

# Indicators of status and benchmarks for Conservation Units in Canada's Wild Salmon Policy

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# Acknowledgements

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# Overview

1. Introduction: Conceptual framework for status assessment
2. Wild Salmon Policy: Indicators of status, metrics, and benchmarks
3. Evaluating benchmarks using simulation modelling

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# Conceptual framework for status assessment

## Identifying benchmarks

Information required	
Frame of reference	
Goal	
Time frame for achieving	
Harvest scenario	
Assumption about biological production	
Sources of uncertainty	
Risk tolerance	

# Conceptual framework for status assessment

## Identifying benchmarks

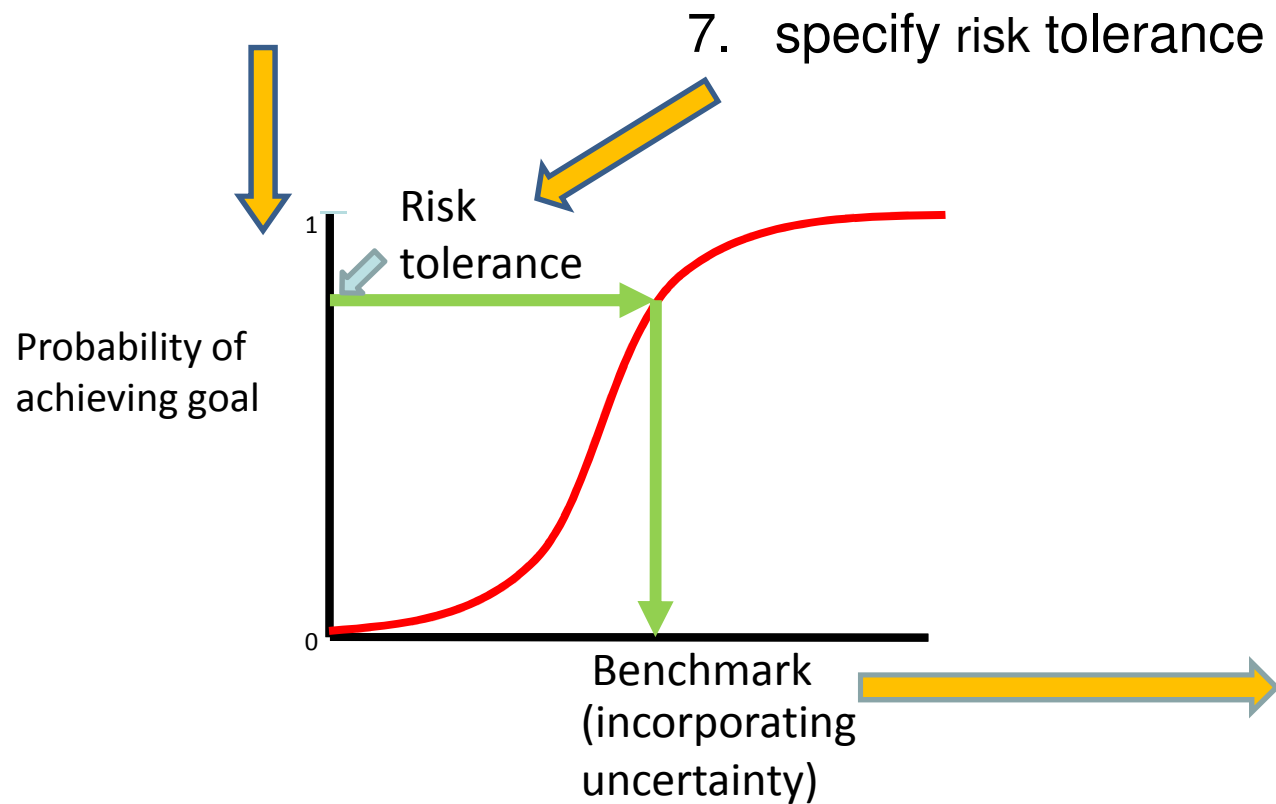
Information required	Example
Frame of reference	Biological yield
Goal	$S_{MSY}$
Time frame for achieving	3 generations
Harvest scenario	No directed fishing
Assumption about biological production	Stock-recruitment relationship
Sources of uncertainty	Recruitment variability, outcome uncertainty
Risk tolerance	Acceptable probability of achieving target

## Science

5. production model
6. Incorporate uncertainty

## Fisheries Management

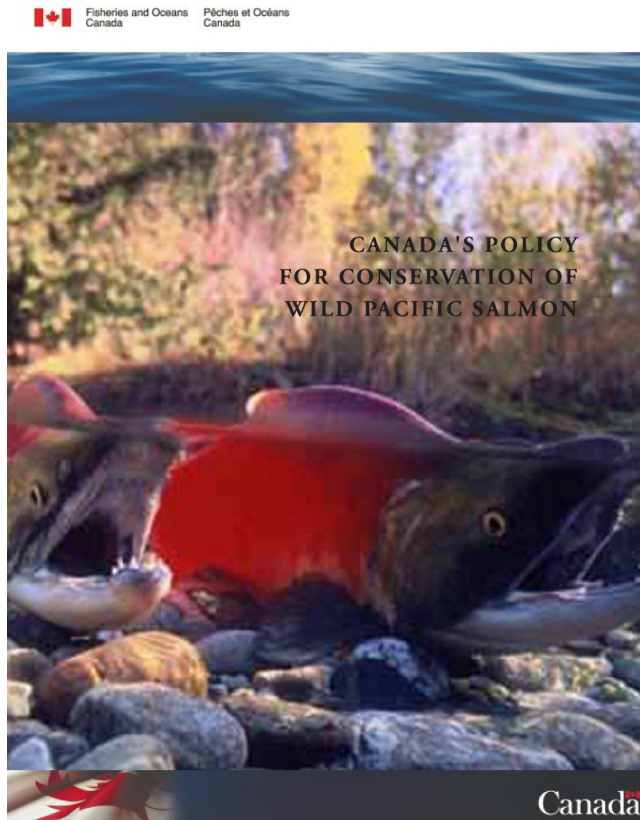
1. reference frame
2. goal
3. time frame for recovery
4. fishery management action



# Overview

1. Introduction: Conceptual framework for status assessment
2. **Wild Salmon Policy: indicators of status, metrics, and benchmarks**
3. Evaluating benchmarks using simulation modelling

# Wild Salmon Policy



The goal is "to restore and maintain healthy and diverse salmon populations and their habitats for the benefit and enjoyment of the people of Canada in perpetuity."

(WSP 2005, p.8)

# Wild Salmon Policy

## Strategies

- 1) Standardized monitoring of wild salmon status
- 2) Assessment of habitat status
- 3) Inclusion of ecosystem values and monitoring
- 4) Integrated strategic planning
- 5) Annual program delivery
- 6) Performance review

(WSP 2005, Table 1)

