Concepts and Approaches to WSP Benchmarks and Managing Mixed-Stock Fisheries

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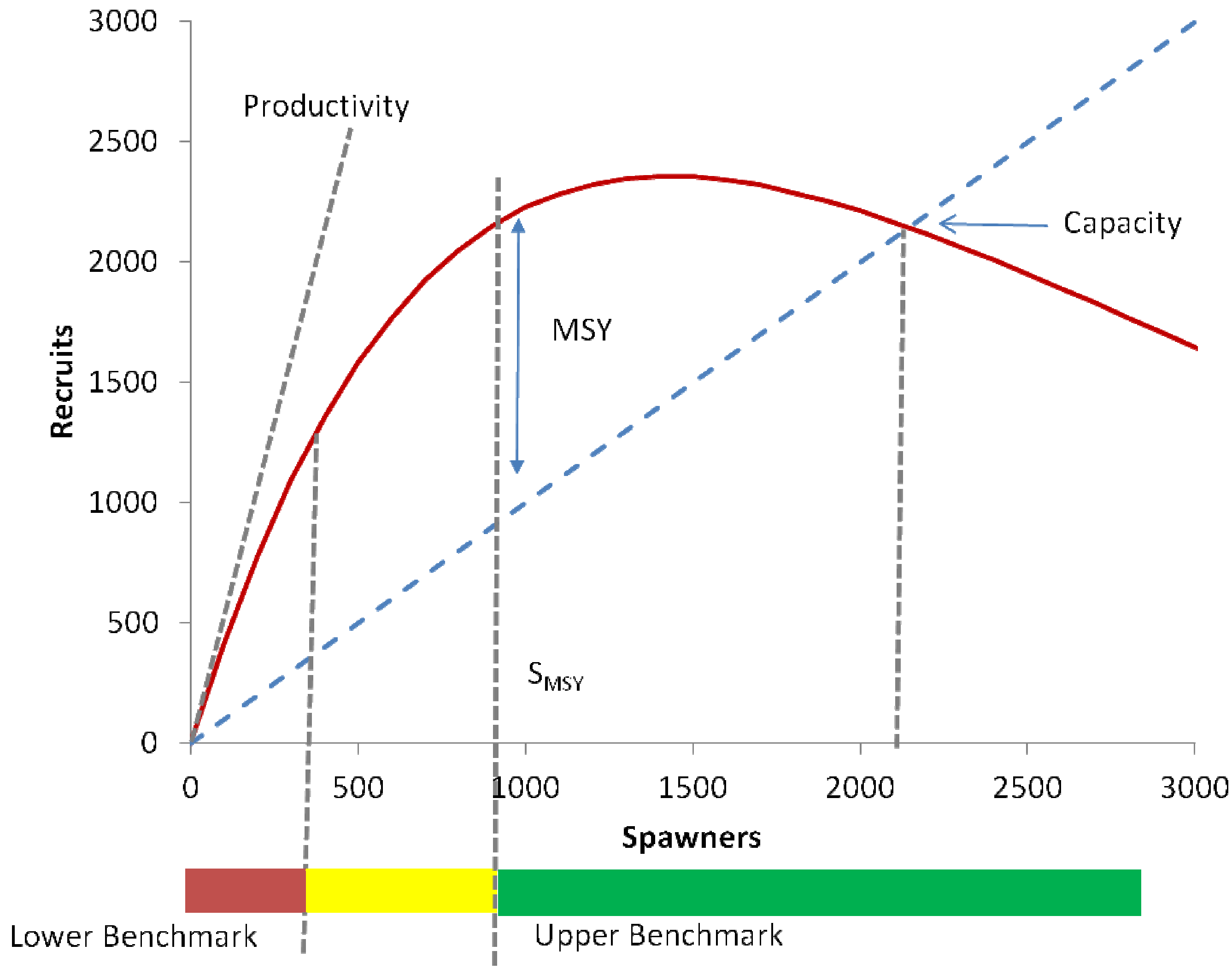
Objective for session: Explain some key concepts needed to determine WSP benchmarks and how these are extended to development of a multi-stock fishing plan, with input from community/industry advisors.

