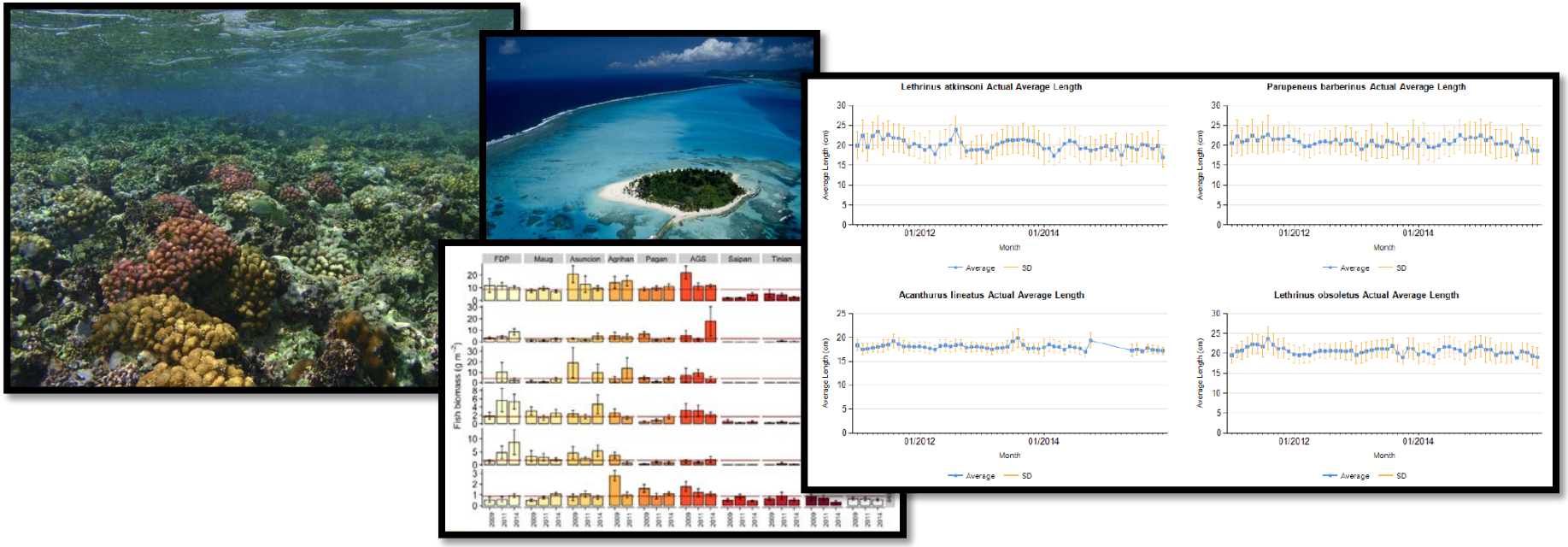
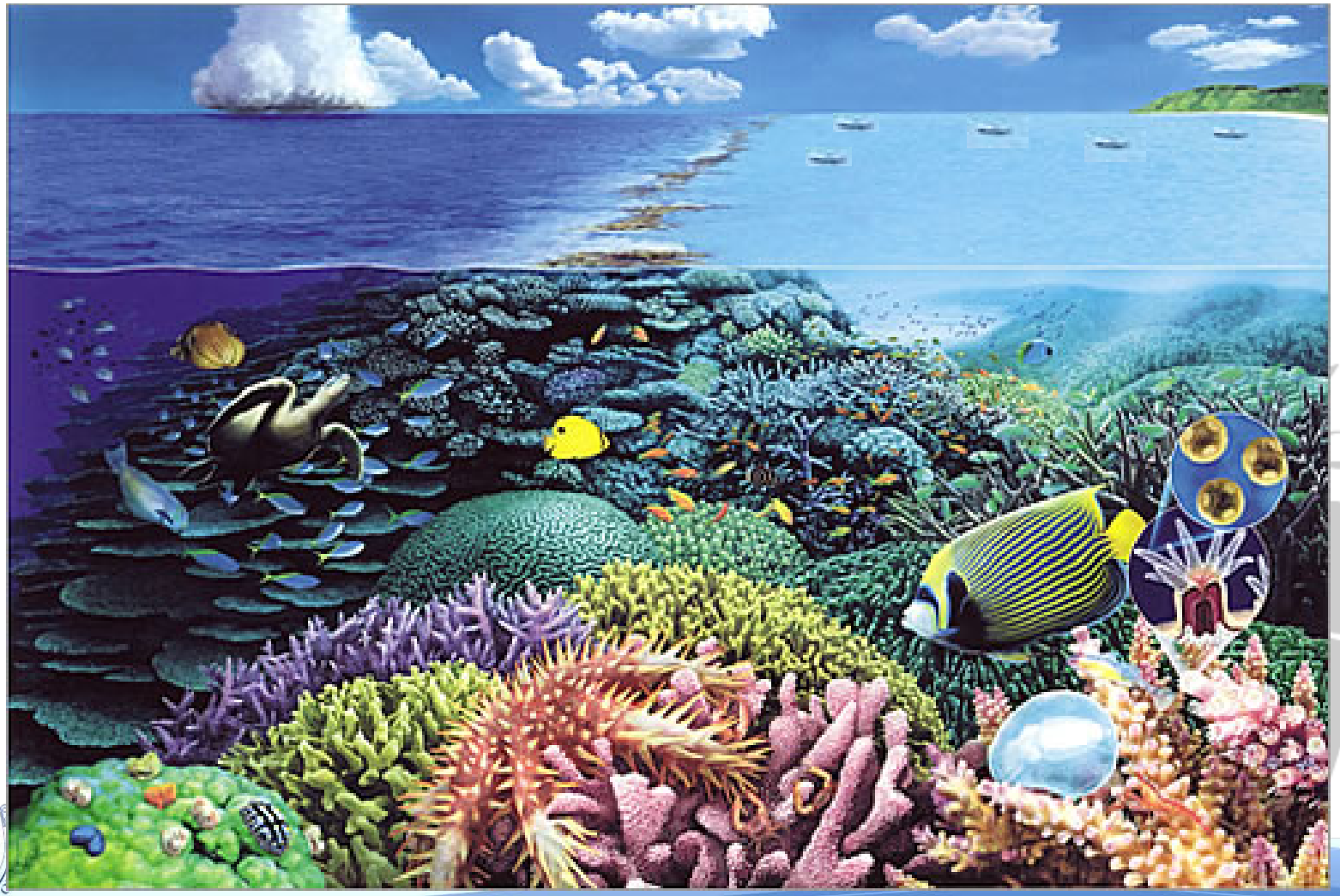


Marianas Reef Fishery Sustainability – What do we know so far?

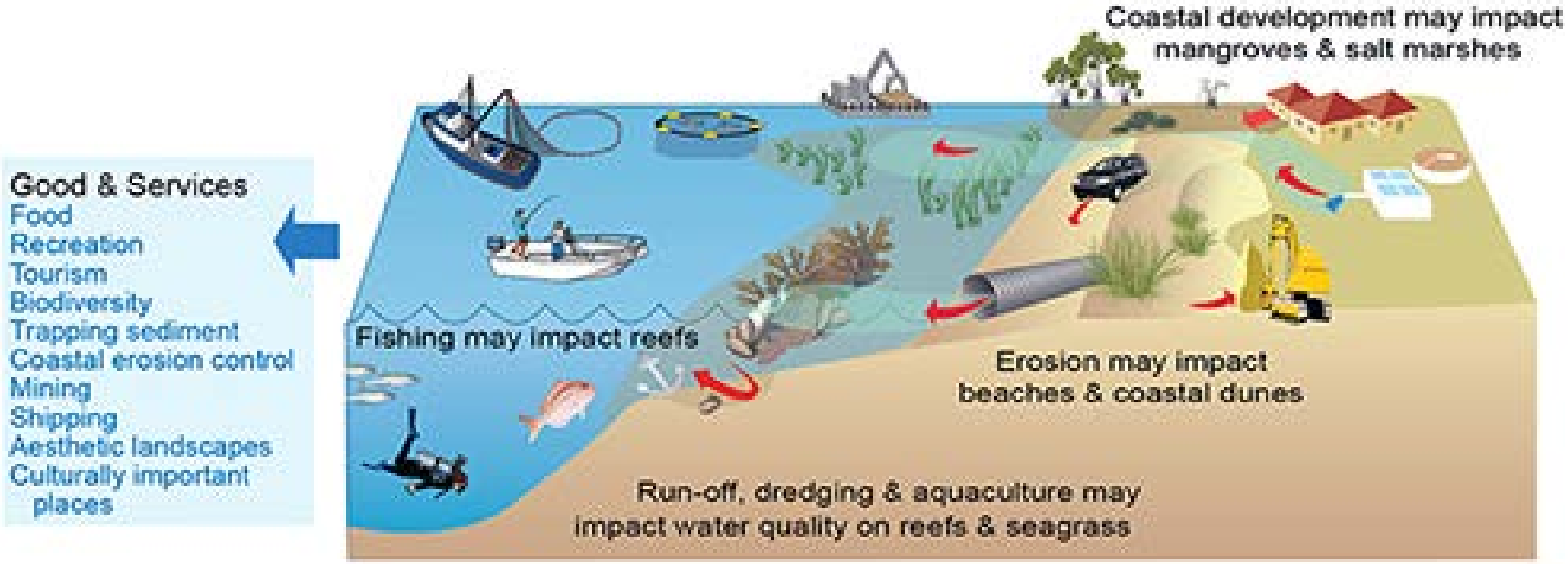
MARLOWE SABATER
1164 Bishop St. Suite 1400, Honolulu HI 96813

36th Meeting of the U.S. Coral Reef Task Force
September 23, 2016
Hyatt Regency, Guam