# Wild Salmon Policy

## Strategies

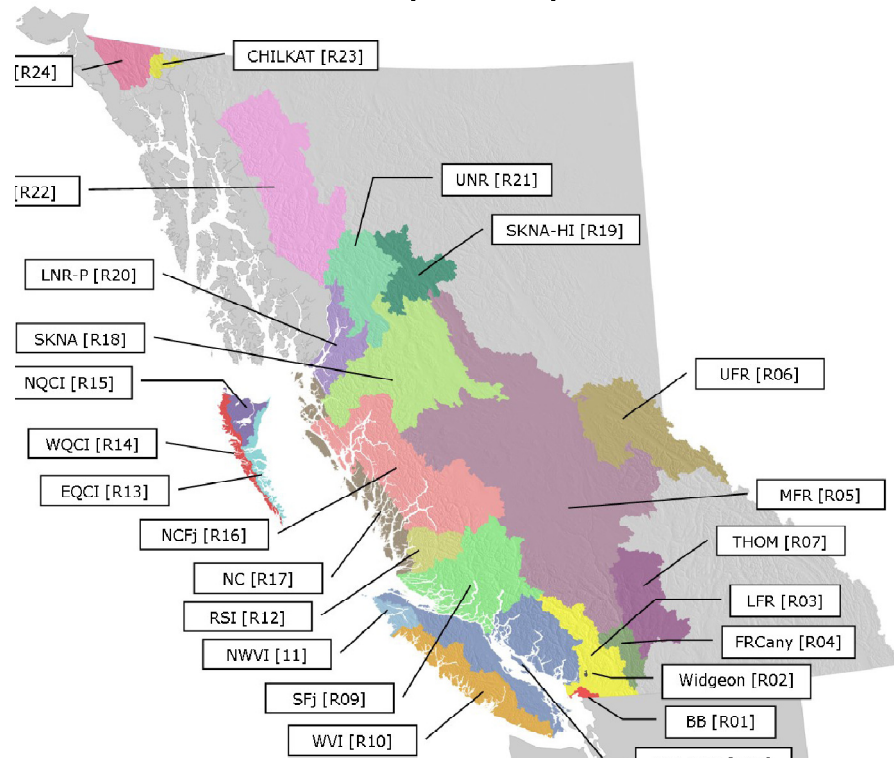
- 1) Standardized monitoring of wild salmon status
  - ✓ • Identify Conservation Units (CUs)
  - Develop criteria to assess CUs and identify benchmarks to represent biological status
  - Monitor and assess status of CUs

# Wild Salmon Policy

## Strategies

- 1) Standardized monitoring of wild salmon status
  - ✓ Identify Conservation Units (CUs)

CUs for river-type sockeye salmon

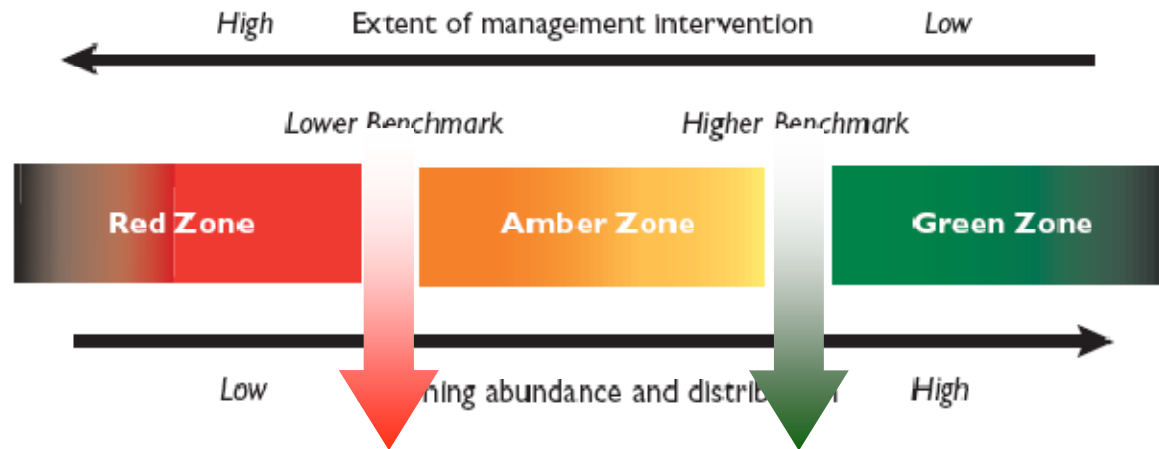


# Wild Salmon Policy

## Strategies

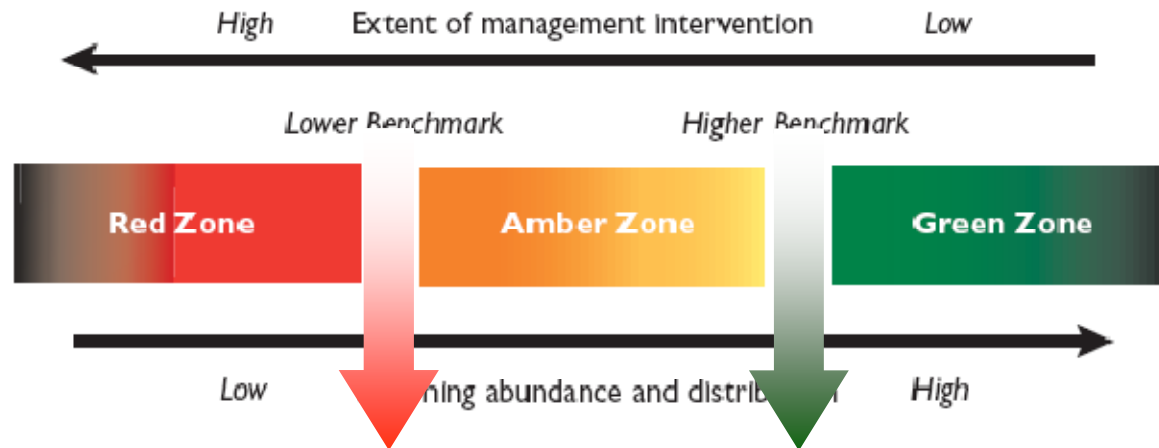
- 1) Standardized monitoring of wild salmon status
  - ✓ • Identify Conservation Units (CUs)
  - • Develop criteria to assess CUs and identify benchmarks to represent biological status
    - Monitor and assess status of CUs

# Wild Salmon Policy



(WSP 2005, p.18)

# Wild Salmon Policy



•"at a level ... high enough to ensure there is a substantial **buffer** between it and any level of abundance that could lead to a CU being considered at **risk of extinction by COSEWIC** "

•"the level expected to provide, on an average annual basis, the **maximum annual catch**"

•"there would **not be a high probability** of losing the CU"

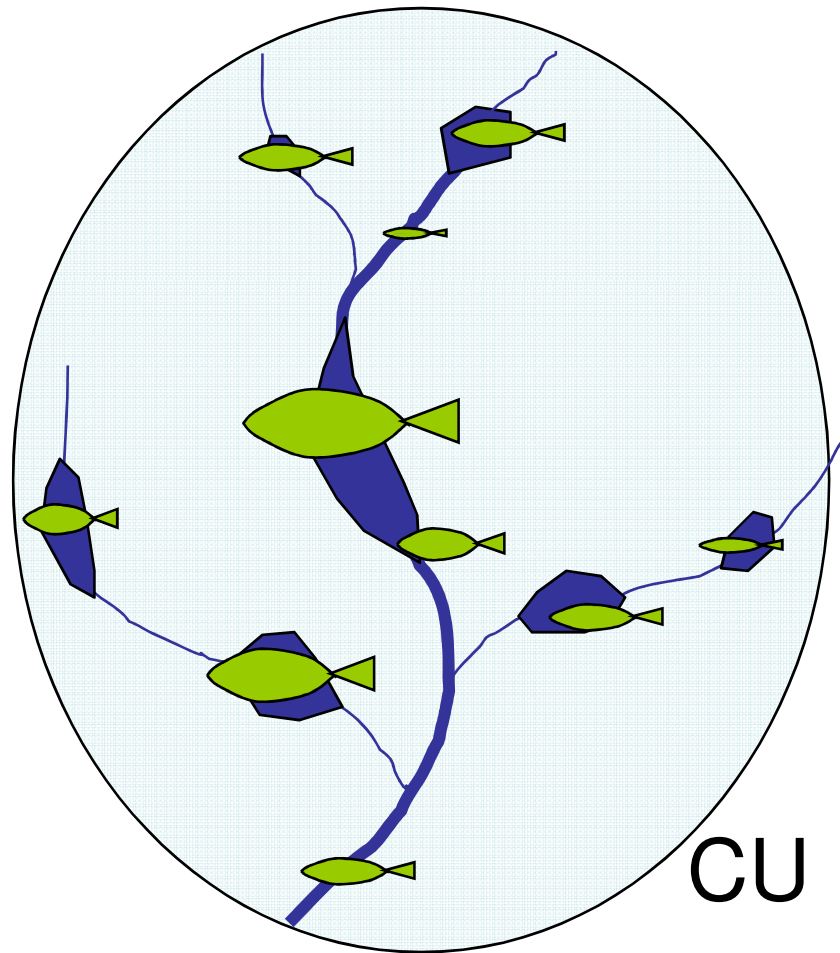
# Wild Salmon Policy

## Risk of extinction by COSEWIC

<b>Criteria</b>
A. Declining total population
B. Small distribution and decline or fluctuation
C. Small population size and decline
D. Very small population or restricted distribution
E. Quantitative analysis (probability of extinction)

