CONSTRUCTION OF A FISHERIES-INDEPENDENT INDEX OF RED GROUPER (EPINEPHELUS MORIO) USING DATA FROM THE DRY TORTUGAS NATIONAL PARK, 1994-2004

Doug Harper, Todd Kellison and Steve Smith

Data contacts:
Doug Harper (doug.harper@noaa.gov; 305.361.4257)
Todd Kellison (todd.kellison@noaa.gov; 305.361.4496)

1. BACKGROUND AND METHODS

Red grouper data were collected in the Dry Tortugas region using standardized Reef Fish Visual Census (RVC) surveys during the following years: 1994-2000, 2002, and 2004 (Bohnsack, et al. 1999, Ault, et al., 2002, and Ault, et al. 2006). Surveys were habitat-specific; however, habitat classifications changed considerably beginning in 2000. We were unable to re-assign habitat classifications from pre-2000 samples according to the post-2000 classification scheme, due predominantly to the fact that the habitat maps that guide the current classification scheme contain multiple habitat types over small spatial scales. Although all pre-2000 dives are associated with specific latitude / longitude coordinates, those coordinates mark the site at which the research vessel anchored. Divers then deployed from the vessel and descended to make their survey, which necessarily occurred at different coordinates. Thus, because the current habitat maps are characterized by habitat changes over small spatial distances, it is impossible to determine the habitat over which previous surveys occurred. Thus, data are pooled for each year across habitat types. While red grouper were distributed across multiple habitat types, the pooling will likely result in little loss of information, as there were very small sample sizes by habitat types for pre-1999 surveys (thus habitat-specific trends would be unreliable), and there was consistent, proportional sampling of habitat types for 1999-2004.

Data are presented in three formats: pre-exploited phase (< 50cm), exploited phase (≥ 50cm), and "total" (both phases combined). Data are presented separately for two strata: Tortugas North Ecological Reserve (TNER) and Dry Tortugas National Park (DRTO). The TNER was open to commercial and recreational fishing until July 2001, when all fishing was prohibited within its boundaries. DRTO has been open only to recreational fishing since 1994. The Tortugas Bank area occurring outside the TNER is another possible stratum. However, only one site within this stratum was surveyed during the 1994-1998 time period and this stratum was therefore excluded from this analysis due to insufficient replicates.

Note that annual sample sizes increased considerably during the sampling period (the "nm" column in the data sheets corresponds to number of individual diver surveys).

Sample sizes were particularly small (in some cases less than 20 replicates) in early years of the survey.

For the graphs in the Excel file, BANK_MPA refers to TNER, and PARK_REC refers to DRTO.

2. RESULTS:

The indices constructed are quite similar in trend, regardless of the size considered or the area analyzed (Tables 1-3; Figure 1-3). All indicate a recent increase in the abundance of red grouper in the Tortugas North Ecological Reserve (TNER) and Dry Tortugas National Park (DRTO).

3. DISCUSSION

Dr. Steve Smith, a biostatistician who performed the analyses, offers the following comments:

> "From the plots, it seems the densities were generally quite low during the early years; however, there is really no way to know whether this is a true result or if it is an artifact of the very low sampling (particularly primary units) in those earlier years."

and

> "In the end, I'm not sure what we gain by trying to extend the time series back to 1994: 1) it is near impossible to figure out what habitats were sampled (hence the stratification by management zone only); 2) sampling pre-1999 generally focused on a few primary units with a lot of rvc counts inside those units. If it were up to me, I would stick with using the short but likely unbiased and precise time series from 1999-2004 in any type of analysis. Something the SEDAR assessment folks should be aware of."

4. LITERATURE CITED

Bohnsack, J.A., D.B. McClellan, D.E. Harper, G.S. Davenport, G.J. Konoval, A.M. Eklund, J.P. Contillo, S.K. Bolden, P.C. Fischel, G.S. Sandorf, J.C. Javech, M.W. White, M.H. Pickett, M.W. Hulsbeck, J.L. Tobias, J.S. Ault, G.A. Meester, S.G. Smith, and J. Luo. 1999. Baseline data for evaluating reef fish populations in the Florida Keys. NOAA Technical Memorandum. NMFS-SEFSC-427. 61 p.

Ault, J. S., S. G. Smith, G. A. Meester, J. Luo, J. A. Bohnsack, and S.L. Miller. 2002. Baseline Multispecies Coral Reef Fish Stock Assessment for Dry Tortugas. NOAA Technical Memorandum NMFS-SEFSC-487. 117 p.