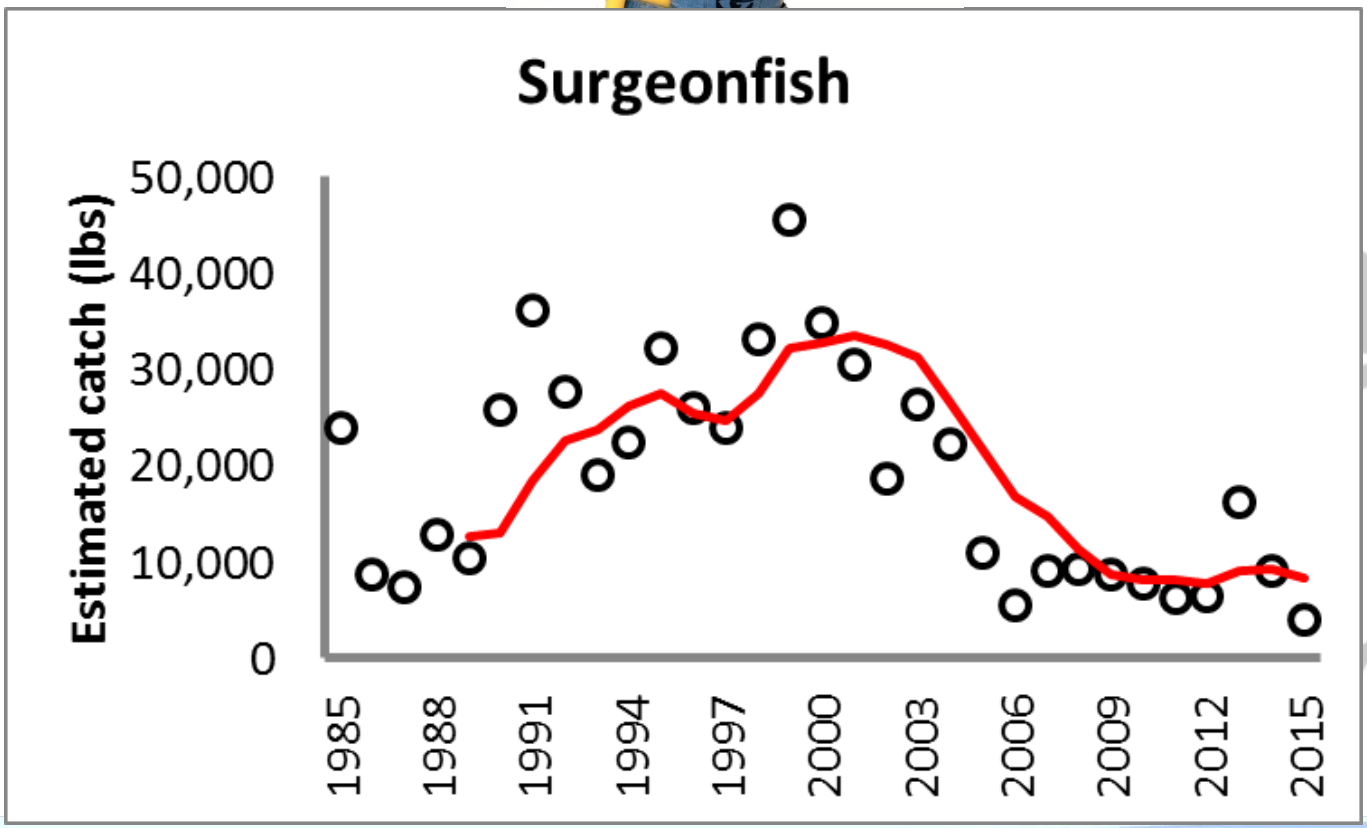
Coral reef ecosystem and fisheries



Ecosystem health

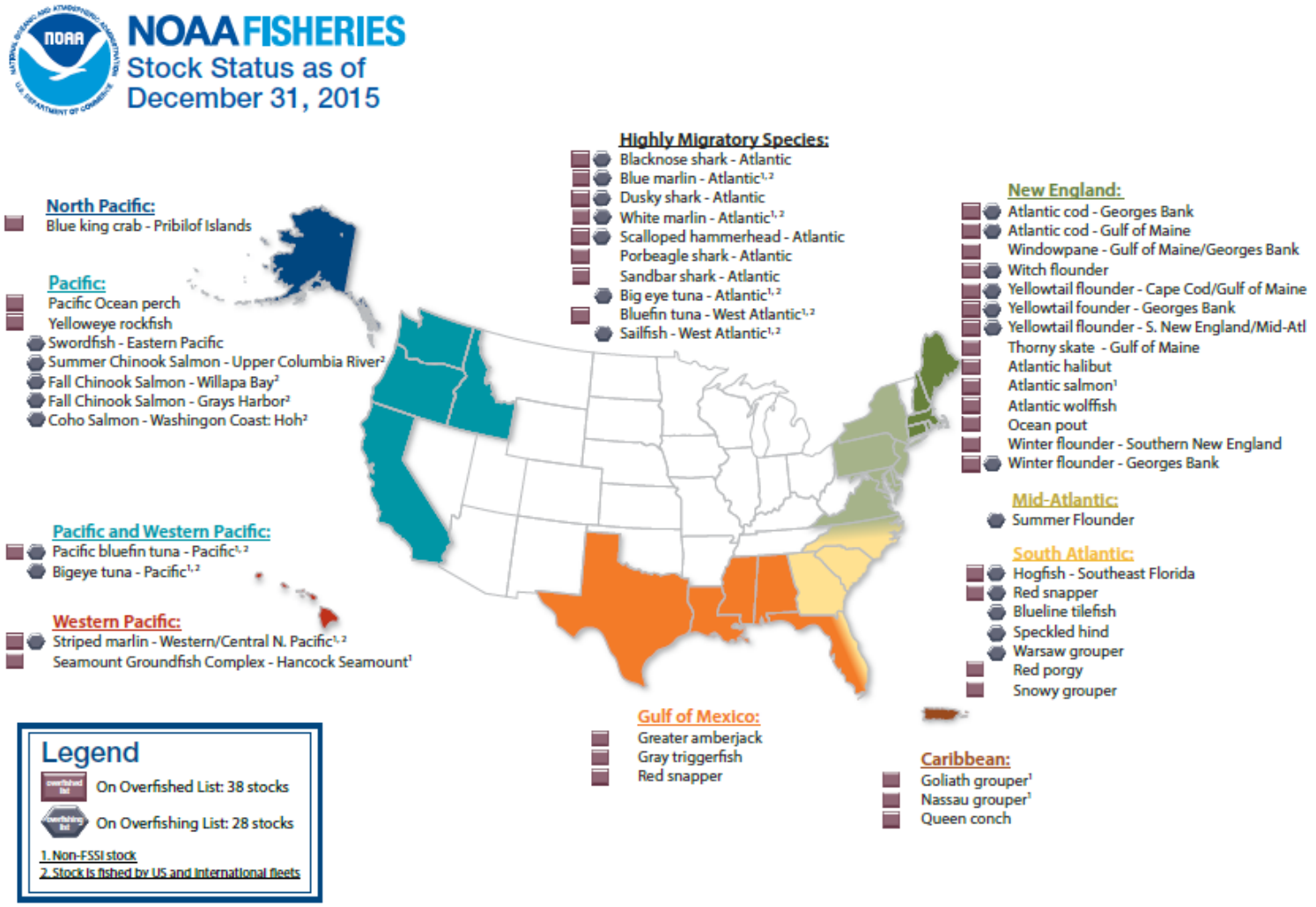


BEE-DO BEE-DO
BEE-DO BEE-DO




Biological Overfishing
So many taken out they make baby slower
Recruitment overfishing
not enough fish to make baby fish
Over Fishing
fishing to much
Growth Overfishing
more fish being caught less fish being born
Ecosystem Overfishing
when so many are taken it affects the ecosystem

Stocks: overfished & overfishing



Stock assessment recipe

With Fishing

- Basic Equation

$$\frac{dB}{dt} = rB\left(1 - \frac{B}{K}\right) - qEB$$

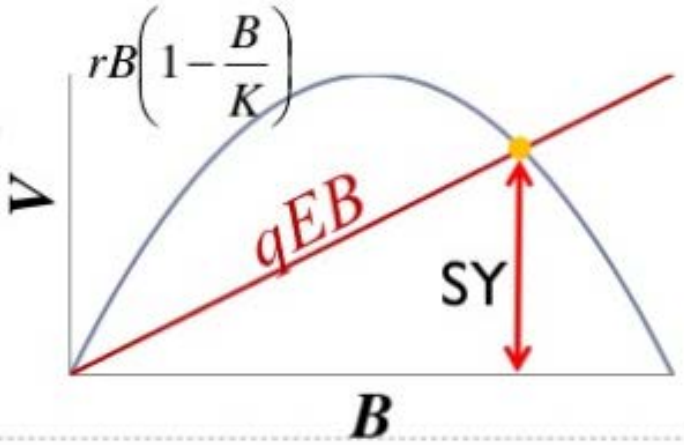
- r: intrinsic growth rate
  B:Biomass
  K:Carrying Capacity
  q:Catchability Coefficient
  E:Fishing Effort

$$u = Y_e / X = q\bar{P}$$

$$\bar{P} = u / q$$

- At Sustainable Yield
- $\frac{dB}{dt} = 0$

$$SY = qEB = rB\left(1 - \frac{B}{K}\right)$$



How would you know the status of the stock?

CPUE and *E at equilibrium*

$$Y = qEB = rB\left(1 - \frac{B}{K}\right)$$

$$qE = r\left(1 - \frac{B}{K}\right)$$

$$\frac{qE}{r} = 1 - \frac{B}{K}$$

$$\frac{B}{K} = 1 - \frac{qE}{r}$$

$$B = K\left(1 - \frac{qE}{r}\right)$$

$$Y = qEB = qEK\left(1 - \frac{qE}{r}\right)$$

$$Y = qKE - \frac{q^2K}{r}E^2$$

$$\frac{Y}{E} = qK - \frac{q^2K}{r}E$$

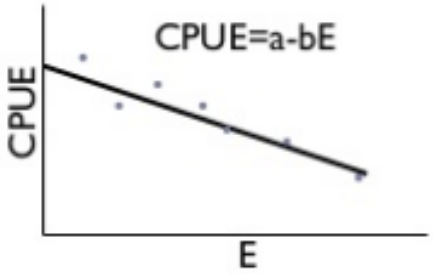
$$CPUE = qK - \frac{q^2K}{r}E$$

8

How would you know the status of the stock?

Estimation of MSY from CPUE

$$CPUE = a - bE$$



$$SY = qKE - \frac{q^2 K}{r} E^2$$

$$qK = a$$

$$CPUE = qK - \frac{q^2 K}{r} E$$

$$q^2 K / r = b$$

$$MSY = \frac{rK}{4} = \frac{(qK)^2}{4(q^2 K/r)} = \frac{a^2}{4b}$$

$$E_{MSY} = \frac{r}{2q} = \frac{1}{2}(qK)\left(\frac{r}{q^2 K}\right) = \frac{a}{2b}$$

$$\boxed{MSY = a^2/4b \qquad E_{MSY} = a/2b}$$

Marianas Fisheries

Coral Reefs
DOI 10.1007/s00338-011-0826-3

REPORT

Commercial coral-reef fisheries across Micronesia: A need for improving management

P. Houk · K. Rhodes · J. Cuetos-Bueno · S. Lindfield · V. Fread · J. L. McIlwain

Rev Fish Biol Fisheries (2015) 25:179–194
DOI 10.1007/s11160-014-9358-6

RESEARCH PAPER

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Javier Cuetos-Bueno · Peter Houk

Re-estimation of small-scale fishery catches for U.S. flag-associated island areas in the western Pacific: the last 50 years

Dirk Zeller (contact author)[1]
Shawn Booth[1]
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Current Biology 17, 655–658, April 3, 2007 DOI 10.1016/j.cub.2007.02.054

Report

Current and Future Sustainability of Island Coral Reef Fisheries

Biological Characteristics of the Spotcheek Emperor, *Lethrinus rubrioperculatus*, in the Northern Mariana Islands[1]

Michael S. Trianni[2]

Comparative demography of commercially important parrotfish species from Micronesia

B. M. Taylor*†‡ and J. H. Choat*

Age-based demographic and reproductive assessment of orangespine *Naso lituratus* and bluespine *Naso unicornis* unicornfishes

B. M. Taylor*†, K. L. Rhodes‡, A. Marshell§ and J. L. McIlwain||

Beyond abundance and biomass: effects of marine protected areas on the demography of a highly exploited reef fish

Brett M. Taylor*, Jennifer L. McIlwain

Reconciling conservation agenda & fishery management

Magnuson-Stevens Fishery Conservation and Management Act

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

Reconciling conservation agenda & fishery management

A simple method for estimating MSY from catch and resilience

Steven Martell[1] *& Rainer Froese*[2]

chapter eleven

Augmented catch-MSY approach to fishery management in coral-associated fisheries

Marlowe Sabater and Pierre Kleiber

An integrated Catch-MSY model for data poor stocks

Steven Martell

Biomass-augmented Catch-MSY

SOURCE: Martell and Froese 2012; Sabater and Kleiber 2014

b_t = biomass in year t
b_0 = biomass at start
c_t = catch in year t

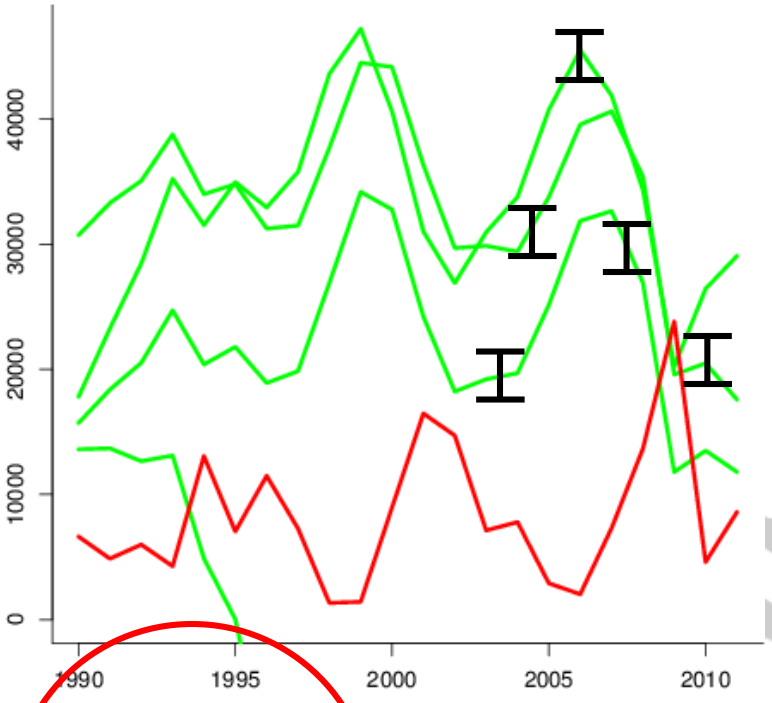
Schaefer Model

$$b_{t+1} = \left[(b_t + r b_t(1 - \frac{b_t}{k}) - c_t\right] e^{x_t}$$

Biomass trajectories (green lines) depend on parameters

Task is to find workable combinations of *r* and *k* values which are chosen from reasonable priors and can accommodate the catch series while keeping biomass within set boundaries

