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Assessing and Managing Fish Stocks with Limited Information

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Project Director, TNC CA & FISHLAB

Session Overview

1. Introduction to Fisheries Science and Data Poor Stock Assessments:– **Jono Wilson**
2. Palau Case Study: – **Steven Victor**
3. Solomon Islands Case Study: **Rick Hamilton**
4. Incorporating Local Knowledge: **Rick Hamilton**
5. Designing a Decision-Making Framework: **Jono Wilson**
6. Panel Discussion

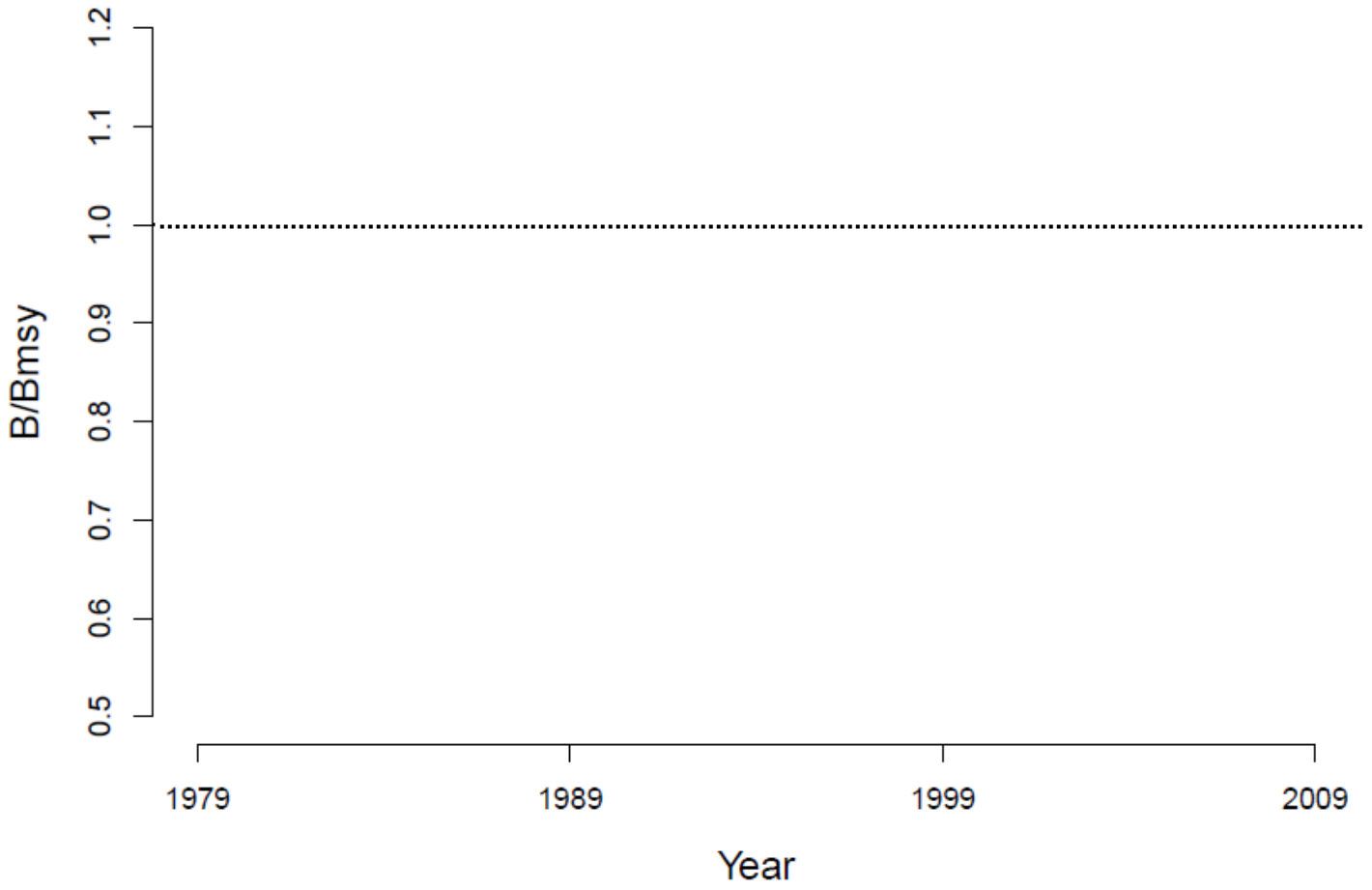
"I work with fish populations. The trouble with fish is that you never get to see the whole population. They're not like trees. Mostly you see fish only when they're caught...So, you see, if you study fish populations, you tend to get little bits of information here and there. These bits of information are part of a much larger story. My job is to try to put the story together. I'm a detective really, who assembles clues into a coherent picture"

-Jon Schnute

Food For Thought

- What are the key elements of stock assessments?
- What types of information can be used in data poor stock assessments?
- What types of situations can data poor assessments facilitate?
- What data biases create challenges for data poor stock assessments?
- Why are density estimates from underwater surveys difficult to use in decision-making?

