

Reef fish habitat use as a measure of coral reef restoration success at the Fortuna Reefer grounding site, Mona Island, Puerto Rico



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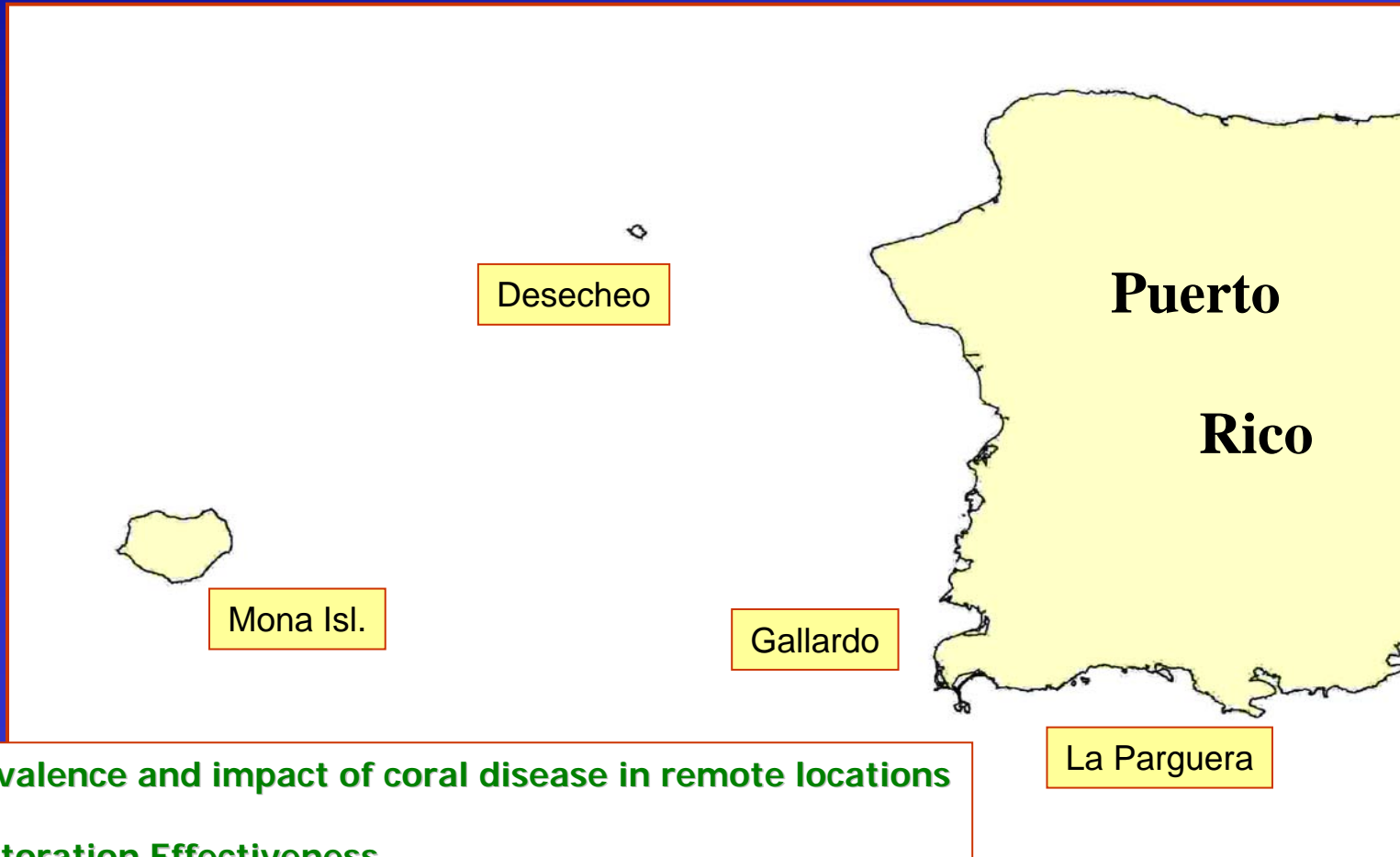
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NOAA Fisheries -- Silver Spring, MD

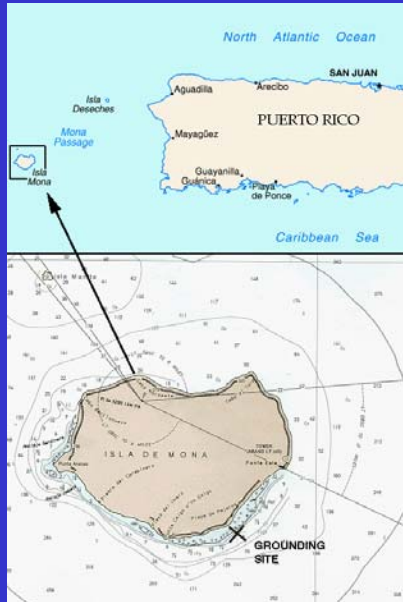


Long-term Monitoring Sites



1. Prevalence and impact of coral disease in remote locations
2. Restoration Effectiveness
(Recovery of *Acropora palmata* community and reef fish assemblages)

M/V Fortuna Reefer Grounding



(NOAA, July 1997)

24 July 1997
326 foot freighter
Aground 8 days (*Acropora palmata* zone)
1° & 2° damage = 2.75 ha.
Loss of 3-D structure



Shattered massive coral head. (Coastal Planning & Engineering, Inc., Sept. 1997)



Elkhorn coral fragments. (Coastal Planning & Engineering, Inc., Sept. 1997)

