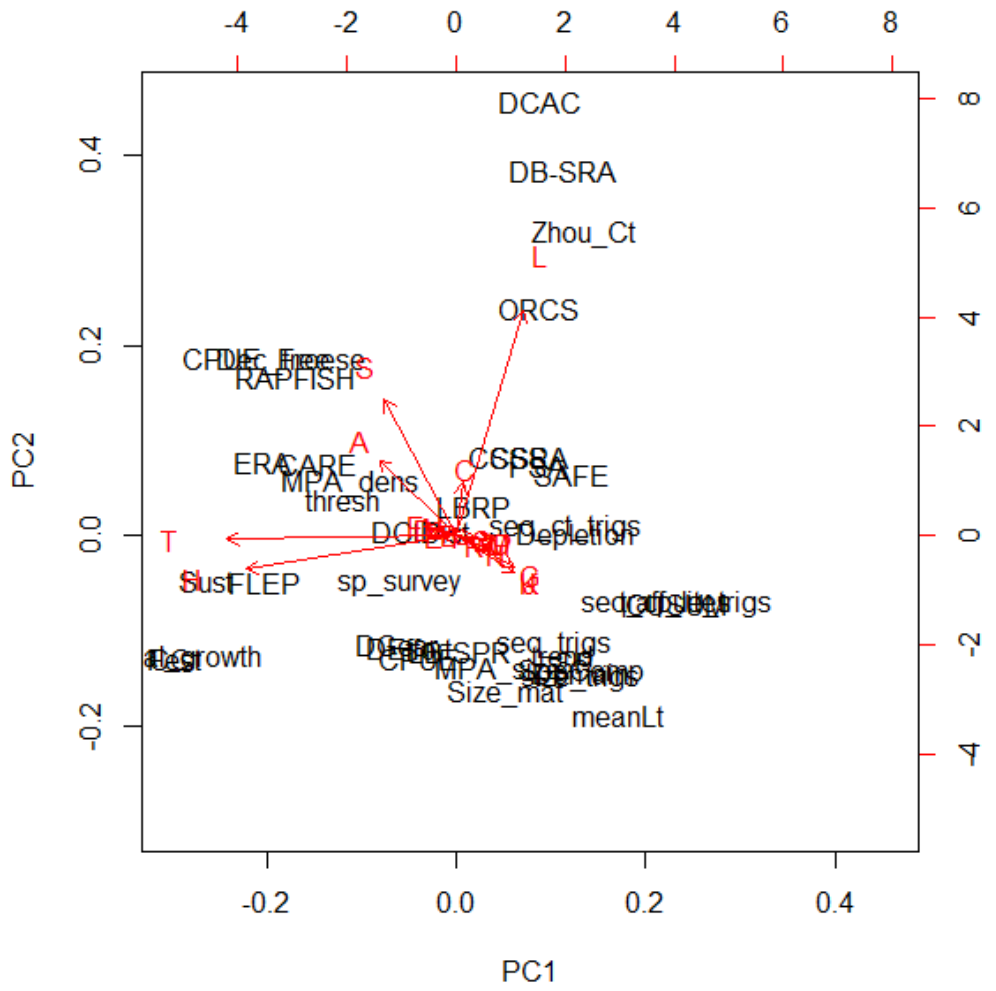
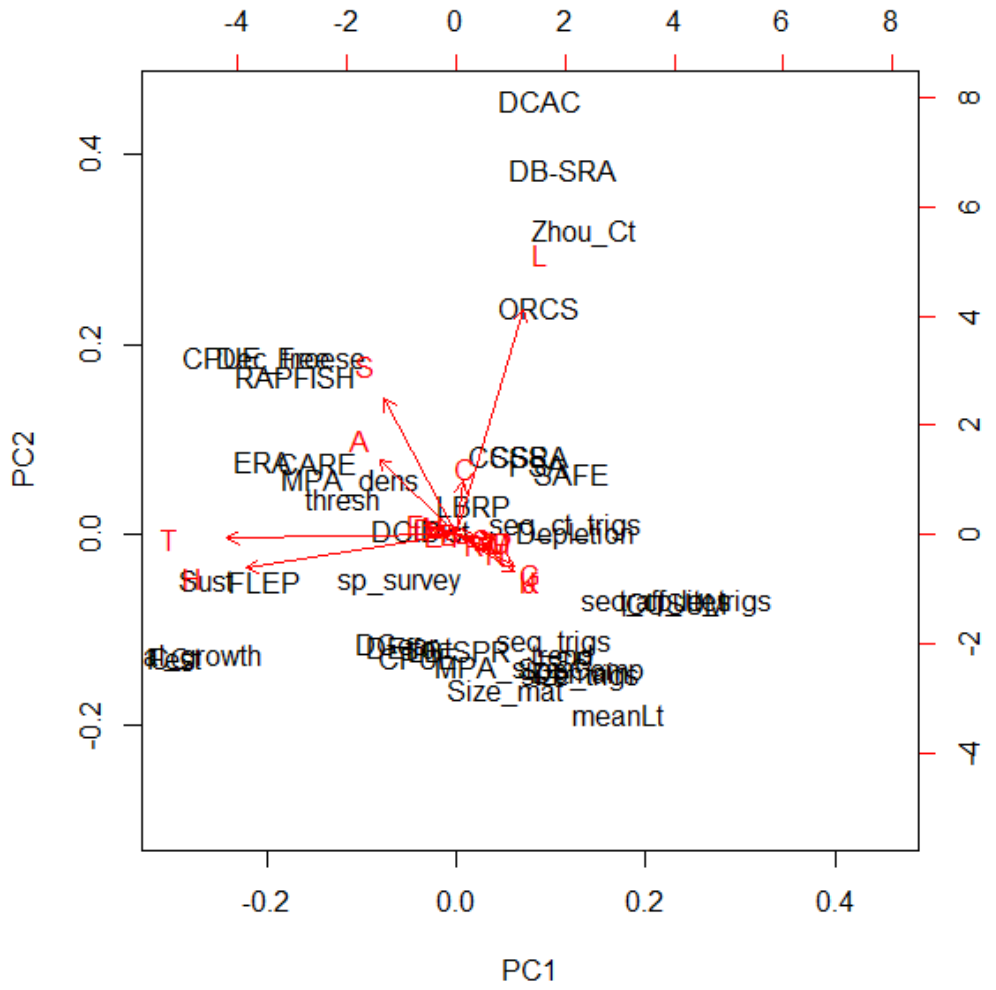
Data-limited methods: An overview