# Wild Salmon Policy

- Maintenance of biodiversity



# Assessing status

Abundance

Trends in  
abundance

Distribution

Fishing  
mortality

# Assessing status

Abundance

Low abundance greater risks of extirpation due to depensatory mortality, environmental variation, genetic processes, ecological interactions, demographic stochasticity

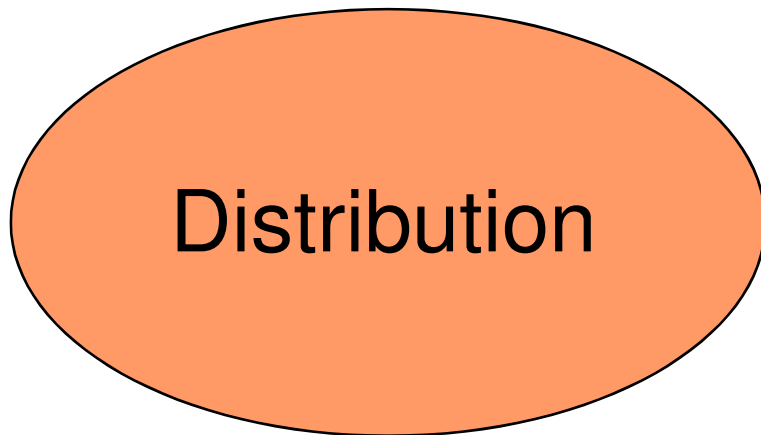
# Assessing status



Trends in  
abundance

Declines may warrant management attention despite abundances not at levels of concern

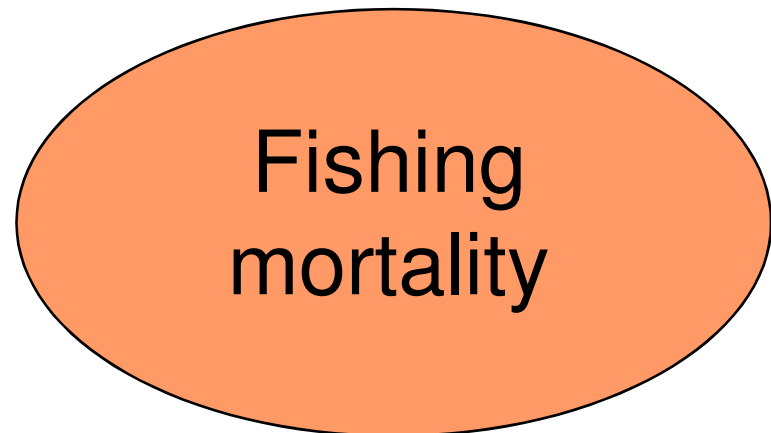
# Assessing status



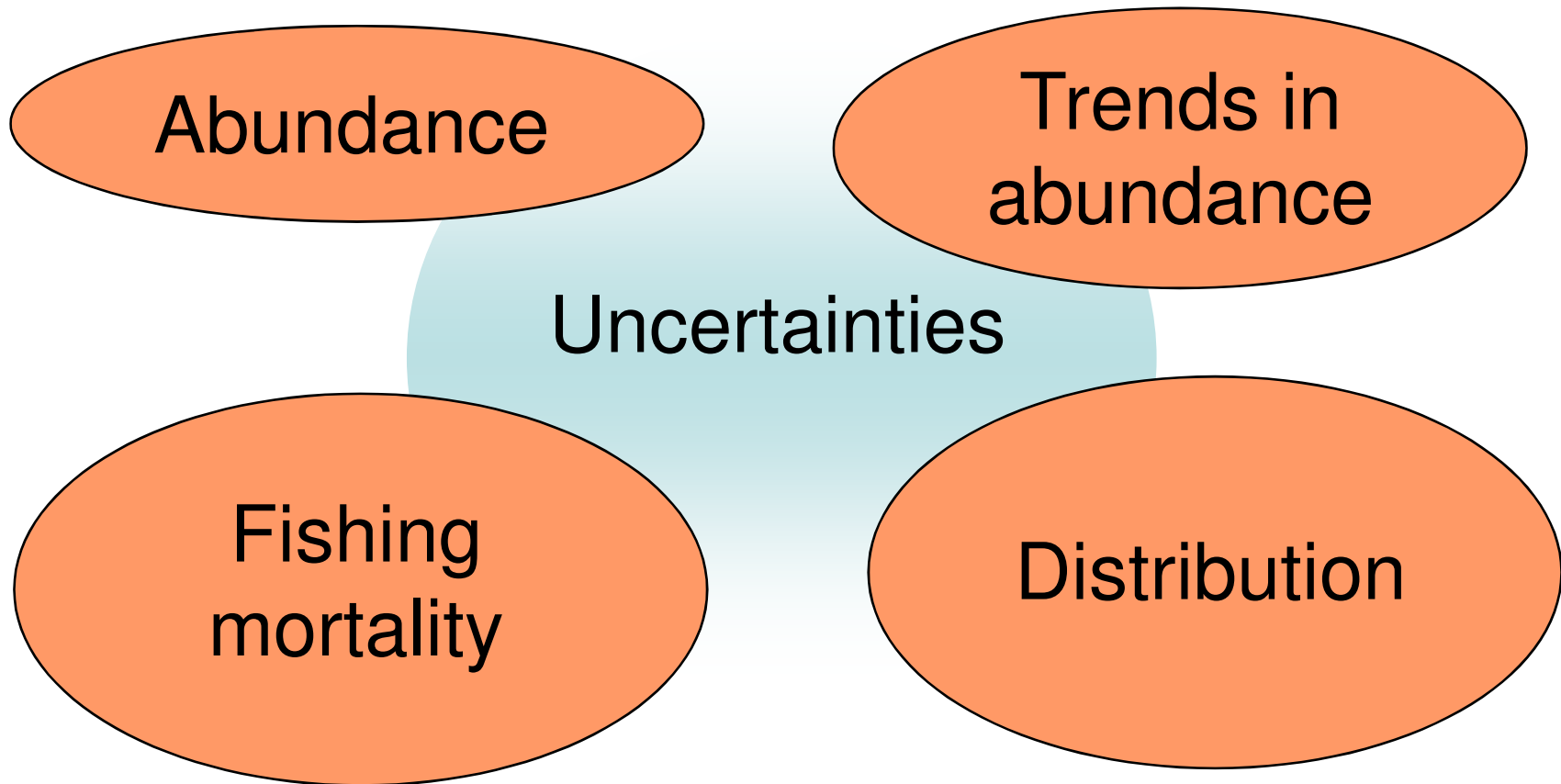
Distribution may be related to the diversity of habitats and life-history characteristics, and hence responses to changes in environmental conditions