Global Fisheries



Global Fisheries

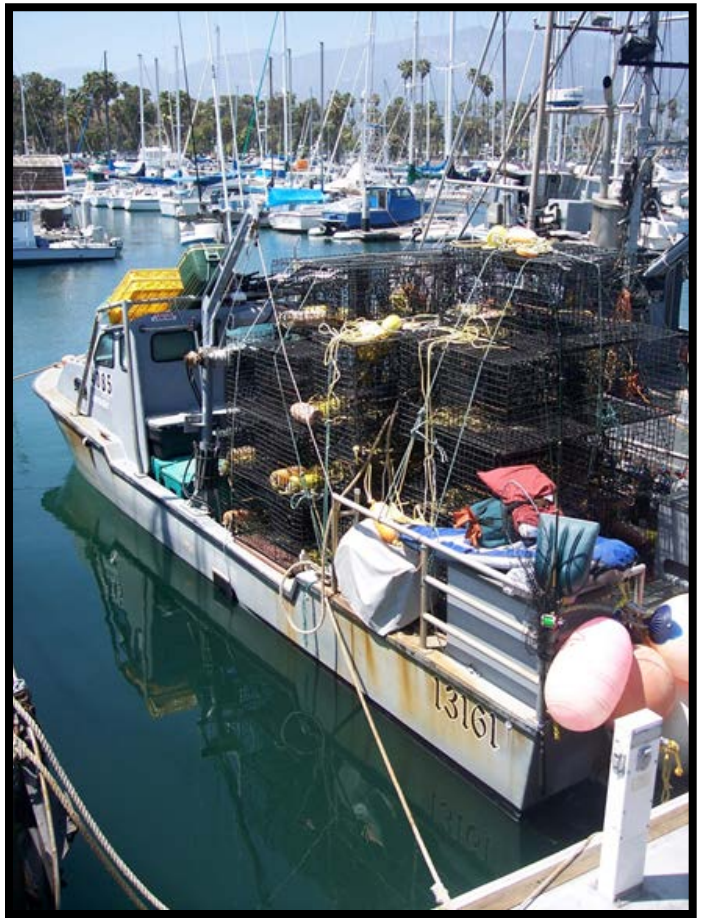
Costello et al 2012

Global Fisheries

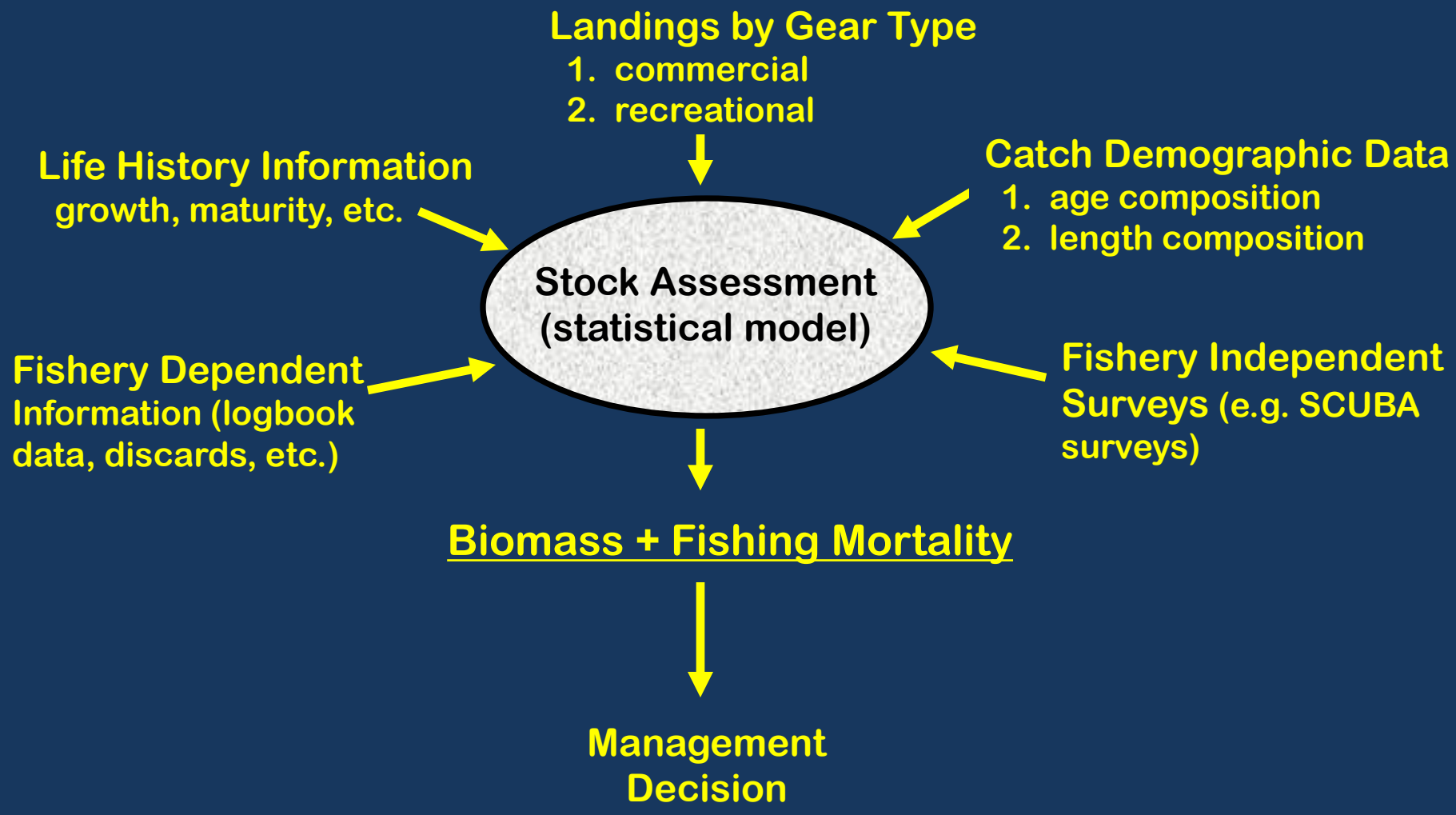
Costello et al 2012

Unassessed Fisheries

- 90% of all the fishermen in the world
- 80% of global fish landings

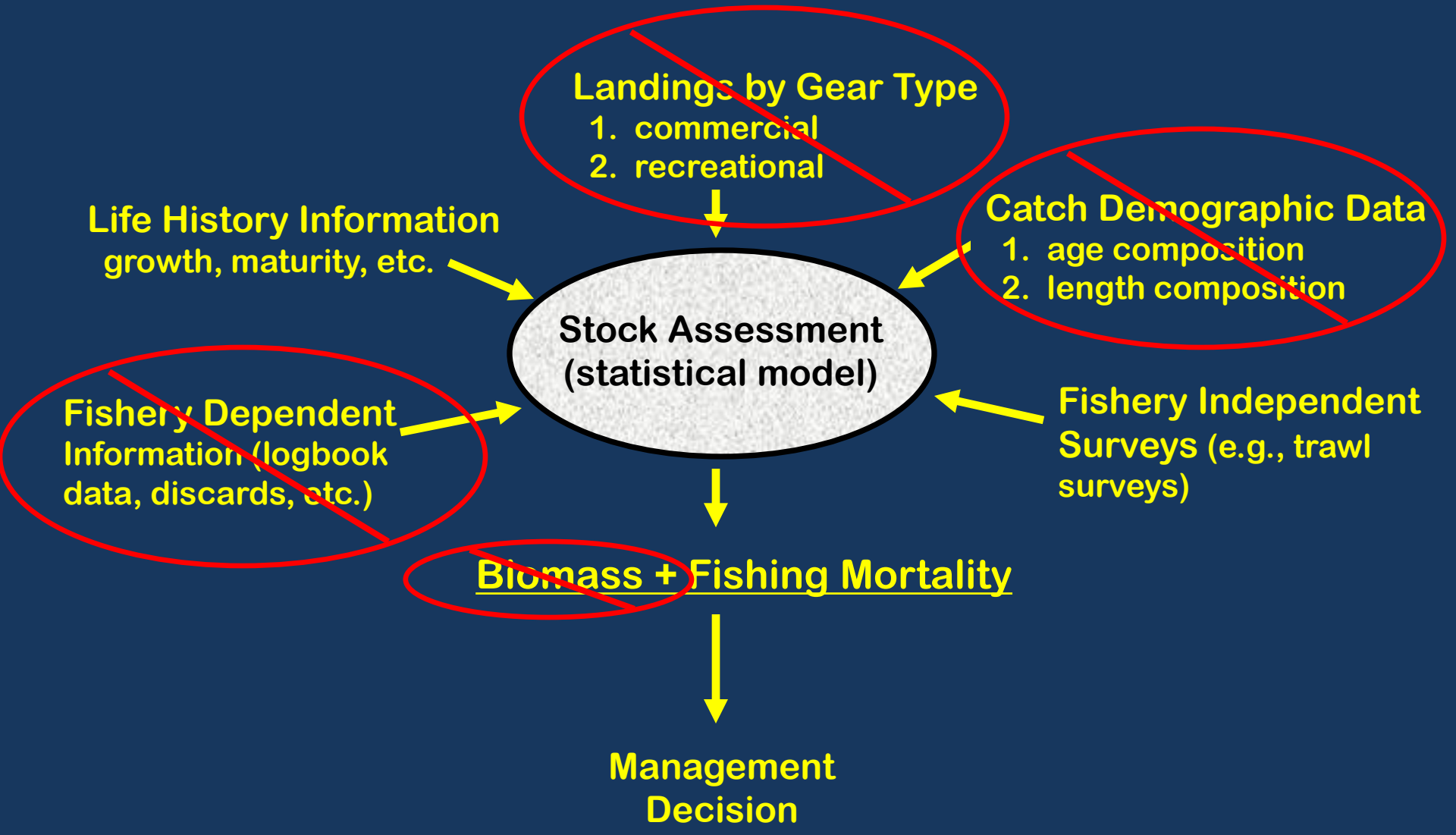


Stock Assessment: The Foundation of Fisheries Management



S. Ralston

Stock Assessment: The Foundation of Fisheries Management

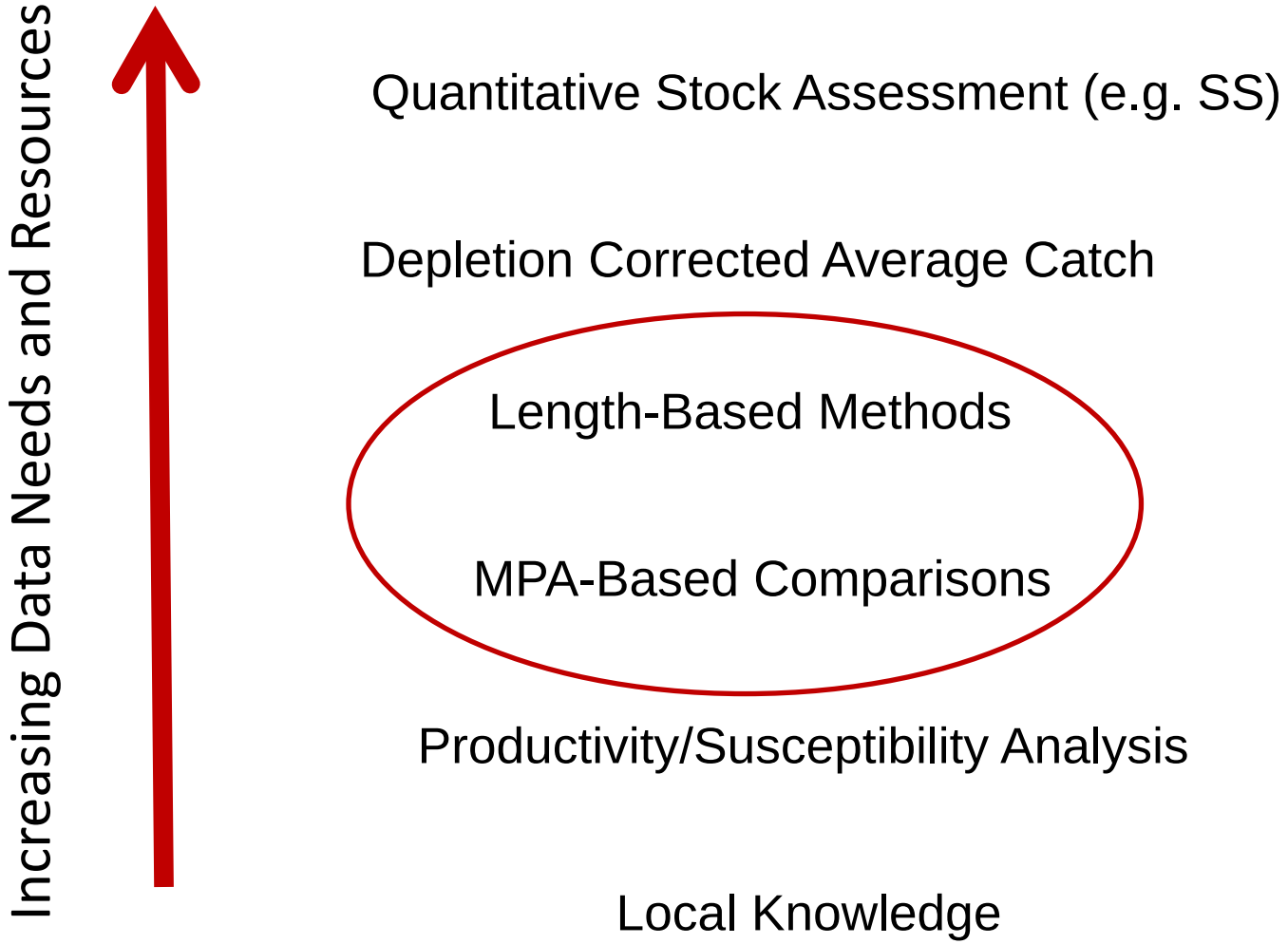


Data Poor Stock Assessments

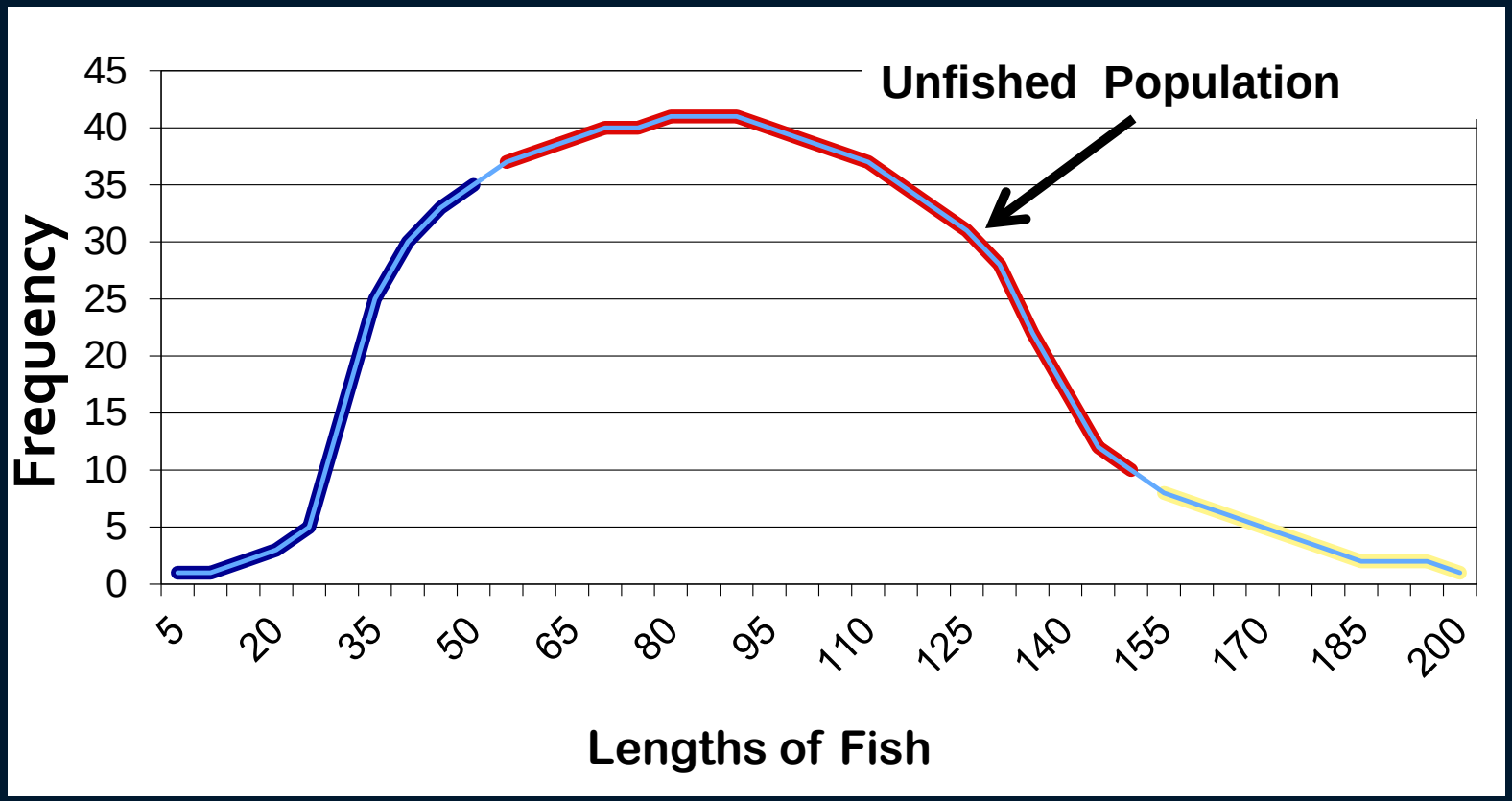
- Like using “clues” to provide insight on the current status of the fishery

Utility

- Set a baseline
- Support for management intervention
- Inform management interventions


Method
Increasing Data Needs and Resources
Quantitative Stock Assessment (e.g. SS)
Depletion Corrected Average Catch
Length-Based Methods
MPA-Based Comparisons
Productivity/Susceptibility Analysis
Local Knowledge

