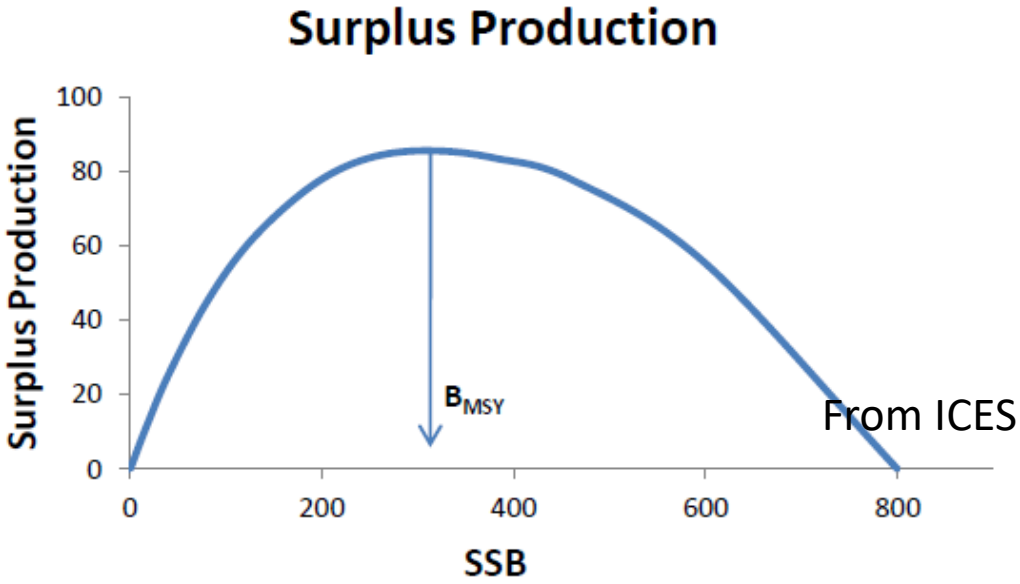
Empirical Harvest Rules

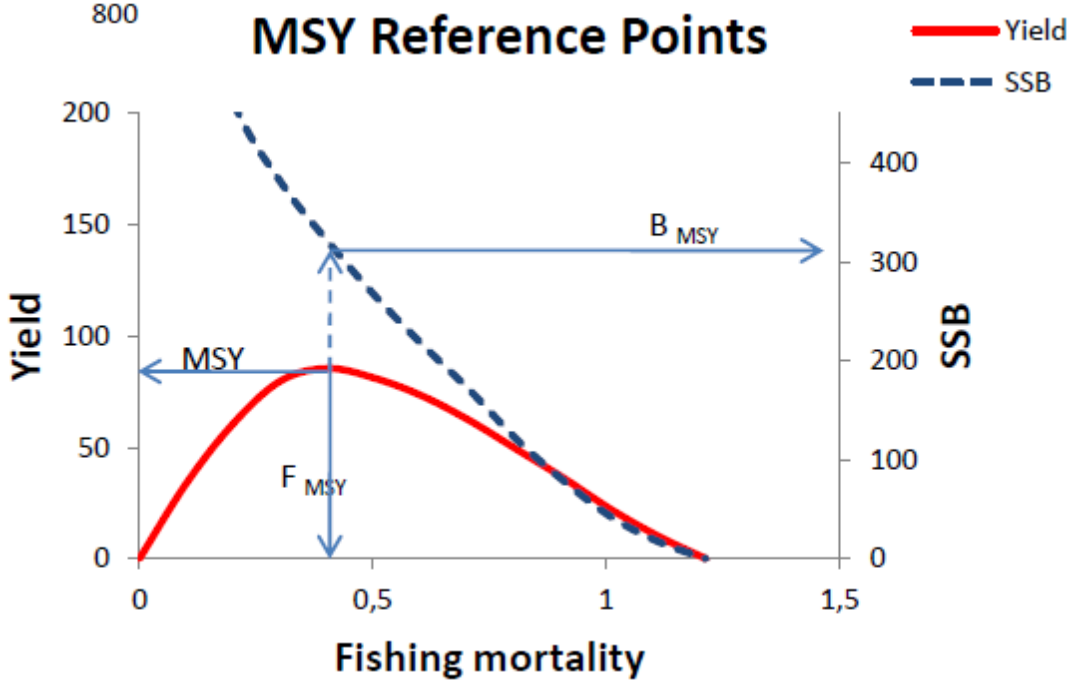
Their use in the development of advice for the SEAFO fisheries

