.0825	
Mycteroperca acutirostris	Comb Grouper	0.0068	3.2051	* No data available for species; used *Mycteroperca bonaci* as model
Mycteroperca bonaci	Black Grouper	0.0068	3.2051	
Mycteroperca interstitialis	Yellowmouth Grouper	0.0068	3.2051	* No data available for species; used *Mycteroperca bonaci* as model
Mycteroperca microlepis	Gag	0.0130	3.0305	
Mycteroperca phenax	Scamp	0.0068	3.2051	* No data available for species; used *Mycteroperca bonaci* as model
Mycteroperca tigris	Tiger Grouper	0.0094	3.1200	* Cuban data used: n=145, a=0.0094, b=3.12 (**3**)
Mycteroperca venenosa	Yellowfin Grouper	0.0095	3.1400	* St. Thomas/St. John data used: n=103, a=0.0069, b=3.14 (**1**)
Ocyurus chrysurus	Yellowtail Snapper	0.0405	2.7180	
Pomacanthus arcuatus	Gray Angelfish	0.0344	2.9680	
Pomacanthus paru	French Angelfish	0.0203	3.1264	
Scarus coelestinus	Midnight Parrotfish	0.0153	3.0618	
Scarus coeruleus	Blue Parrotfish	0.0124	3.1109	
Scarus guacamaia	Rainbow Parrotfish	0.0155	3.0626	
Scarus inserti[1]	Striped Parrotfish	0.0147	3.0548	(was *S. croicensis)*
Scarus sp.	Unidentified Scarus	0.0250	2.9214	* Used *Sparisoma viride* as model
Scarus taeniopterus	Princess Parrotfish	0.0335	2.7086	
Scarus trispinosus	Greenlip Parrotfish	0.0153	3.0618	* No data available for species; used *Scarus coelestinus* as model
Scarus vetula	Queen Parrotfish	0.0250	2.9214	* No data available for species; used *Sparisoma viride* as model
Sparisoma atomarium	Greenblotch Parrotfish	0.0121	3.0275	
Sparisoma aurofrenatum	Redband Parrotfish	0.0046	3.4291	
Sparisoma chrysopterum	Redtail Parrotfish	0.0099	3.1708	
Sparisoma radians	Bucktooth Parrotfish	0.0121	3.0275	* No data available for species; used *Sparisoma atomarium* as model
Sparisoma rubripinne	Redfin Parrotfish	0.0156	3.0641	
Sparisoma spp.	Unidentified Sparisoma	0.0250	2.9214	* Used *Sparisoma viride* as model
Sparisoma viride	Stoplight Parrotfish	0.0250	2.9214	
Sphyraena barracuda	Great Barracuda	0.0050	3.0825	
Xanthichthys ringens	Sargassum Triggerfish	0.0267	2.9903	* No data available for species; used *Balistes vetula* as model

[1]Genus and species names according to the classification in Eschmeyer et al. (1998).

[2](**1**) = Bohnsack and Harper (1988); (**2**) = Bullock et al. (1992); (**3**) = Claro and García-Arteaga (1994); (**4**) = Letourneur et al. (1998)