These combinations give a list of possible MSY values from which we get a mean or median and distribution for MSY



$$\text{MSY} = \frac{rk}{4}$$

Analyses with Real Data

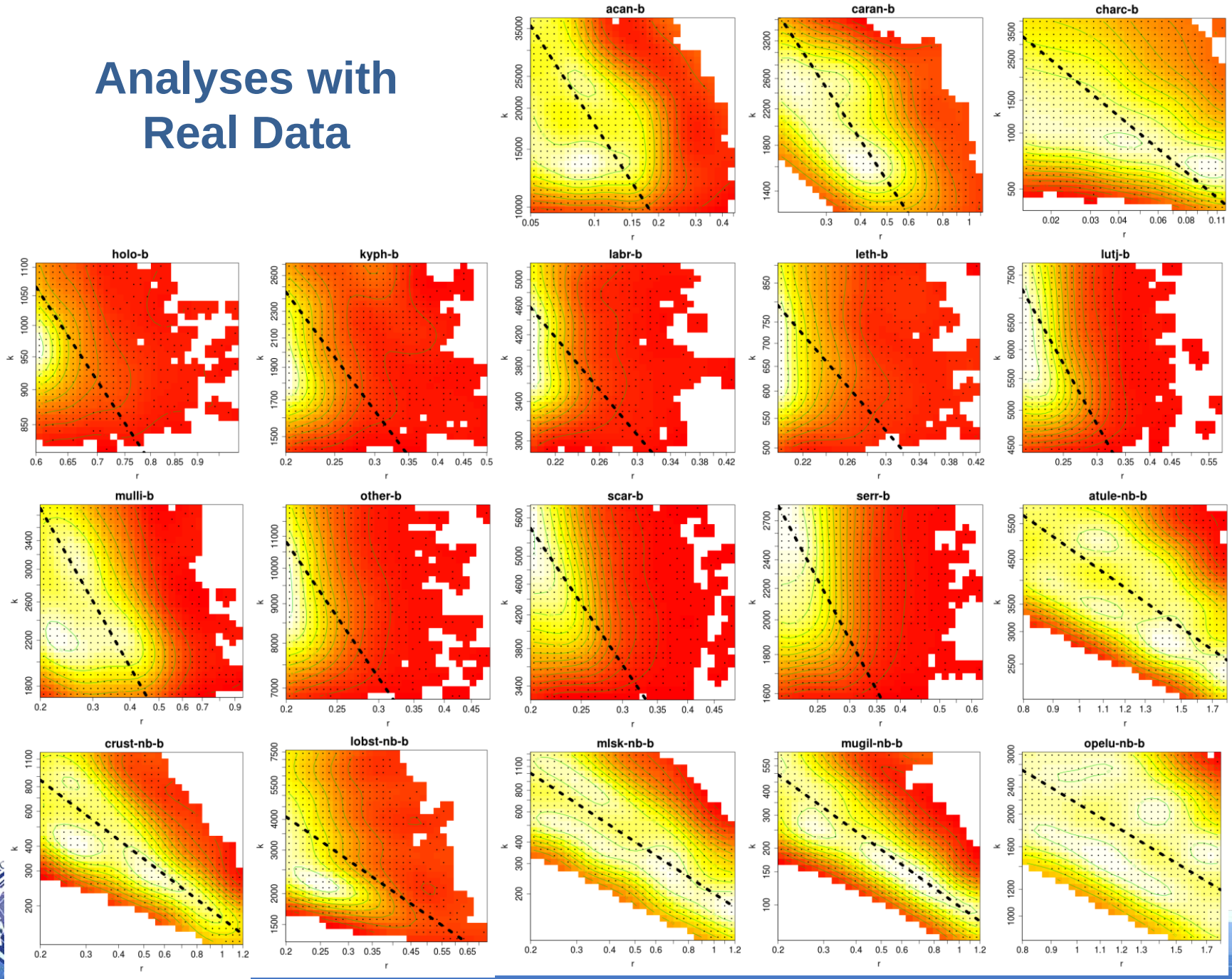
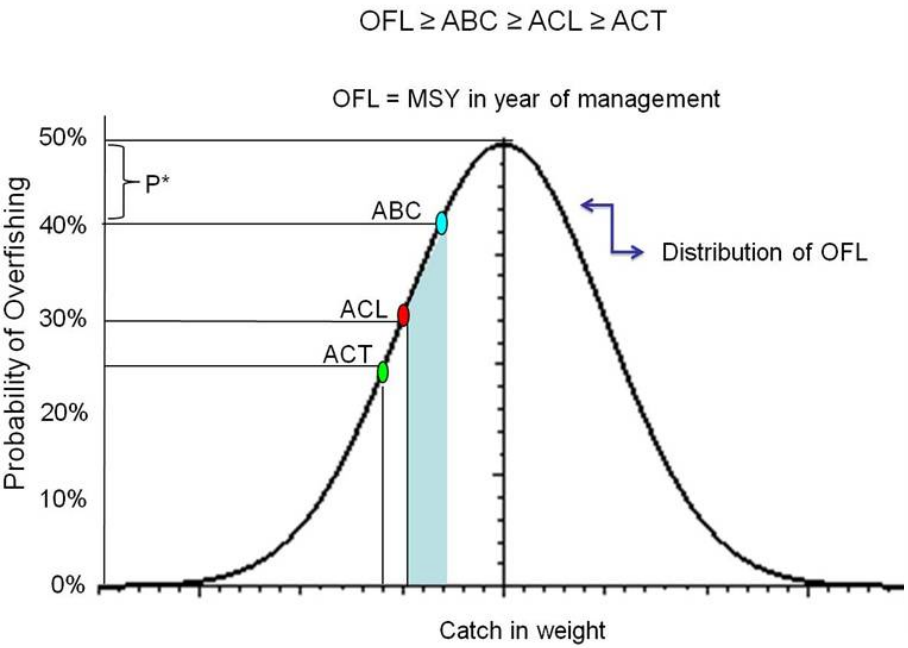
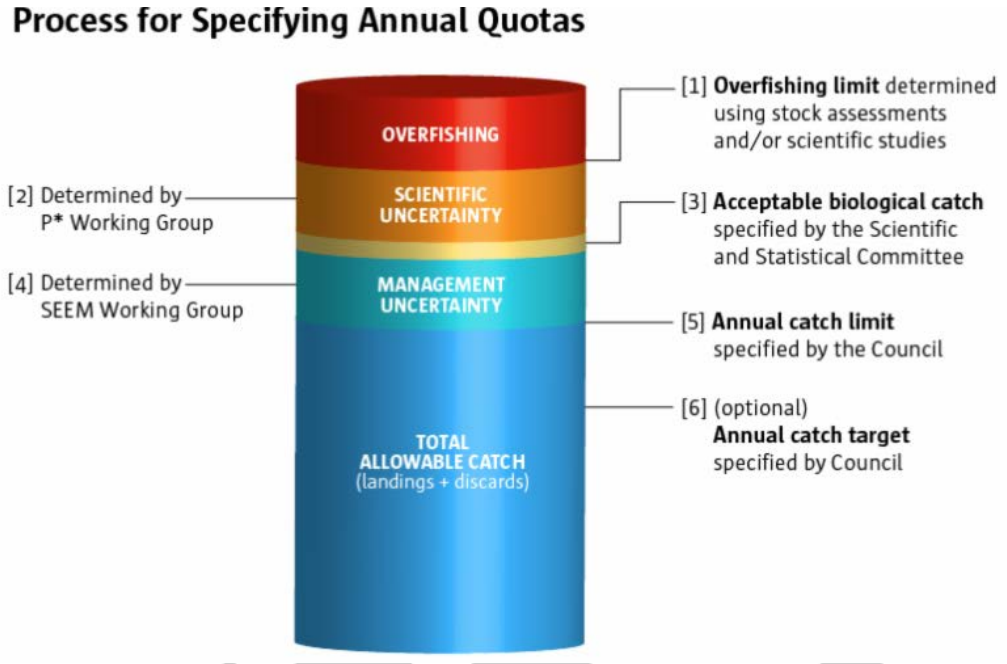


Table 44. Best available MSY estimates for the coral reef MUS in Guam

Coral Reef MUS Complex	MSY (lbs)
Selar crumenophthalmus – atulai or bigeye scad	61,300
Acanthuridae – surgeonfish	118,000
Carangidae – jacks	31,700
Crustaceans – crabs	8,600
Holocentridae – squirrelfish	13,900
Kyphosidae – chubs/rudderfish	10,300
Labridae – wrasses[1]	28,500
Lethrinidae – emperors	78,000
Lutjanidae – snappers	21,800
Mollusks – turbo snail; octopus; giant clams	29,000
Mugilidae – mullets	26,200
Mullidae – goatfish	16,400
Scaridae – parrotfish[2]	87,100
Serranidae – groupers	28,600
Siganidae – rabbitfish	19,700
All Other CREMUS Combined - Other CRE-finfish - Other invertebrates - Misc. bottomfish - Misc. reef fish - Misc. shallow bottomfish	211,300
Cheilinus undulatus – humphead (Napoleon) wrasse	N.A.
Bolbometopon muricatum – bumphead parrotfish	N.A.
Carcharhinidae – reef sharks	2,900