Reminder: Some Basic Ideas



The MSY concept

From ICES (2014a)



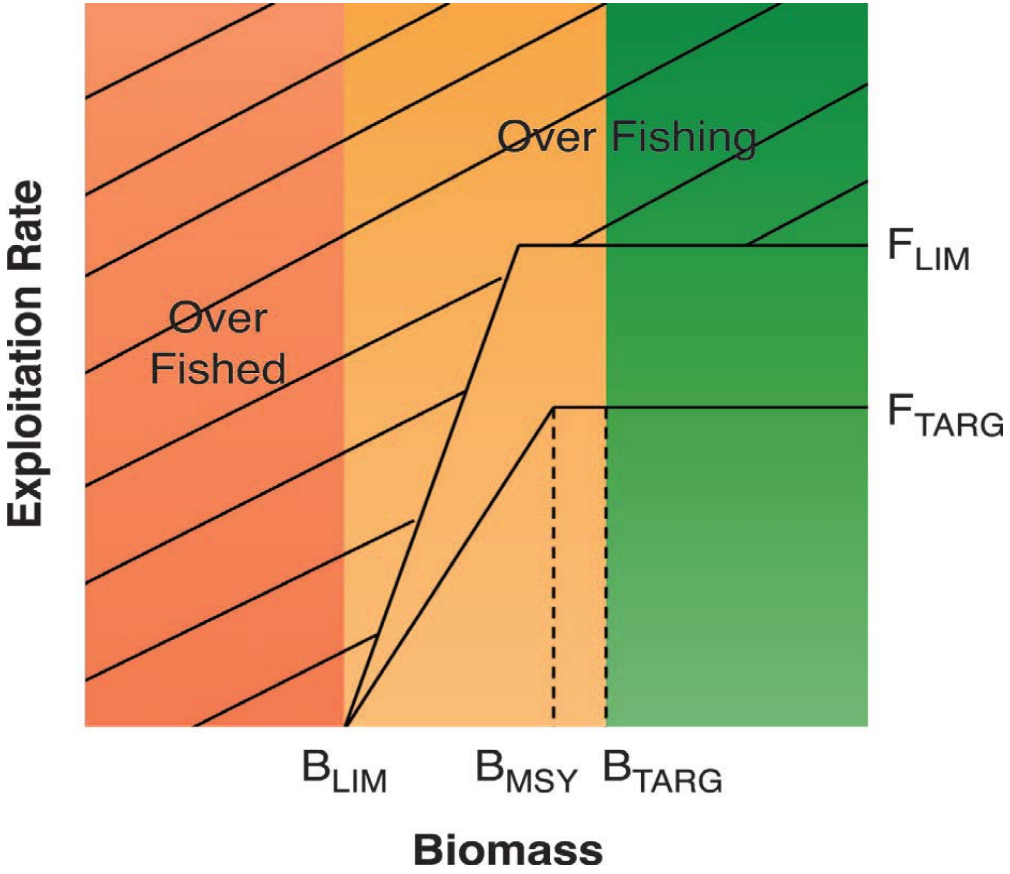
Purpose of Harvest Rules

- **Pre-agreed** actions:
- IT this happens, THEN we do THAT
- Have a plan!
- Decisions on RULES must be taken BEFORE the need arises
  - Hot heads not good at taking decisions–Ad-hoc management feels good, but performs poorly

Managing Fisheries Sustainably: Fisheries Control Rules

MSY-Based Fisheries Control Rule used in ICES framework

A General Fisheries Control Rule compatible with Australia's Harvest Strategy Policy