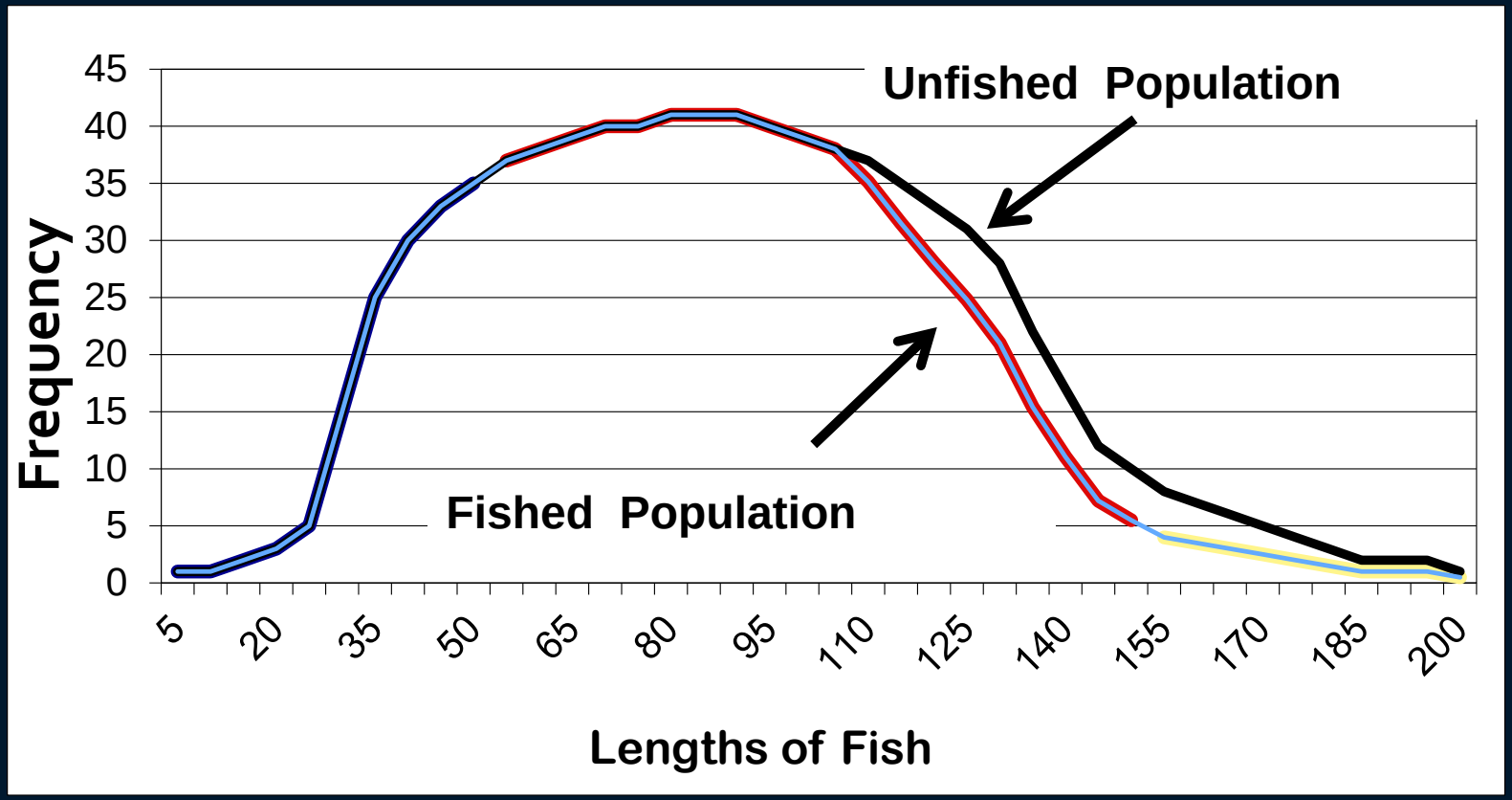
Length-Based Assessments



FISHING EFFORT = 0

J. Prince

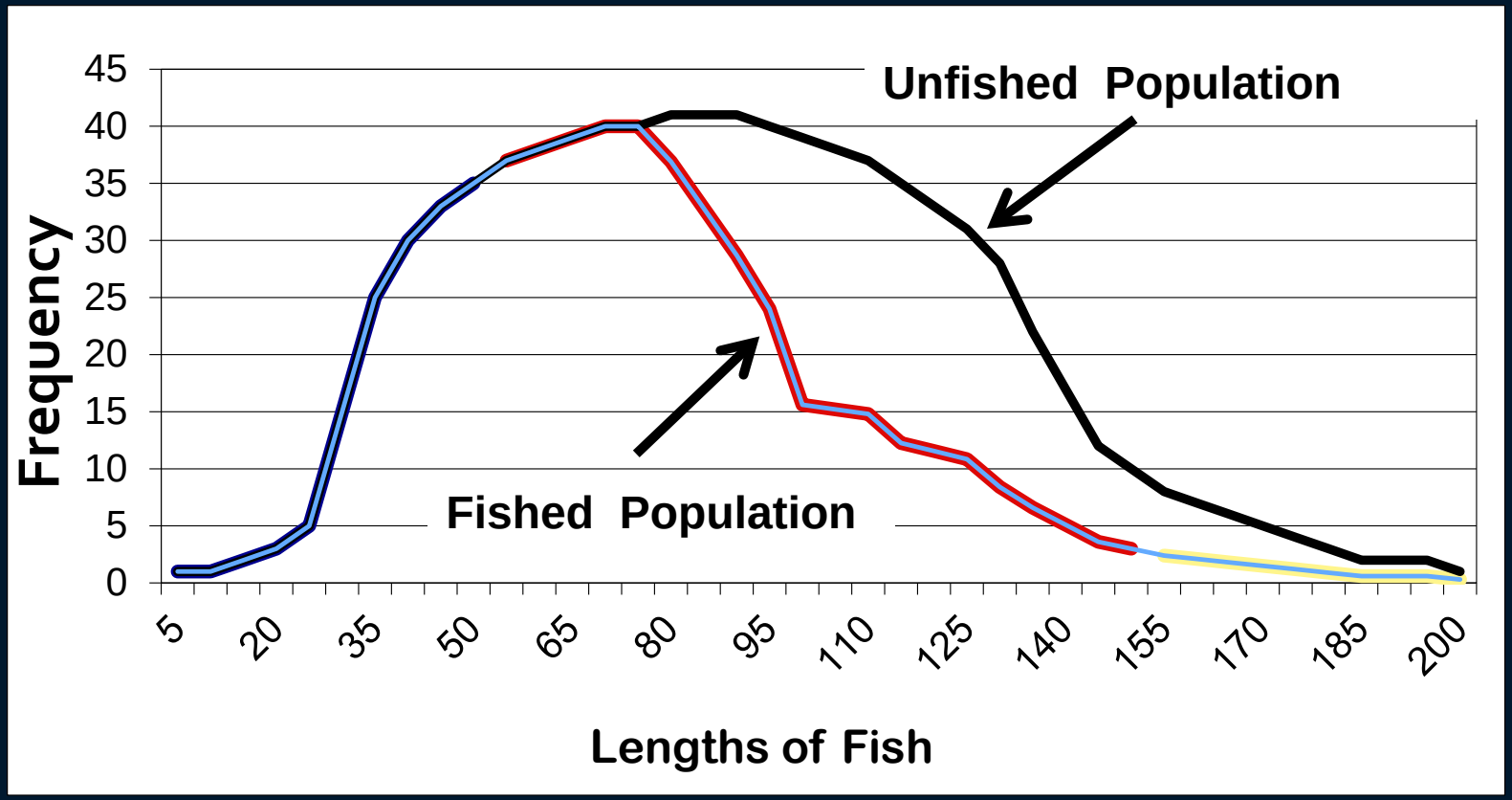
Length-Based Assessments



FISHING EFFORT = Light

J. Prince

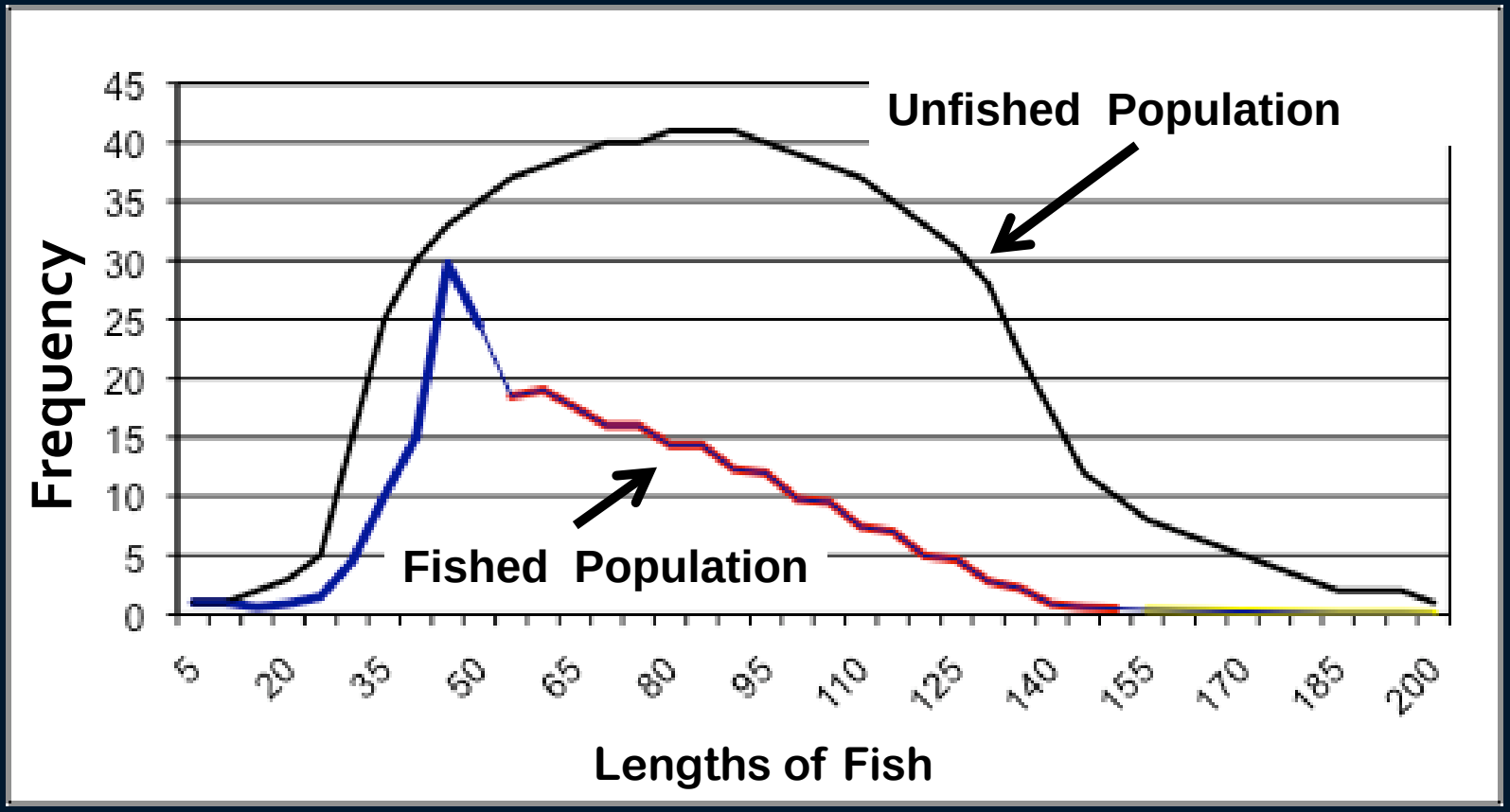
Length-Based Assessments