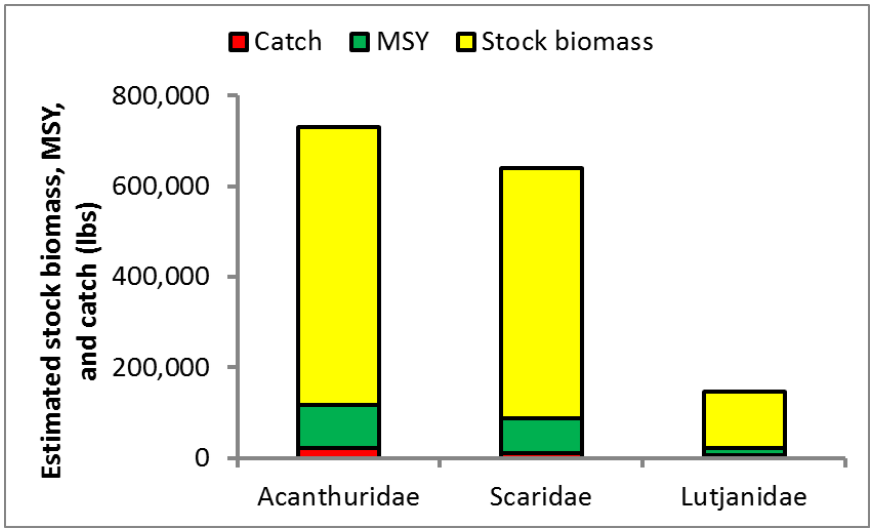
Biomass-augmented Catch-MSY

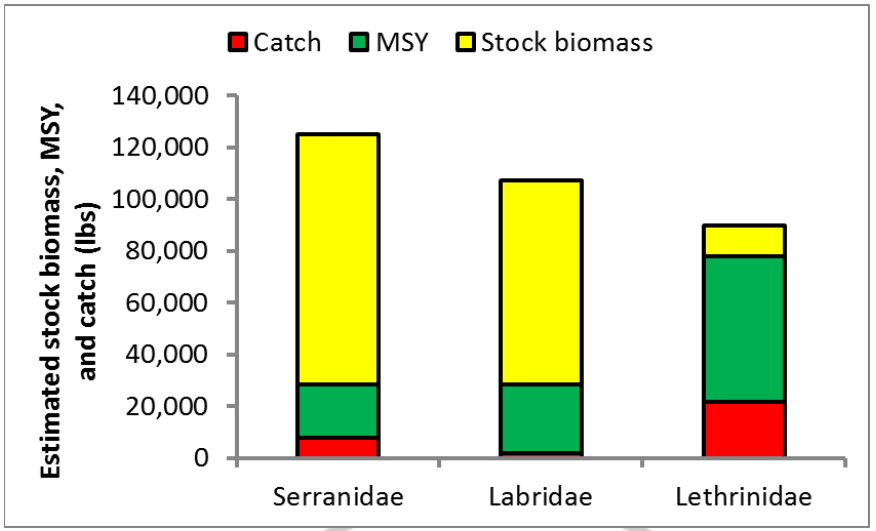


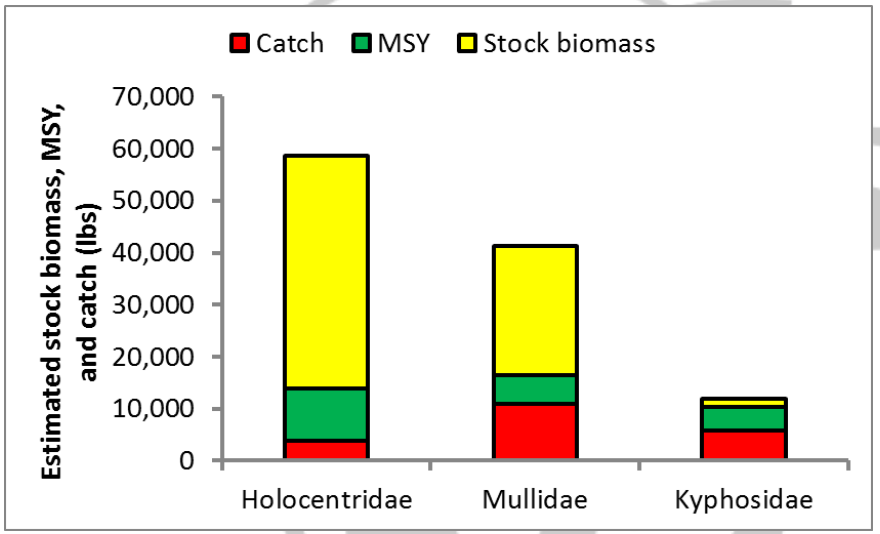


CREMUS Groupings - GUAM	MSY	OFL	ABC	ACL
Selar crumenophthalmus – atulai	61,300	60,800	52,300	50,200
Acanthuridae – surgeonfishes	118,000	114,700	101,700	97,600
Carangidae – jacks	31,700	32,200	29,900	29,300
Carcharhinidae – reef sharks	2,900	2,900	2,000	1,900
Crustaceans - crabs	8,600	8,600	7,600	7,300
Holocentridae – squirrelfishes	13,900	13,800	12,000	11,400
Kyphosidae – rudderfishes	10,300	10,300	9,800	9,600
Labridae – wrasses[1]	28,500	28,200	25,800	25,200
Lethrinidae – emperors	78,000	76,600	58,000	53,000
Lutjanidae – snappers	21,800	20,700	18,600	18,000
Mollusks – turbo snail; octopus; giant clam	29,000	28,600	25,000	23,800
Mugilidae – mullets	26,200	24,500	19,400	17,900
Mullidae – goatfishes	16,400	16,300	15,600	15,300
Scaridae – parrotfishes[2]	87,100	86,500	75,000	71,600
Serranidae – groupers	28,600	27,400	23,700	22,500
Siganidae – rabbitfishes	19,700	19,200	18,800	18,600
Cheilinus undulatus	Unknown	Unknown	1,960	1,960
Bolbometopon muricatum	Unknown	Unknown	797	797
All Other CREMUS Combined	211,300	209,200	191,300	185,000

Standing stock-MSY-Catch: GUAM 2015



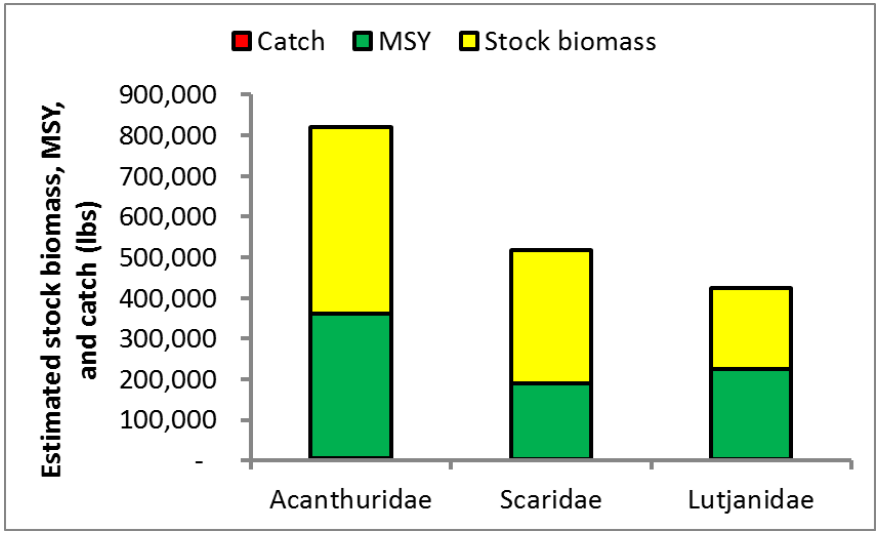


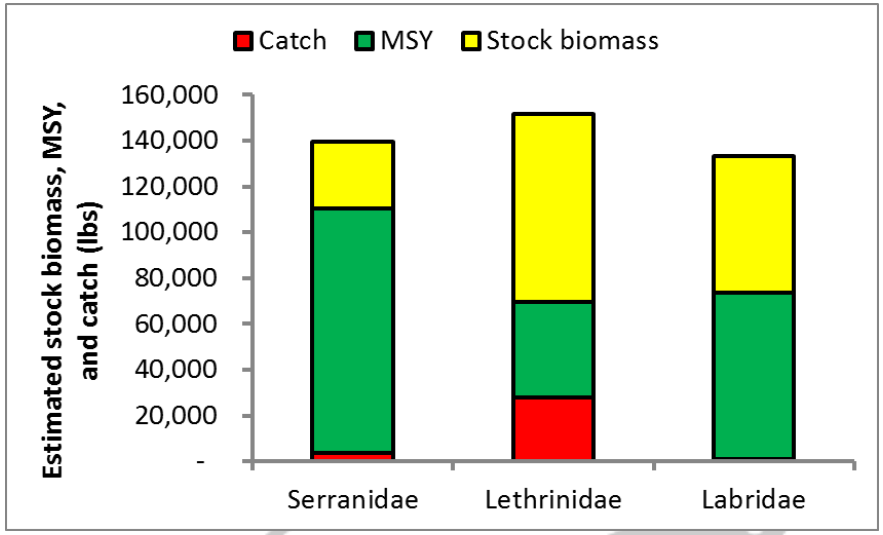


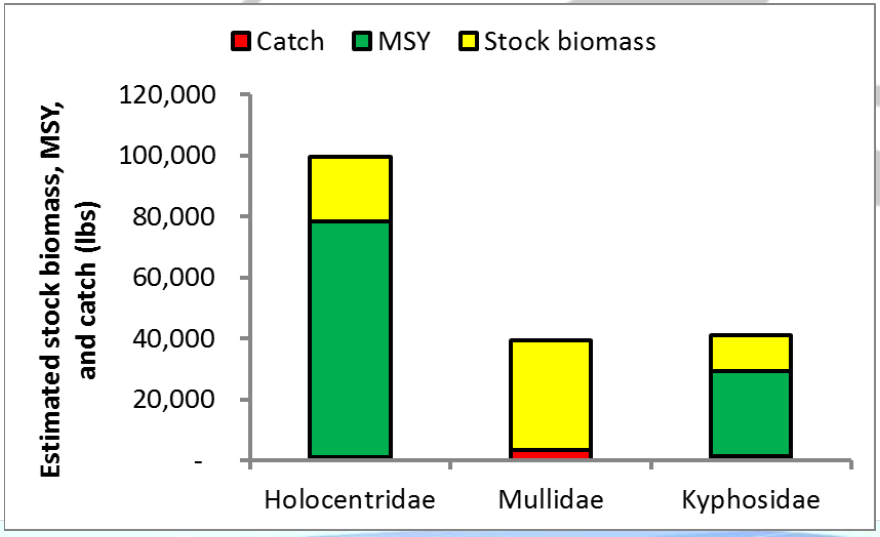
Data sources:

- ***Standing stock biomass*** – Williams 2011; PIFSC CREP Stationary Point Count
- ***MSY*** – Sabater and Kleiber 2014
- ***Catch*** – creel + commercial; DAWR & WPacFIN (2015 data)

Standing stock-MSY-Catch: CNMI - 2015







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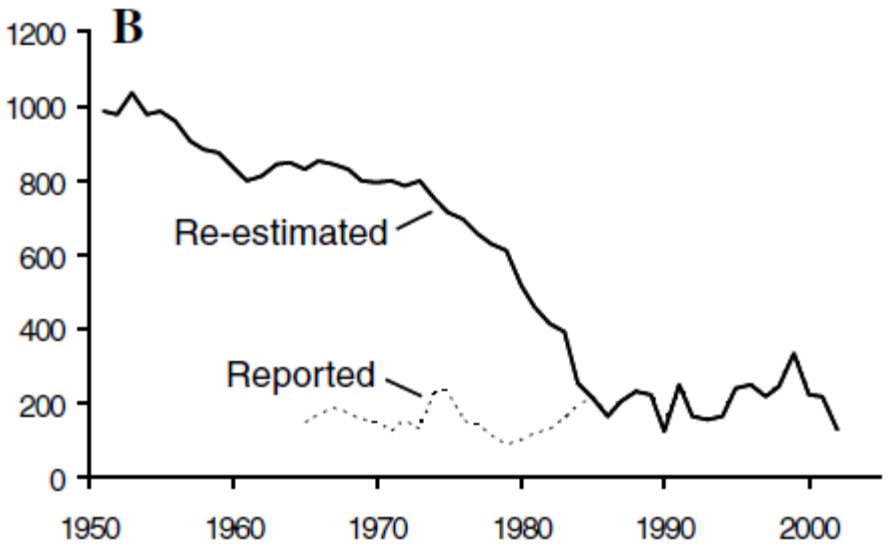
Standing stock-MSY-Adjusted Catch: Guam

Re-estimation of small-scale fishery catches for U.S. flag-associated island areas in the western Pacific: the last 50 years

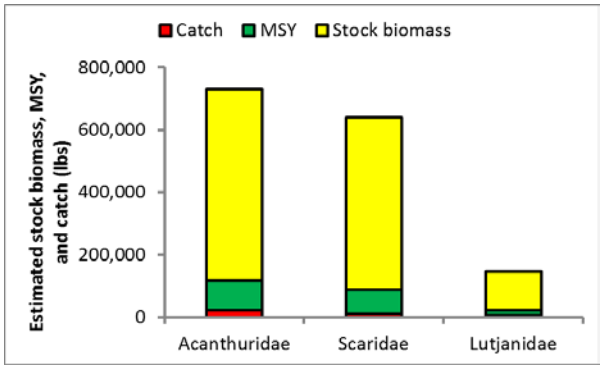
Dirk Zeller (contact author)[1]
Shawn Booth[1]
Gerald Davis[2]
Daniel Pauly[1]