Organizing data-limited methods



- Vulnerability/Risk
- Life-history based
- Catch-only
- Length-based
- Model based
- MPA-based

Organizing data-limited methods



Grouping methods

- Input/Data types
- Static vs dynamic
- Baseline vs non-baseline
- Effort vs catch (management units)

Organizing data-limited methods

- Risk Analysis
- Empirical indicators
- Multiple indicators
- Life history based
- “Catch-only”
- Size-based
- Marine Protected Area-based
- Population models

DLM Methods: Risk Analysis

Risk analysis: Methods

Qualitative to semi-quantitative methods that assess relative risk of serious population decline and/or overfishing

- Productivity-Susceptibility Analysis (PSA)
- Ecological Risk Assessment for Effects of Fishing (ERAEF)
- Sustainability Assessment for Fishing Effects (SAFE)
- Comprehensive assessment of risk to ecosystems (CARE)

Pros

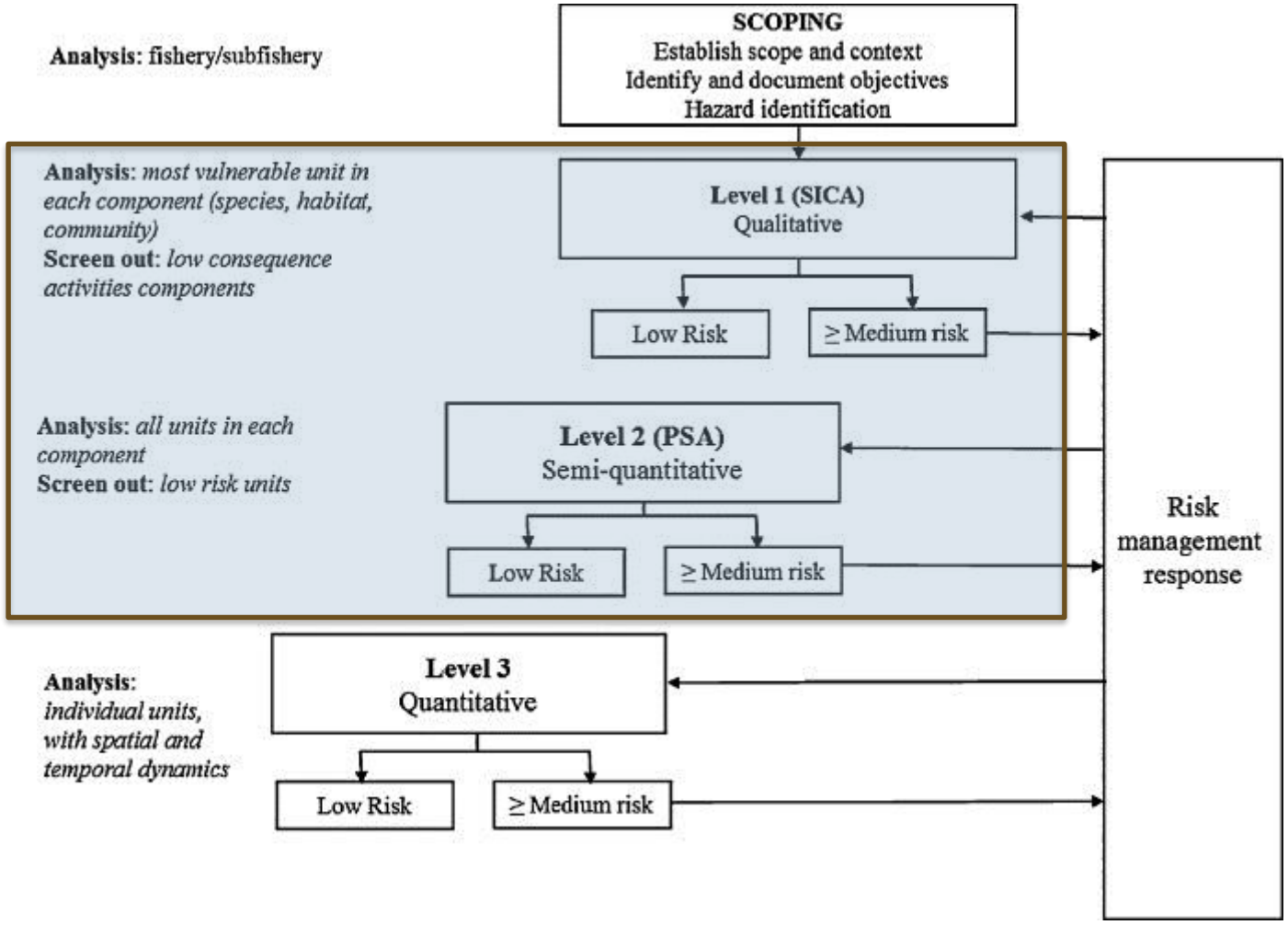
- Low data requirements
- Focuses management
- Identify data gaps
- Include stakeholders

Cons

- Incomplete legislative connection
- Lacks catch optimization
- Lacks harvest control rule

Risk analysis: ERAEF

Data-limited portion



Level 1: identifying hazards (Hobday et al. 2007, section 2.3)