# Assessing status

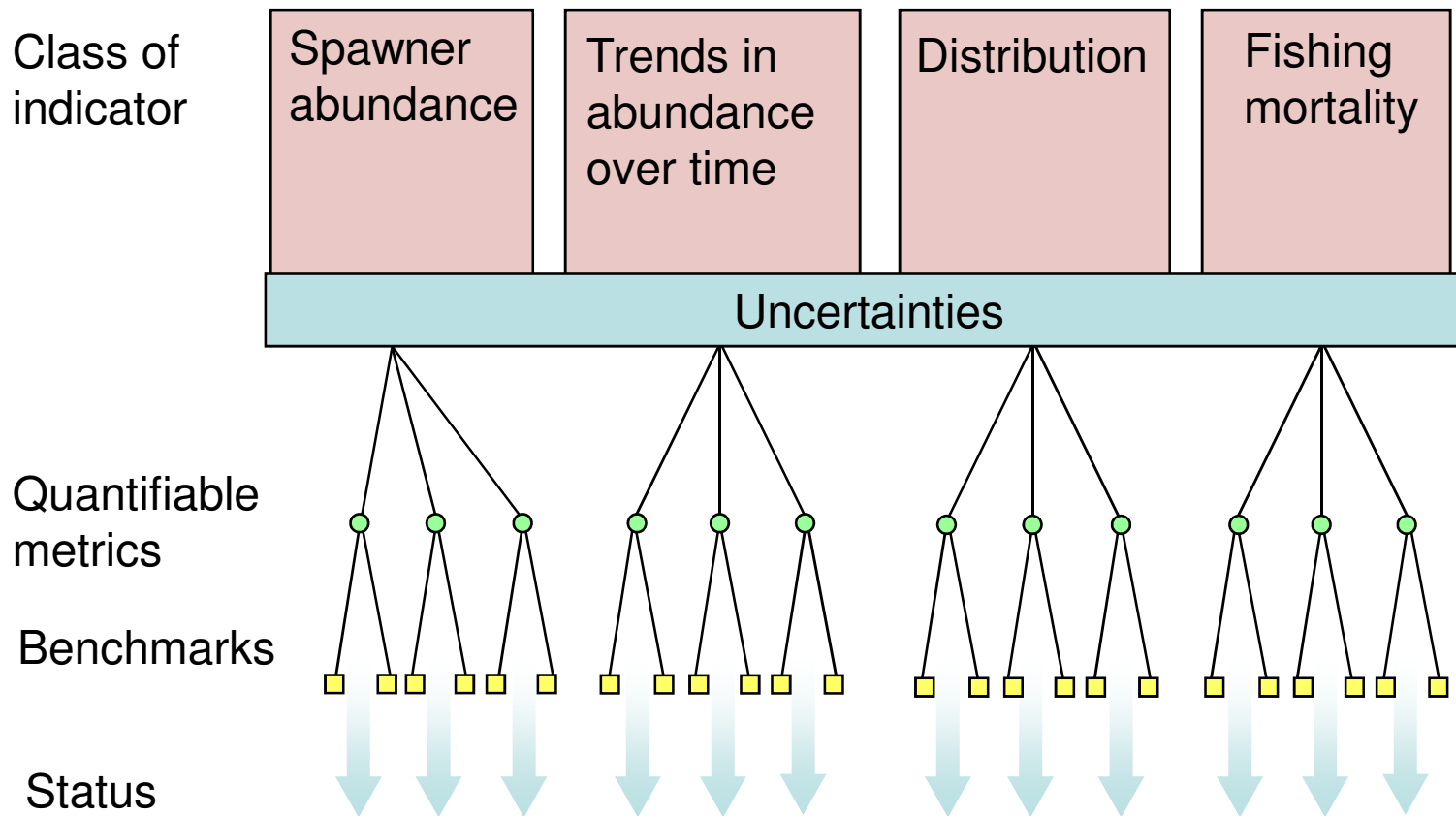
Fishing mortality relative to stock productivity reflects the ability of a CU to sustain that fishing pressure



# Assessing status

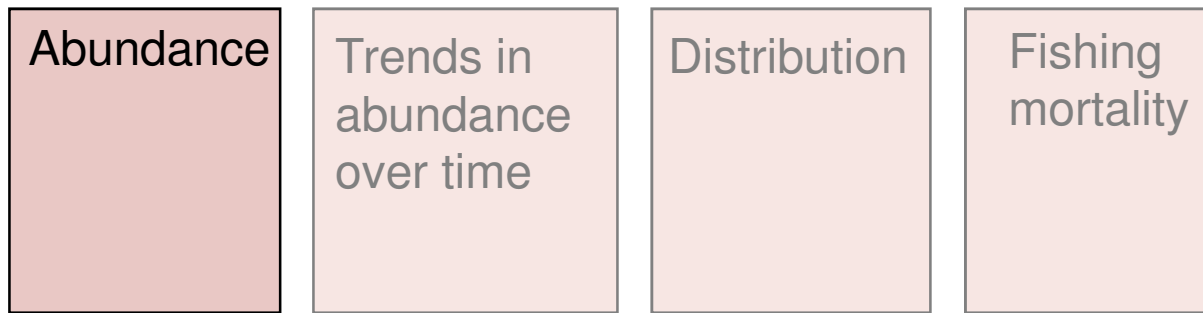


# Assessing status



# Indicators, metrics, and benchmarks

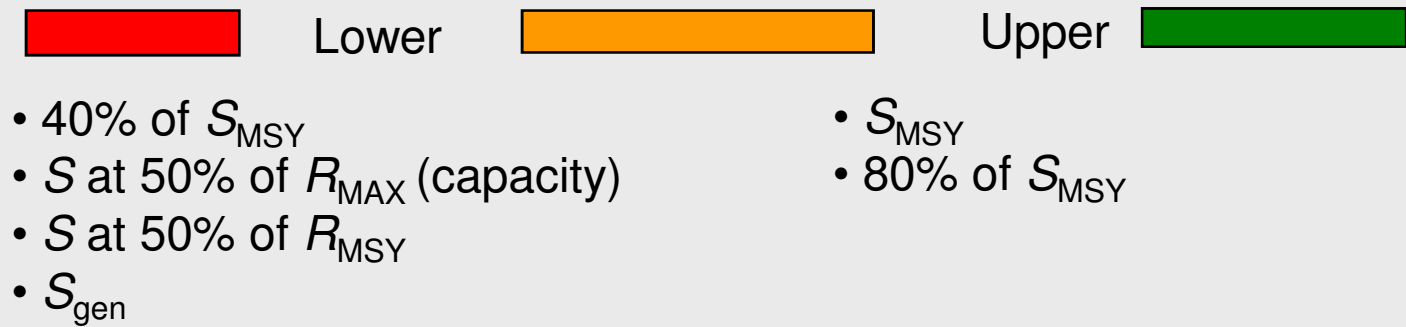
Class of indicator



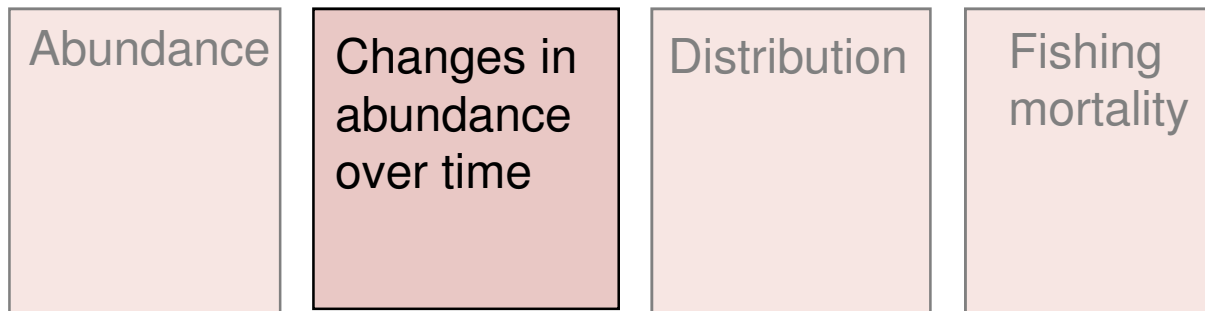
Metrics

- Spawner abundance in current year

Benchmarks



Class of indicator



Metrics

- Slope in the linear change in  $\log_e(\text{spawner abundances})$  over 3 generations (10 years)