M/V Fortuna Reefer Restoration



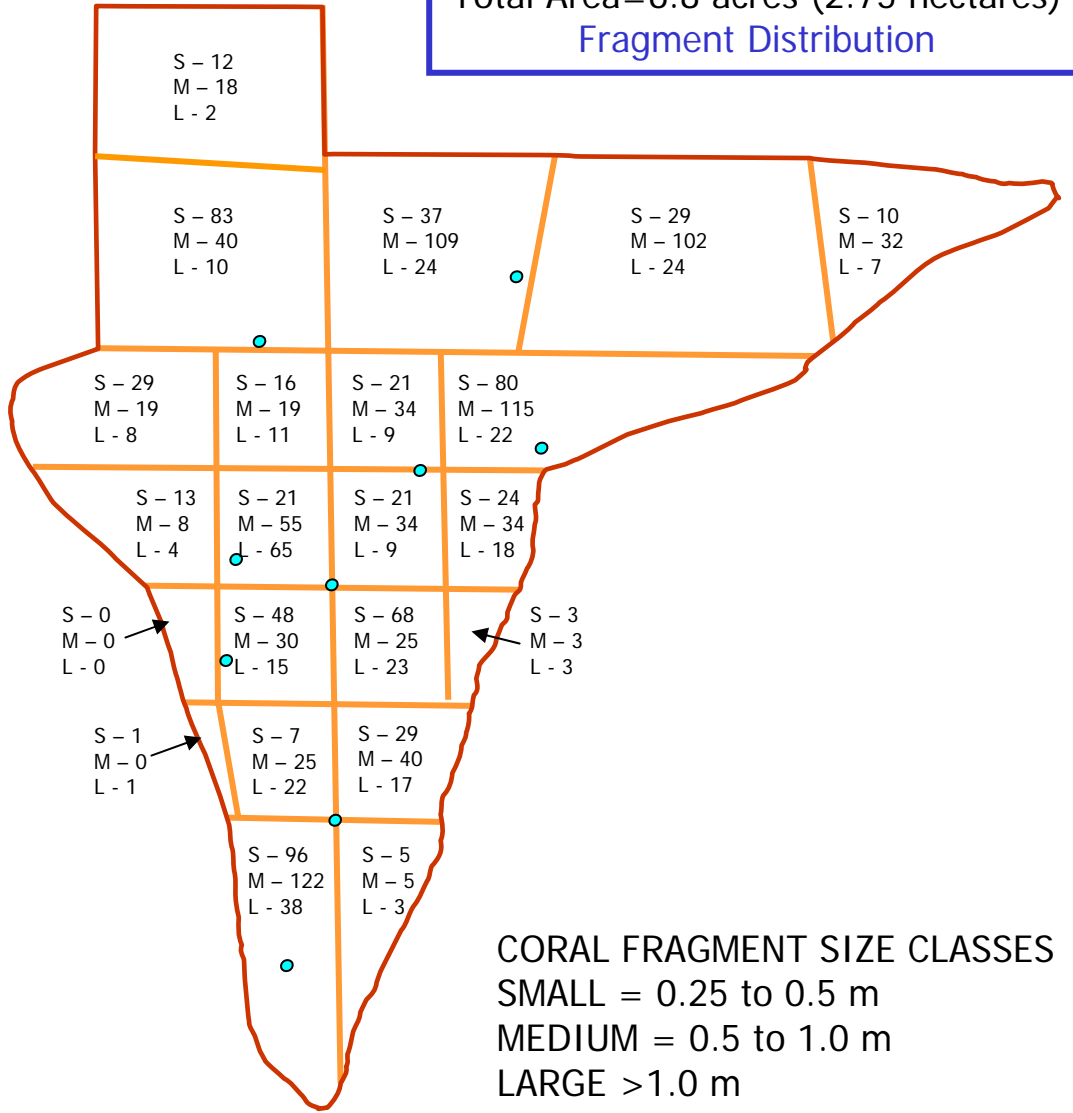
Control Area Available: Undamaged elkhorn coral near grounding. Sept. '97

24 Sept-14 October 1997

- Stabilized 1857 *A. palmata* fragments
 - Min: 15 cm/Max: 3.4 m
 - Affixed to reef substrate or standing dead
 - Reattached upright or upside down
 - “Control” fragments left in sand (rebar)
- Monitoring plan (limited)
- Mid course correction (2003)



MONA ISLAND
 FORTUNA REEFER DAMAGE SITE
 Total Area=6.8 acres (2.75 hectares)
 Fragment Distribution



S - 171
 M - 301
 L - 67
TOTAL - 539

S - 344
 M - 376
 L - 187
TOTAL - 907

S - 138
 M - 192
 L - 81
TOTAL - 411

S - 653
 M - 869
 L - 335
TOTAL - 1857

CORAL FRAGMENT SIZE CLASSES
 SMALL = 0.25 to 0.5 m
 MEDIUM = 0.5 to 1.0 m
 LARGE >1.0 m

Restoration Success



Monitoring Restoration Effectiveness:

- Document coral survival/health, etc
- Understand natural conditions (control)
- Assess habitat value (reef fish community)

Methods: Taxa

Stony Corals

- abundance and diversity
- size frequency (L x W x H)
- amount of mortality (recent and old)
- cause of mortality (disease, predation, etc.)

Other Benthic Organisms (e.g., Gorgonians)

Algae

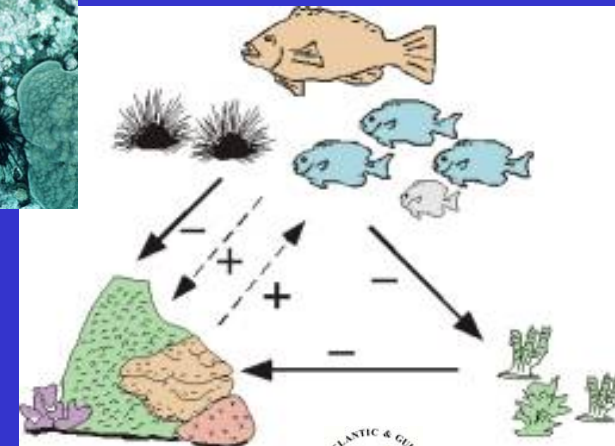
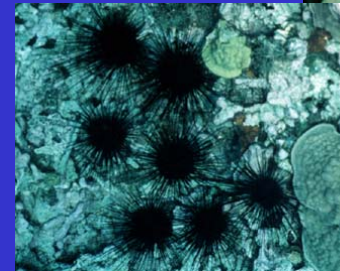
- turf, coralline, macroalgae

Reef Fishes

- abundance & size
- complete assemblage
- commercially and ecologically important

Key macro-invertebrates

- urchins, lobsters, gastropods, octopus, crabs



Benthic Monitoring Approaches

Fragment Survival and Growth

- Original mapped position
 - Survival, growth, fused, protobranches
 - Disease, predators, competitors

Belt Transect (line intercept and point intercept methods)

- Each coral that touches the line* (10 cm or larger):
 - Record coral (organism) to species
 - Measure diameter and height
 - Mortality: % old, % recent
 - Identify cause of recent mortality
- Tally total # of each species smaller than 10 cm
 - If they are not 100% live, record same parameters as above