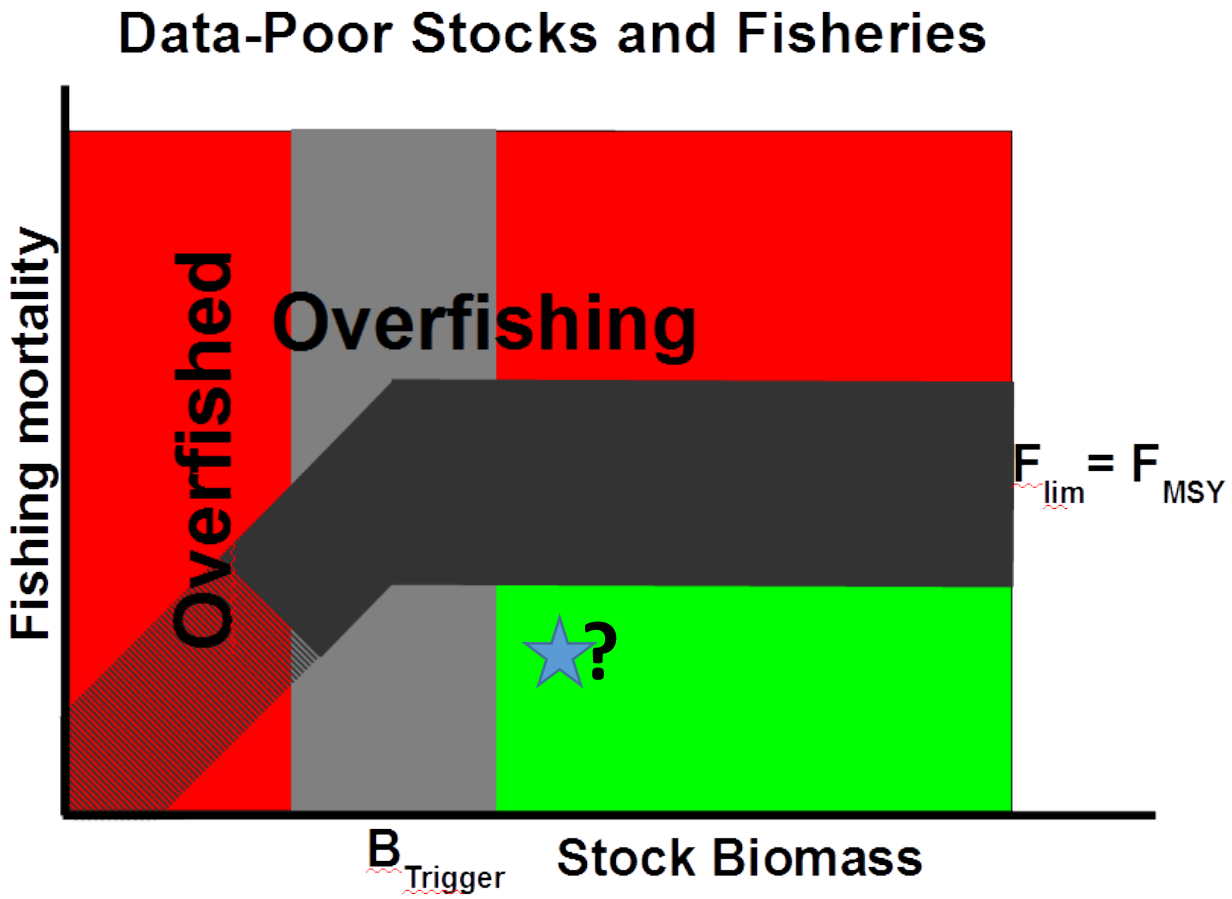


Purpose of fish stock assessment:

Where do we want (not) to be!
Where are we?
Where should we go?

Problems in Data-Poor Stocks/Fisheries

- Do not know where we are
- Do not know where we want to be….



