Management Strategies: Objectives, Harvest Control Rules, Reference Points

Management Strategies for Tuna Industry Stakeholders in the Eastern Pacific Ocean (EPO)
San Diego, August 12, 2019
What is a Management Strategy?

- Combination of monitoring, stock status evaluation, harvest control rule (with or without Reference Points) and management actions designed to achieve fisheries objectives.

- Development and success of Management Strategies benefit from the involvement of all stakeholders in the management planning stage.
Management strategies

Management objectives
Social (e.g. jobs, food)
Economics (e.g. high CPUE)
Biological (e.g. low risk of collapse)
Ecosystem (e.g. bycatch, diversity)
Political (e.g. allocations)

Performance metrics
Managers specify
e.g. Total catch, CV of catches, CPUE

Target Reference Points
Managers specify
e.g. \( x\%B_{MSY} \)
\( x\%F_{MSY} \)
MEY, CPUE, etc

Limit Reference Points
Science specify
e.g. \( x\%Bo \)

Harvest Control Rules

Biology

Modified from Berger et al. 2012
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**Harvest Control Rules**

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Management objectives

- Stated explicitly, specifically and unequivocally
  - Social (e.g. jobs, food access)
  - Economical (e.g. profitability)
  - Biological (e.g. low risk of collapse)
  - Ecosystem (e.g. bycatch, diversity)
  - Political (e.g. allocation)
Management objectives

- Clear objectives fundamental to establish reference points and evaluate performance of management strategies
- Avoid being too generic (examples)
- Should specify:
  - Quantities
  - Probabilities
  - Timelines
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Performance metrics

“I want it all, and I want it now…”

Freddie Mercury

- Long-term total catch
- Long-term average catch
- Long-term variability in catch
- Short-term variability in catch
- Long-term average CPUE
- Long-term average effort (fishing days)
- Probability of falling below reference points
- Probability of stock recovery
- Many more!
Tradeoffs

“You can’t always get what you want...”

Mick Jagger

- Long-term catch & Long-term CPUE
- Long-term catch & Probability below reference points
- Long-term catch & Short-term catch
- Long-term CPUE & Annual catch variability
- Long-term effort & Probability of stock recovery
Tradeoffs

- Risk metrics
  - Probability of overfishing/overfished
  - Probability of collapse (economical o biological)
  - Probability of closures (spatially or temporally)

- Behavior towards risk
  - Risk Averse (avoidance)
  - Risk Prone (seeking)
  - Risk Neutral (indifferent)
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Biology

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What do we know about Biology?

“Counting fish is like counting trees…

…except they are invisible and they move.”

John Shepherd
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Reference Points

- Management benchmarks against which to measure stock abundance, fishing mortality or social/economic indicators to determine status.
Reference Points

- Limit Reference Point
- Threshold Reference Point
- Target Reference Point
Target Reference Point

Should be met, on average, given a set of management objectives. Corresponds to a desirable fishery or stock status.
Threshold Reference Point

Indicates the biomass fell below the **Target**, or the fishing mortality is over the **Target**, additional management actions are required to prevent the stock reaching the **Limit**.
Limit Reference Point

Not to be exceeded with any substantial probability, given a set of management objectives. When reached, the status of the stock is not desirable and management actions are required. When stock abundance is very low, may result in fishery closures.
Reference Points

• Based on models
  - Biomass ($B_{MSY}, B_{MEY}$) or fishing mortality ($F_{MSY}$)
  - $F_{max}, F_{0.1}, F_{35\%}, F_{40\%}$, per-recruit calculations

• Based on data alone (empirical)
  - CPUE
  - Fish size
Typical roles of participants

• Managers and stakeholders identify:
  – Management objectives,
  – Candidate target reference points,
  – Candidate harvest control rules, criteria against which their performance should be evaluated.

• Scientists identify appropriate biological limits to exploitation and evaluate the performance of identified candidate harvest control rules.
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MANAGERS + STAKEHOLDERS

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Harvest Control Rules

Modified from Berger et al. 2012
Harvest Control Rules (HCR)

- **Pre-agreed** management actions to changes in the stock and/or environmental, economic factors relative to reference points, or trends in stock indicators.
- Operationalize **management objectives**
- Increase management decisions **transparency**
- Framework to implement harvest strategies using decision making based on science.
“Stock”

Reference Points

Control Rule

Keep on playing

Hydration

Hospital
Additional Harvest Control Rule elements

- Control measure, tactics:
  - Regulations available to apply the strategy
Control measures / Tactics

**Input Controls** – regulate fishing effort
- number and size of fishing vessels
- length of fishing season
- spatial closures

**Output Controls** – regulate catch
- total allowed catch (TAC)
- transferable quotas (ITQ)
- Quota allocation by gear/fleet
Control measures / Tactics

Why **Output Controls**?