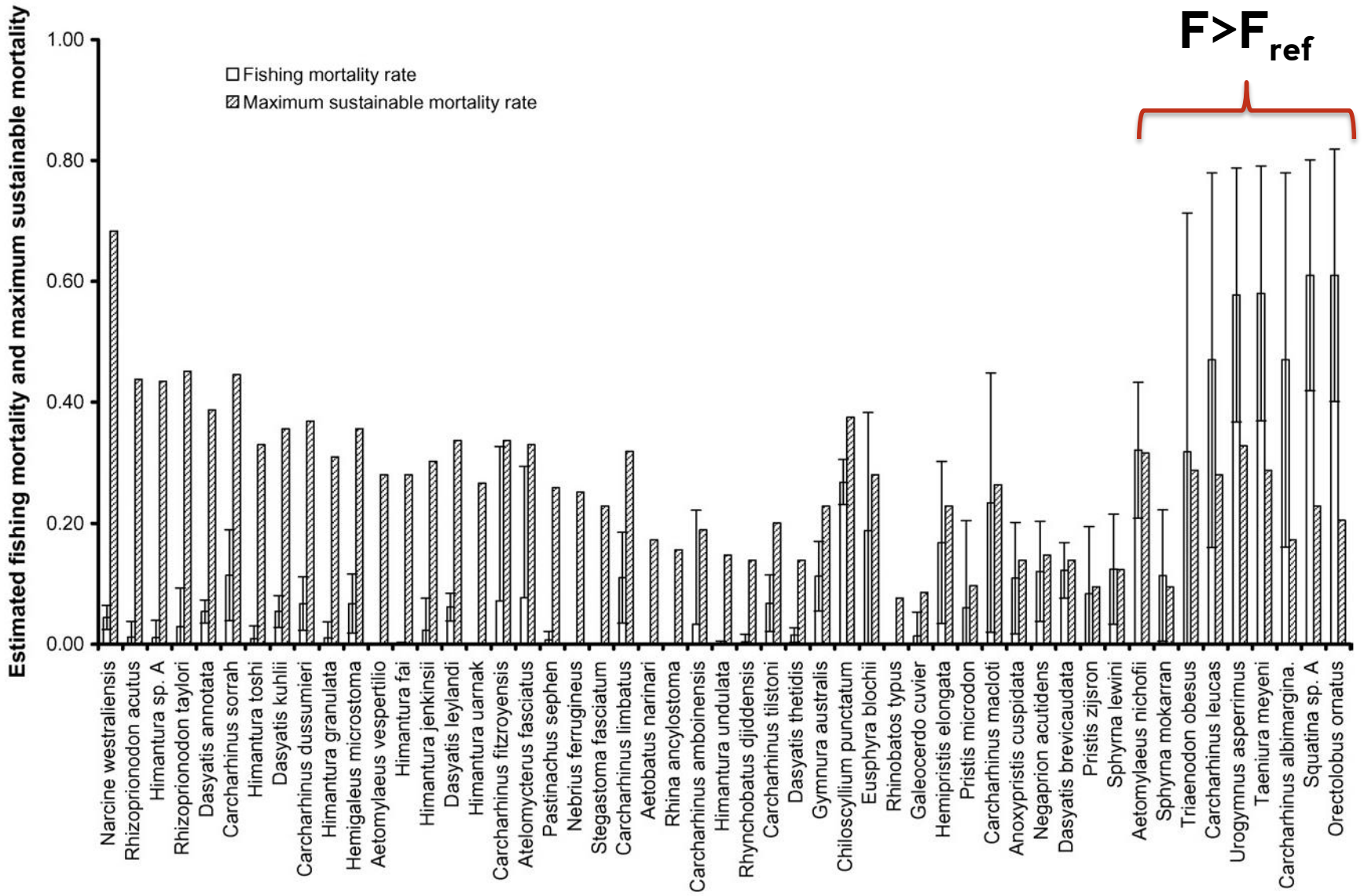
Level 2: PSA

Sources: Hobday et al. 2007, 2011

Risk analysis: SAFE

Estimates fishing mortality using:

- species distribution data
  - location
  - abundance
- fisheries effort distribution



Sources: Zhou et al. 2007; Zhou & Griffiths 2008

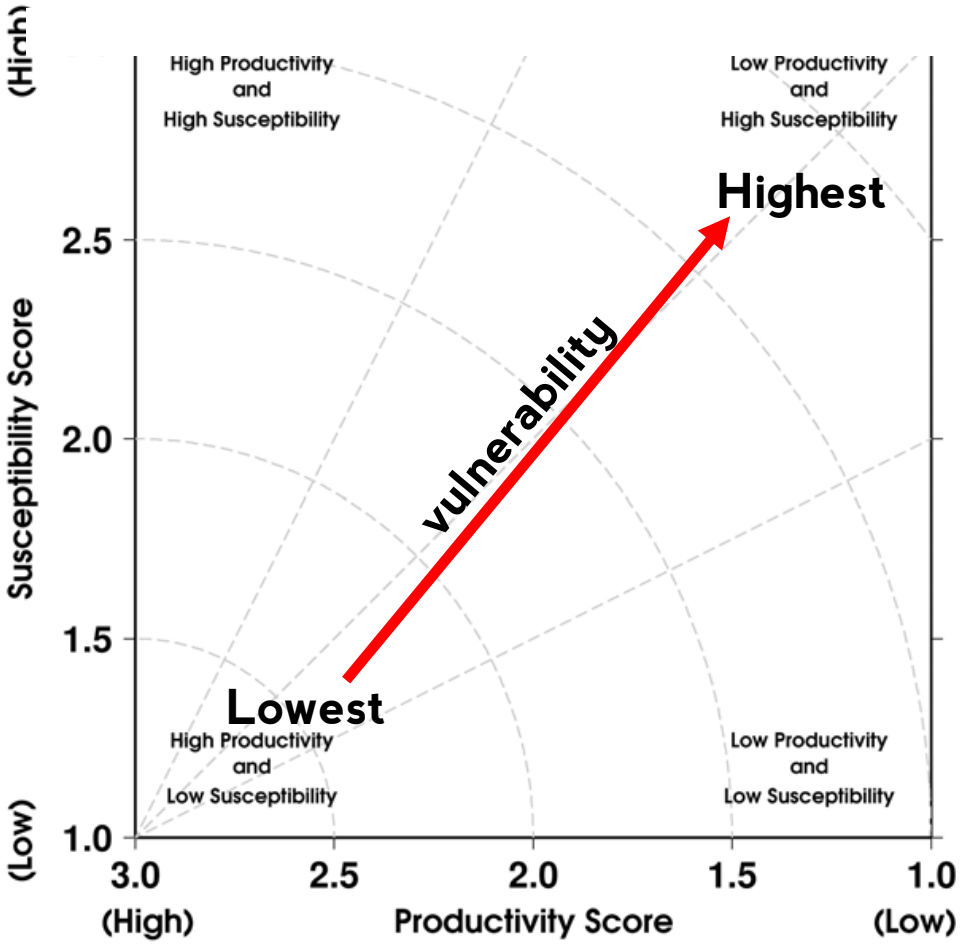
Risk analysis: PSA

Vulnerability to overfishing = Productivity & Susceptibility

PSA

- Vulnerability in 2-D
- Euclidean distance from origin (3,1)
- Productivity attributes reflect stock life history
- Susceptibility attributes reflect impacts of fishing
- Management influences S
- Data quality also ranked