Fish Monitoring Approaches

Belt Transects 30 x 2 m

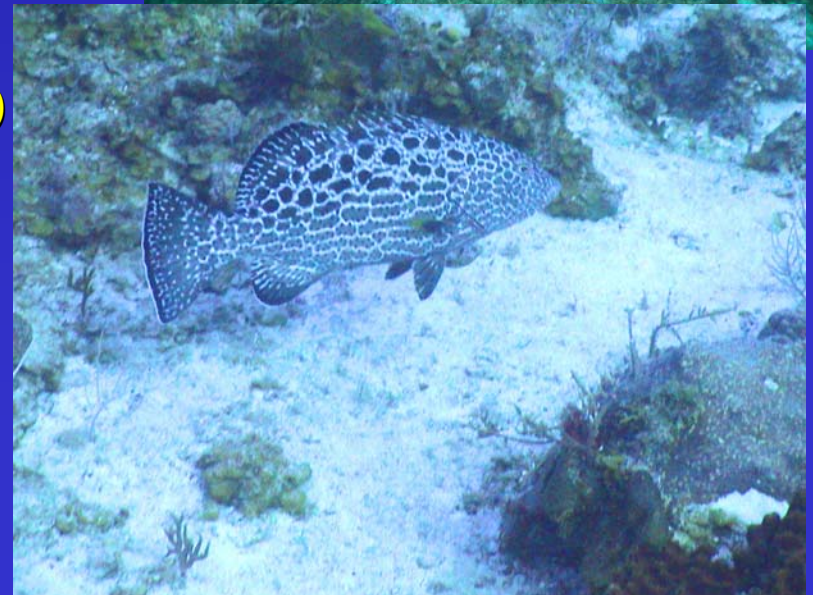
- Modified AGRRA protocol
 - Fishery spp
 - Ecologically important spp
- Paired

Point Counts

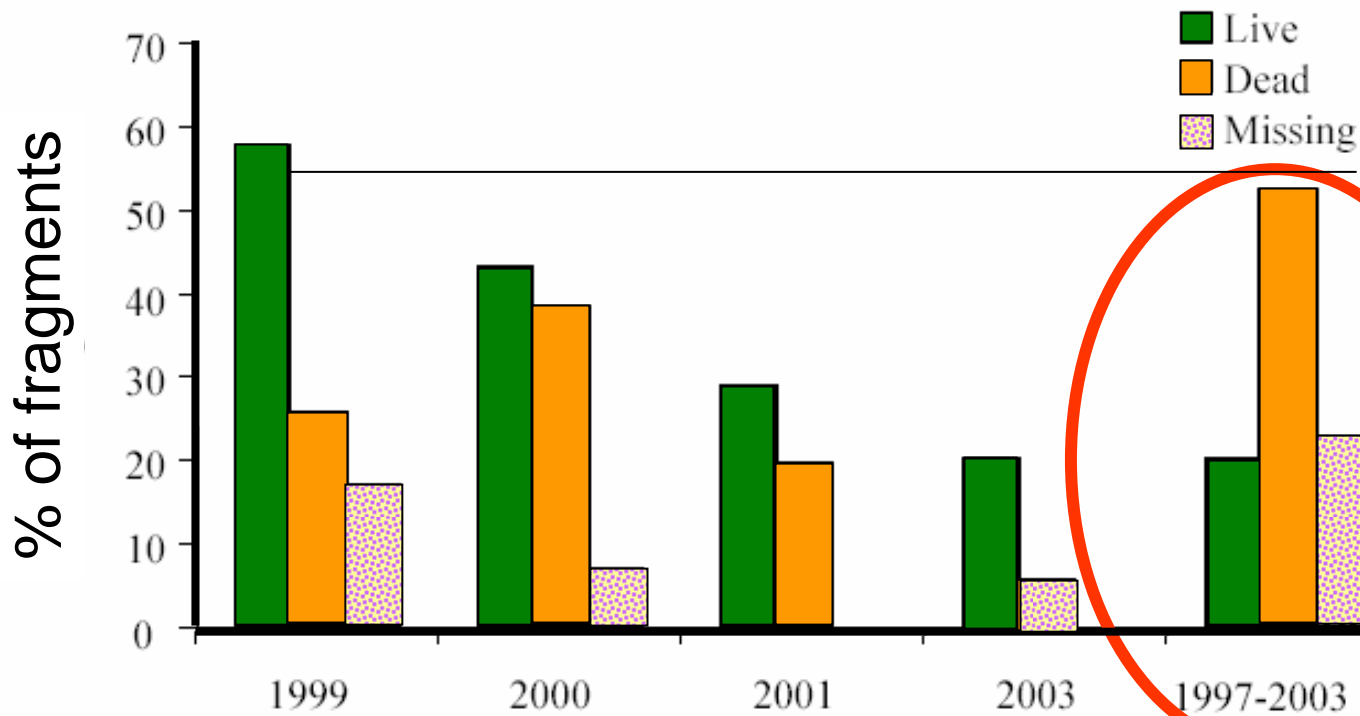
- Bohnsack & Bannerot (Bortone mod.)
- Diurnal, non-cryptic species