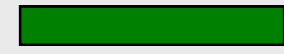
Benchmarks



Lower



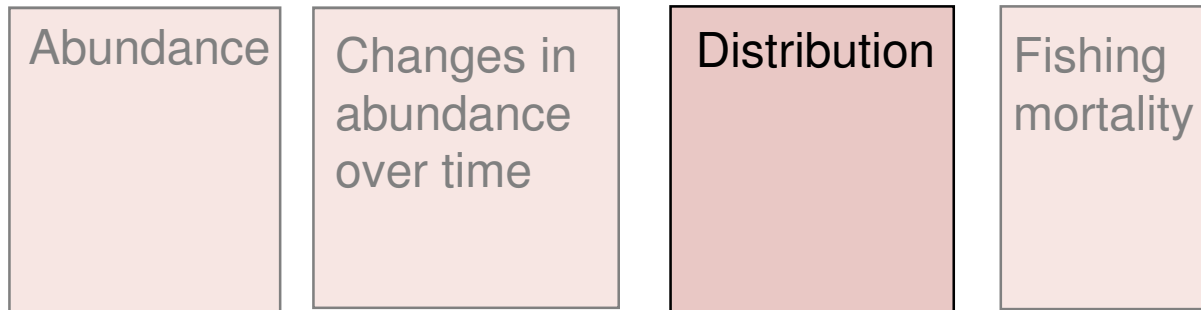
Upper



- Slope = -30% (COSEWIC threatened listing)

- Slope = a fraction of COSEWIC threatened listing (e.g., 2/3)

Class of indicator



Metrics

- Number of spawning groups within a CU
- Proportion of spawner in each spawning group
- Change in spatial location/habitat use of spawners/juveniles
- Spatial extent of spawning habitat

Benchmarks



Qualitative assessment

Class of indicator

Abundance

Changes in abundance over time

Distribution

Fishing mortality

Metrics

- Fishing mortality in most current year

Benchmarks



Lower



Upper



•  $F_{med}$  (median  $\ln(R/S)$ )

•  $F_{MSY}$

# Assessing status: Data requirements

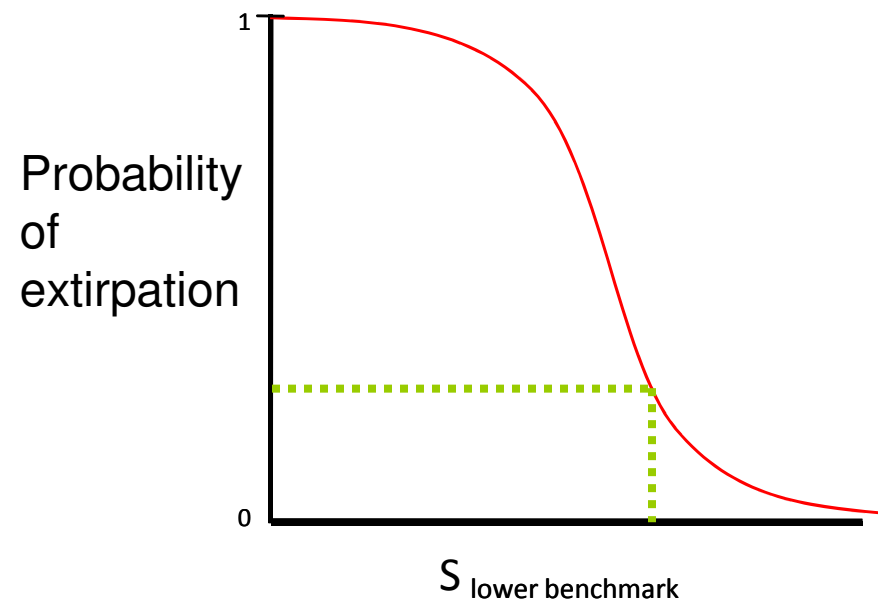
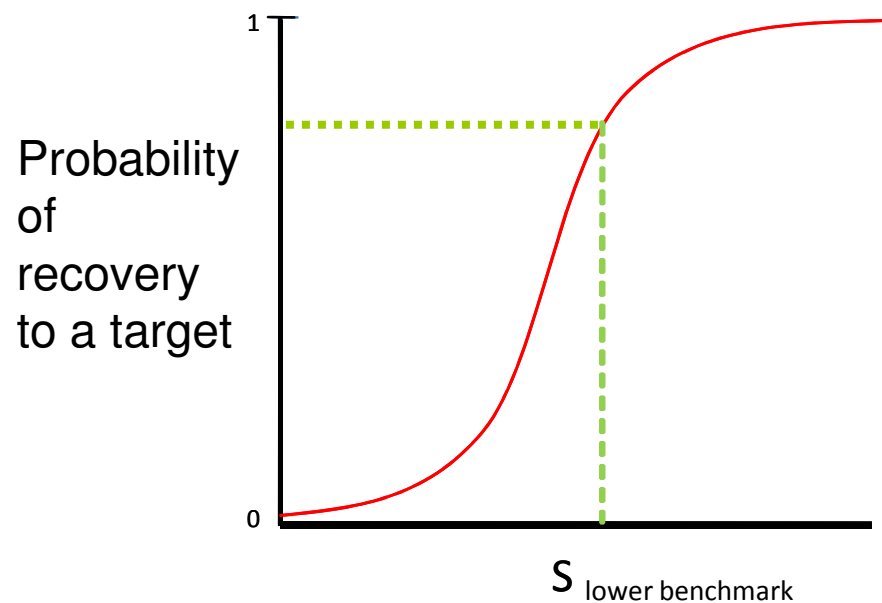
Minimum data required	Metrics of status (examples)				
	S relative to $S_{MSY}$	S relative to capacity	Trends in S	Fishing mortality relative to productivity	Distribution of S across spawning groups
Current S	<b>X</b>	<b>X</b>			
Time series of S (absolute)	<b>X</b>				
Time series of S (relative)			<b>X</b>		
Capacity		<b>X</b>			
Time series of recruitment	<b>X</b>				
Current F				<b>X</b>	
Estimate of productivity				<b>X</b>	
Current S by spawning group					<b>X</b>