Ault, J.S., S.G. Smith, J.A. Bohnsack, J.Luo, D.E. Harper, and D.B. McClellan. 2006. Building sustainable fisheries in Florida's coral reef ecosystem: positive signs in the Dry Tortugas. Bulletin of Marine Science 78(3): 633-654

Table 1. Index statistics for pre-exploited red grouper (<50cm TL)

Dry Tortugas fishery-independent visual surveys
Red Grouper
Pre-exploited sizes, <50 cm TL

specnum	species	geo	yr	ntot	mtot	n	nm	avdns	se_dns
202	EPI MORI	BANK_MPA	1994	2112	226	2	12	0.08333	0.08331
202	EPI MORI	BANK_MPA	1995	2112	226	1	4	0.08325	
			1996						
202	EPI MORI	BANK_MPA	1997	2112	226	10	35	0.16667	0.07206
202	EPI MORI	BANK_MPA	1998	2112	226	9	47	0.27937	0.1399
202	EPI MORI	BANK_MPA	1999	2112	226	66	124	0.54831	0.06346
202	EPI MORI	BANK_MPA	2000	2112	226	58	103	0.54167	0.06369
			2001						
202	EPI MORI	BANK_MPA	2002	2112	226	20	39	0.4875	0.08593
			2003						
202	EPI MORI	BANK_MPA	2004	2112	226	63	126	0.42857	0.05406
202	EPI MORI	PARK_REC	1994	4397	226	6	47	0.11044	0.05226
202	EPI MORI	PARK_REC	1995	4397	226	2	11	0.1833	0.18326
202	EPI MORI	PARK_REC	1996	4397	226	7	42	0.19048	0.05949
202	EPI MORI	PARK_REC	1997	4397	226	9	72	0.15512	0.06287
202	EPI MORI	PARK_REC	1998	4397	226	5	30	0.51667	0.20131
202	EPI MORI	PARK_REC	1999	4397	226	76	147	0.58032	0.05332
202	EPI MORI	PARK_REC	2000	4397	226	120	221	0.39427	0.03874
			2001						
202	EPI MORI	PARK_REC	2002	4397	226	99	192	0.52273	0.05206
			2003						
202	EPI MORI	PARK_REC	2004	4397	226	197	359	0.36041	0.02891

Table 2. Index statistics for exploited red grouper (>50cm TL)

Dry Tortugas fishery-independent visual surveys
Red Grouper
Exploited sizes, >=50 cm TL