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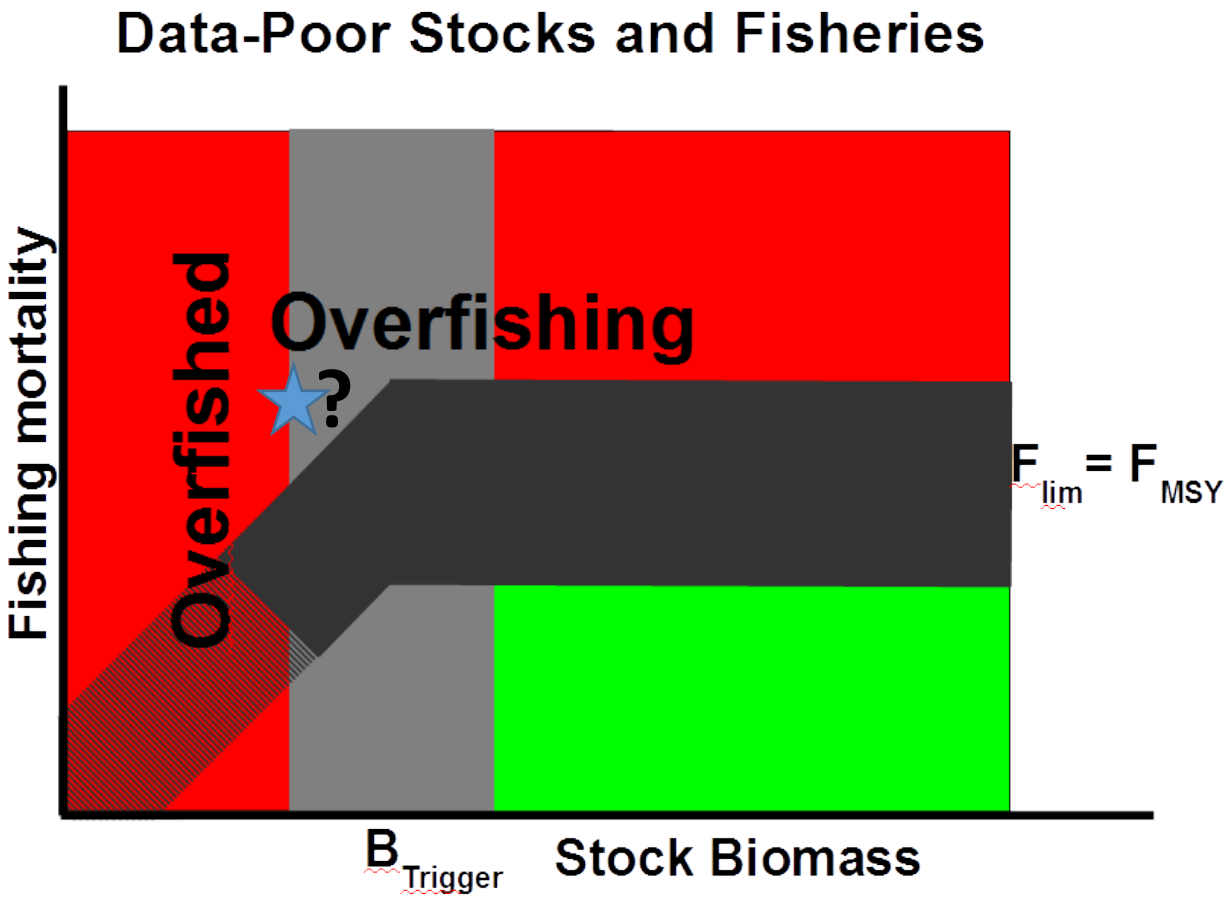