Milton 2001, Stobutzki et al. 2001, Hobday et al. 2007, Smith et al. 2007



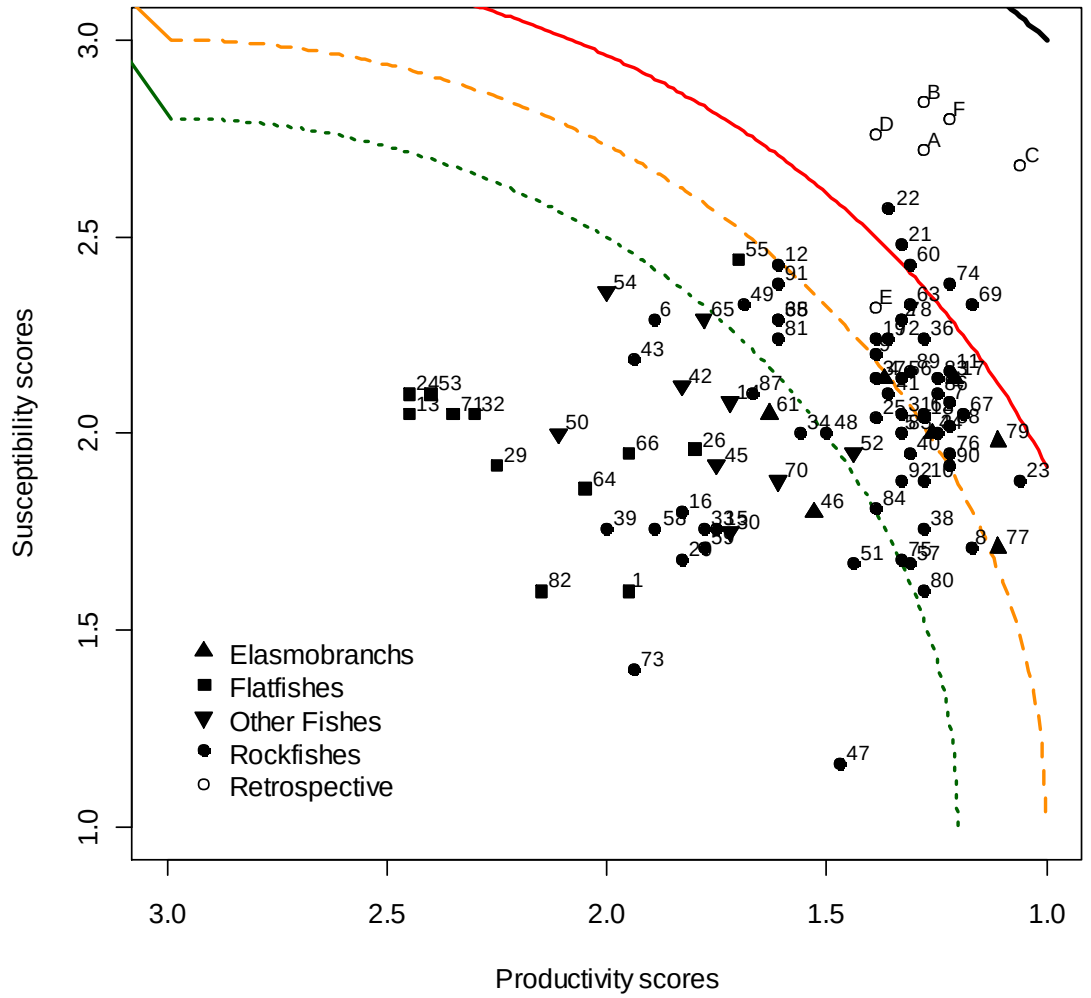
PSA attributes: Productivity (N=10)

Attributes	High (3)	Moderate (2)	Low (1)
r (intrinsic increase)	>0.5	0.5-0.16 (mid-pint 0.10)	<0.16
Maximum age	< 20 years	20-40 years	> 40 years
Maximum size	< 40 cm	40-80 cm	> 80 cm
VonBert (k)	> 0.20	0.10 - 0.20	< 0.10
Natural mortality	> 0.20	0.10 - 0.20	< 0.10
Measured fecundity	> 10e4	10e2-10e3	< 10e2
Breeding strategy	0	between 1 and 3	≥4
Recruitment	highly frequent	moderately frequent	infrequent
Age at maturity	< 2 years	2-4 years (mid-point 3.0)	> 4 years
Mean trophic level	<2.5	2.5-3.5	>3.5

PSA attributes: Susceptibility (N=12)

Attributes	Low (1)	Moderate (2)	High (3)
Management strategy	Targeted stocks have catch limits and proactive accountability measures	Targeted stocks have catch limits and reactive accountability measures	Targeted stocks do not have catch limits or accountability measures
Areal overlap	< 25% of stock occurs in the area fished	Between 25% and 50% of the stock occurs in the area fished	> 50% of stock occurs in the area fished
Geographic concentration	stock is distributed in > 50% range	stock in 25% to 50% range	stock is < 25% of its total range
Vertical overlap	< 25% of stock occurs in the depths fished	Between 25% and 50% of the stock occurs in the depths fished	> 50% of stock occurs in the depths fished
Spawning stock biomass	B is > 40% of B0	B is between 25% and 40% of B0	B is < 25% of B0
Morphology Affecting Capture	low selectivity to the fishing gear.	moderate selectivity to the fishing gear.	high selectivity to the fishing gear.
Survival After Capture and Release	Probability of survival > 67%	33% < probability of survival < 67%	Probability of survival < 33%
Desirability/Value of the Fishery	stock is not highly valued	stock is moderately valued	stock is highly valued