FISHING EFFORT = Medium

J. Prince

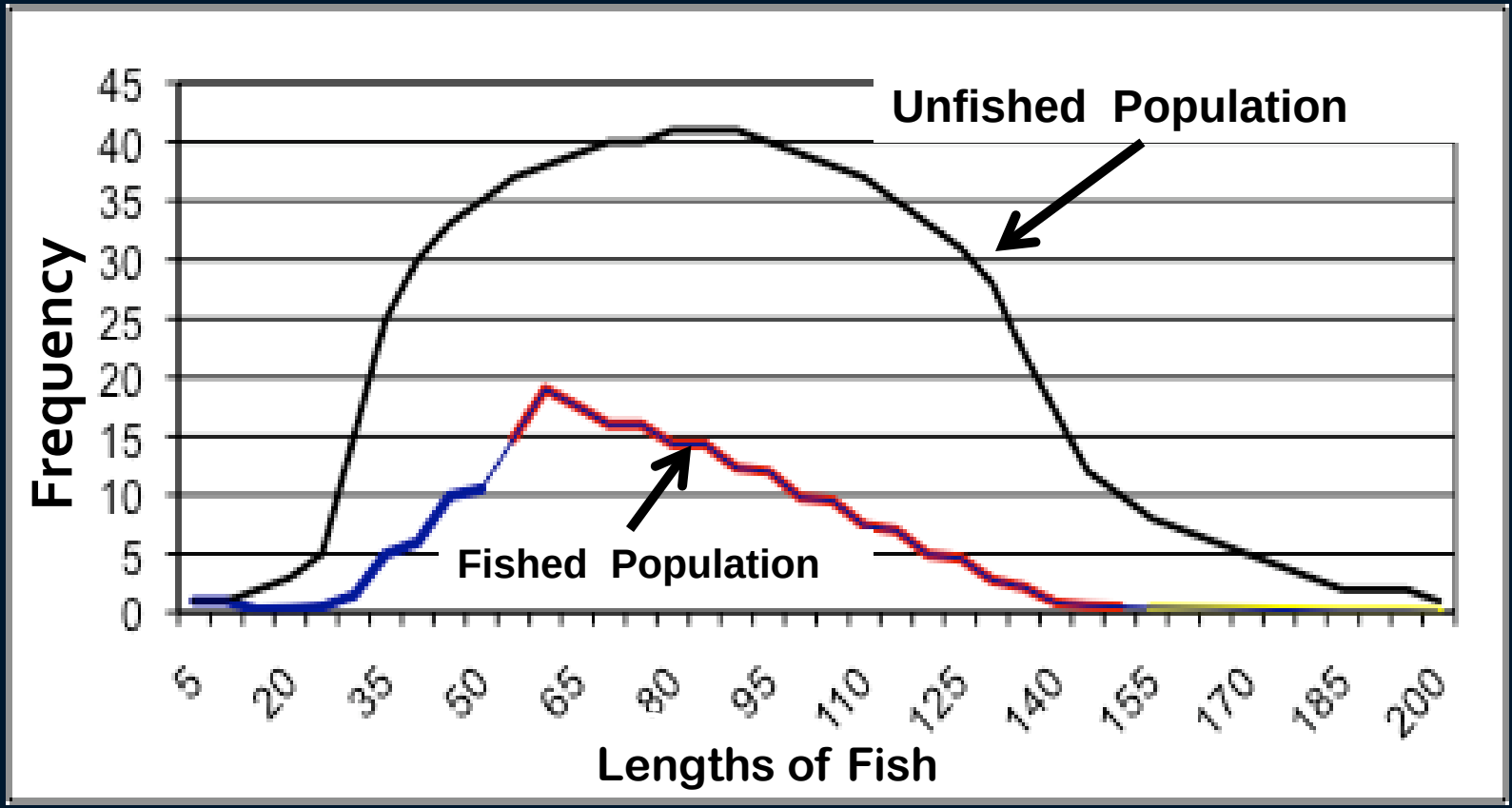
Length-Based Assessments



FISHING EFFORT = High

J. Prince

Length-Based Assessments



FISHING EFFORT = Overfishing

J. Prince

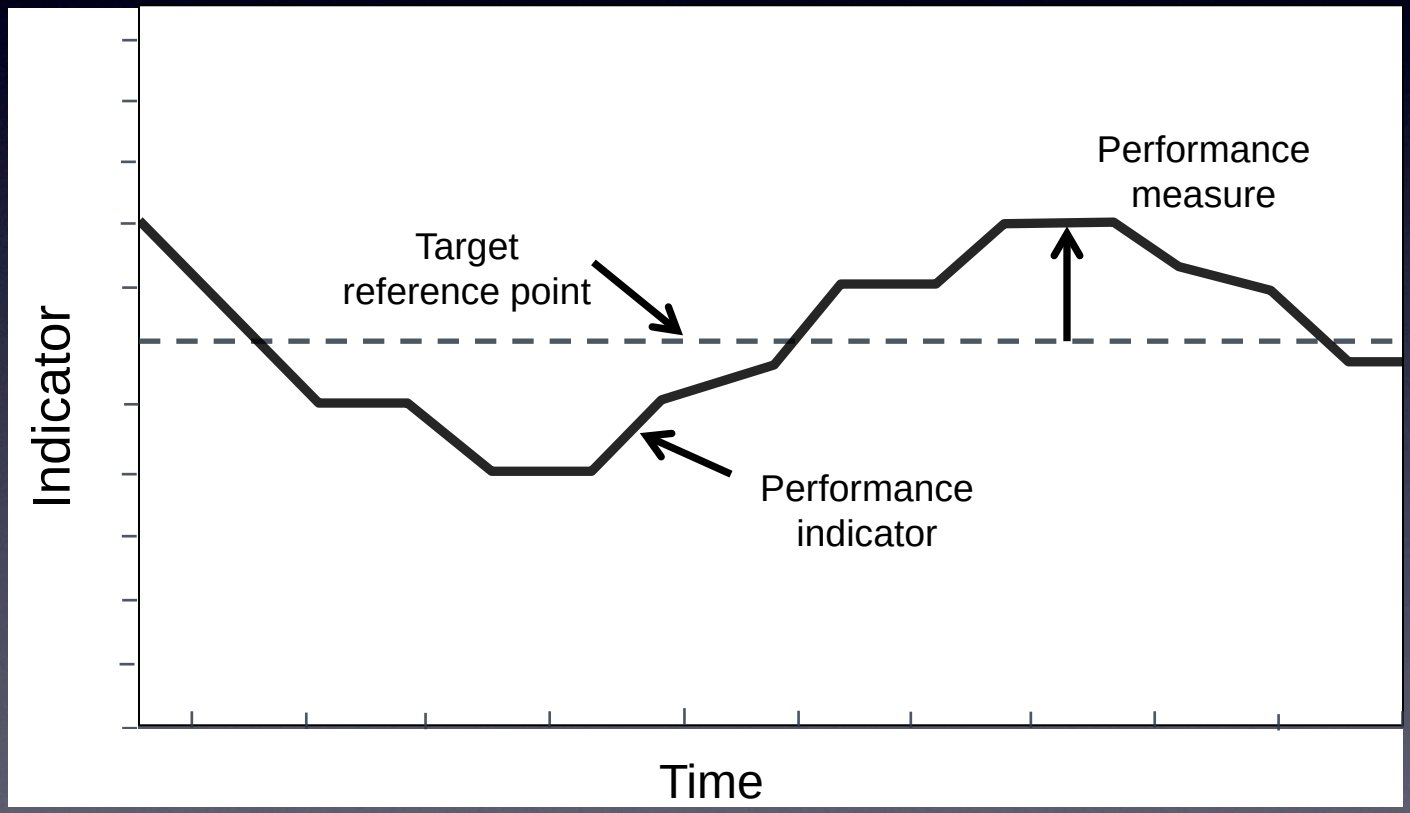
What “clues” can provide information?