- Better adherence to allowed catch
- Reduce (not always) the “race for fish”

Challenges of **Output Controls**

- Incentivize catch misreporting
- Less robust to assessment errors
- More difficult and costly to monitor
Control measures / Tactics

Why **Input Controls**?

- Simple and inexpensive to implement
- Easy to monitor
- Mixed fisheries where it is difficult to monitor all species.

Challenges with **Input Controls**

- Incentivize a “race for fish”
- More robust to assessment errors
- Difficult to limit all sources of fishing effort
- Fishing effort can re-distribute or change
- Tend to exceed the allowable catch
Types of Harvest Control Rules (HCR)
Harvest Control Rule cycle

Data:
(e.g. catch, CPUE, sizes)

Fishery operates according to management action

Management action
(e.g. TAC, days closure)

Data analyses

Harvest Control Rule
Harvest Control Rule types

- **Constant**
- **Empirical Rule**
  - Minimum treatment of data
  - Easy to compute, explain and understand
  - Care required to minimize responses to noisy data
- **Model-based Rule**
  - Based on models of varied complexity (e.g. assessments)
Empirical rule example

- Based on monitoring and feedback
- Simple rule, even when evaluation of its performance uses complex computer simulations (such as MSE)

Example: adjust catch using CPUE trends
Indicators, EPO Skipjack tuna

Based on **data** or **simple model** population estimates

- **Data** (catch, effort, CPUE, mean weight)
- **Simple model estimates** (biomass, recruitment and exploitation rate)
Indicators for bigeye

- **Catch**
  - Graph showing catch trend from 2000 to 2020.

- **Average weight**
  - Graph showing average weight trend from 2000 to 2020.

- **Adjusted capacity**
  - Graph showing adjusted capacity trend from 2000 to 2020.

- **Number of sets**
  - Graph showing number of sets trend from 2000 to 2020.

- **CPUE**
  - Graph showing CPUE trend from 2000 to 2020.

- **Days fished**
  - Graph showing days fished trend from 2000 to 2020.
Empirical Rule example

- CPUE(T) < CPUE Target = Decrease TAC(T+1)
- CPUE(T) > CPUE Target = Increase TAC(T+1)
- Decrease TAC(T+1) for CPUE slope
- Increase TAC(T+1) for CPUE slope

CPUE Observed

CPUE Target

Departure from Target

Period to compute slope

Time

T
Model-based Rule example

1) Fit a pre-specified stock assessment
2) Use the HCR to determine next year’s TAC

TAC for 2021 = 100 t
TAC for 2026 = 50 t

Assessment for 2025
Assessment for 2020
Stock assessment uncertainty

![Graph showing stock assessment uncertainty](image)

- **Total Allowed Catch (TAC)**
- **Biomass estimate**
- **Stock assessment**
HCR must provide a unique action

Uncertainties must be recognized and included during the evaluation of management strategies.

Total Allowed Catch (TAC)

Biomass estimate

Stock assessment
HCR and Reference Points

[Diagram showing control measures and catch/effort relationships across different stock status levels: LRP, TrRP, TRP.]
HCR development

- Harvest control rules (including their component biological reference points) should be developed in the management planning stage with the involvement of all stakeholders.
- The success of HCRs is generally enhanced by involvement of stakeholders in the definition of the problem, including assumptions, and as it facilitates trust and policy “buy in”.
Management Strategies Summary

- Combination of monitoring, stock status evaluation, harvest control rule (with or without RPs) and management actions designed to achieve fisheries objectives.

- The emphasis of management strategy elements varies by fishery, their historical context (e.g. developing, stable, rebuilding) and the level of monitoring, available analyses and management systems.

- RPs and HCRs cannot be properly evaluated without specific management objectives, data collection, analyses, treatment of uncertainty and other components of a management strategy.

- Development and success of HCRs and RPs benefit from the involvement of all stakeholders in the management planning stage.
Thank you!

COMMON OCEANS