Applying PSA: Vulnerable stocks



Vulnerability reference points

V ≥2.2 : major

2.0≤V<2.2: high

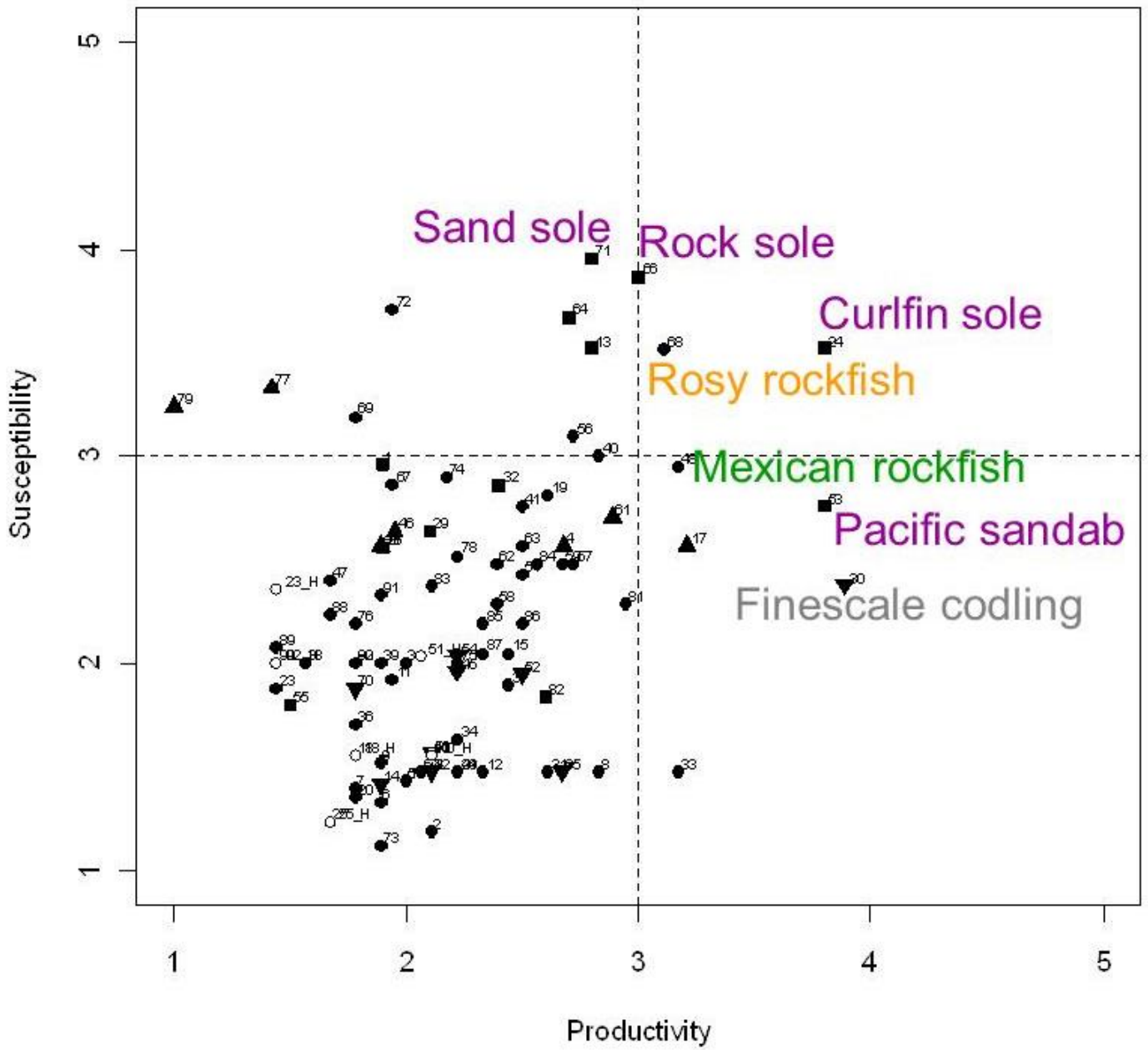
1.8≤V<2.0: medium

V <1.8: low

"Areas of concern"