Overview of presentation:

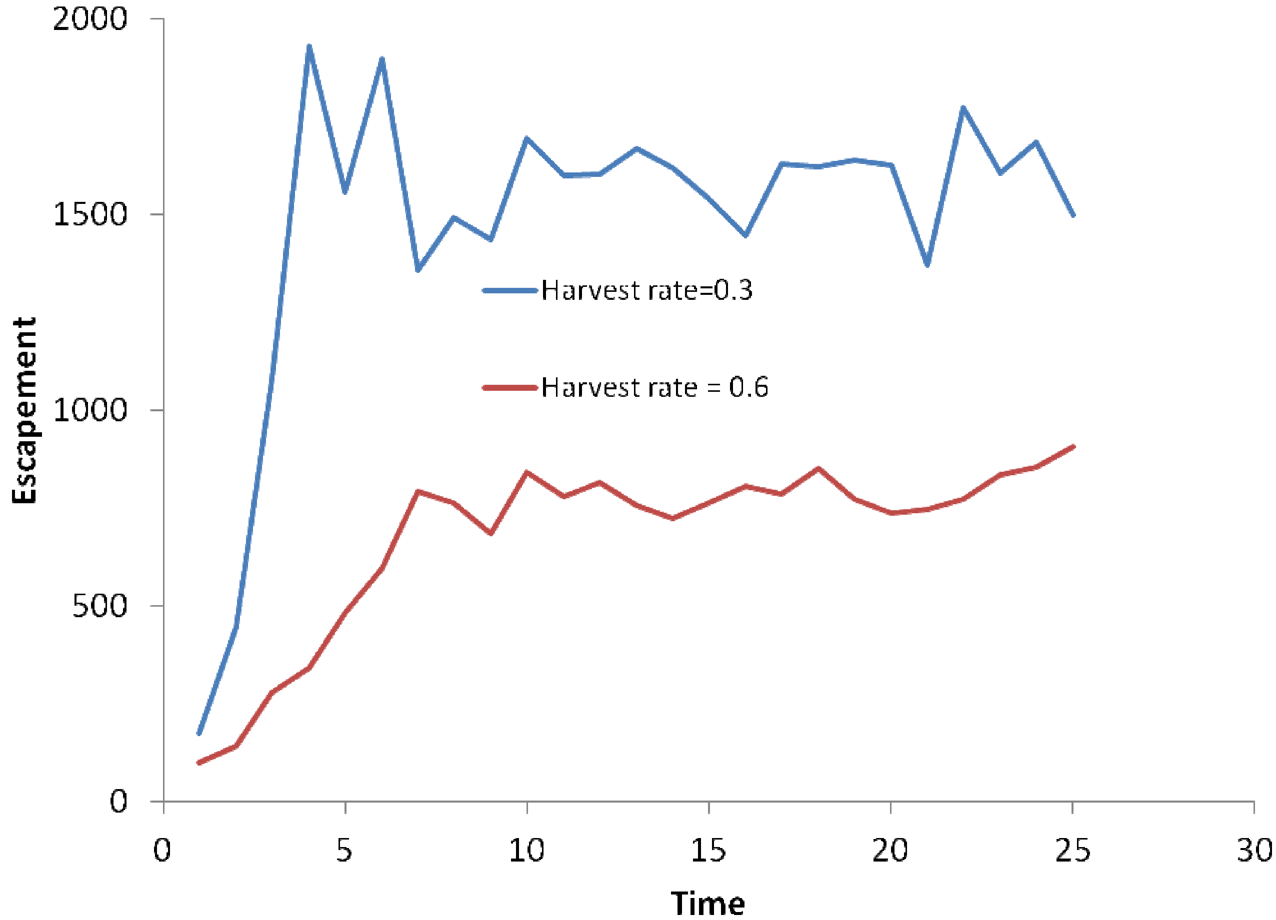
1. Single production unit assessment (Conservation unit)
2. Key data, concepts, and uncertainties
3. Comparison of multiple production units
4. Role for structured decision making and inclusion of values
5. Outcomes: trade-offs, limiting factors and monitoring, inclusion of time and spatial frames, model extensions.