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# Wild Salmon Policy

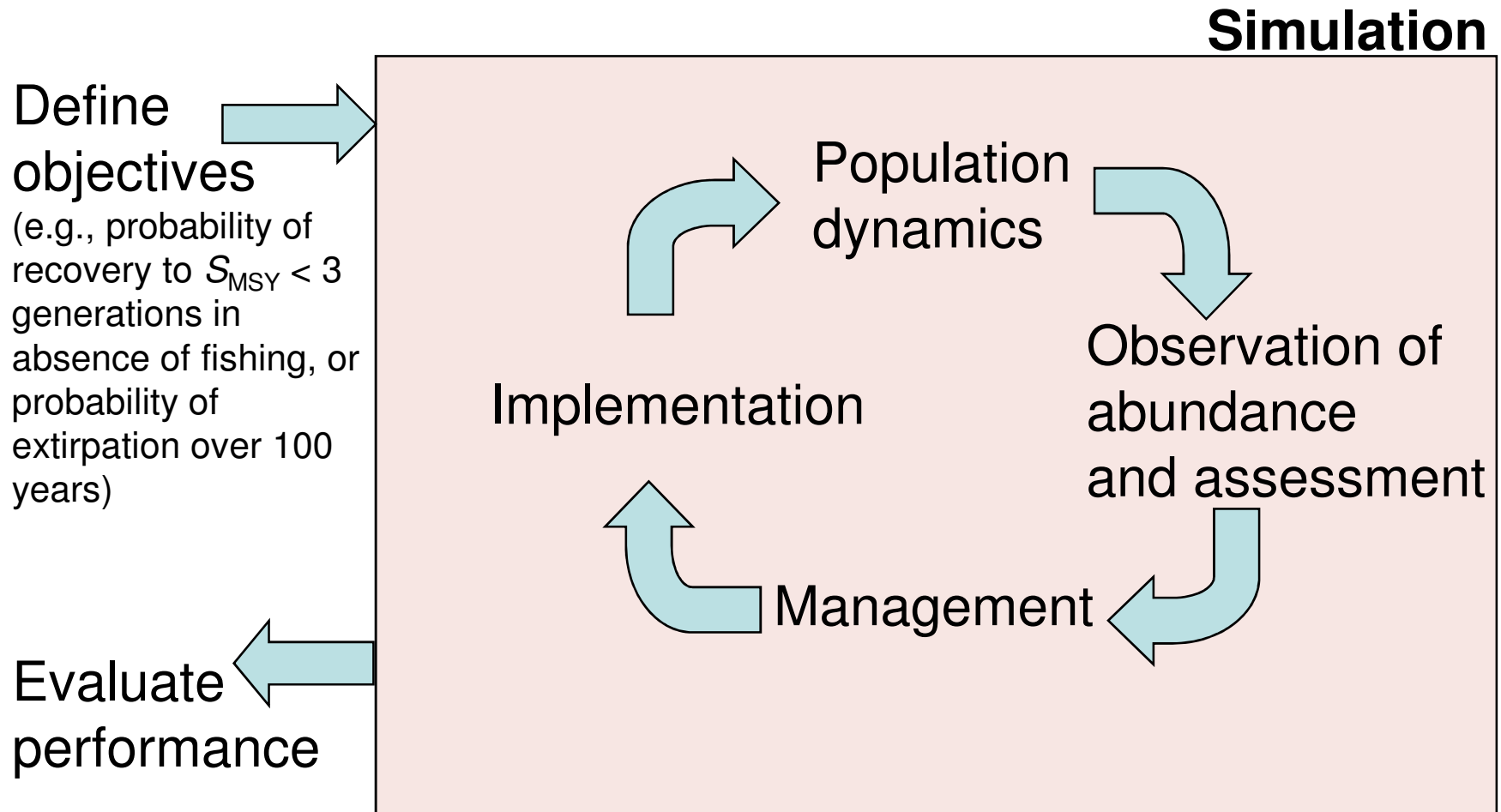
Benchmarks should "account for **uncertainty** in data and control of harvest management"



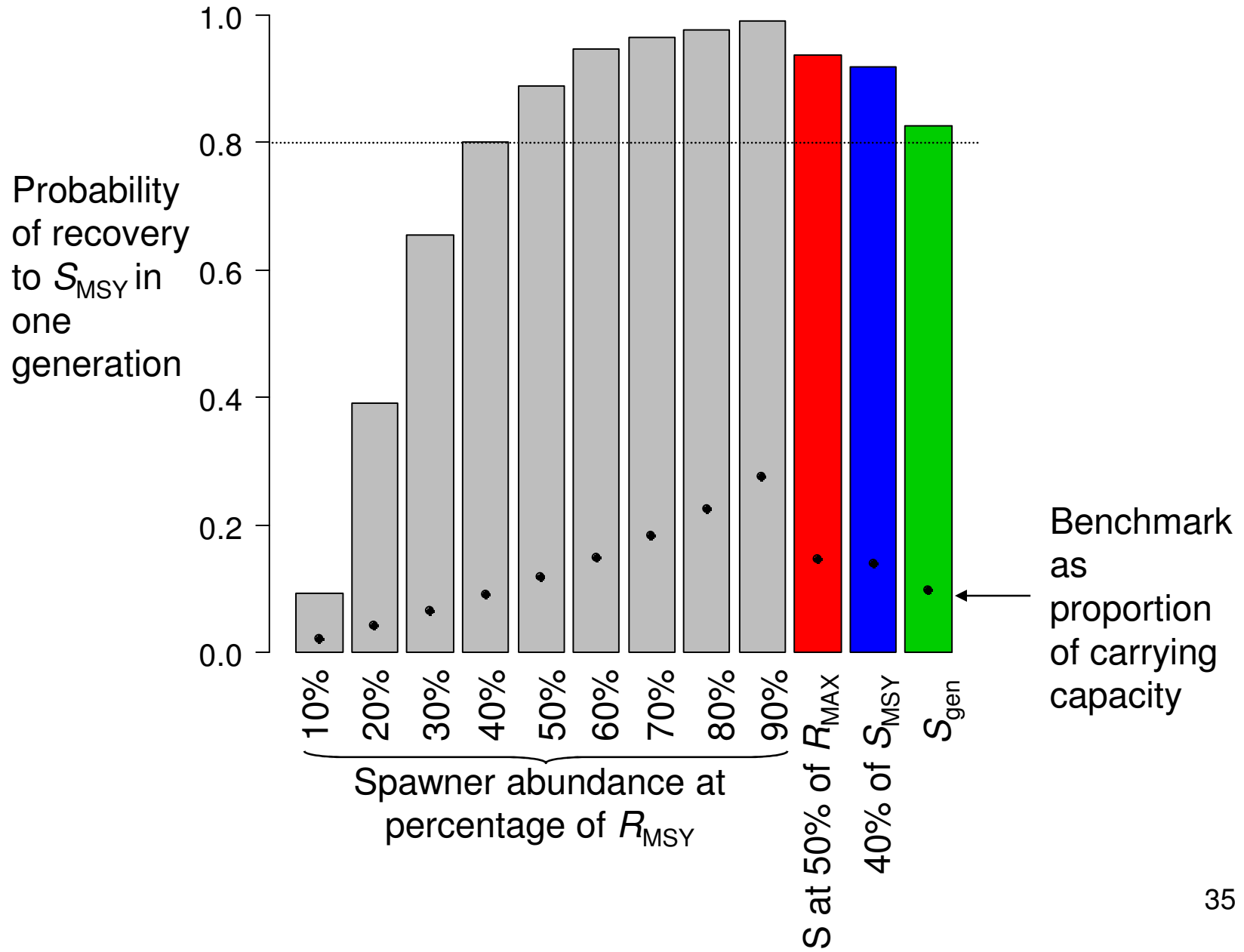
# Evaluating lower benchmarks

- (1) Probability of recovery to  $S_{MSY}$  within one (three) generation(s) in the absence of directed fishing
- (2) Probability of extirpation (<100 fish for one generation) over 100 years with a constant escapement policy equivalent to the lower benchmark