Source: Cope et al. 2011

Applying PSA: Data quality and future monitoring

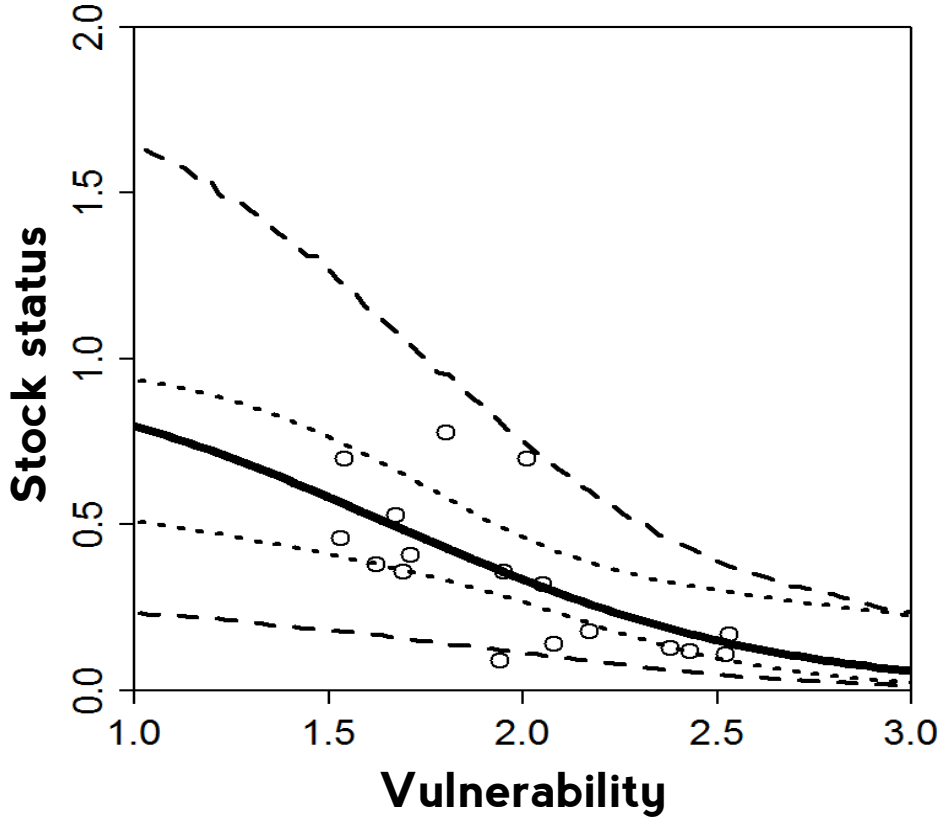


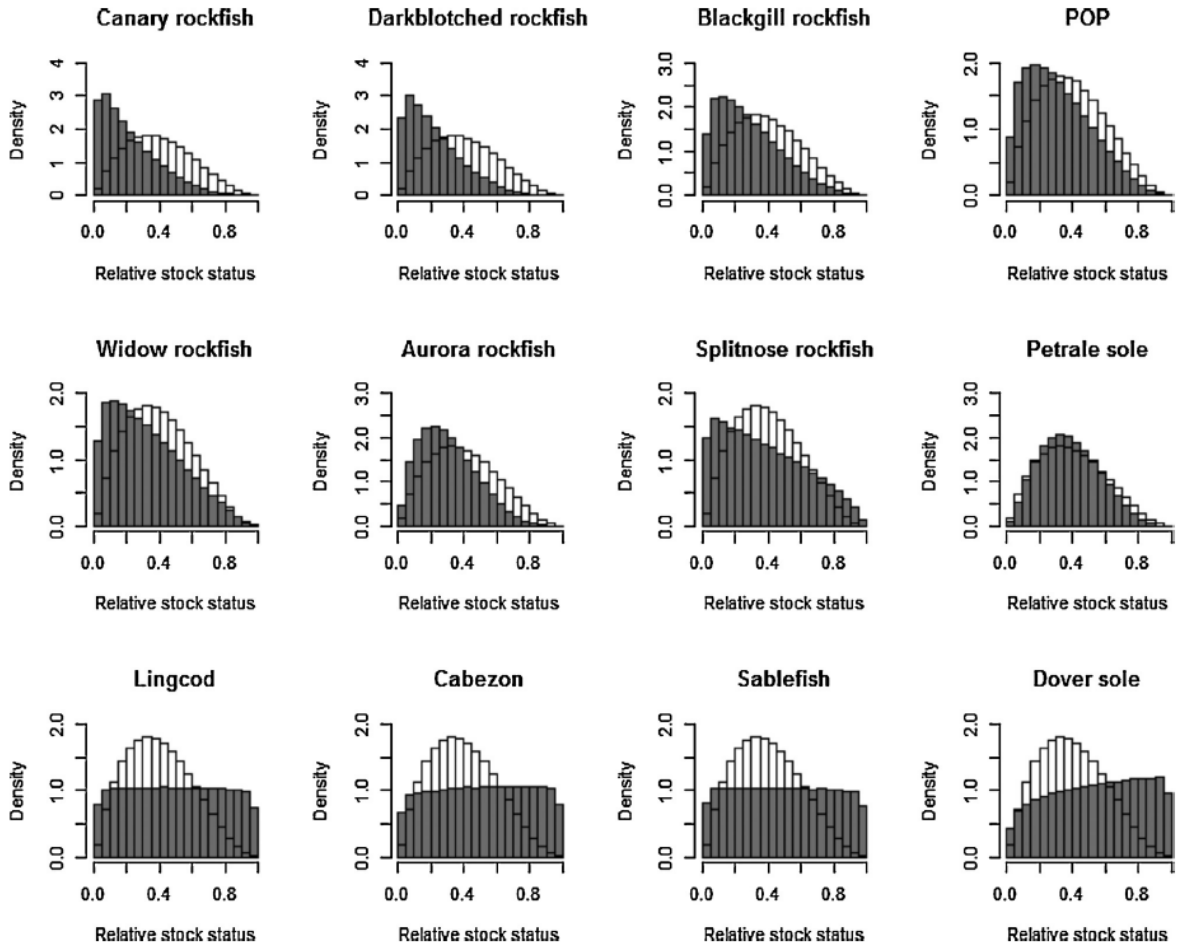
Applying PSA: Stock Complexes

Vulnerability	Depth category			
	Nearshore	Shelf-shallow	Shelf-deep	Slope
Major (V≥2.2)	**China rockfish (2.23)**			**Rougheye rockfish (2.27)**
	Quillback rockfish (2.22)			Shortraker rockfish (2.25)
	Copper rockfish (2.27)			
High (2.0≤V<2.2)	Blue rockfish (2.01)	Speckled rockfish (2.1)	**Redstripe rockfish (2.16)**	Redbanded rockfish (2.02)
		Starry rockfish (2.09)	**Rosethorn rockfish (2.09)**	Aurora rockfish (2.1)
		Vermilion rockfish (2.05)	**Sharpchin rockfish (2.05)**	Blackgill rockfish (2.08)
			Silvergrey rockfish (2.02)	
			Tiger rockfish (2.06)	
			Bank rockfish (2.02)	
			Bronzespotted rockfish (2.12)	
			Chameleon rockfish (2.03)	
			Pink rockfish (2.02)	
Medium (1.8≤V<2.0)	Brown rockfish (1.99)	**Yellowtail rockfish (1.88)**	**Greenstriped rockfish (1.88))**	**Splitnose rockfish (1.82)**
	Grass rockfish (1.89)	Flag rockfish (1.97)	**Harlequin rockfish (1.94)**	Yellowmouth rockfish (1.96)
	Honeycomb rockfish (1.97)	Greenspotted rockfish 1.98)	**Stripetail rockfish (1.80)**	
	Olive rockfish (1.87)	Rosy rockfish (1.89)	Greenblotched rockfish (1.92)	
		Squarespot rockfish (1.86)	Mexican rockfish (1.80)	
		Swordspine rockfish (1.94)	Pinkrose rockfish (1.82)	
Low (V<1.8)	Black-and-yellow rockfish (1.7)	**Pygmy rockfish (1.42)**		
	Gopher rockfish (1.76)	Calico rockfish (1.46)		
	Kelp rockfish (1.59)	Freckled rockfish (1.44)		
	Treefish rockfish (1.73)	Halfbanded rockfish (1.26)		