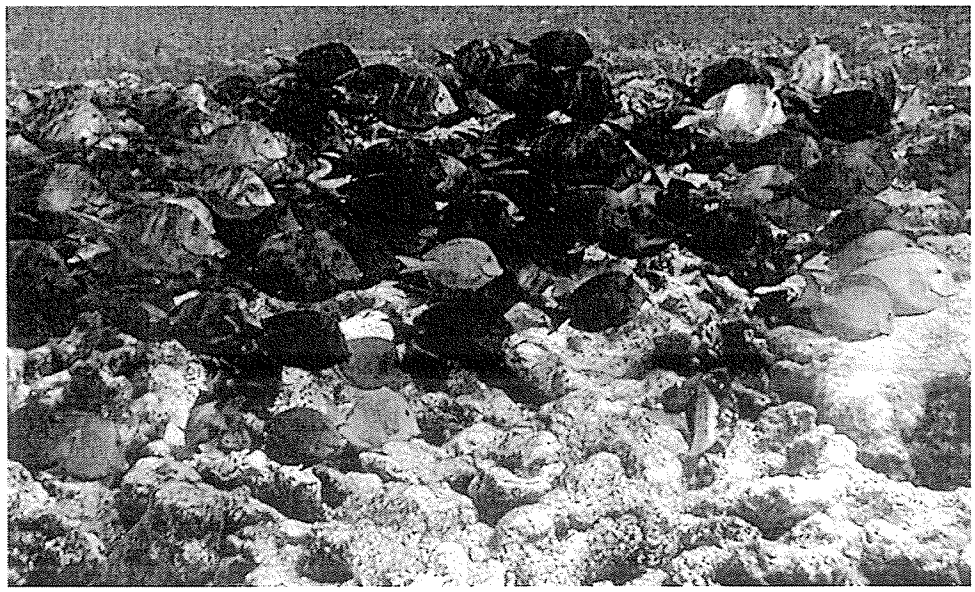

Plate 13A. Reef fishes play many important roles in coral reef community dynamics by their trophic interactions as herbivores and as predators. Schooling acanthurids, as shown here, overwhelm damselfish to raid their gardens. In the AGRRA belt transect method, sampling biases are minimized by restricting the width of the belt transect and the number of species recorded which help to maintain a relatively consistent search image. (Photo Kenneth W. Marks)

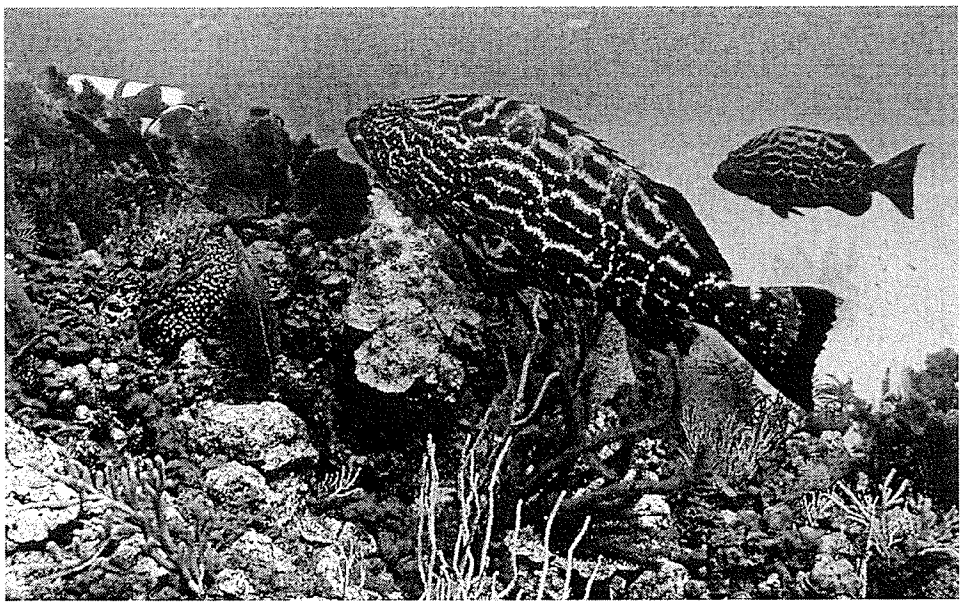

Plate 13B. Belt transects are used to estimate the abundance and size (used for biomass estimations) of ecologically and/or commercially significant fishes, such as these black groupers (*Mycteroperca bonaci*) which have been overharvested in much of the wider Caribbean. REEF's Roving diver surveys are used to assess fish species richness and relative abundance and complement the belt transect method. (Photo Robert W. Steneck)