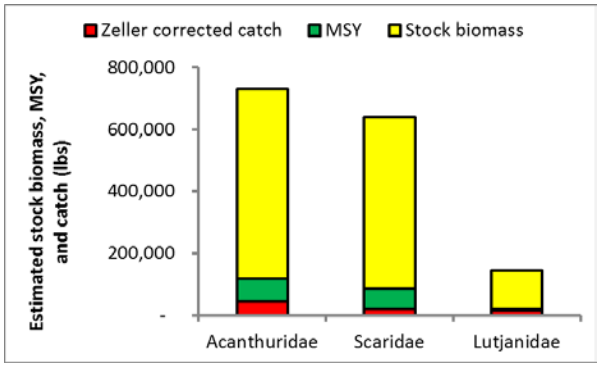
Guam has 2.5 fold under-reporting

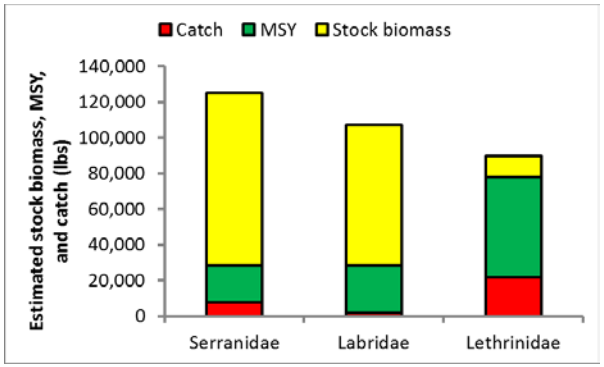


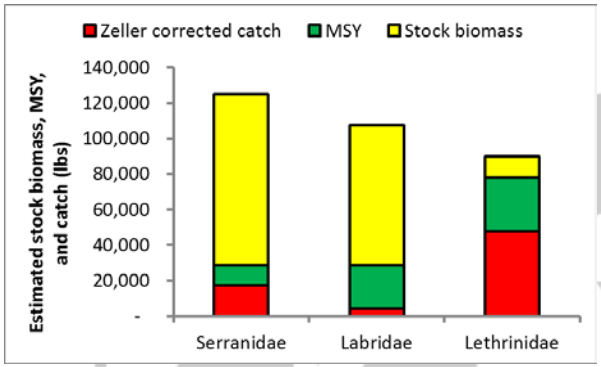
SOURCE: Zeller et al. 2007

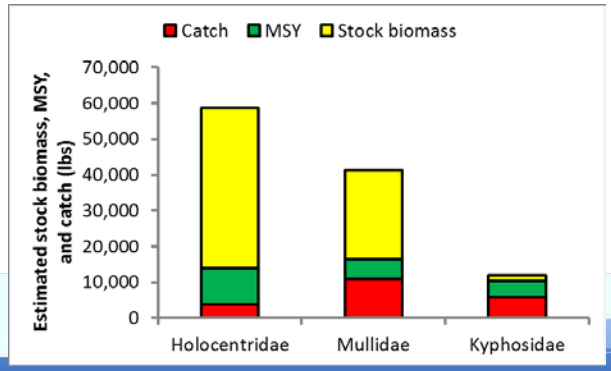
Standing stock-MSY-Adjusted Catch: Guam 2015

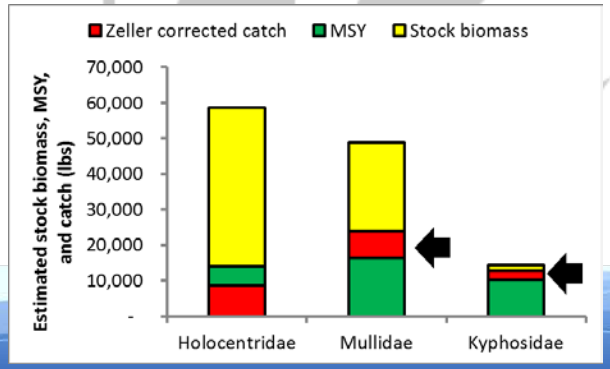












Standing stock-MSY-Adjusted Catch: CNMI

Rev Fish Biol Fisheries (2015) 25:179–194
DOI 10.1007/s11160-014-9358-6

RESEARCH PAPER

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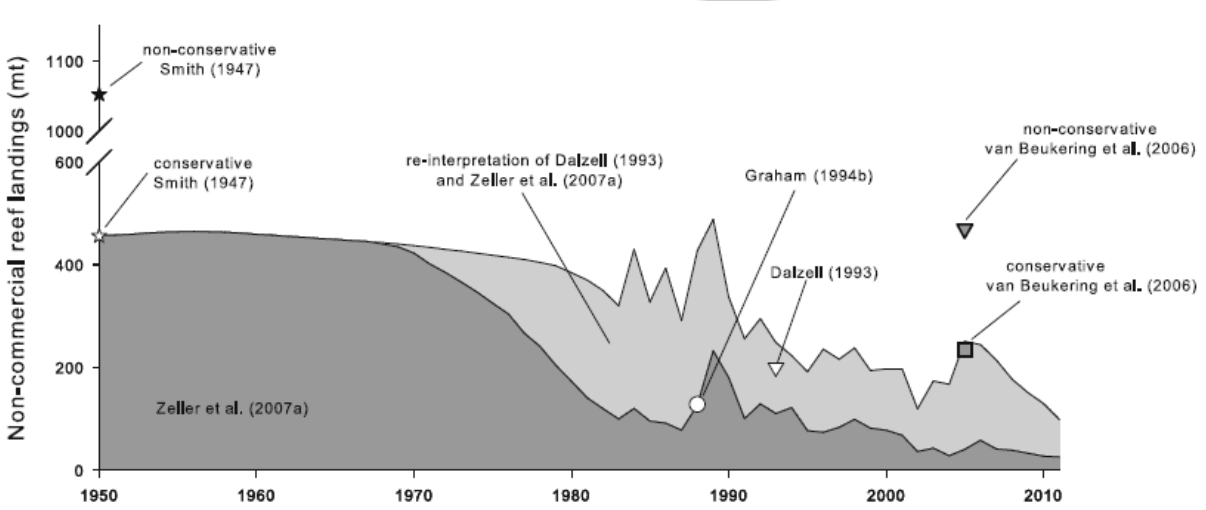
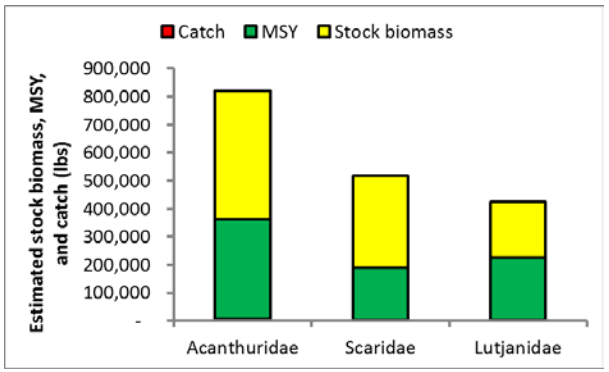
Javier Cuetos-Bueno · Peter Houk

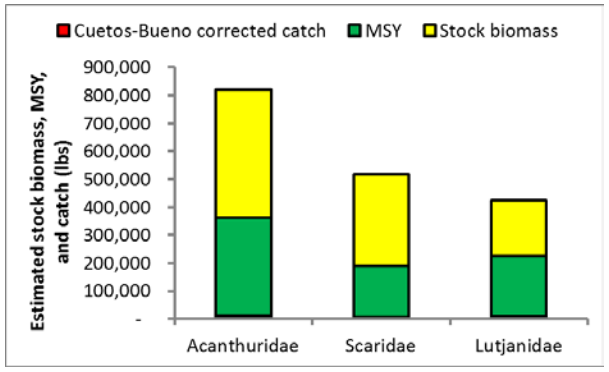
CNMI landings from a non-conservative estimates showed a 73% decline

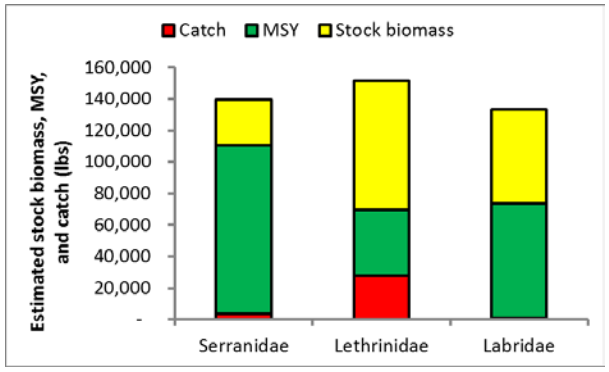


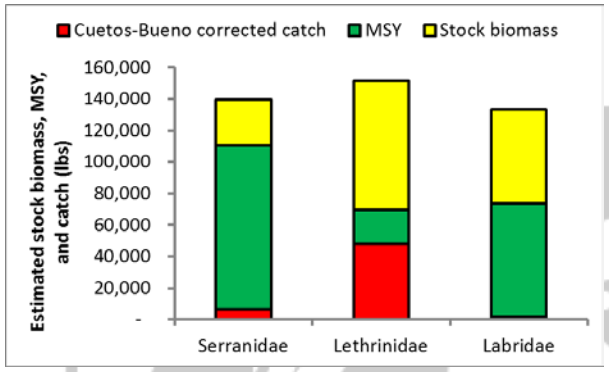
SOURCE: Cuetos-Bueno and Houk. 2015

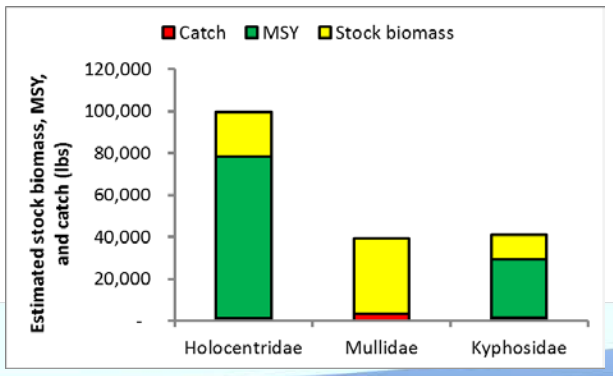
Standing stock-MSY-Adjusted Catch: CNMI - 2015