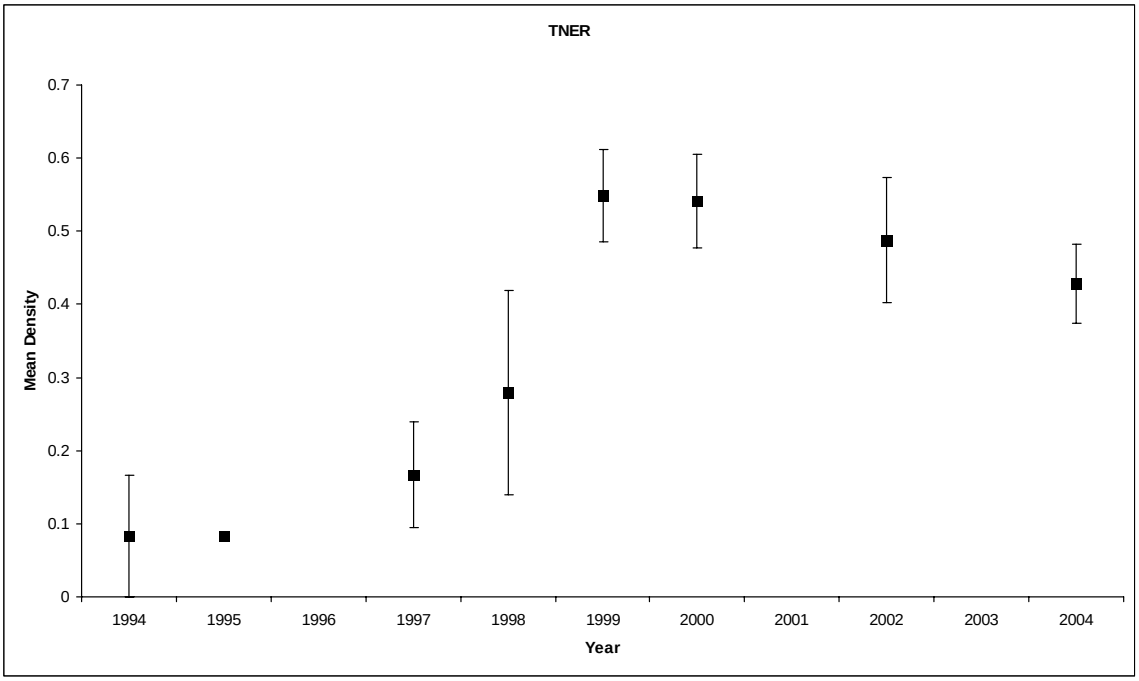
specnum	species	geo	yr	ntot	mtot	n	nm	avdns	se_dns
202	EPI MORI	BANK_MPA	1994	2112	226	2	12	0	0
202	EPI MORI	BANK_MPA	1995	2112	226	1	4	0	
			1996						
202	EPI MORI	BANK_MPA	1997	2112	226	10	35	0.05417	0.02915
202	EPI MORI	BANK_MPA	1998	2112	226	9	47	0.12857	0.092486
202	EPI MORI	BANK_MPA	1999	2112	226	66	124	0.12216	0.023779
202	EPI MORI	BANK_MPA	2000	2112	226	58	103	0.13075	0.030992
			2001						
202	EPI MORI	BANK_MPA	2002	2112	226	20	39	0.1375	0.04961
			2003						
202	EPI MORI	BANK_MPA	2004	2112	226	63	126	0.42989	0.047268
202	EPI MORI	PARK_REC	1994	4397	226	6	47	0.01896	0.012081
202	EPI MORI	PARK_REC	1995	4397	226	2	11	0.225	0.025105
202	EPI MORI	PARK_REC	1996	4397	226	7	42	0.0119	0.011905
202	EPI MORI	PARK_REC	1997	4397	226	9	72	0.0205	0.01596
202	EPI MORI	PARK_REC	1998	4397	226	5	30	0.1	0.048585
202	EPI MORI	PARK_REC	1999	4397	226	76	147	0.19819	0.029801
202	EPI MORI	PARK_REC	2000	4397	226	120	221	0.14323	0.020941
			2001						
202	EPI MORI	PARK_REC	2002	4397	226	99	192	0.20202	0.031936
			2003						
202	EPI MORI	PARK_REC	2004	4397	226	197	359	0.26777	0.025357

Table 3. Index statistics for all red grouper (pre-exploited + exploited)

Dry Tortugas fishery-independent visual surveys
Red Grouper
All sizes combined

specnum	species	geo	yr	ntot	mtot	n	nm	avdns	se_dns	comment
202	EPI MORI	BANK_MPA	1994	2112	226	2	12	0.08333	0.08331	only 2 prim. units, caution
202	EPI MORI	BANK_MPA	1995	2112	226	1	4	0.08325		only 1 prim. unit, no variance, may want to discard
			1996							no survey
202	EPI MORI	BANK_MPA	1997	2112	226	10	35	0.22083	0.09568	
202	EPI MORI	BANK_MPA	1998	2112	226	9	47	0.40794	0.16778	
202	EPI MORI	BANK_MPA	1999	2112	226	66	124	0.67047	0.07018	
202	EPI MORI	BANK_MPA	2000	2112	226	58	103	0.67242	0.07438	
			2001							no survey
202	EPI MORI	BANK_MPA	2002	2112	226	20	39	0.625	0.10019	
			2003							no survey
202	EPI MORI	BANK_MPA	2004	2112	226	63	126	0.85846	0.07593	
202	EPI MORI	PARK_REC	1994	4397	226	6	47	0.12939	0.06076	
202	EPI MORI	PARK_REC	1995	4397	226	2	11	0.4083	0.15827	only 2 prim. units, caution
202	EPI MORI	PARK_REC	1996	4397	226	7	42	0.20238	0.06259	
202	EPI MORI	PARK_REC	1997	4397	226	9	72	0.17562	0.07665	
202	EPI MORI	PARK_REC	1998	4397	226	5	30	0.61667	0.22134	
202	EPI MORI	PARK_REC	1999	4397	226	76	147	0.77851	0.05499	
202	EPI MORI	PARK_REC	2000	4397	226	120	221	0.5375	0.04056	
			2001							no survey
202	EPI MORI	PARK_REC	2002	4397	226	99	192	0.72475	0.06161	
			2003							no survey
202	EPI MORI	PARK_REC	2004	4397	226	197	359	0.62817	0.03969	