Example:

- Density and size of fishes inside and outside no-take zones (NTZs)

The Keys Elements of a Stock Assessment:

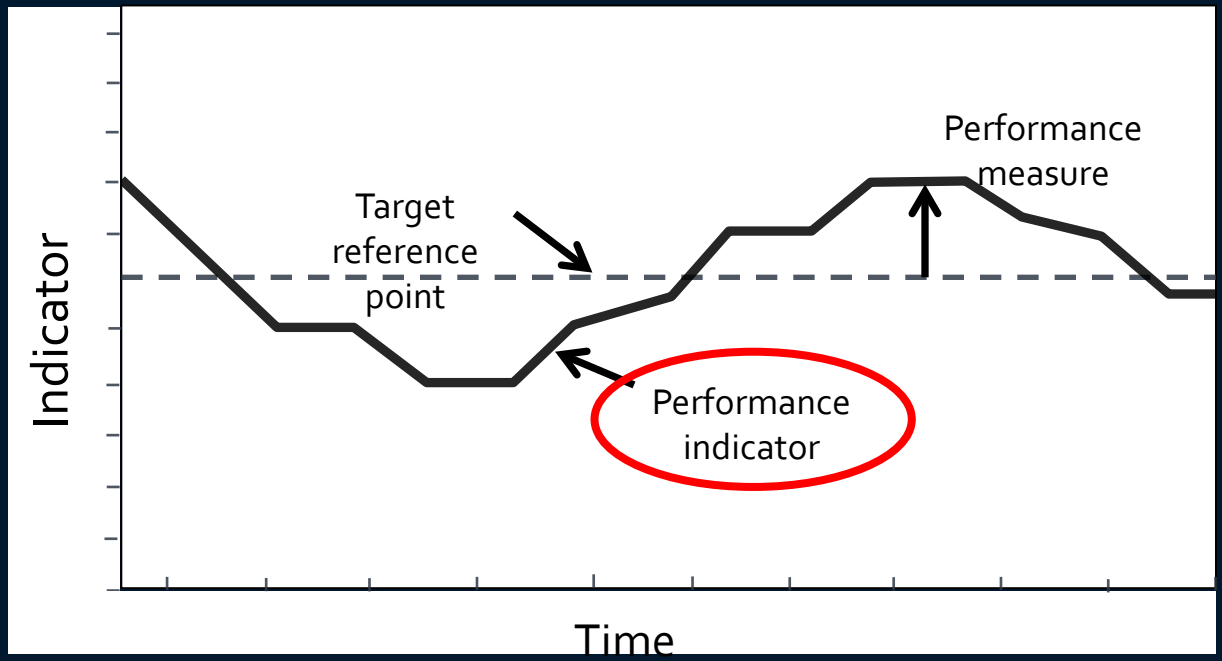
Reference Points and Indicators



Stock Status Performance Indicators

Performance Indicator: a value (or range of values) that is used to determine the current state of the fishery

Fishing mortality
SPR
Catch
Mean size
Catch per unit effort
Size distribution
Max size
Local knowledge



Reference Points

Target Reference Point:

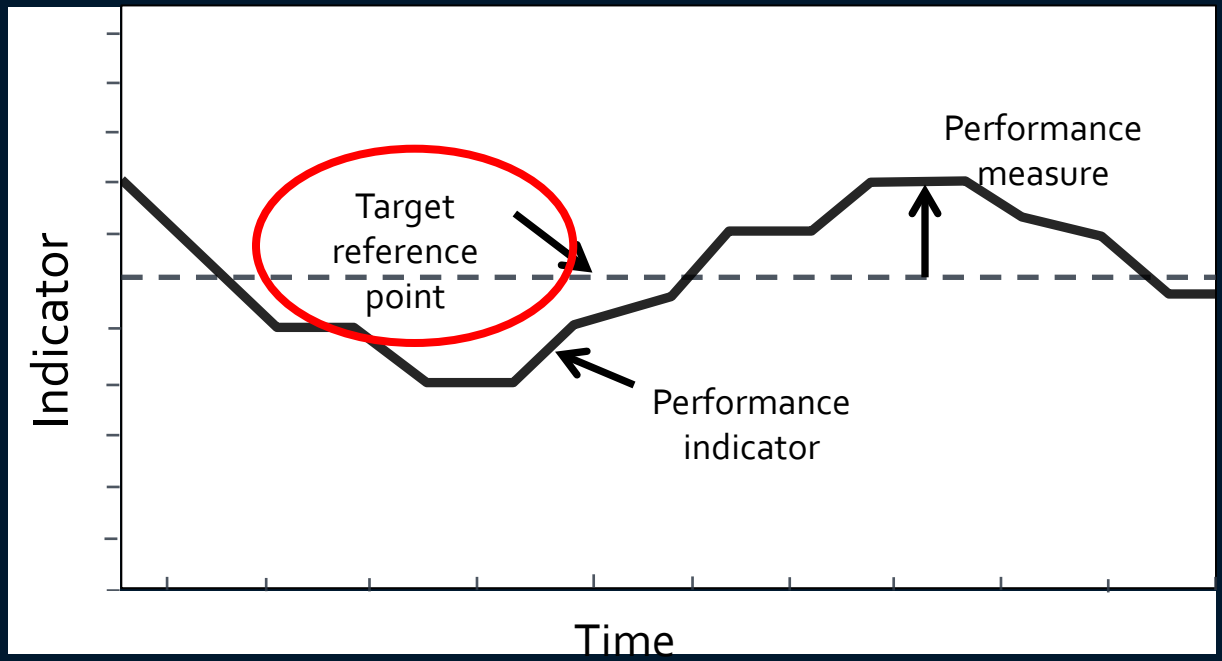
a numerical value (or range of values) that indicates that the status of a stock is at a desirable level

F_{MSY}

B_{MSY}

$F_{0.1}$

SPR_{target}



Reference Points

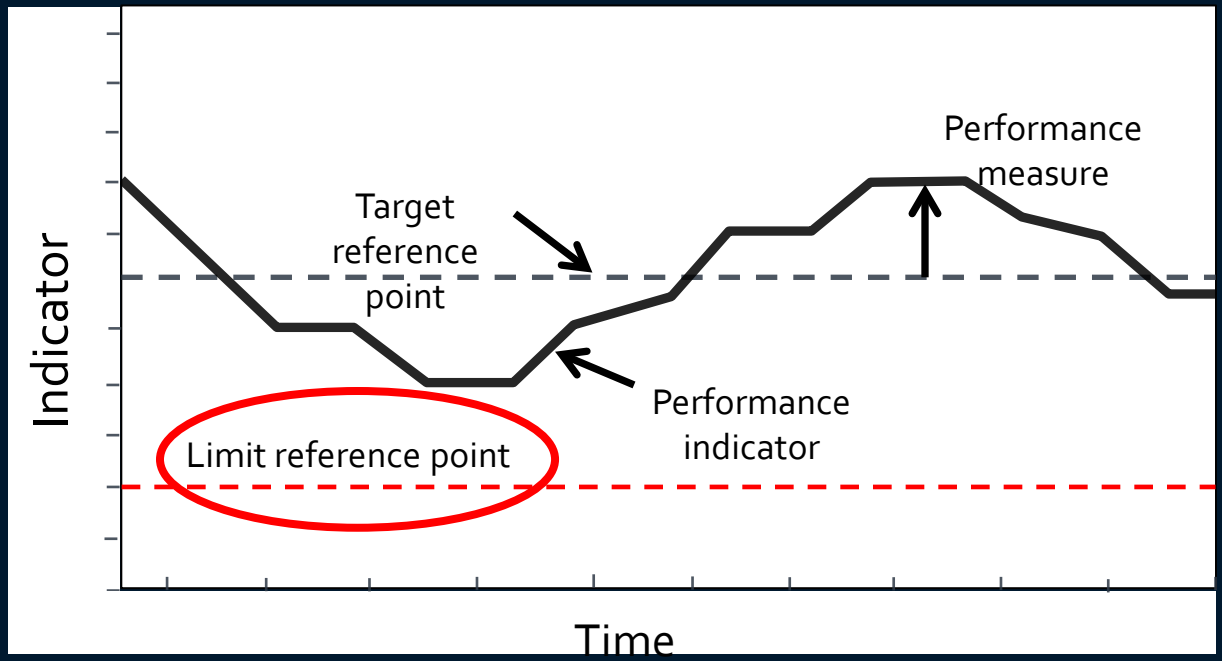
Limit Reference Point:

a numerical value that indicates that the status of a stock is unacceptable (e.g. overfished).