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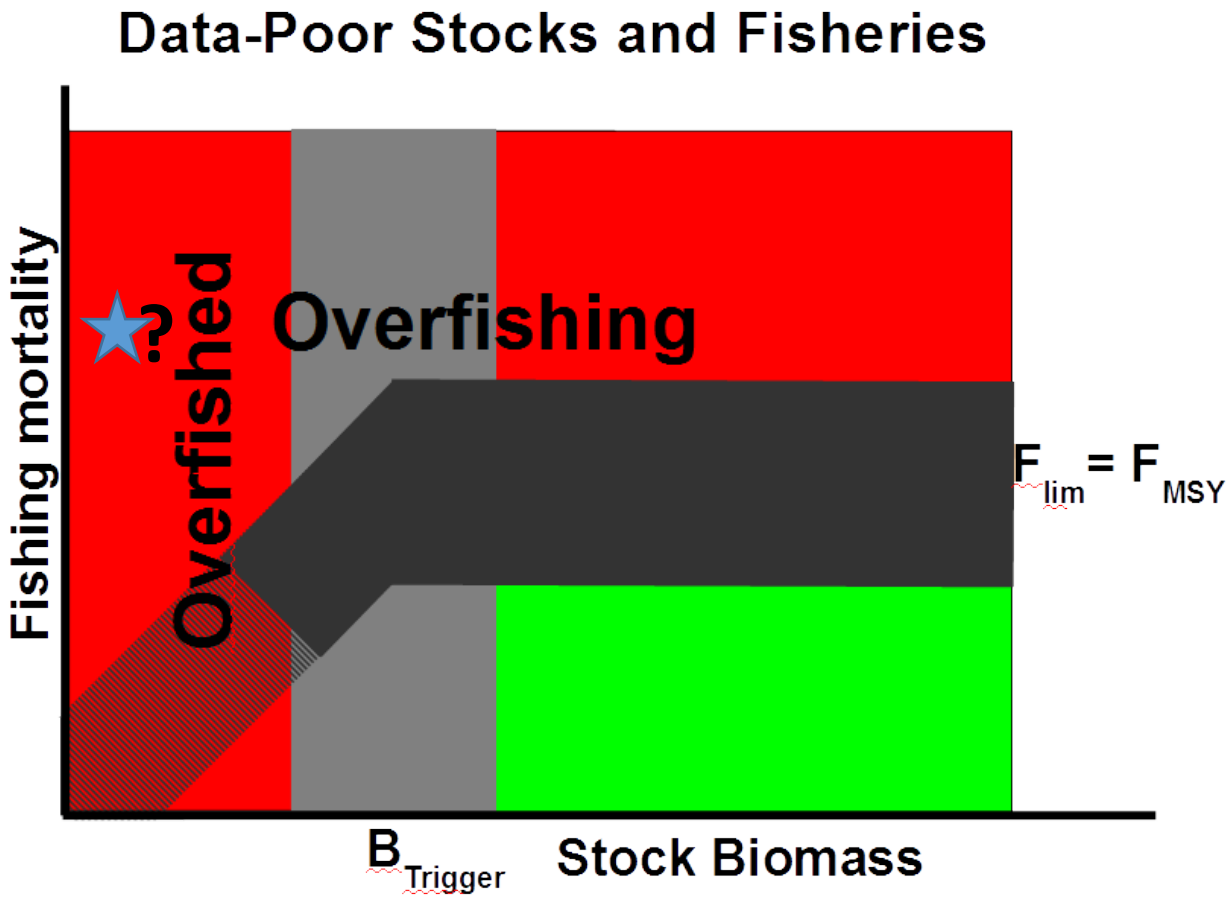
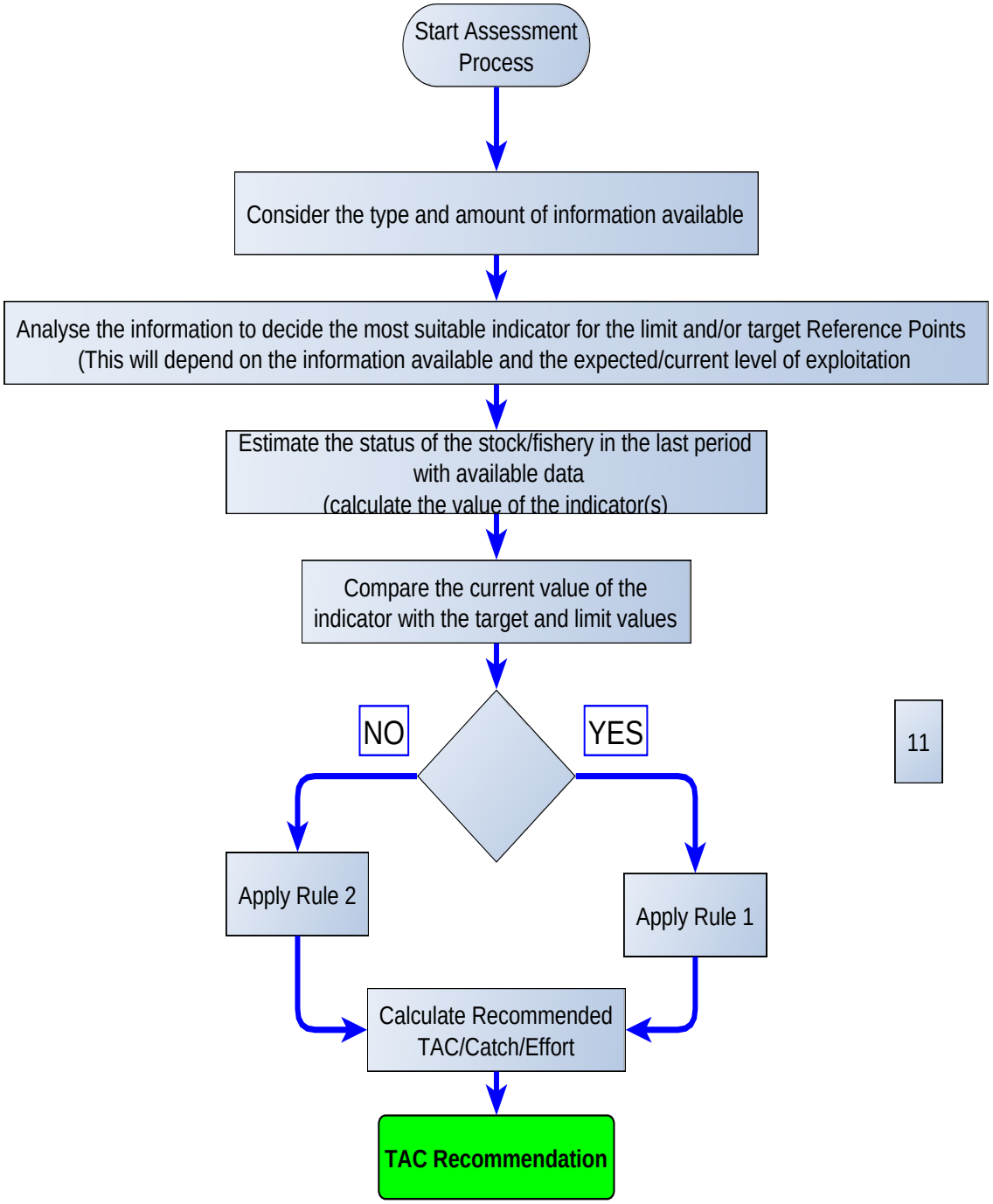