Source: Cope et al. 2011

Applying PSA: Stock status

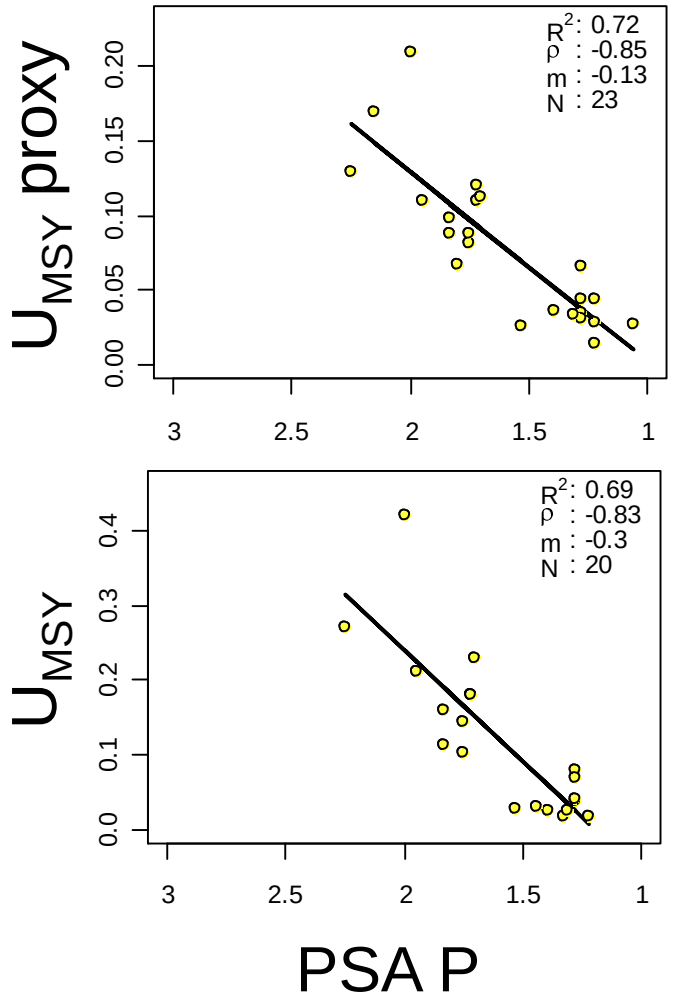




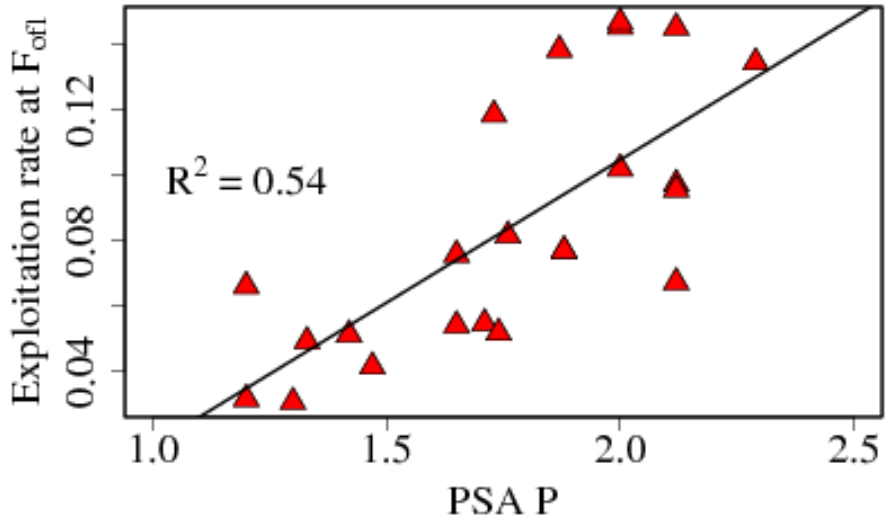
Source: Cope et al. 2014

Applying PSA: Stock Complexes

PFMC stocks



NPFMC stocks



Category 2 stocks:

OFL = M*B = U_{ofl}*B

Cope, Patrick, and Spencer in prep.