# Simulation model to evaluate lower benchmarks



# Results

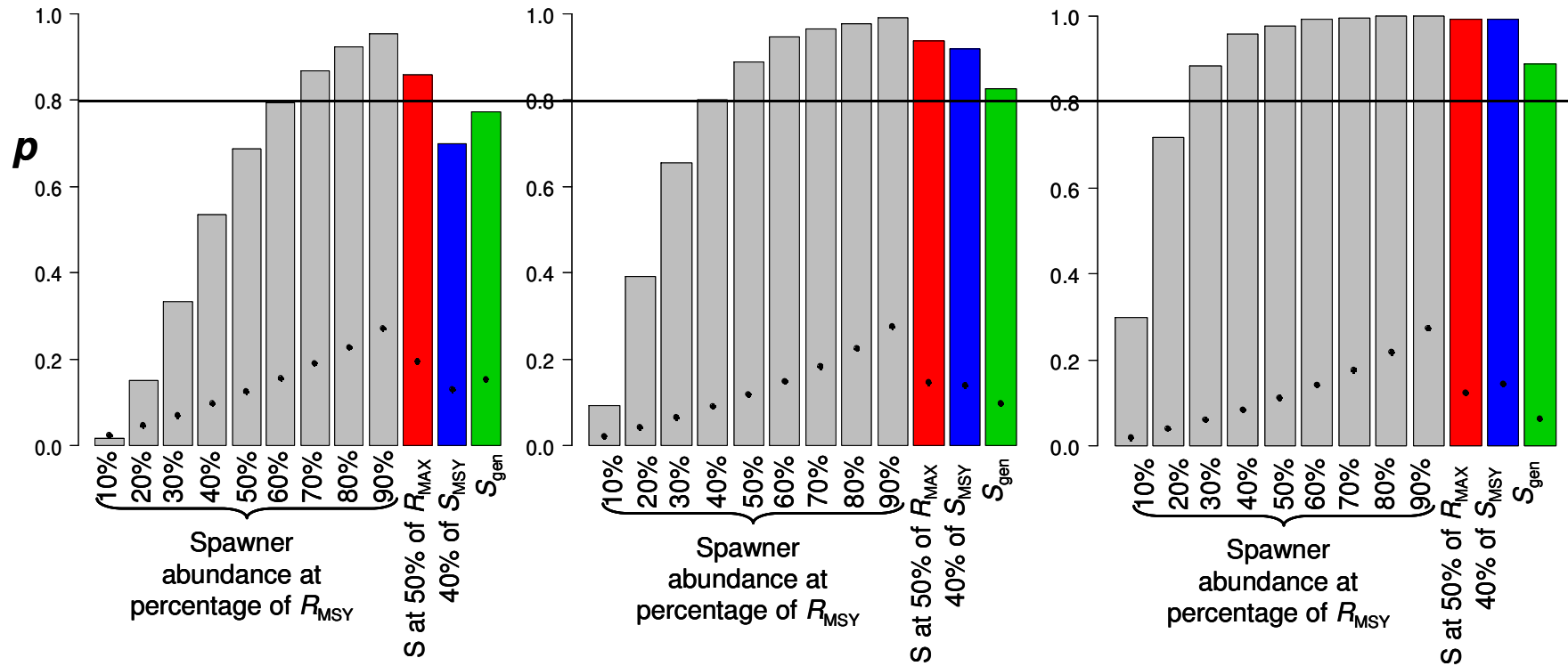


# Results

Low productivity



High productivity

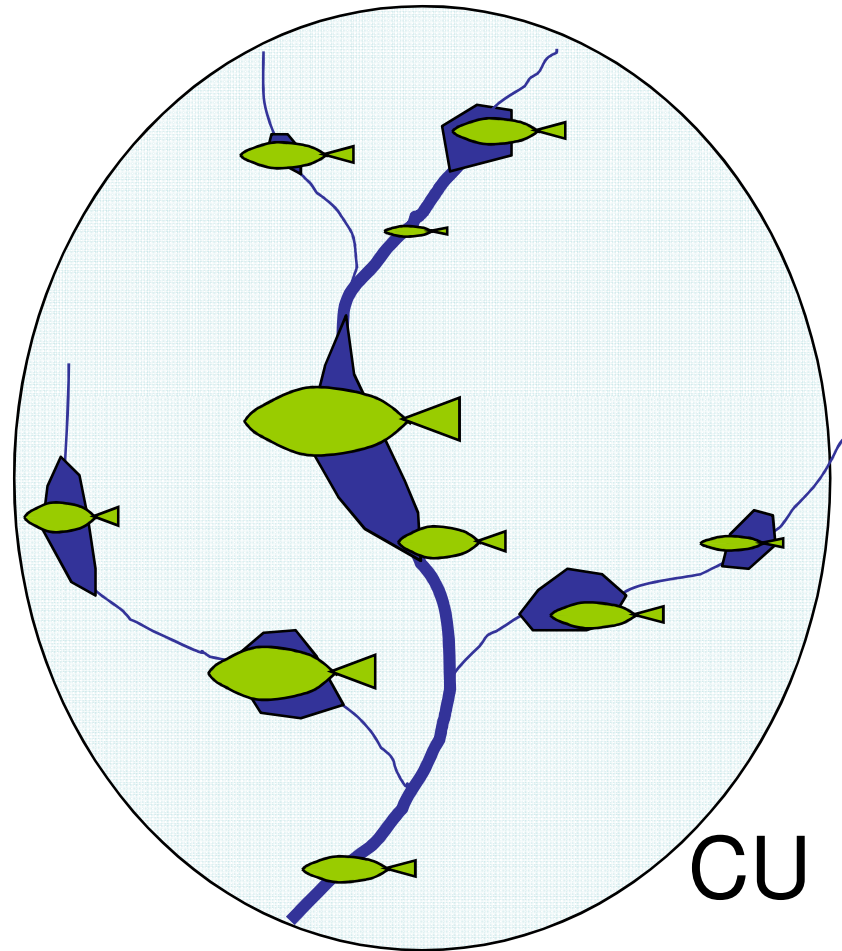


# Simulation model to evaluate lower benchmarks

- Choice of specific benchmark depends on risk tolerance
- Simulation model → tool to evaluate risk

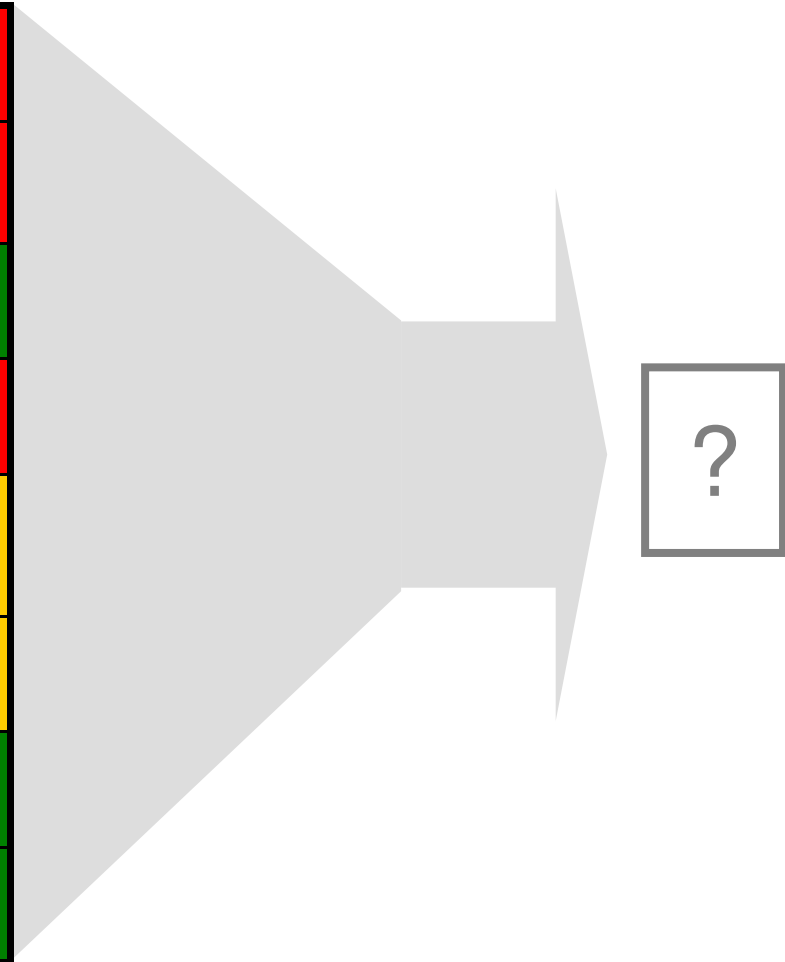
# Challenges

Benchmarks on  
assessment of  
distribution?