F_{Limit}

B_{Limit}

SPR_{Limit}



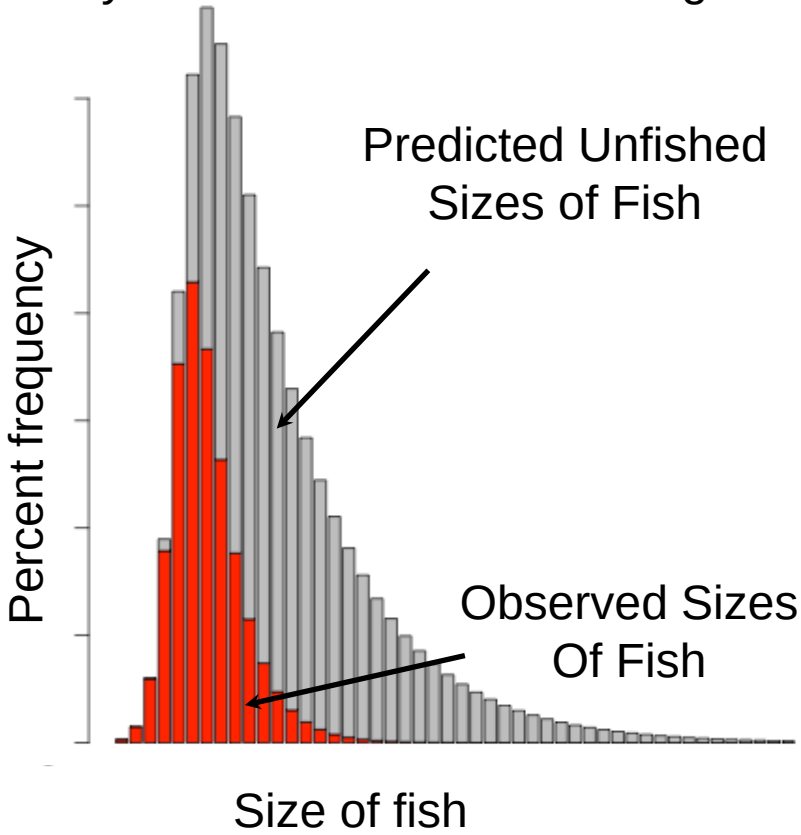
Palau

Length-based Data Poor Stock Assessment

Jeremy Prince

Noah Idechong

Steven Victor



Second presentation

SPR: Comparing fished to unfished egg production

- Spawning Potential Ratio: the proportion of unfished spawning biomass left by a given fishing policy

$$SPR = \frac{P_{fished}}{P_{unfished}}$$

stimating SPR

We start with 1000 individuals

Age
1
2
3
4
5
.
.
.
.

We model births, growth, reproduction, and deaths for that cohort

Max

Estimating SPR

Fish grow bigger with age

Age	Size
1	
2	
3	
4	
5	
.	
.	
.	
.	
Max	

Estimating SPR

Fish become reproductively mature at a given age

Age	Size	Maturity
1		0%
2		0%
3		10%
4		20%
5		50%
.		.
.		.
.		.
.		
		100%
Max		100%

Estimating SPR

Fish produce eggs in relation to age/size

Age	Size	Maturity	Eggs
1		0%	0
2		0%	0
3		10%	5,000
4		20%	80,000
5		50%	200,000
.		.	.
.		.	.
.		.	.
.			
		100%	900,000
Max		100%	1,000,000

Estimating SPR

Fish die of natural causes

Age	Size	Maturity	Eggs	# in Unfished Pop.
1		0%	0	1000
2		0%	0	829
3		10%	5,000	674
4		20%	80,000	470
5		50%	200,000	396
.		.	.	.
.		.	.	.
.		.	.	.
.				
		100%	900,000	19
Max		100%	1,000,000	1

Estimating SPR

Calculate egg production in an unfished cohort

Age	Size	Maturity	Eggs	# in Unfished Pop.
1		0%	0	1000
2		0%	0	829
3		10%	5,000	674
4		20%	80,000	470
5		50%	200,000	396
.		.	.	.
.		.	.	.
.		.	.	.
.				
Max		100%	900,000	19
		100%	1,000,000	1

Sum across columns to calculate the expected # of Eggs in an unfished cohort

Estimating SPR

Now we do the same calculation for a fished cohort

$$SPR = \frac{P_{fished}}{P_{unfished}}$$

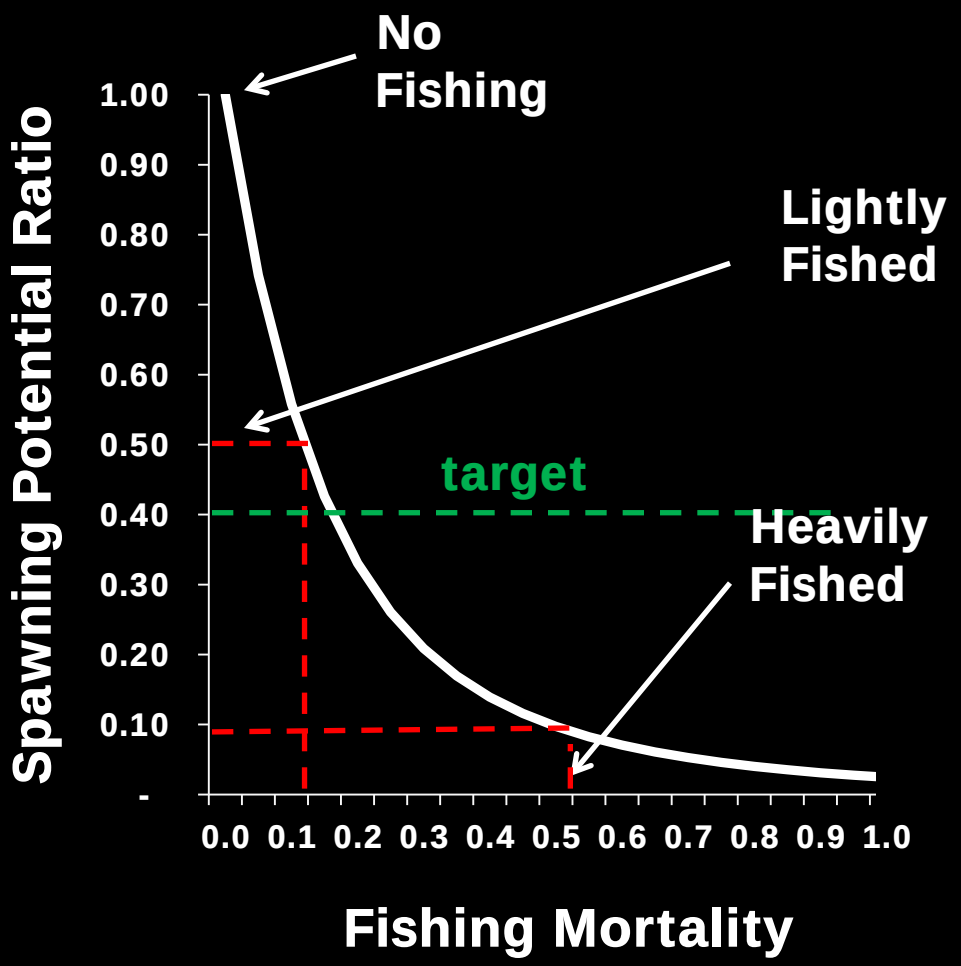
The # of fish is reduced by both M and F

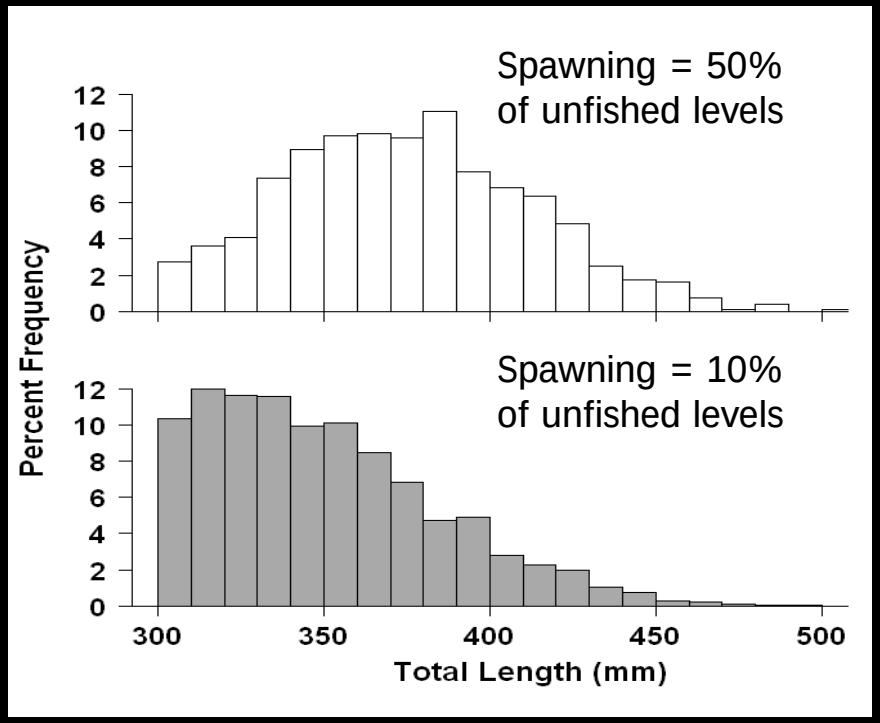
Sum up eggs under that F

Age	Size	Maturity	Eggs	# in Unfished Pop.	# in Fished Pop.
1		0%	0	1000	1000
2		0%	0	829	784
3		10%	5,000	674	598
4		20%	80,000	470	443
5		50%	200,000	396	312
.		.	.	.	.
.		.	.	.	.
.		.	.	.	.
.					
Max		100%	900,000	19	7
		100%	1,000,000	1	1

Egg Production = Spawning Potential Ratio (SPR)