PSA demo

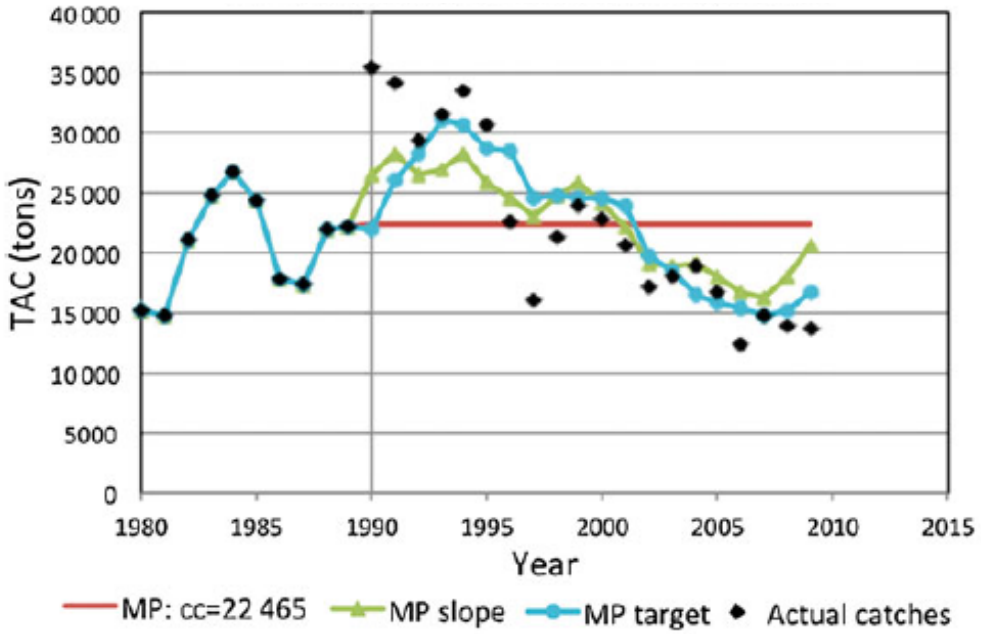
Summary: Risk Analysis

- One of the simpler approaches
- Qualitative to semi-quantitative methods
- Used to prioritize stock or data collection
- Expert/stakeholder opinion
- Often lacks operational management connection

DLM Methods: Indicator-based approaches

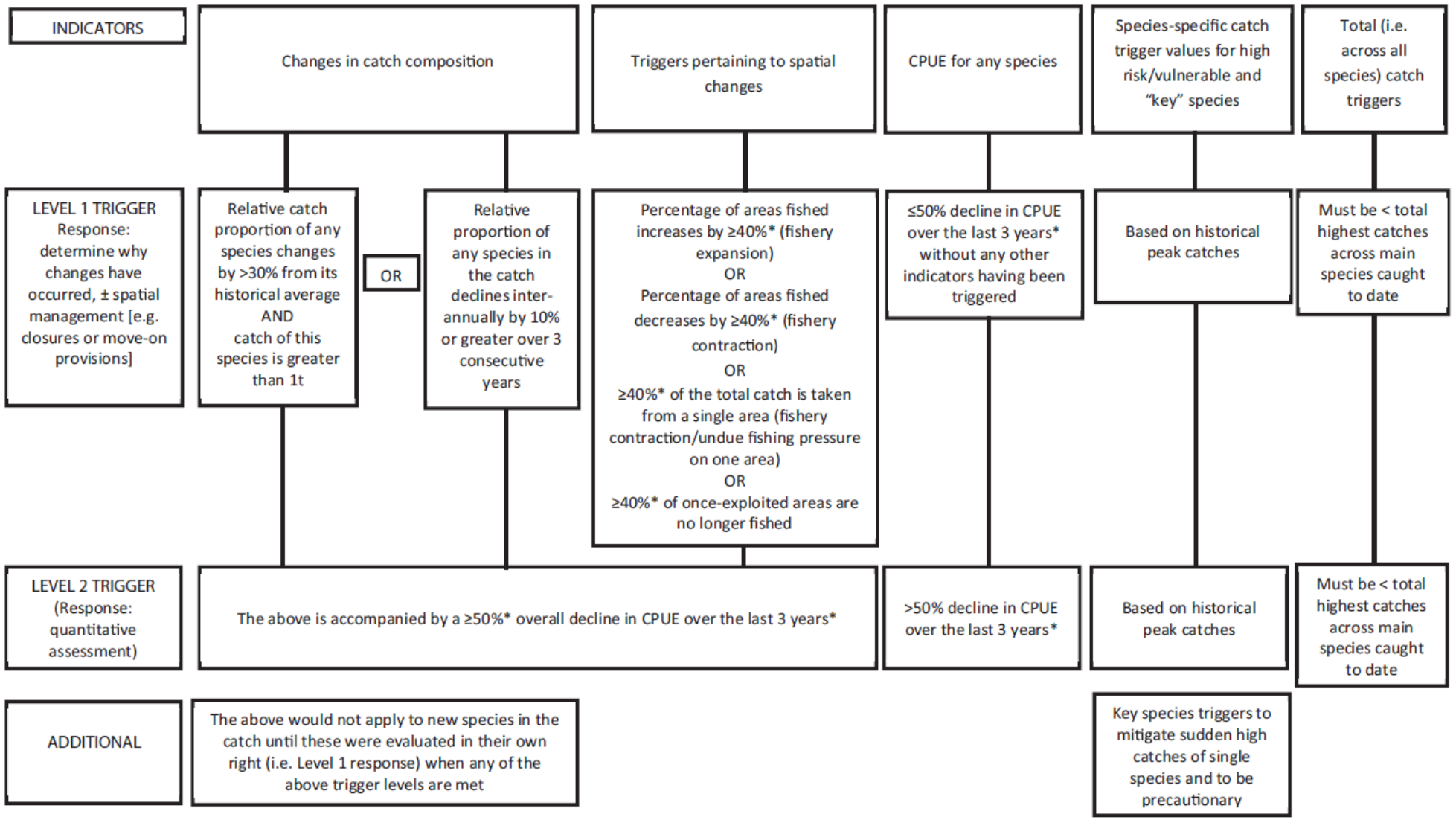
Empirical indicator approach

Empirical MPs	Control parameters
MP constant catch	$TAC_{y+1} = TAC^{target}$, where TAC^{target} is the annual catch required to reach the target spawning biomass
MP slope: TAC adjusted up or down if the trend in recent survey index values is positive or negative	$TAC_{y+1} = TAC_y\,(1 + \lambda S_y)$, where λ is the smoothing parameter, and S_y the average survey slope over the most recent p years
MP target: TAC adjusted up or down if average of recent survey index values is above or below the target index value.	$TAC_{y+1} = TAC^{target}[w + (1-w)((I_y^{recent} - I^0)/(I^{target} - I^0))]$ *if* $I_y^{recent} \geq I^0$ $TAC_{y+1} = wTAC^{target}(I_y^{recent}/I^0)^2$ if $I_y^{recent} < I^0$, where I^{target} is the target reference point for survey, $I^0 = 0.21^{ave}$ is the limit reference point for survey, I^{ave} the average survey abundance index over past 5 years, I_y^{recent} the average survey of most recent 4 years, TAC^{target} the equilibrium catch, and w a smoothing parameter



Source: Geromont and Butterworth 2014

Multiple indicator approach



Source: Dowling et al. 2014