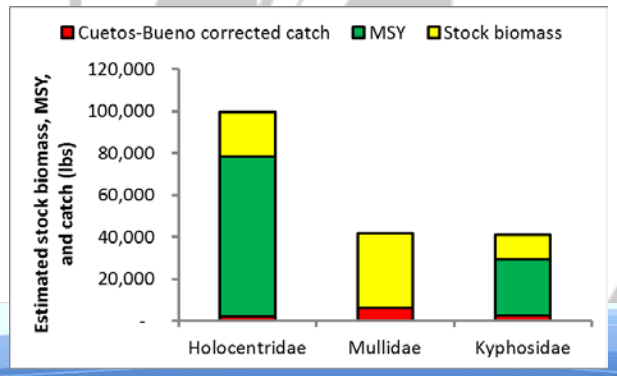




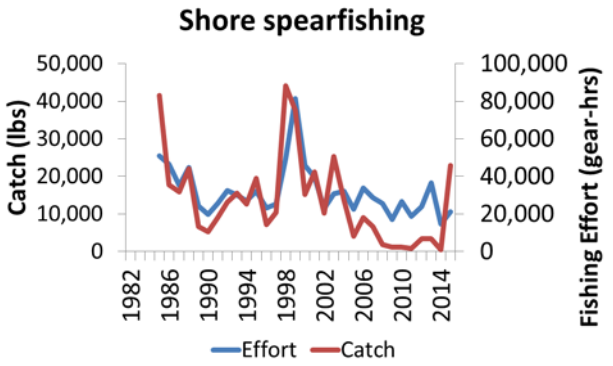


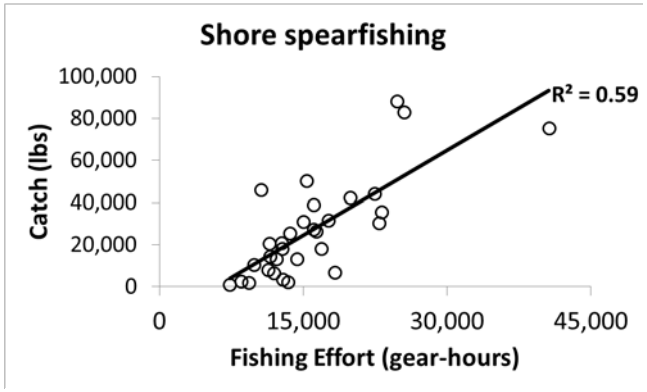


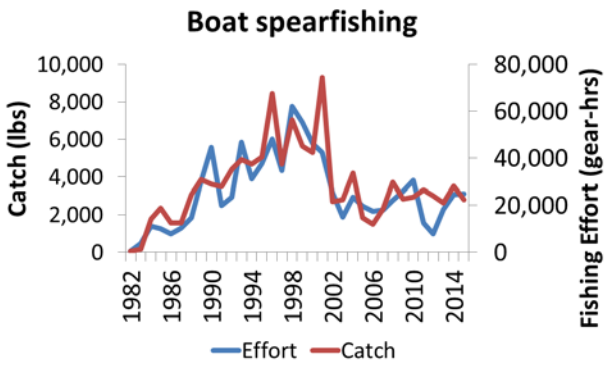


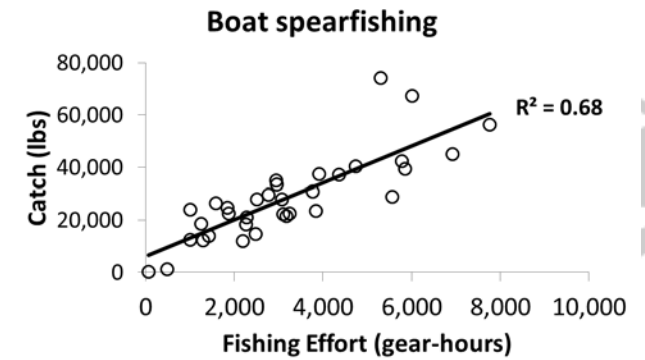


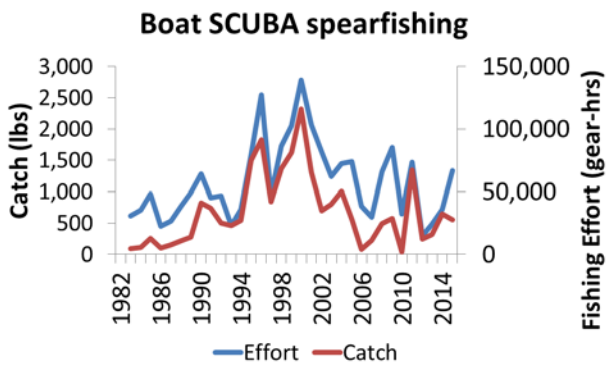
Monitoring fishing effort - Guam

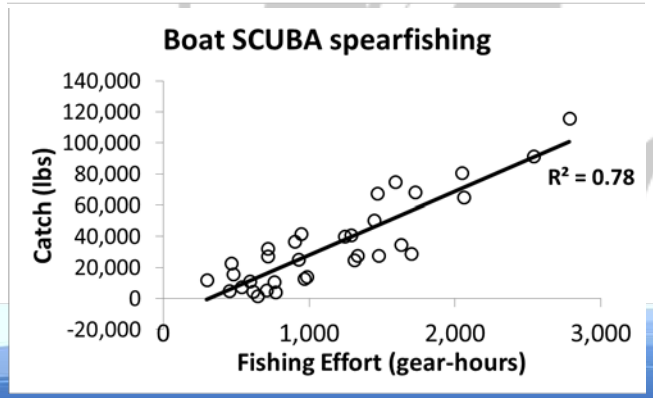




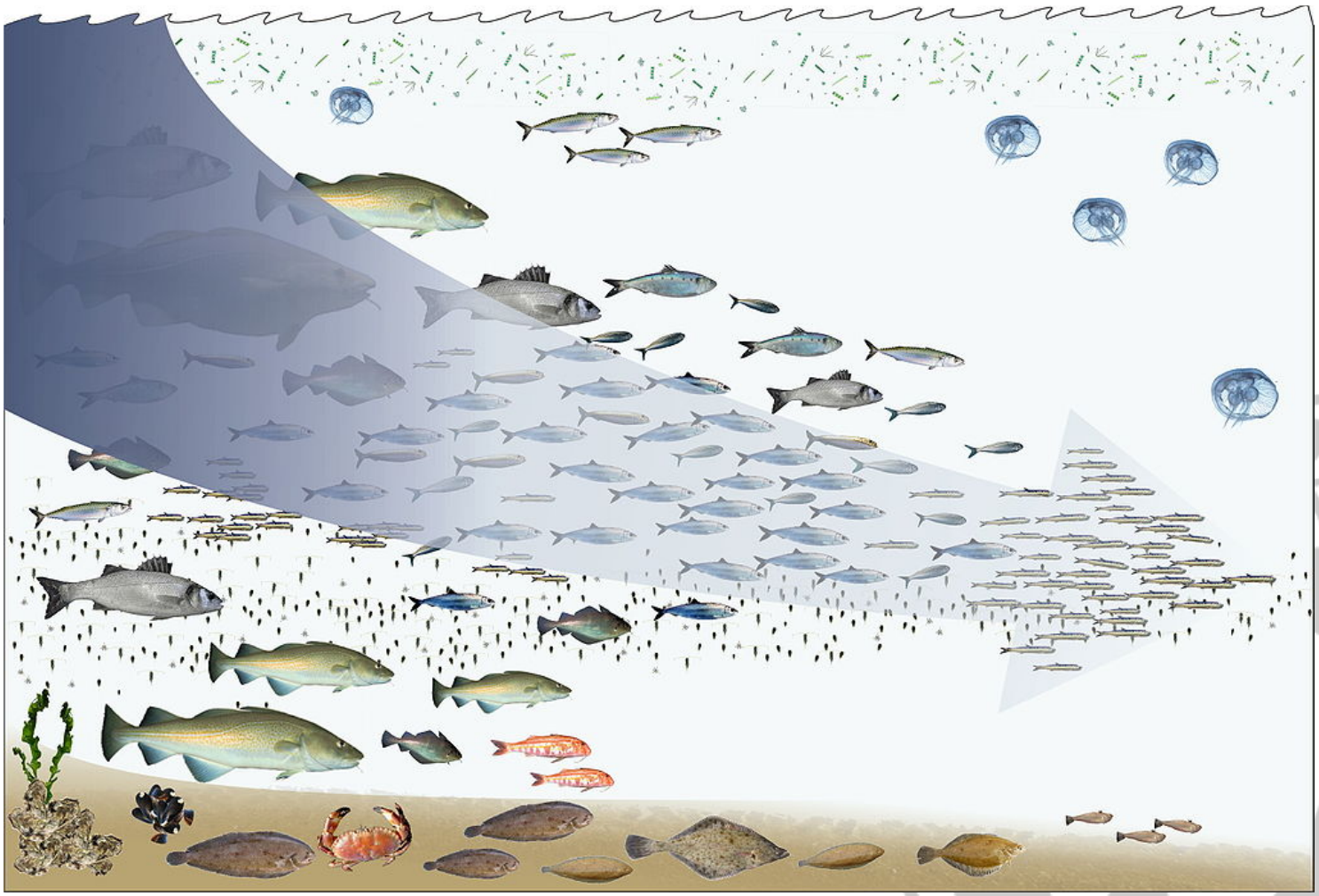


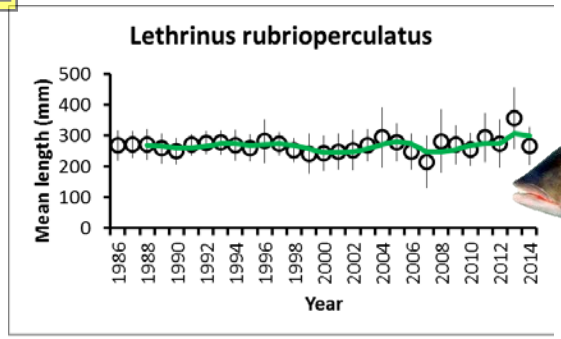


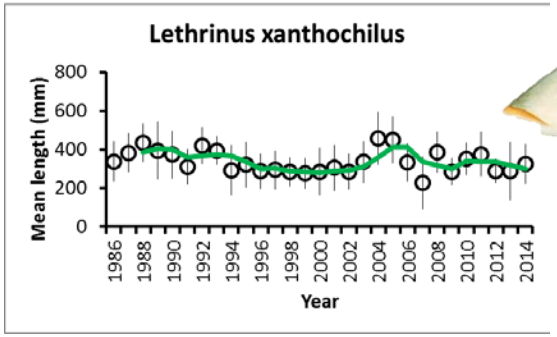


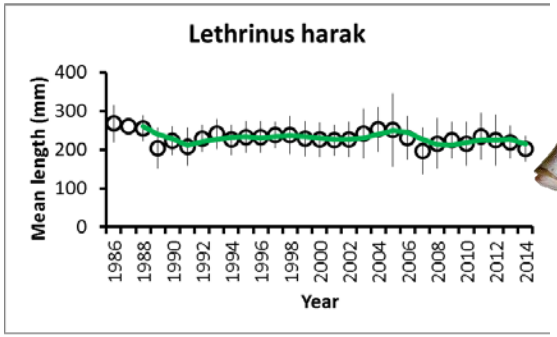


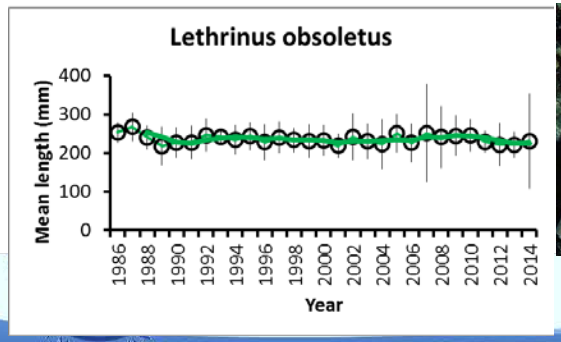
Fishing impact indicator: change in spp. composition and mean size

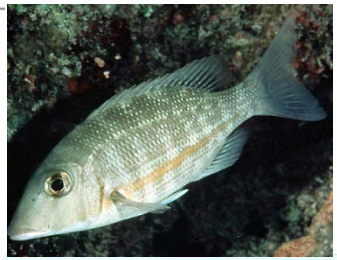


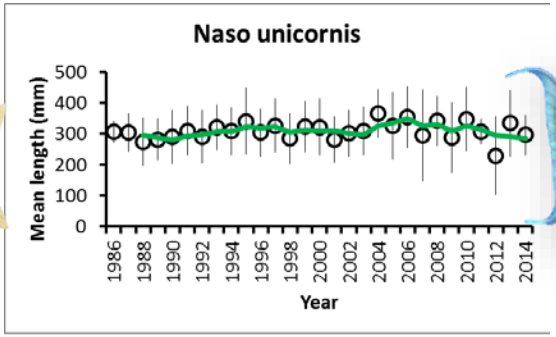

Lethrinus rubrioperculatus
Mean length (mm)
500
400
300
200
100
0
1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
Year

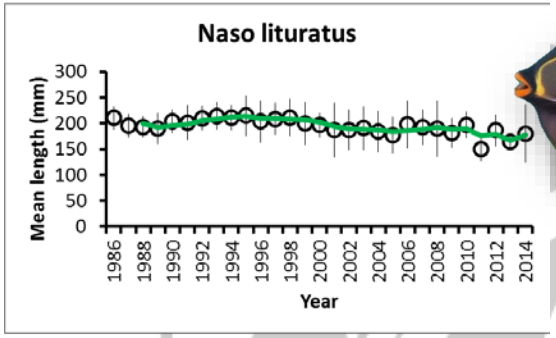

Lethrinus xanthochilus
Mean length (mm)
800
600
400
200
0
1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
Year

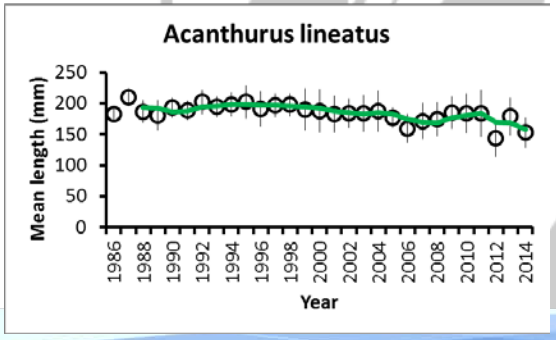

Lethrinus harak
Mean length (mm)
400
300
200
100
0
1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
Year