Roving Diver Surveys

- 5 min. between other surveys
- Elusive species



Fortuna Reefer Restoration- Fragment fates



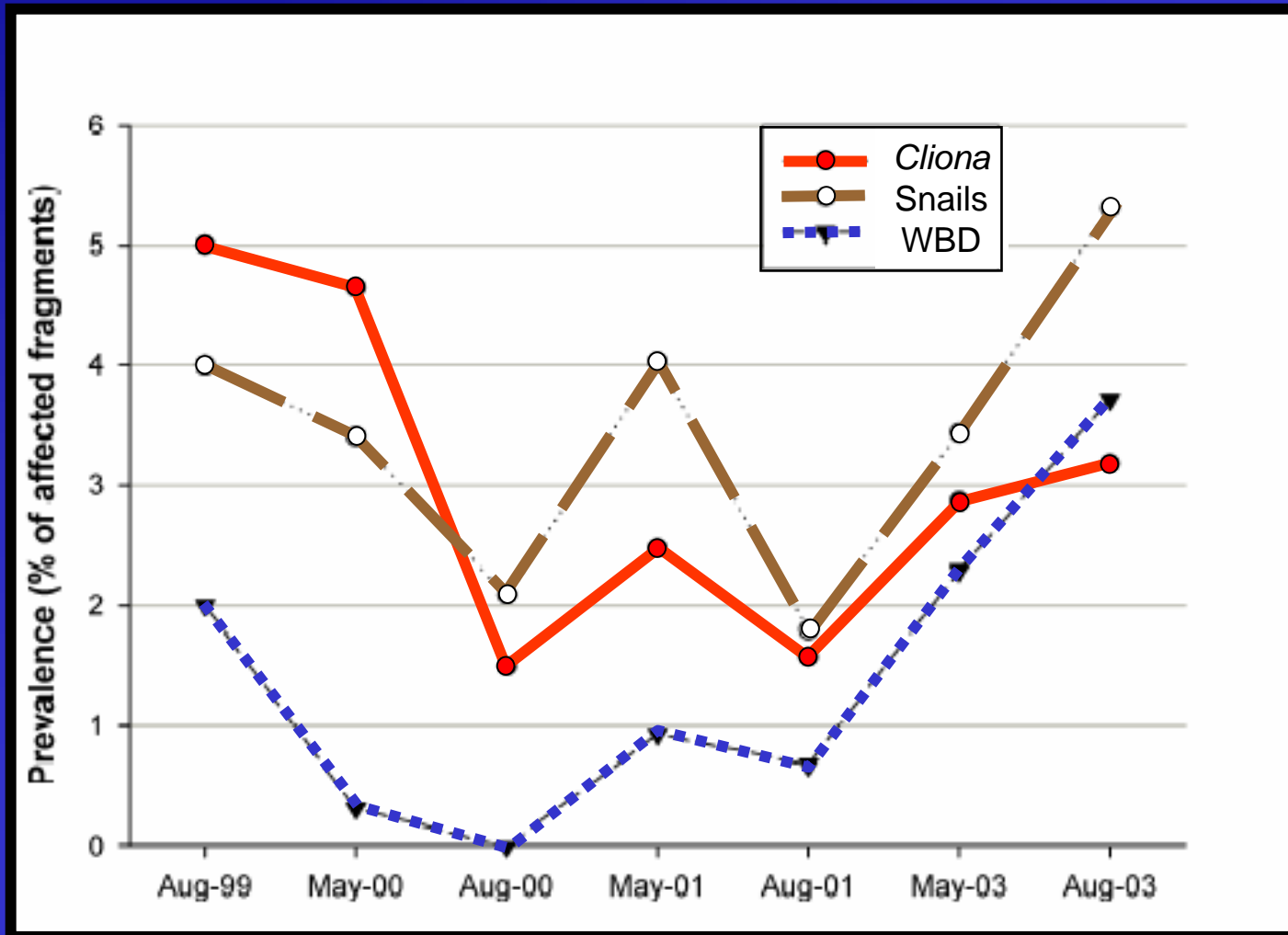
* Prior to the midcourse correction

Fortuna Reefer (fragment conditions) Aug 2003

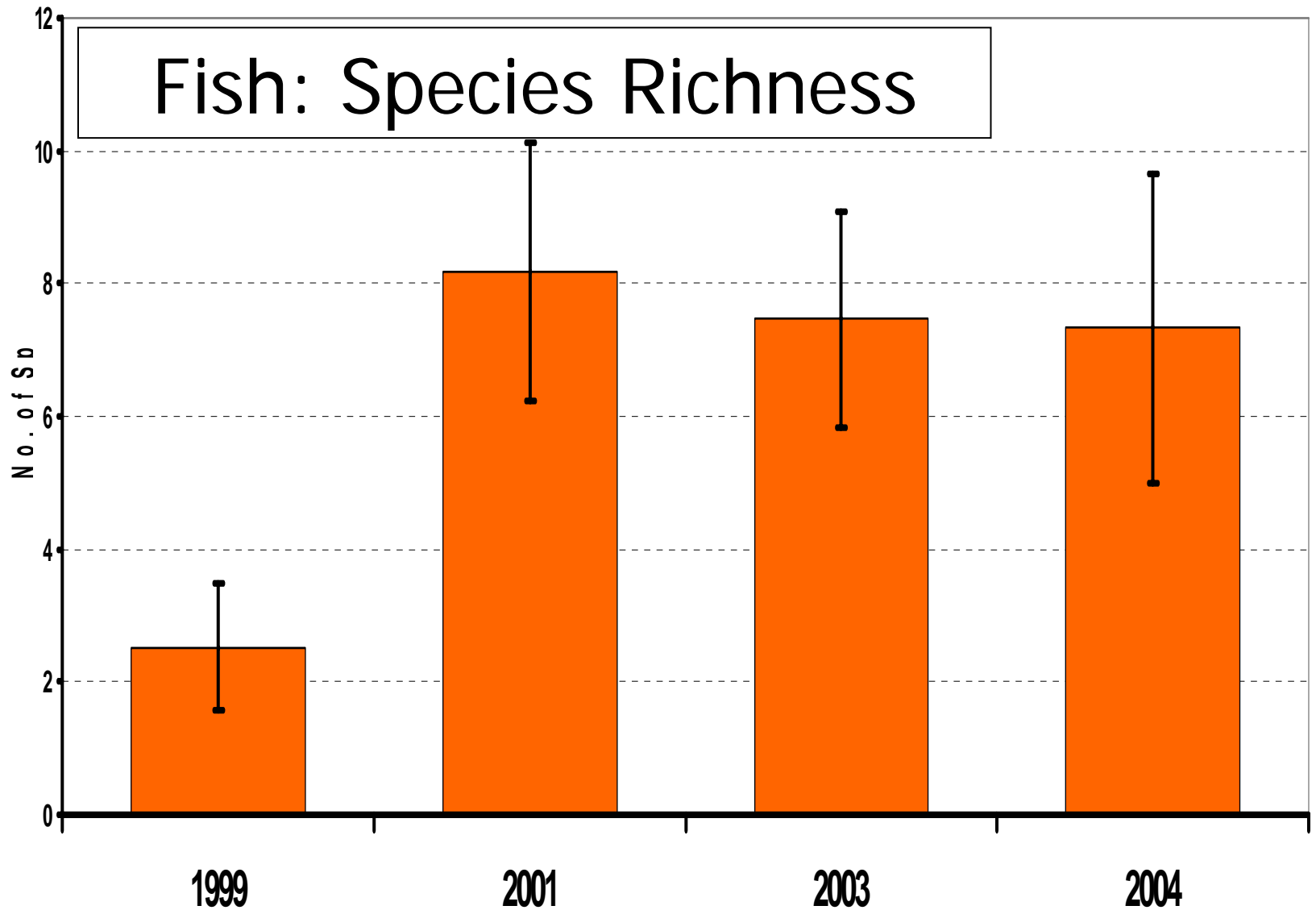
Live fragments	377	41% of original
Protobranchs	218	58% of live fragments
Protobranch length (cm)	21.5	se=0.96
Protobranch number	1-30	mean=4.4
Fusion	114	30%
Partial Mortality (old)	39.6%	
Partial mortality (recent)	0.6%	
Disease (WBD)	13	3.4%
Snails	19	5.0%
<i>Cliona</i> overgrowth	11	2.9%