Notes:
1. BANK_MPA is Tortugas North Ecological Reserve, northern portion of Tortugas Bank, open to rec and comm fishing 1994-June 2001, closed to all fishing July 2001-2004
2. PARK_REC is Dry Tortugas National Park, open to recreational fishing 1994-2004
3. Strata are geo zones only; habitat class not considered in stratification due to lack of hab data prior to 1999
4. ntot=number of primary units in the 'geo' domain, 1 unit=40,000 m2
5. mtot=number of second-stage units within each primary unit, 1 unit=177 m2 (sample cylinder)
6. n=number of primary units sampled
7. nm=number of second-stage units sampled; statistical sample size for inference purposes
8. avdns= mean density, number of fish per 177 m2; 2-stage Stratified Random Survey estimates
9. se_dns=standard error of mean density; 2-stage Stratified Random Survey estimates
10. See Ault et al. 2002 for details of 2-stage sampling design and computations, field methods.
11. See Ault el al. 2005 for maps of geo zones; zone 'BANK_CRF', southern Tortugas Bank open to fishing, not included since no sampling prior to 1999



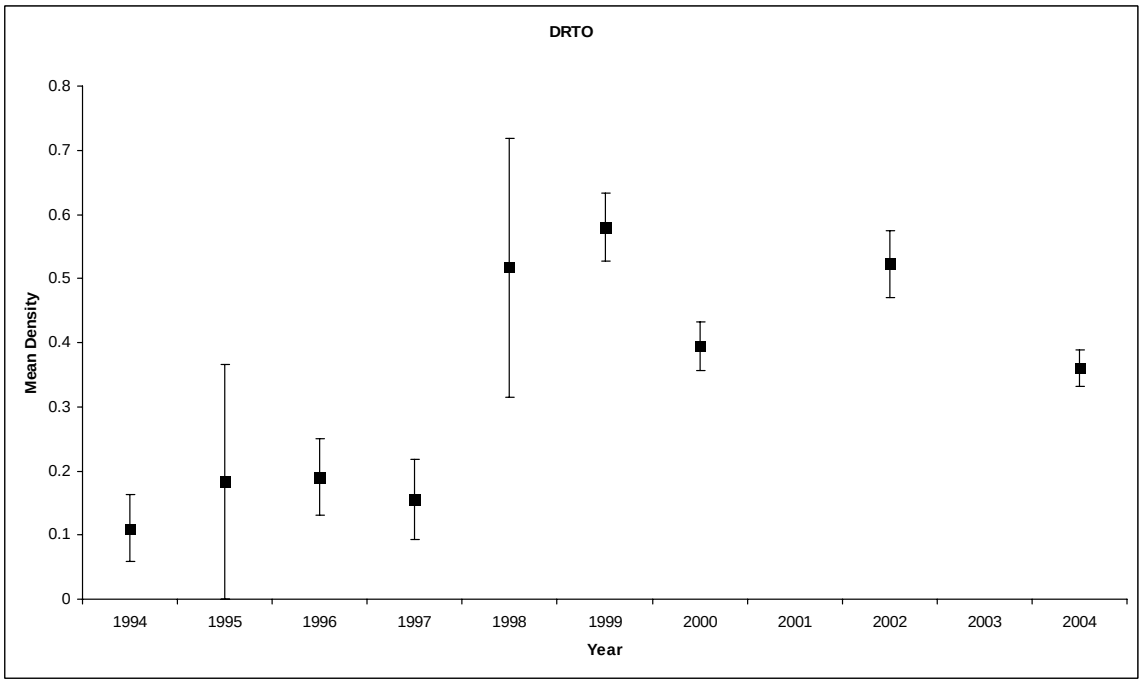


Figure 1. Indices of abundance for un-exploited red grouper (<50cm TL) in the Tortugas North Ecological Reserve (TNER) and Dry Tortugas National Park (DRTO).