A measure of current egg production relative to unfished levels





MPA-Based Assessment Program

University of California
Santa Barbara

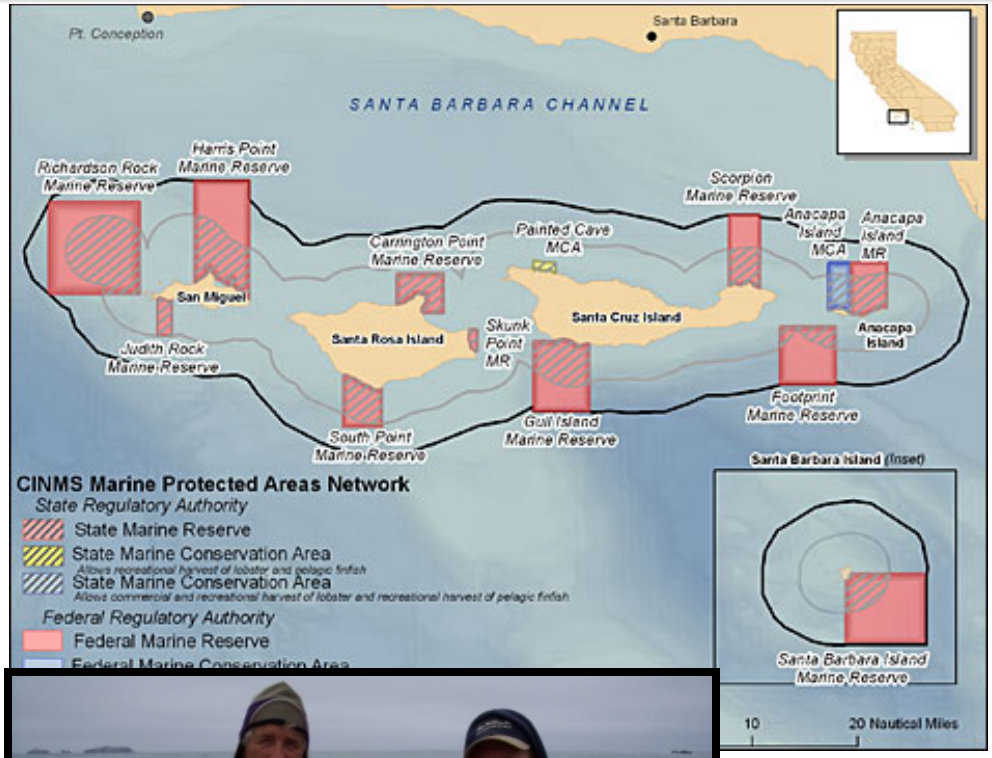
"Fishing for science changed my perspective on management"

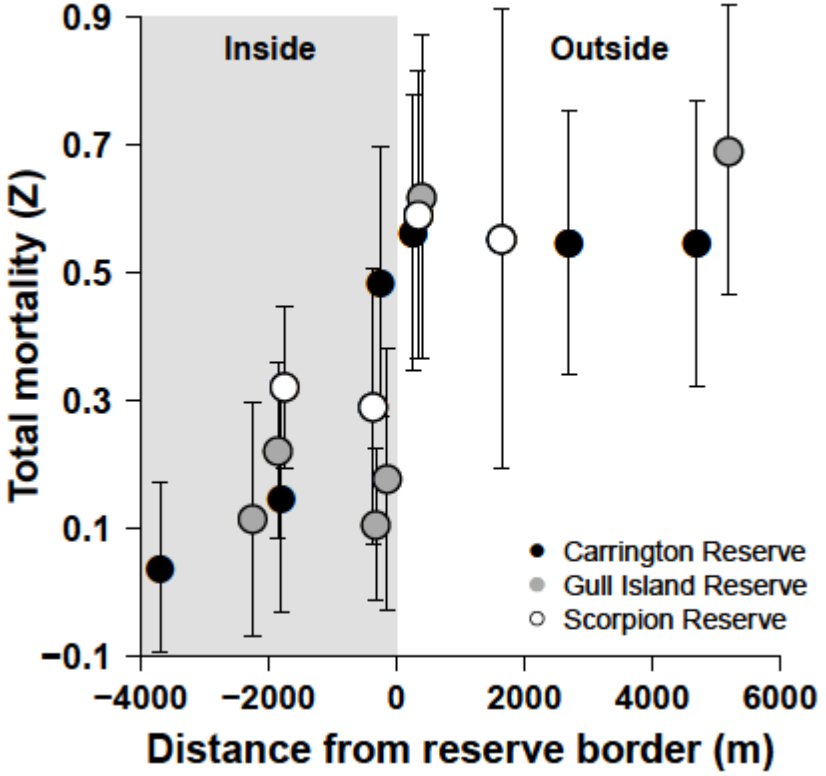
- John Colgate, commercial fisherman

10 km

California
Data Poor Stock Assessment

MPA-based

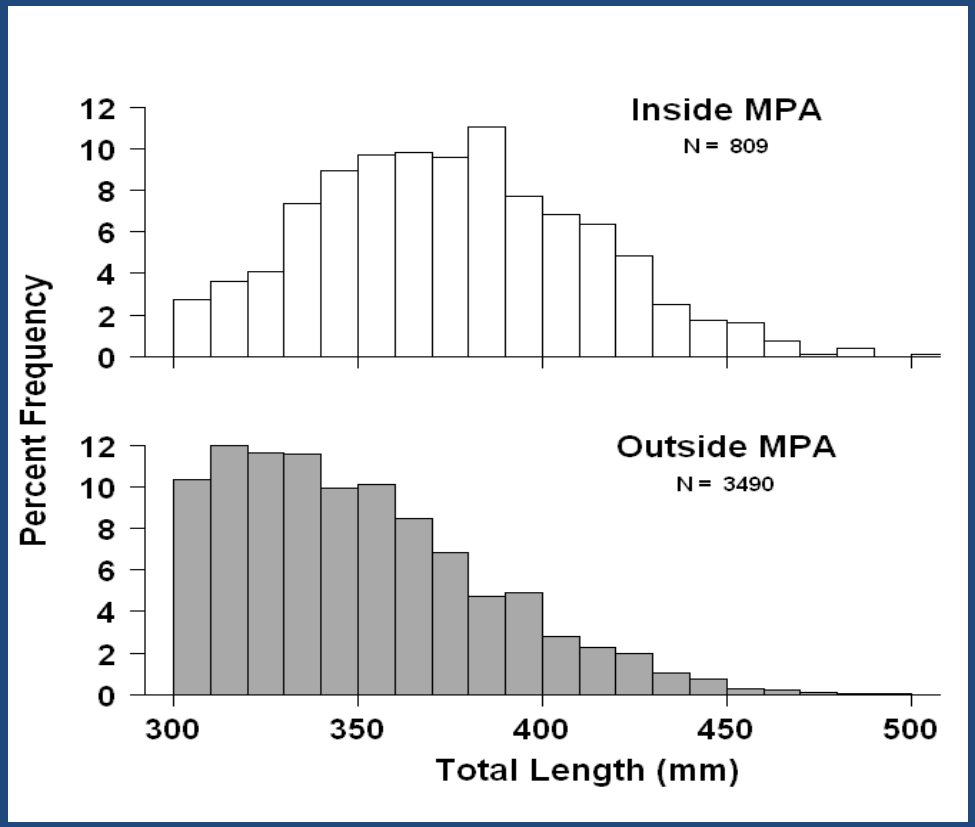




MPA-Based Assessments

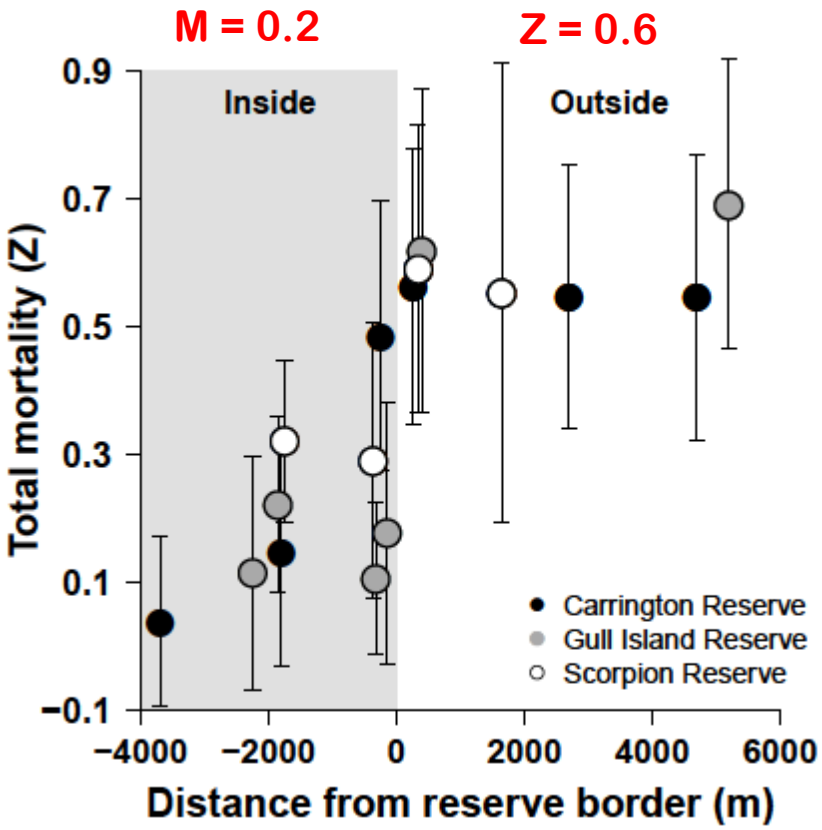
Example:

- Fish length distributions inside and outside NTZs



Data Poor Stock Assessment

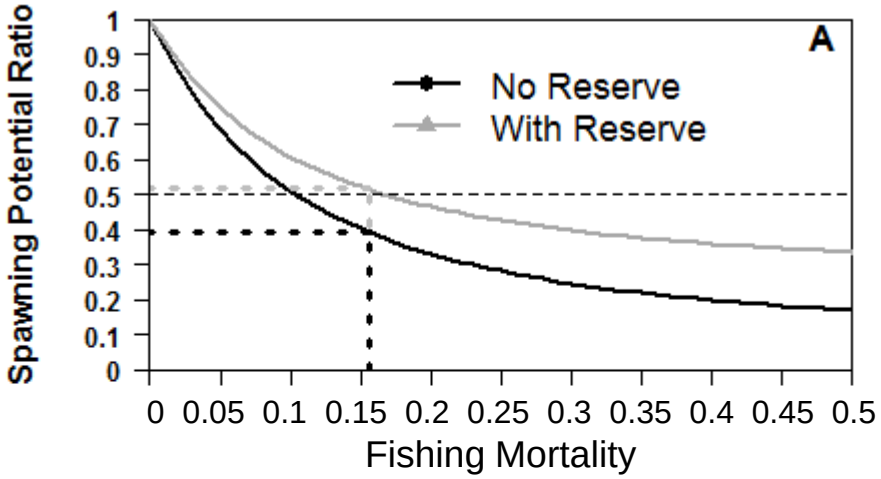
Using MPAs to measure fishing mortality



F = 0.4

Kay and Wilson 2012

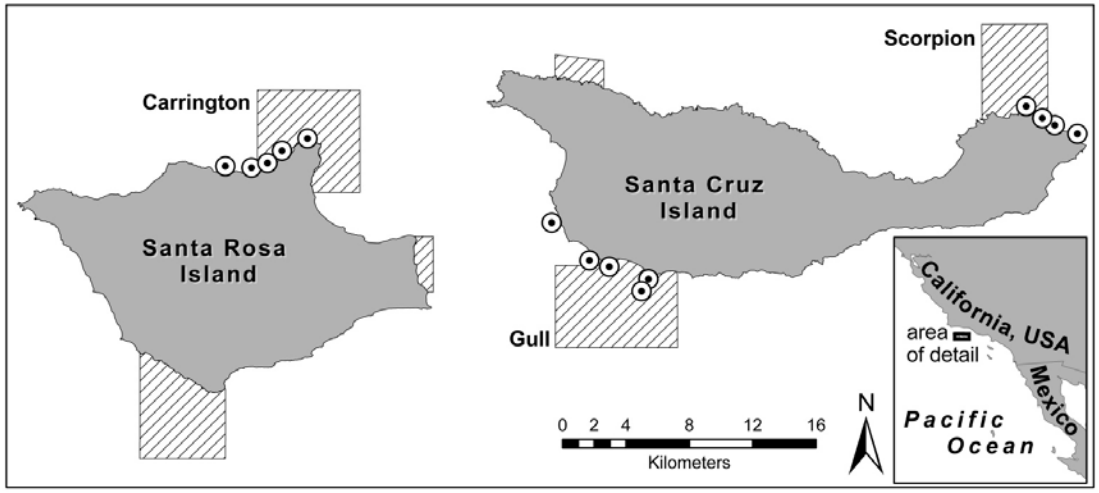
Crediting MPAs in assessments

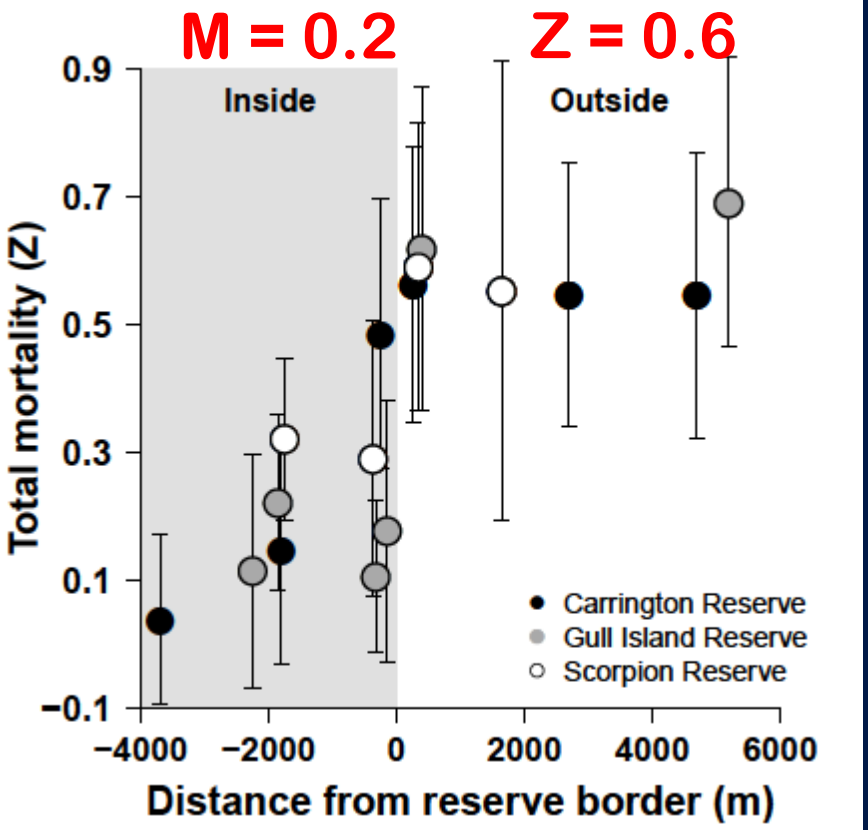


MPAs increase SPR and reduce the probability of overfishing

Wilson et al. in press

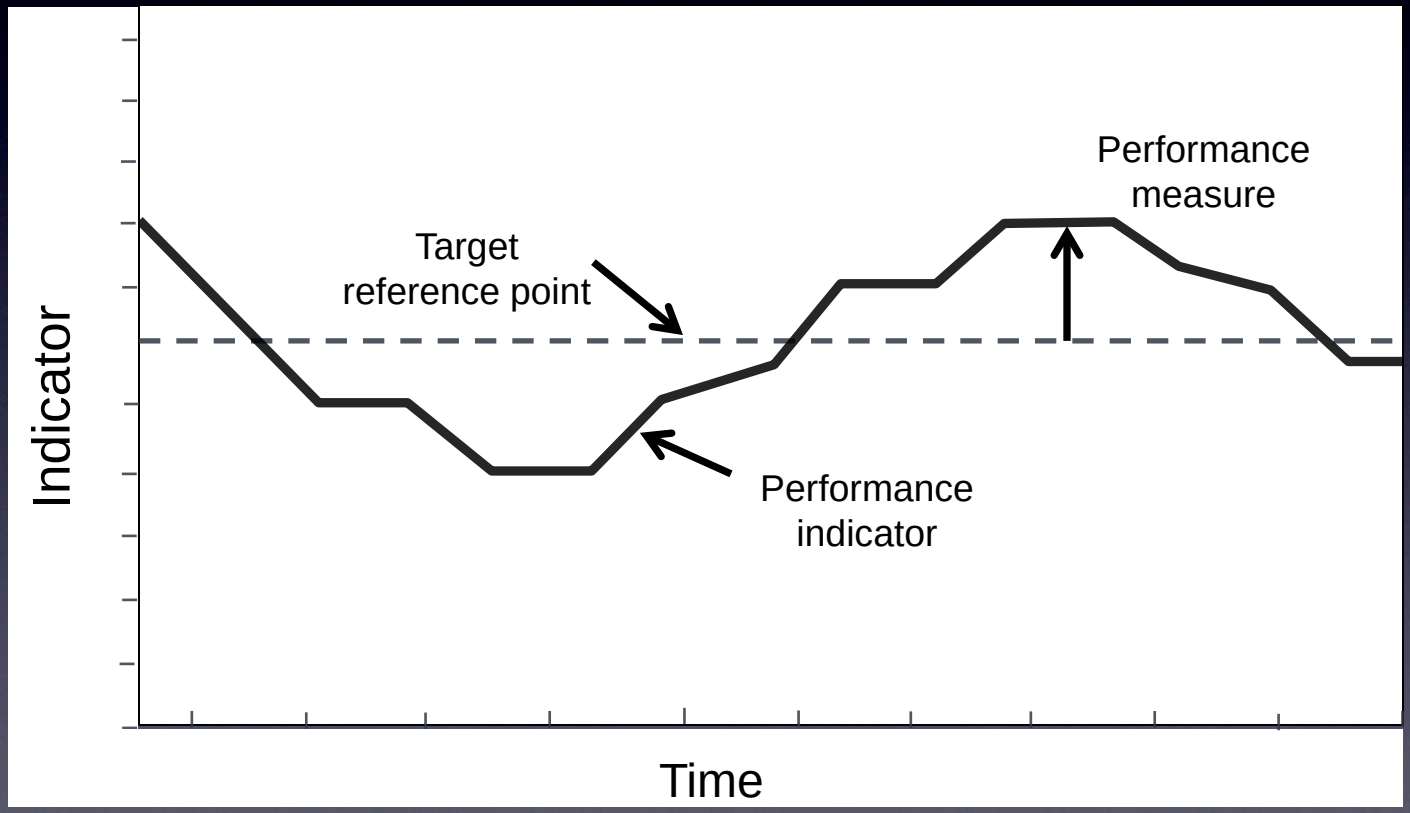
Using MPAs to measure fishing mortality





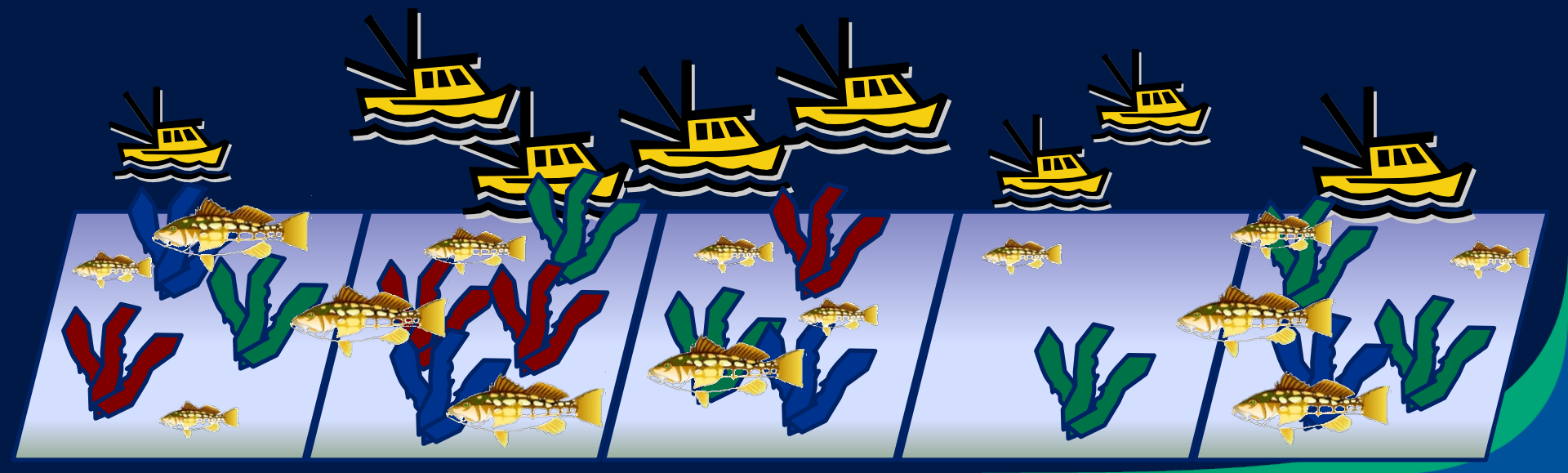
Fishing Mortality = 0.4

Kay et al. 2011 Ecological Applications


Indicator
Time
Performance
measure
Target
reference point
Performance
indicator

Why are small scale fisheries difficult to assess?

- Geographic variability
  - Patchy habitat
  - Life History, Demography
  - Larval dispersal
  - Adult movement
  - Catch rates



Why are small scale fisheries difficult to assess?

- Geographic variability
  - Patchy habitat
  - Life History, Demography
  - Larval dispersal
  - Adult movement
  - Catch rates
  - Management
- Limited data
- Lack of management tools