Fisheries Advisory Process (General)



Harvest control rules used for the determination of catch advice

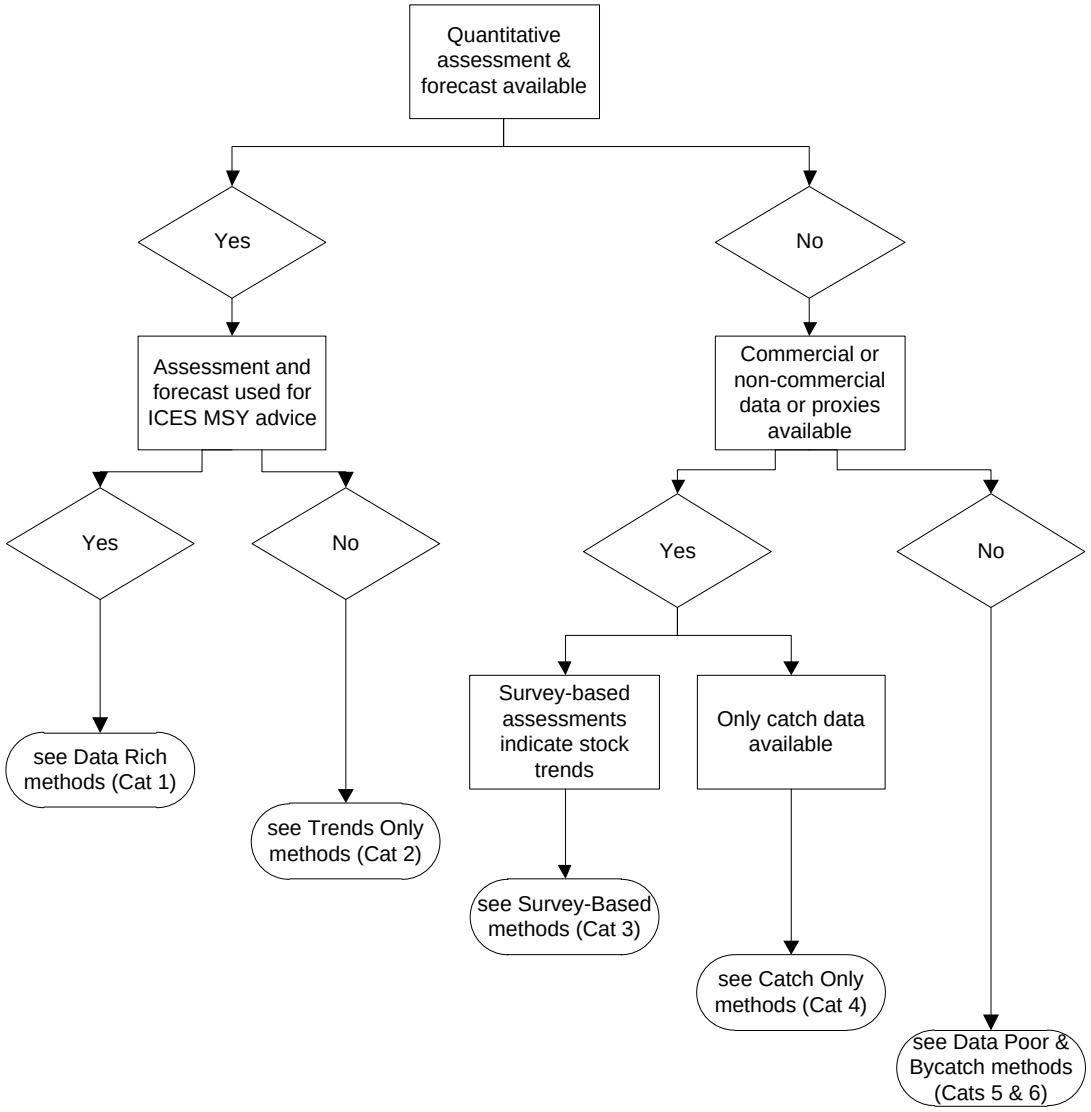
- ICES: Simple approach (2010)