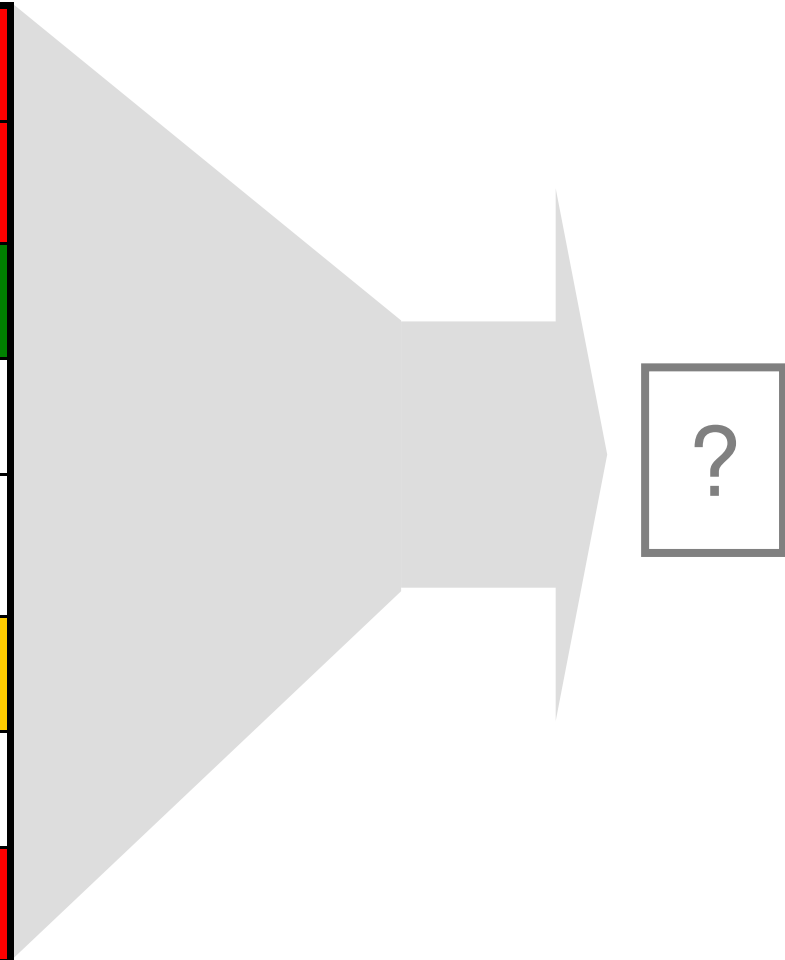
# Challenges

<i>S</i> relative to stock-recruitment benchmarks	Red
Recent linear trends in <i>S</i> relative to COSEWIC "threatened" criteria	Red
<i>S</i> relative to historical mean	Green
<i>S</i> relative to highest generational mean	Red
<i>F</i> relative to slope at origin of stock-recruit relationship and $F_{MSY}$	Yellow
<i>F</i> relative to median recruits/spawner and $F_{MSY}$	Yellow
Distribution of <i>S</i> among spawning groups	Green
Uncertainty in <i>S</i> and <i>R</i> data	Green

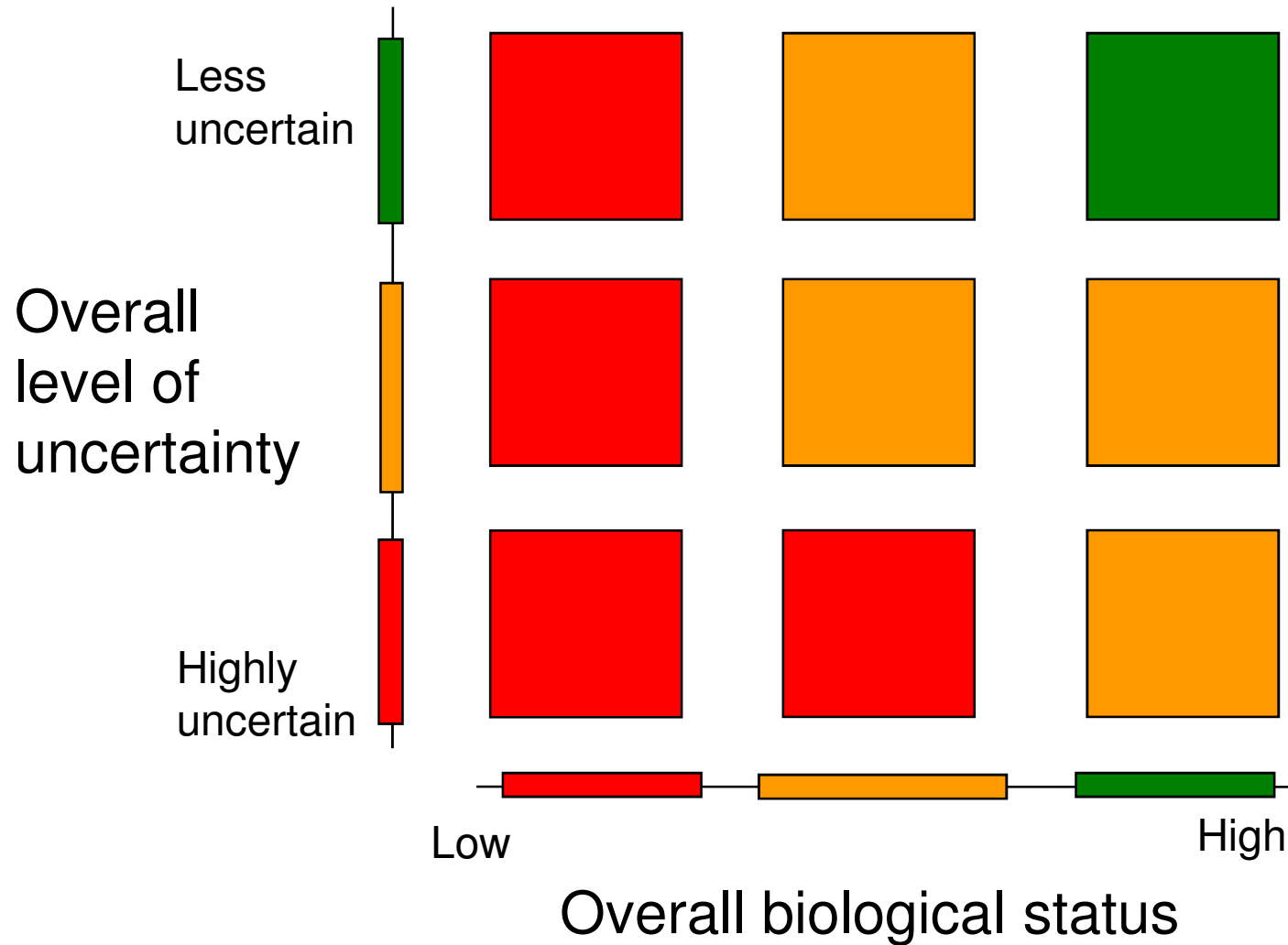


# Challenges

<i>S</i> relative to stock-recruitment benchmarks	Red
Recent linear trends in <i>S</i> relative to COSEWIC "threatened" criteria	Red
<i>S</i> relative to historical mean	Green
<i>S</i> relative to highest generational mean	White
<i>F</i> relative to slope at origin of stock-recruit relationship and $F_{MSY}$	White
<i>F</i> relative to median recruits/spawner and $F_{MSY}$	Yellow
Distribution of <i>S</i> among spawning groups	White
Uncertainty in <i>S</i> and <i>R</i> data	Red



# Challenges



# Summary

1. Wild Salmon Policy requires biological assessment of abundance and **distribution** of salmon within Conservation Units
2. Four classes of indicators: abundance, trends in abundance, distribution, fishing mortality relative to productivity
3. Candidate metrics and benchmarks
4. **Evaluation of benchmarks in simulation model** that explicitly incorporates uncertainties
5. Risk tolerance to be identified by fisheries management