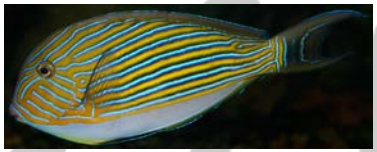

Lethrinus obsoletus
Mean length (mm)
400
300
200
100
0
1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
Year

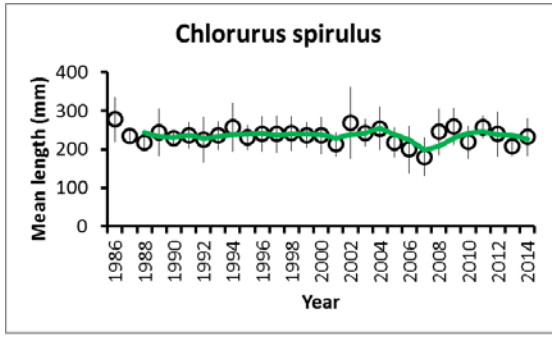


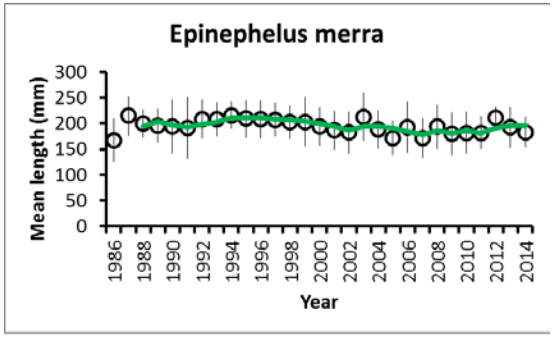

Naso unicornis
Mean length (mm)
500
400
300
200
100
0
1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
Year

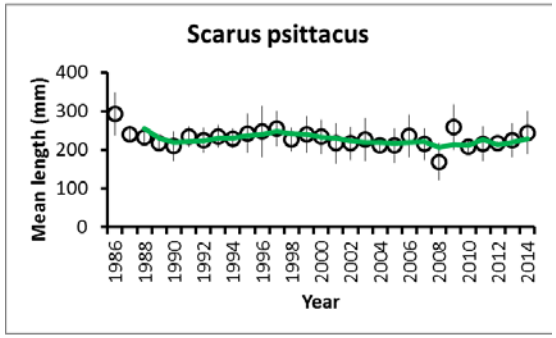

Naso lituratus
Mean length (mm)
300
250
200
150
100
50
0
1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
Year

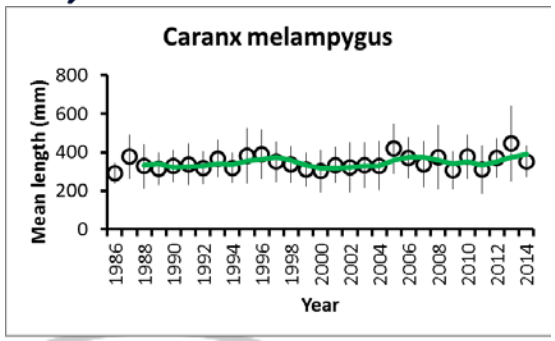

Acanthurus lineatus
Mean length (mm)
250
200
150
100
50
0
1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
Year

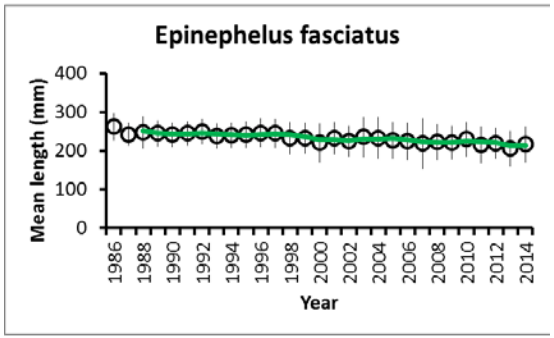


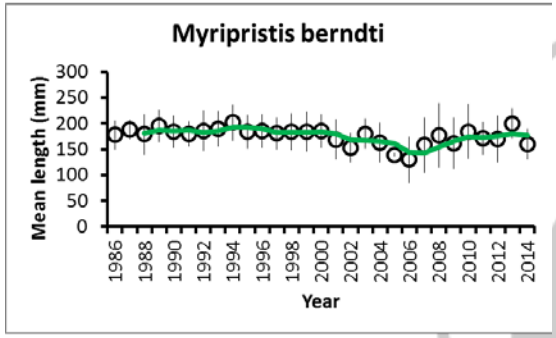

Chlorurus spirulus
Mean length (mm)
0
100
200
300
400
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

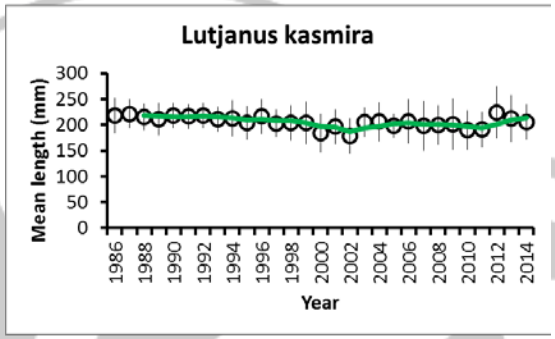

Epinephelus merra
Mean length (mm)
0
50
100
150
200
250
300
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

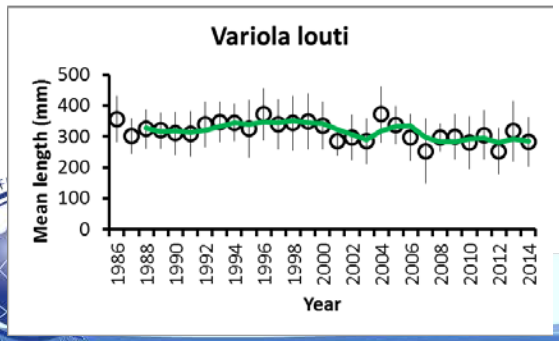

Scarus psittacus
Mean length (mm)
0
100
200
300
400
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

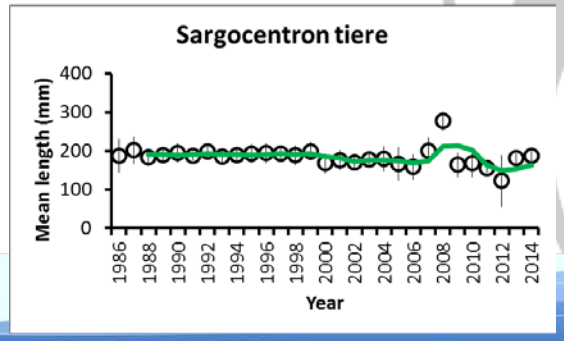

Caranx melampygus
Mean length (mm)
0
200
400
600
800
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

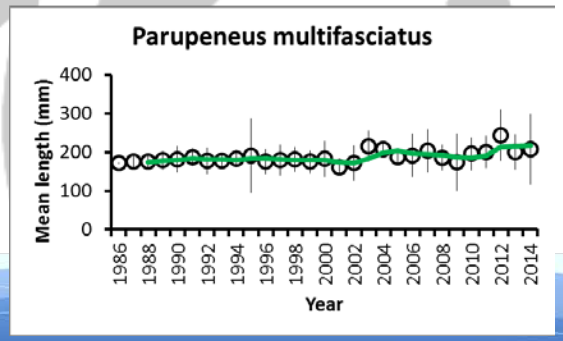

Epinephelus fasciatus
Mean length (mm)
0
100
200
300
400
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

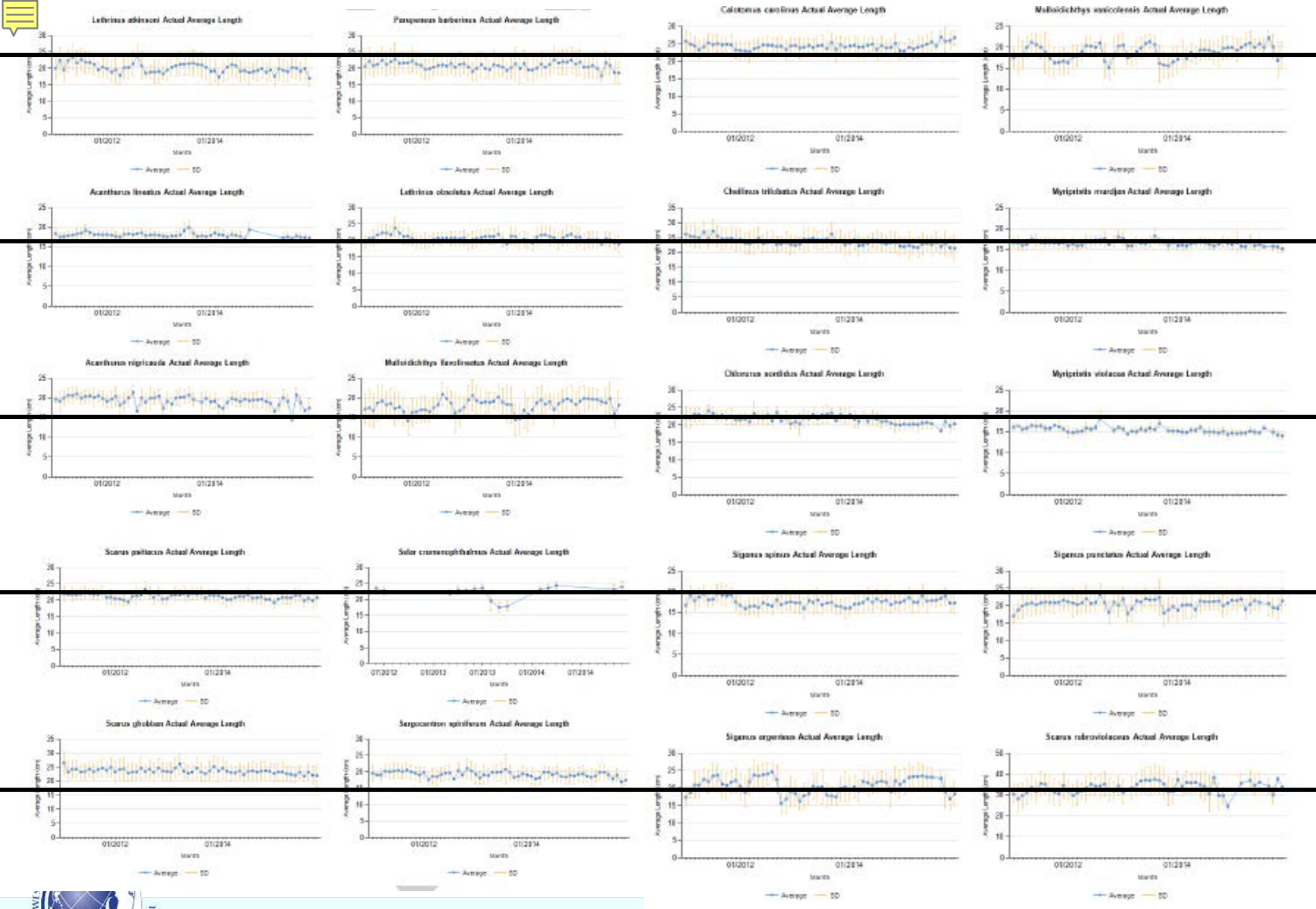

Myripristis berndti
Mean length (mm)
0
50
100
150
200
250
300
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

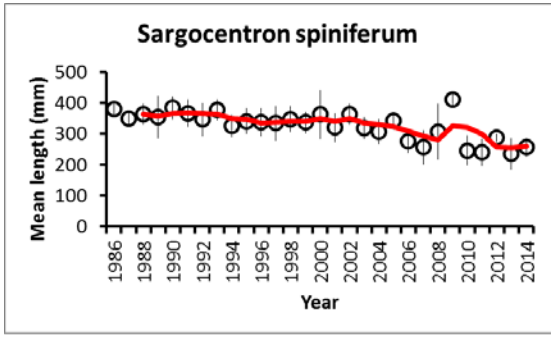

Lutjanus kasmira
Mean length (mm)
0
50
100
150
200
250
300
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