Trend of stock (or indicator)	No Overfishing	Overfishing or Unknown Exploitation Status
Decreasing stock trend	Reduce catch from recent level at rate of stock decrease	Reduce catch from recent level at rate greater than the rate of stock decrease
Stable stock trend	Maintain catch at recent level	Reduce catch from recent level
Increasing stock trend	Increase catch from recent level at rate of stock increase	Maintain catch at recent level

-Alaska 6-tier system-

- Data rich
  - Tier 1: **Reliable** point estimates of B and Bmsy and reliable pdf of Fmsy
  - Tier 2: **Reliable** point estimates of B, Bmsy, Fmsy, $F_{35\%}$ and $F_{40\%}$
  - Tier 3: **Reliable** point estimates of B, B40%, F35% and F40%
  - Tier 4: **Reliable** point estimates of B, F35% and F40%
- Data poor
  - Tier 5: **Reliable** point estimates of B and natural mortality rate M
  - Tier 6: **Reliable** catch history from 1978–1995

ICES 6-Category Approach (2012)



Empirical Harvest Control Rules (1)

- Control rules (Trigger points and actions) are not based on stock assessment results
  - Simple indicators of stock or fishery status
- Empirical HCR need a more rigid and agreed plan
- –The less reliable the indicator, the more you need a plan that is agreed by all stakeholders

Harvest rules
- ICES: Data-Rich Stocks

- If estimated stock biomass in the current year is less than Btrigger: *Method 1.1.2*:
  - Catch advice is based on the ICES MSY control rule, (F<FMSY as a linear function of biomass relative to Btrigger):
  - $F_{MSY-HCR}(2013) = F_{MSY}\left(\frac{B_{2013}}{B_{Trigger}}\right)$
- Ifa gradual transition is not appropriate because stock size is low (e.g. below Blim) and the outlook is for a further de-cline (e.g. as a result of low recruitment) unless fishing mortality is reduced more rapidly: *Method 1.1.3*
  - ICES may advise on a more rapid transition or application of $F_{MSY\text{-}HCR}$ as soon as possible.
- For extremely low biomass: *Method 1.2*:
  - A recovery plan and possibly zero catch are advised

ICES Control Rules

- Category 2: Stocks with analytical assessments and forecasts that are only treated qualitatively
- Harvest Control Rule:
  - If estimated biomass is greater than $B_{trigger}$: *Method 2.1.1*
    - Calculate the recommended catch for next year ($C_{y+1\ Calc}$) using the same equations as in category 1
    - Apply the 20% Uncertainty Cap: $C_{y+1} = 0.8 \times C_{y+1\ Calc}$
  - If estimated biomass is less than Btrigger
    - Catch advice is based on the ICES MSY control rule, (F<FMSY as a linear function of biomass relative to Btrigger):
    - $F_{MSY-HCR}(2013) = F_{MSY}\left(\frac{B_{2013}}{B_{Trigger}}\right)$
    - Apply the 20% Uncertainty Cap: $C_{y+1} = 0.8 \times C_{y+1\ Calc}$

ICES Control Rules

- Category 3: Stocks for which survey-based assessments indicate trends
  - Harvest Control Rule:
- **If a reliable abundance index is available, apply the abundance index-adjusted, status-quo catch (a harvest control rule). If, in addition, the current value of F (), with respect to an F_{MSY} proxy ($F_{MSY\text{-}proxy}$) is known, then**
- The advice is based on a comparison of the two most recent index values with the three preceding values, combined with recent catch or landings data.

1 Determine catch advice from the survey- and F_{MSY}-transition adjusted *status quo* catch

  - where

  - and ω is 0.6 for 2013, 0.8 for 2014, and 1.0 for 2015 according to the 2010 ICES MSY approach for fisheries advice where a stepwise transition is used to reach F_{MSY} by 2015.
  - In cases where F_{SQ} is close to $F_{MSY\text{-}proxy}$: go to F_{MSY} at once $F_{y+1} = F_{MSY\text{-}proxy}$. Note that this was not used in the 2012 advice, but it should be applied going forward.