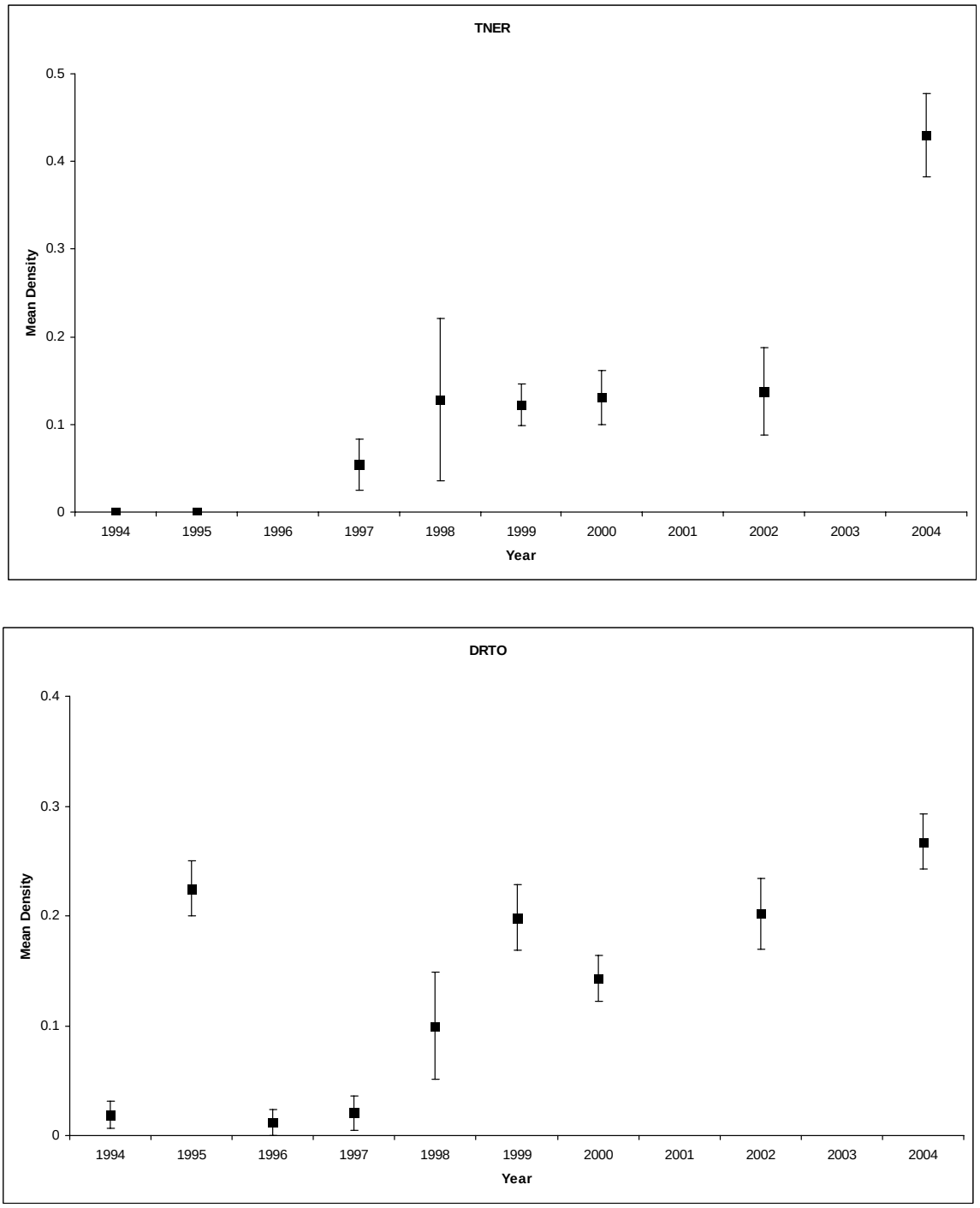
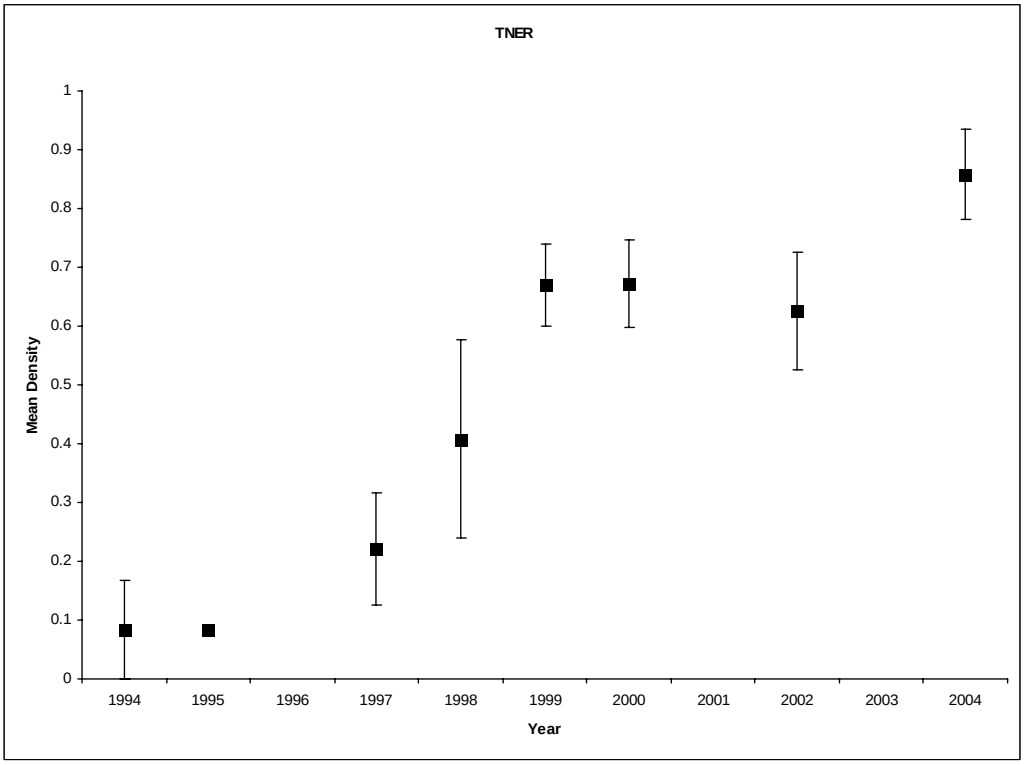