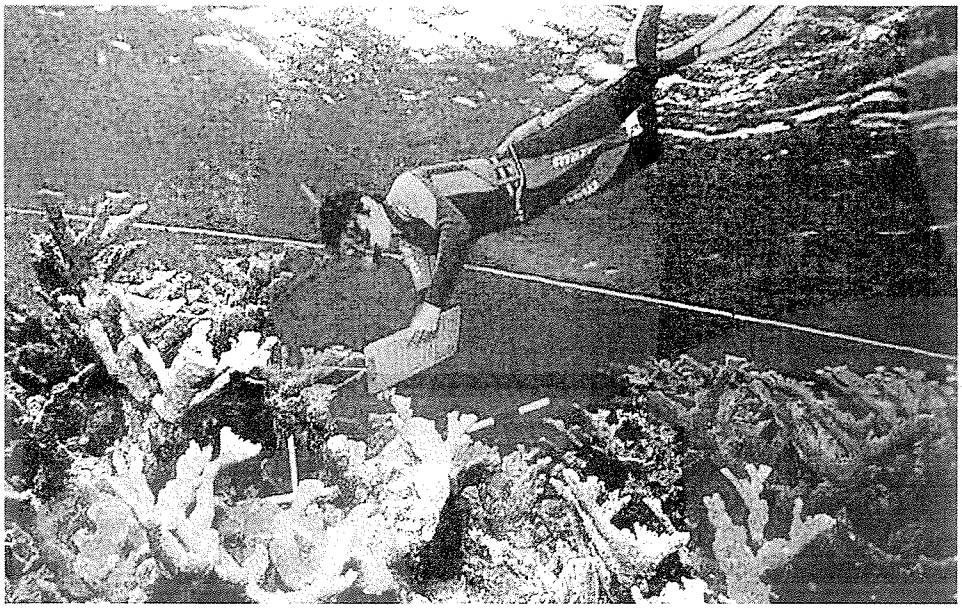

Plate 14A. One of the main objectives of the AGRRA approach is to provide a standardized methodology enabling teams working in different areas to collect and compare data on a regional scale. The transect-based benthos protocol is focused on several indicators of the condition of stony corals and the abundance of reef algae and *Diadema*. (Photo Kenneth W. Marks)

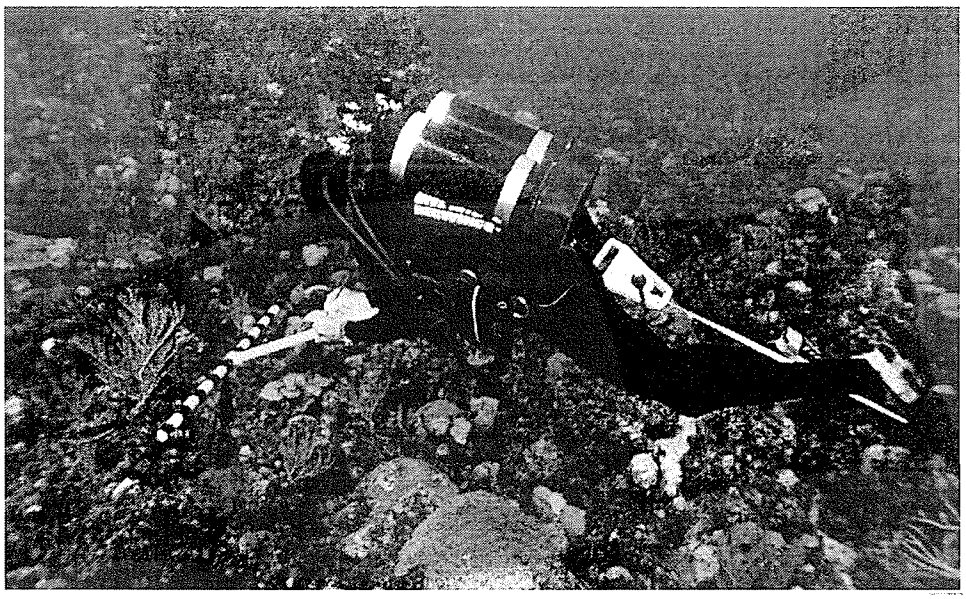

Plate 14B. Two distinct methods, belt transects as shown here, and REEF roving diving surveys, provide complementary "snapshots" of fishes at AGRRA assessment sites. (Photo Kenneth W. Marks)