2 Apply the 20% Uncertainty Cap to the catch advice (see above Methods; Definition of common terms and methods).

  - Apply the 20% Uncertainty Cap: $C_{y+1} = 0.8 \times C_{y+1\ Calc}$
- If estimated biomass is less than Btrigger
  - Catch advice is based on the ICES MSY control rule, (F<FMSY as a linear function of biomass relative to Btrigger):
  - $F_{MSY-HCR}(2013) = F_{MSY}\left(\frac{B_{2013}}{B_{Trigger}}\right)$
  - Apply the 20% Uncertainty Cap: $C_{y+1} = 0.8 \times C_{y+1\ Calc}$

Empirical Harvest Control Rules (3)

- ICES Data-Limited Stocks (DLS) Approach:
- Category 4: Stocks for which reliable catch data are available
  - **Assumptions**
    - Average catch has been sustainable if abundance has not changed
    - Catch advice based on MSY is only appropriate to stocks near B_{MSY}
    - If the MSY estimate is much greater than recent catch
      - Stock size may be less than B_{MSY}
      - Catch advice should increase slowly toward DCAC.

Empirical Harvest Control Rules (4)

- Category 4: Stocks for which reliable catch data are available
  - **Method 4.1:**
    - **A sufficient catch history is available, which need not be continuous, to determine a suitable exploitation rate**
      - **1) Estimate MSY**
        - **DCAC model;**
      - **2) If Recent Catch > MSY**
        - **Method 4.1.1:**

Where the ω is 0.6 for 2013, 0.8 for 2014, and 1.0 for 2015 according to the 2010 ICES MSY approach for fisheries advice where a stepwise transition is used to Apply the 20% Uncertainty Cap to the catch advice (see above Methods; Definition of common terms and methods)

$$C_{y+1} = (1-\omega)C_{SQ} + \omega DCAC$$

Empirical Harvest Control Rules

- ICES Data-Limited Stocks (DLS) Approach -

- Category 5: Data-poor stocks (only landings data)
  - **If there is no indication of where F is relative to proxies and no marked positive trends in stock indicators: *Method 5.2*:**
    - **1) Calculate the recent catch C_{y-1} as the average catch over the 2-3 last years, e.g.** $C_{Y-1} = \frac{\sum_{y-4}^{y-1} C_i}{4}$
    - **2) Calculate the catch advice (C_{y+1}) as** $C_{Y+1} = C_{Y-1}$.
    - **3) Apply the -20% Precautionary Buffer to the catch advice**
      - $C_{Y+1} = 0.8 \times C_{Y-1}$
  - **If catches have declined significantly over a period of time and this is considered to be representative of a substantial reduction in biomass: *Method 5.3*:**
    - **a recovery plan and possibly zero catch is advised**

Greenland Halibut (NAFO)

NCEM Article 10 – Greenland Halibut

Harvest Control Rule (HCR) (model free)

Indicator: Slope of Abundance Index

$$TAC_{y+1} = \begin{cases} TAC_y \times (1 + \lambda_u \times slope) & if \quad slope \geq 0 \\ TAC_y \times (1 + \lambda_d \times slope) & if \quad slope < 0 \end{cases}$$

Slope: average slope of the Biomass Indicator (CPUE, Survey) in recent 5 years

- λ_u :TAC control coefficient if slope > 0 (Stock seems to be growing) : λ_u=1
- λ_d :TAC control coefficient if slope < 0 (Stock seems to be decreasing) : λ_d=2
- TAC generated by the HCR is constrained to ± 5% of the TAC in the preceding year.

Empirical Harvest Control Rules

- Australian HCR for Spanner Crab:
- Basic elements:
  - There is a base TAC calculated from historical data
  - Maximum (Cap) TAC of 2000 tons
- Indicators used: Trends in the commercial CPUE and the survey CPUE (Difference to Base levels)
- Decision Rules:
  - If both indices increased more than 10% and are positive:
    - $C_{Y+1} = C_{Y-1} \times 0.5 \times \frac{I_{Obs}}{I_{Base}}$ (Max is TACCap)
  - If at least one of the indices decreased more than 10%:
    - $C_{Y+1} = C_{Y-1} \times 1.0 \times \frac{I_{Obs}}{I_{Base}}$

Empirical Harvest Control Rules (3) - Australia -

- Australian Western Deepwater Trawl Fishery
- Trigger levels for information requirement
  - Basis: Highest recorded catch (HRC)
  - Trigger 1 (catch > 0.5 HRC)
    - Exploratory analysis of catch and effort data
  - Trigger 2 (Catch > HRC)
    - Simple assessment of the fishery – Standardised CPUE + Biological data
  - Trigger 3 (Catch > 2 * HRC)
    - Targeted fishing stops until full stock assessment demonstrates that any increased catch is sustainable.