Figure 2. Indices of abundance for exploited red grouper (>50cm TL) in the Tortugas North Ecological Reserve (TNER) and Dry Tortugas National Park (DRTO).



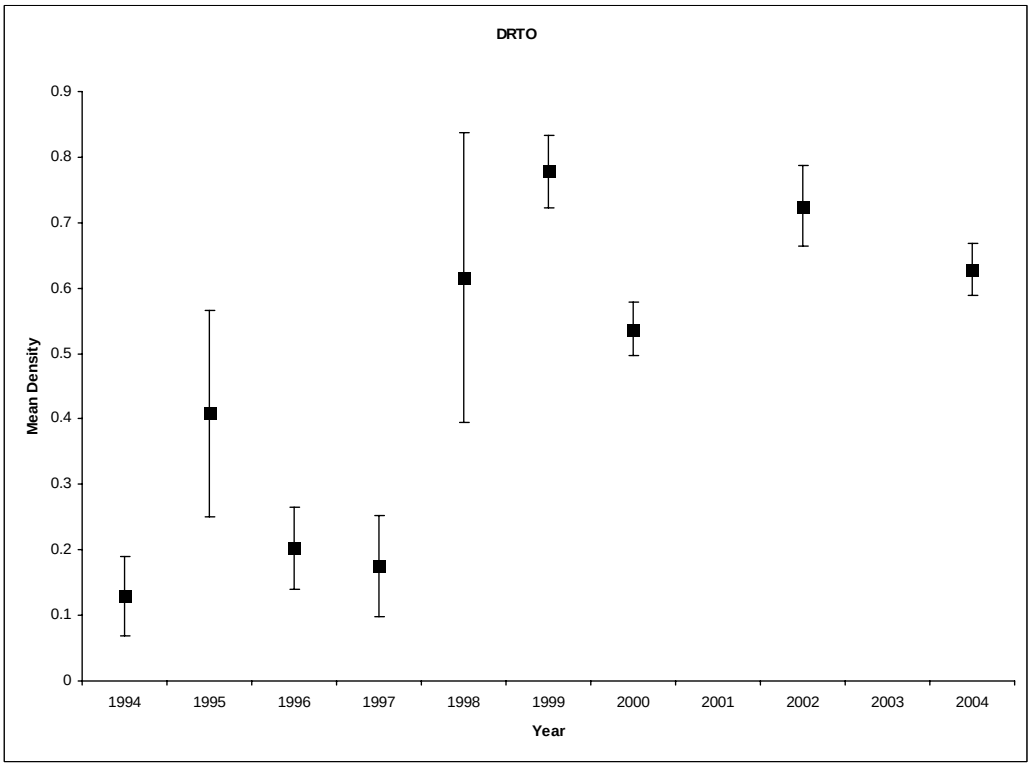


Figure 3. Indices of abundance for all red grouper (pre-exploited and exploited) in the Tortugas North Ecological Reserve (TNER) and Dry Tortugas National Park (DRTO).