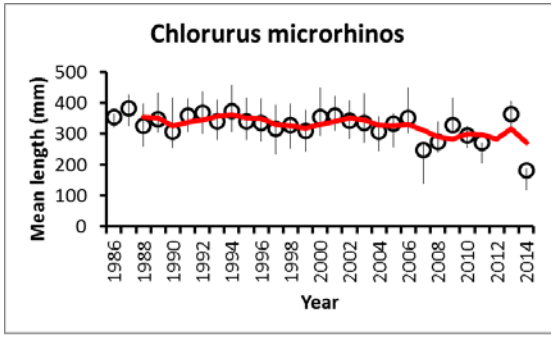

Variola louti
Mean length (mm)
0
100
200
300
400
500
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

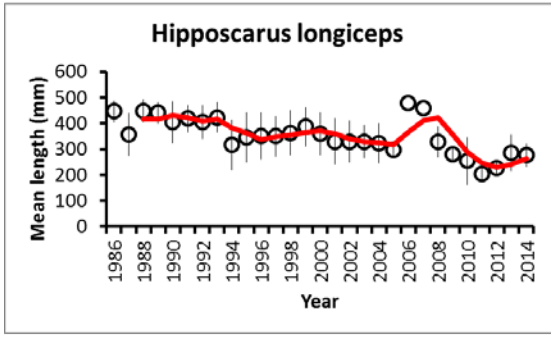

Sargocentron tiere
Mean length (mm)
0
100
200
300
400
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

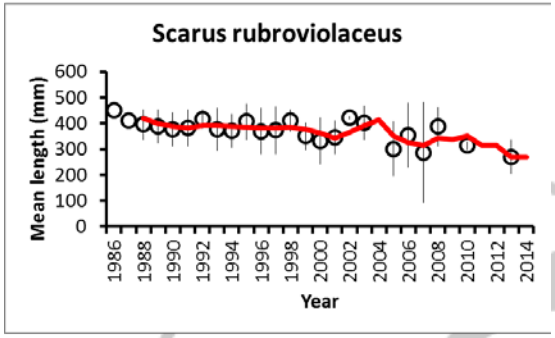

Parupeneus multifasciatus
Mean length (mm)
0
100
200
300
400
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

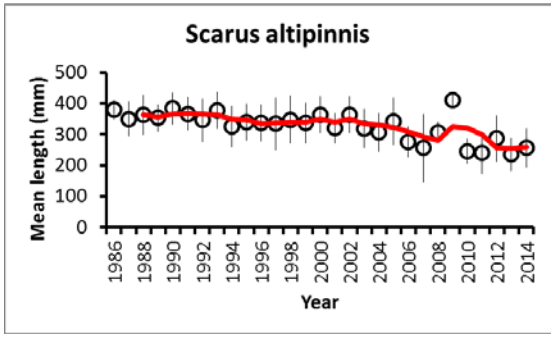

Lethrinus atkinsoni Actual Average Length
Parupeneus barberinus Actual Average Length
Calotomus carolinus Actual Average Length
Mulloidichthys vanicolensis Actual Average Length
Acanthurus lineatus Actual Average Length
Lethrinus obsoletus Actual Average Length
Cheilinus trilobatus Actual Average Length
Myripristis murdjan Actual Average Length
Acanthurus nigricauda Actual Average Length
Mulloidichthys flavolineatus Actual Average Length
Chlorurus sordidus Actual Average Length
Myripristis violacea Actual Average Length
Scarus psittacus Actual Average Length
Selar crumenophthalmus Actual Average Length
Siganus spinus Actual Average Length
Siganus punctatus Actual Average Length
Scarus ghobban Actual Average Length
Sargocentron spiniferum Actual Average Length
Siganus argenteus Actual Average Length
Scarus rubroviolaceus Actual Average Length
Average Length (cm)
Months
01/2012
01/2013
01/2014
Average
SD

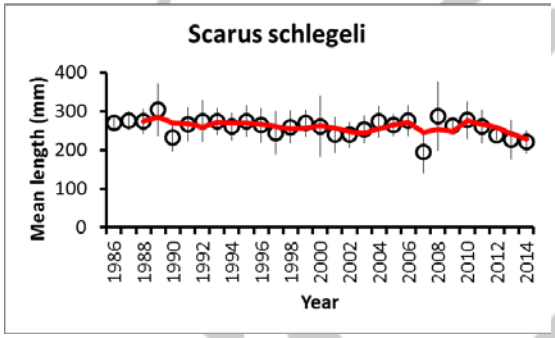

Sargocentron spiniferum
Mean length (mm)
0
100
200
300
400
500
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

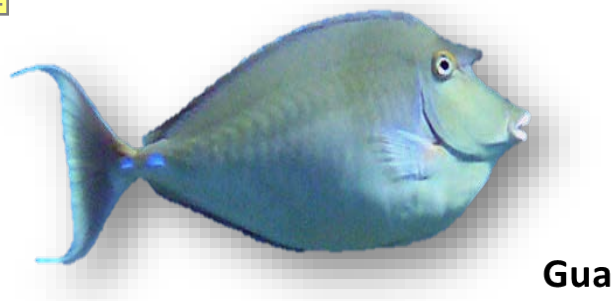

Chlorurus microrhinos
Mean length (mm)
0
100
200
300
400
500
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year


Hipposcarus longiceps
Mean length (mm)
0
100
200
300
400
500
600
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year

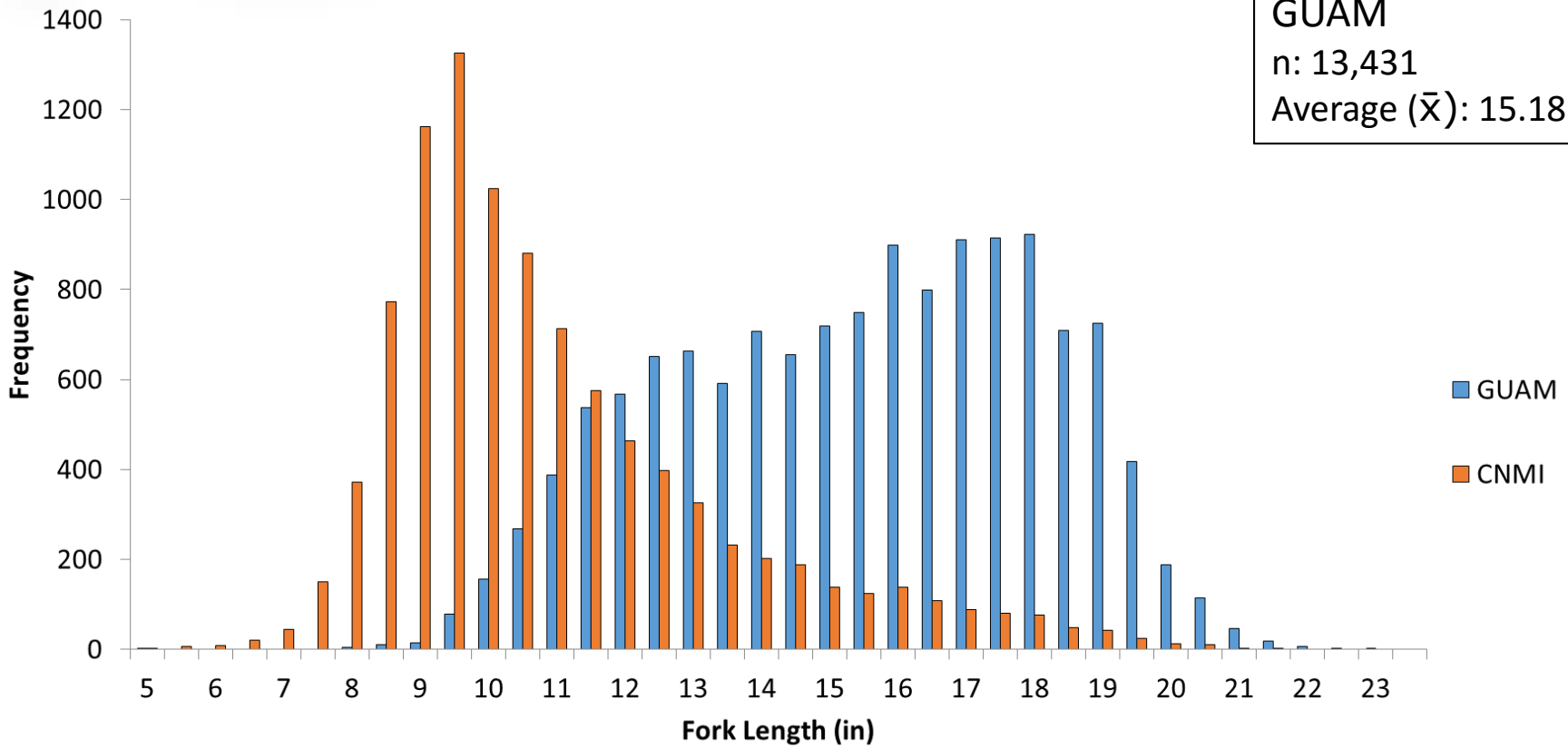

Scarus rubroviolaceus
Mean length (mm)
0
100
200
300
400
500
600
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year


Scarus altipinnis
Mean length (mm)
0
100
200
300
400
500
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year


Scarus schlegeli
Mean length (mm)
0
100
200
300
400
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
Year



Years 2011-2015
Guam & CNMI Commercial *Naso unicornis*



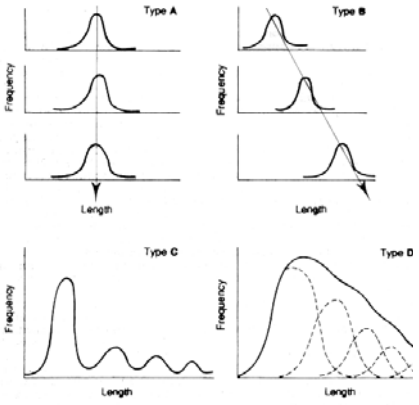
STATISTICS:

CNMI
n: 9,755
Average ($\bar{x}$): 10.64

GUAM
n: 13,431
Average ($\bar{x}$): 15.18

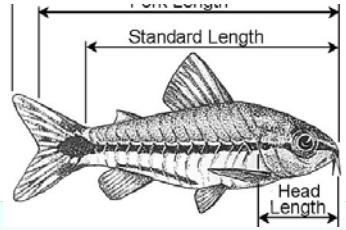
Reduce the number of species via ecosystem component amendment

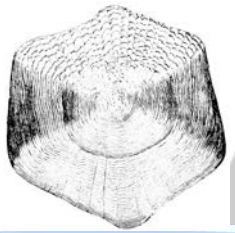
Single species stock assessments of key species in need of management



An integrated Catch-MSY model for data poor stocks

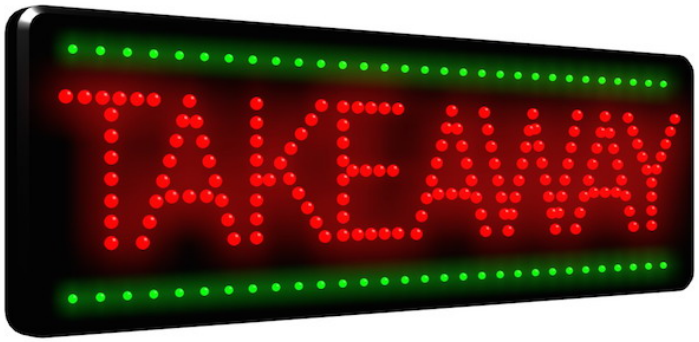
Steven Martell





But for now… data poor assessment seemed to indicate majority of the stock is stable

On a family level, the Marianas coral reef fisheries are harvesting below MSY except for goatfish and rudderfish (Guam only)



Representative commercially important species appears to be stable based on mean length information

Need to take a good hard look at parrotfish

Need to continue improving data-poor assessment models


3
mins