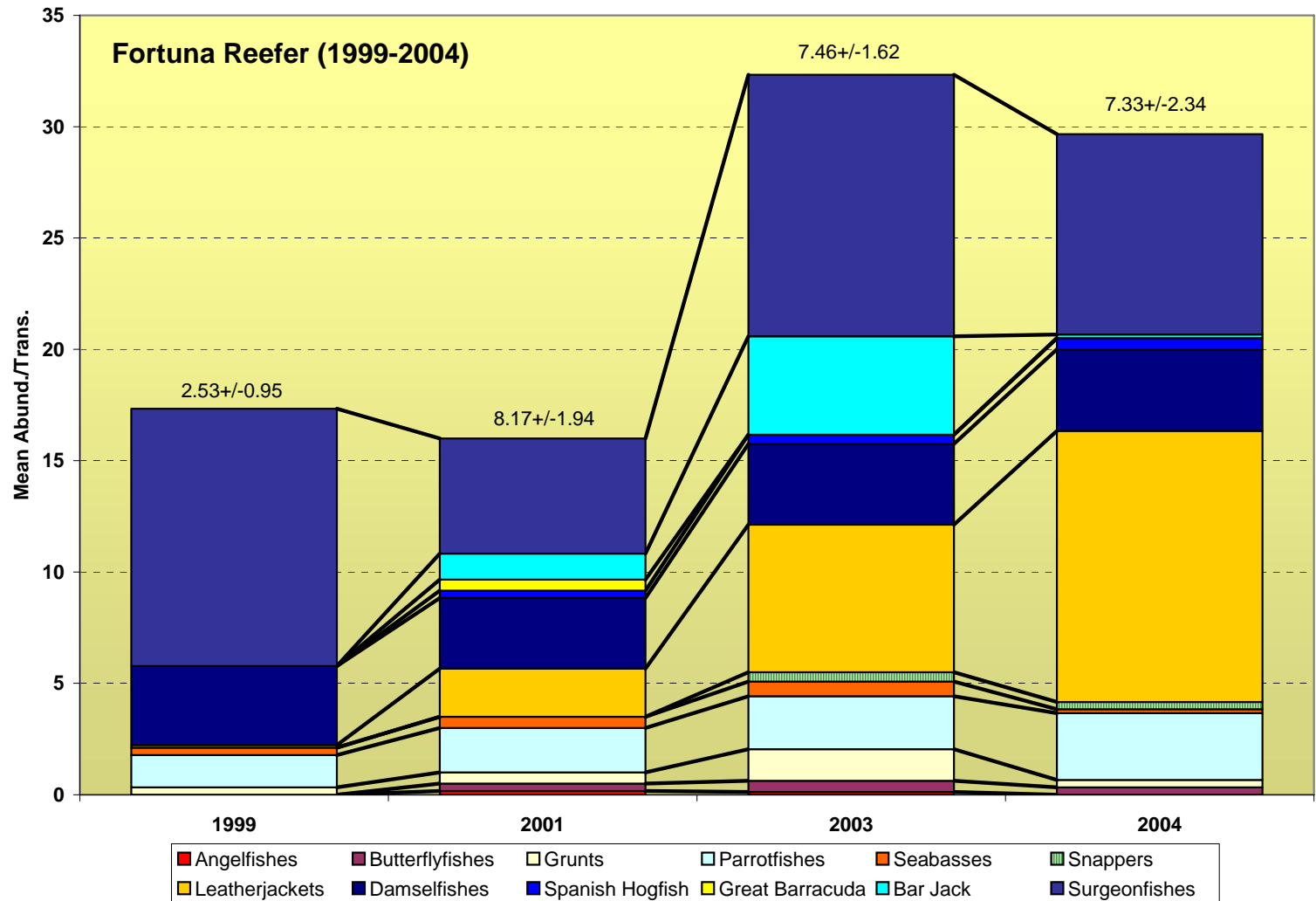
Restoration Success- Natural or Unnatural Causes



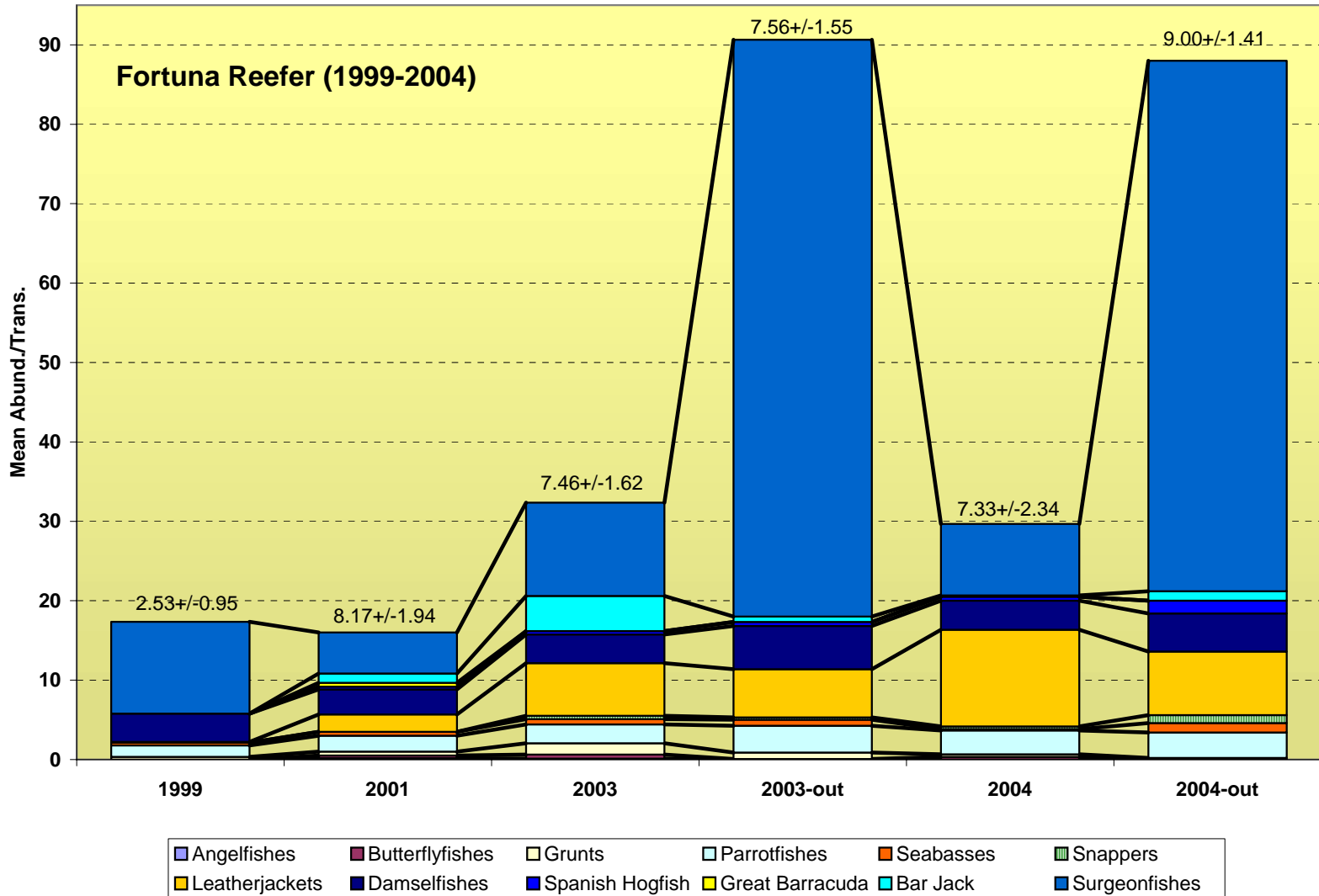
Fish: Species Richness



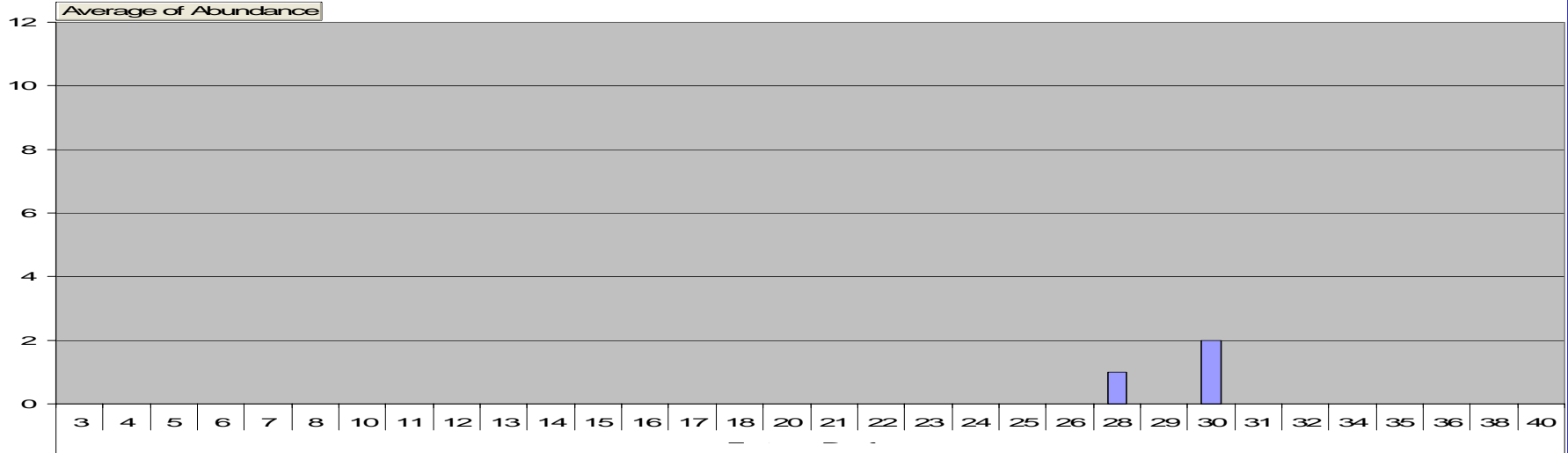
Fortuna Reefer Restoration-Temporal



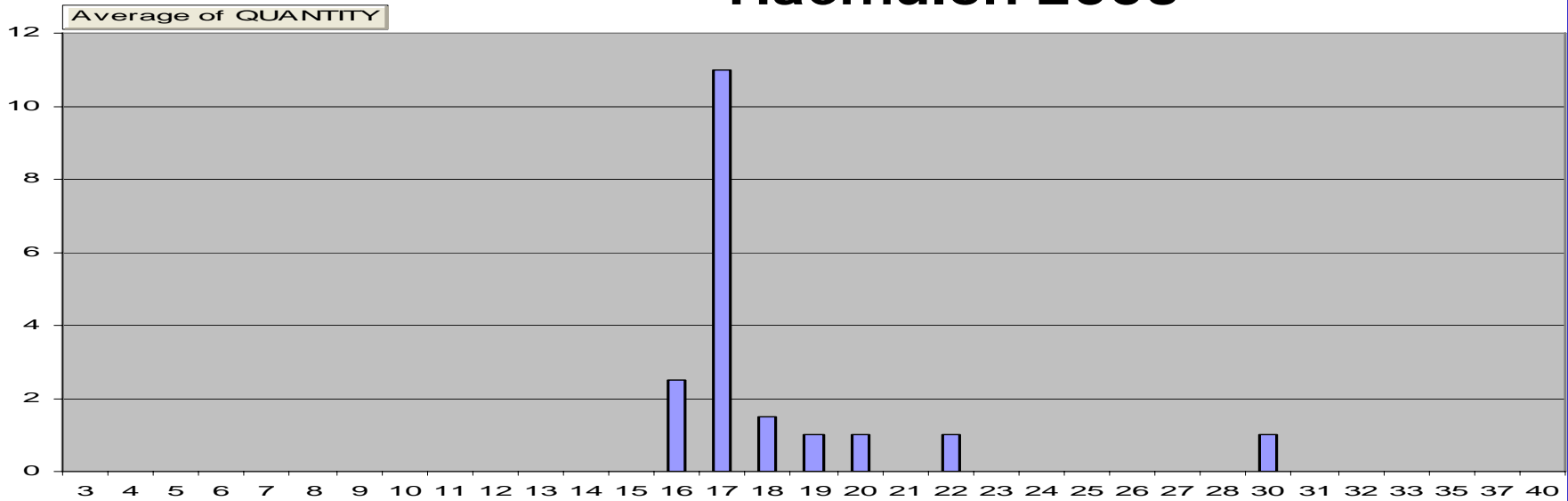
Fortuna Reefer In vs Out



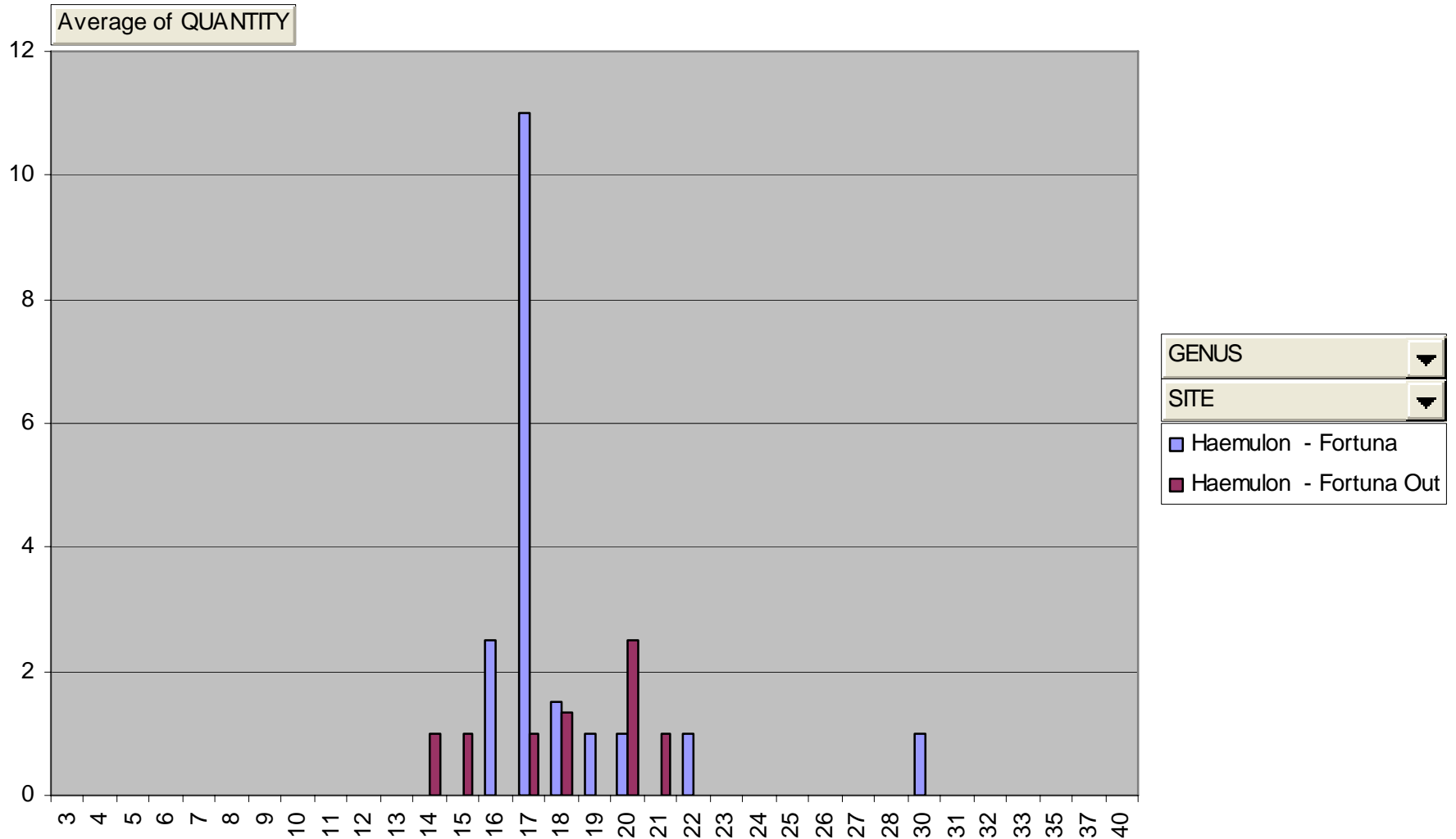
Haemulon 2001



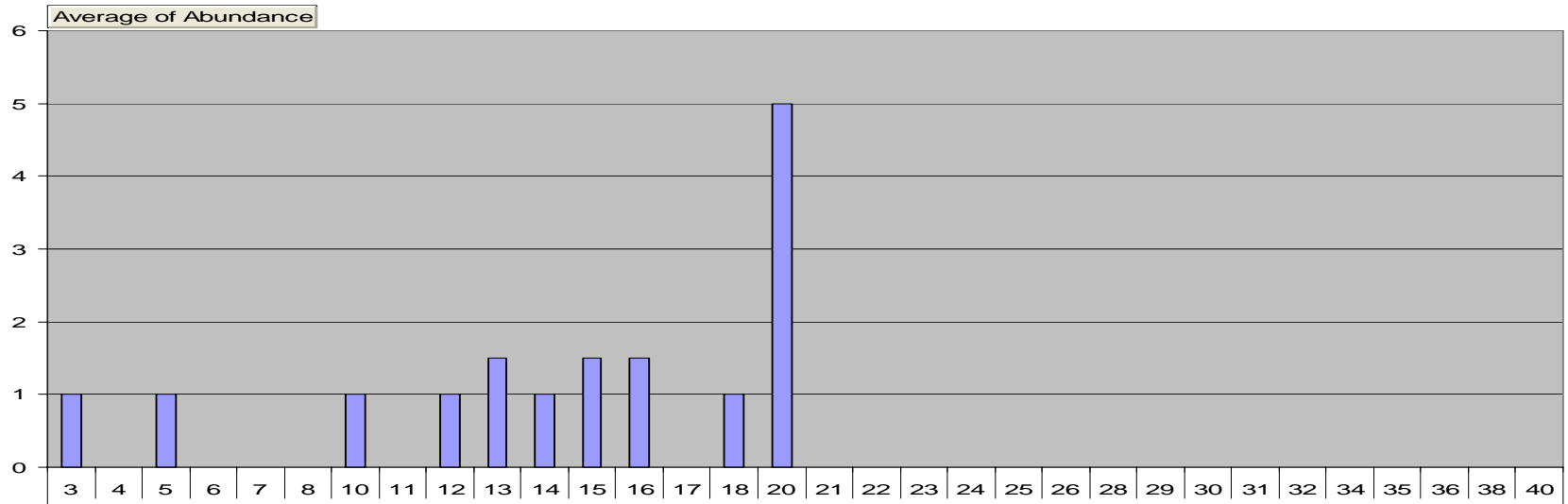
Haemulon 2003



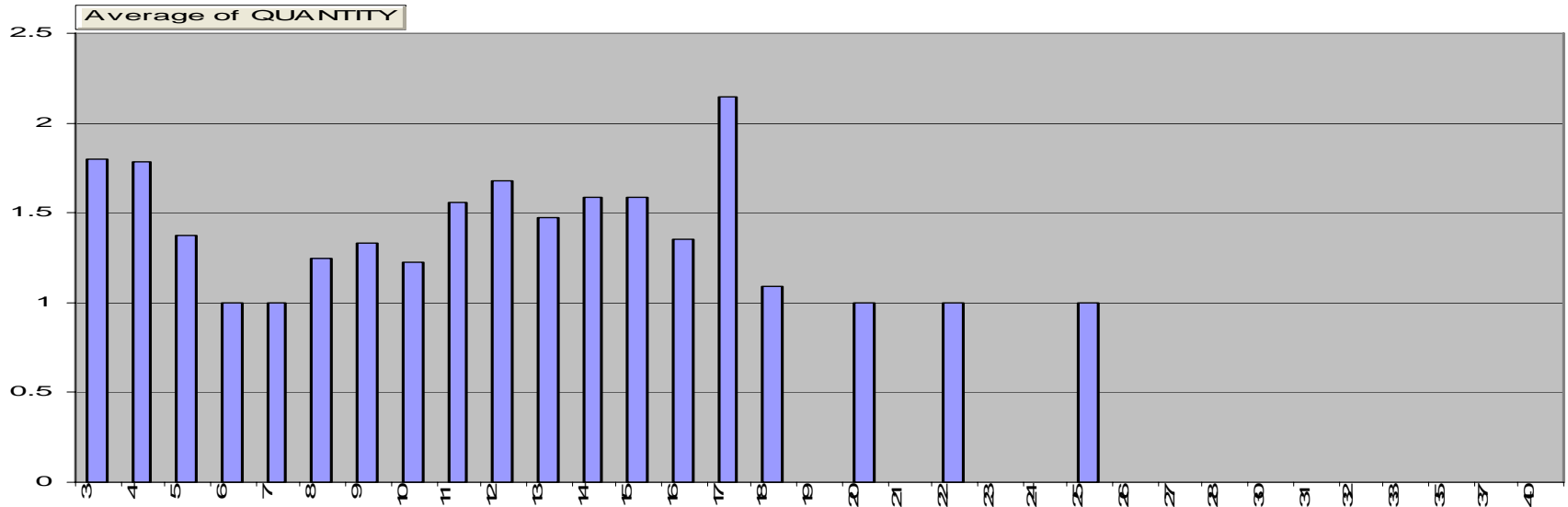
Haemulids 2003



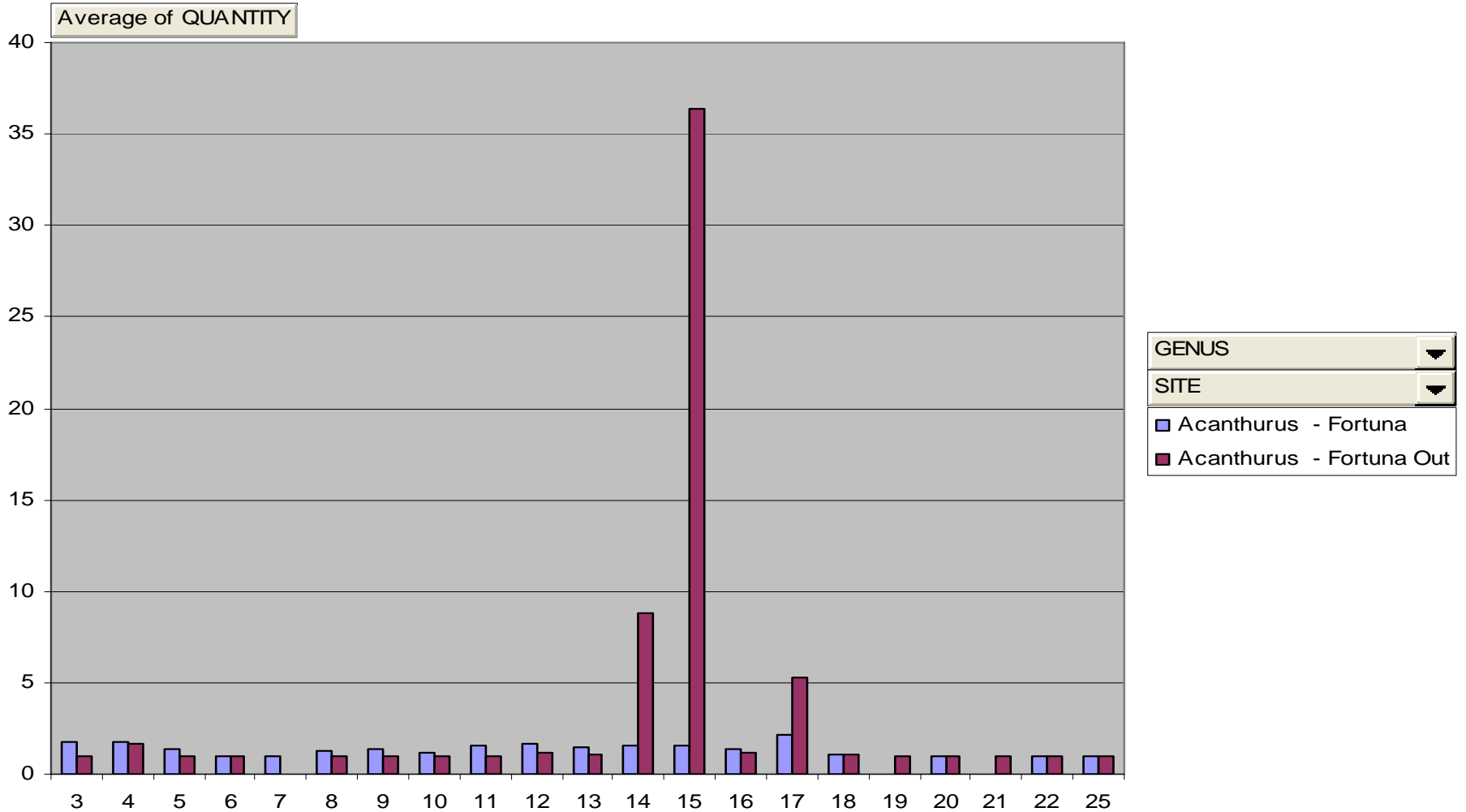
Acanthurus 2001



Acanthurus 2003

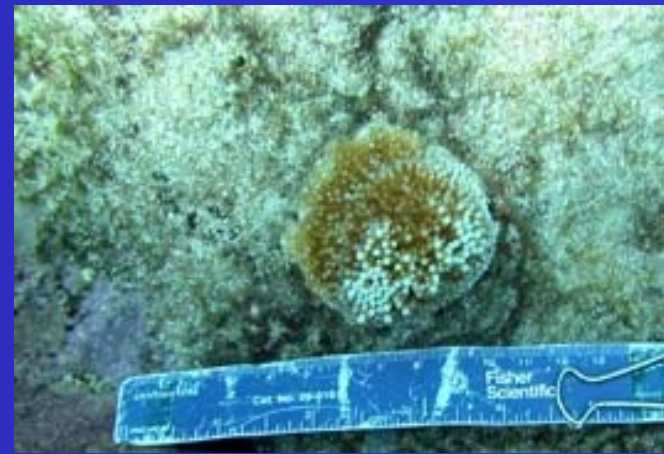


Acanthurids 2003



Restoration Science

- Many coral fragments failed to fuse
- Coral unable to grow over wire/wire failure
- Corals outcompeted by *Cliona*
- Predation and fragment loss
- Mortality greatest in deeper water especially among fragments attached to *A. palmata* skeletons
- Year 4-5
 - Shift to growth of protobranches
 - Increasing fish abundance (habitat value)
- On-going research and analysis needed
 - Fish contribution
- Threats present: Snails, White band disease
- Restoration sites are dynamic; seasonal & interannual variability; monitoring timeframe important



Partners

NOAA Fisheries

- SEFSC-Galveston
- Office of Habitat Conservation
 - Ecosystem Assessment Division
 - Restoration Center

University of Puerto Rico-Mayagüez

- Dr. Richard Appeldoorn, professor
- Numerous graduate students

PR Dept of Natural and Environmental Resources

- Div. of Sanctuaries and Reserves (R. Matos)
- Mona Biological Station

Mona Aquatics (Boqueron) Dive Center

- Paco García