Getting to Strategy 4 of the Wild Salmon Policy

Response to Harvest Depends on Productivity and Capacity of the Stock



Harvest Rate Effects Rate of Recovery (or decline) and Long-Term Abundance



Productivity, Harvest Rates and Extinction: the basic math

If 2 adults can produce on average 6 offspring (i.e., recruits) in their lifetime: Recruits/Adult = 6/2 = 3.

Since R/A > 1, and in the absence of fishing, this population would be expected to grow and fluctuate about the equilibrium population size (capacity).

But, if fishing mortality imposed is 1 in 3 recruits (harvest rate of 33%), then the population will still grow since the remaining R/A = 2 is greater than 1 ... but it will approach capacity at a slower rate.

What if the fishing mortality is doubled to 66%, then R/A is only 1 and the population can replace itself but would be expected to stabilize at S_{MSY}

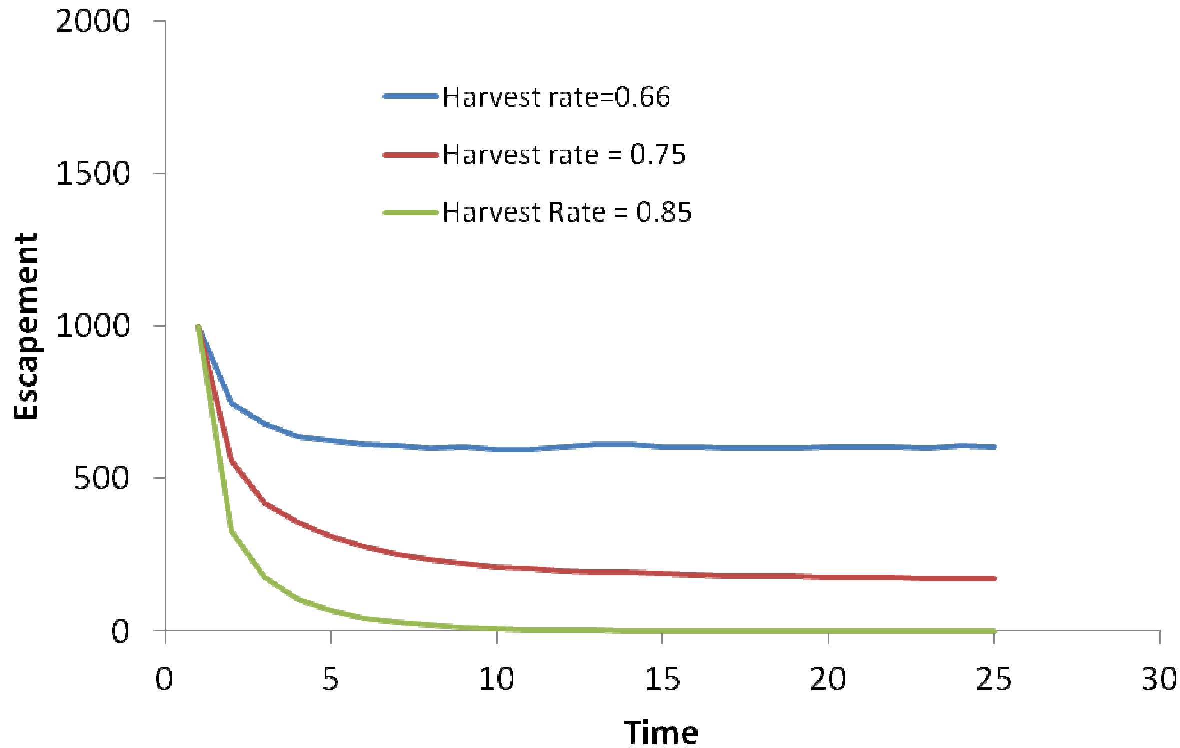
However, if fishing mortality > 66%, then the population size would be expected to decline in proportion to the rate of over-fishing.

Productivity, Harvest Rates and Extinction: the basic math

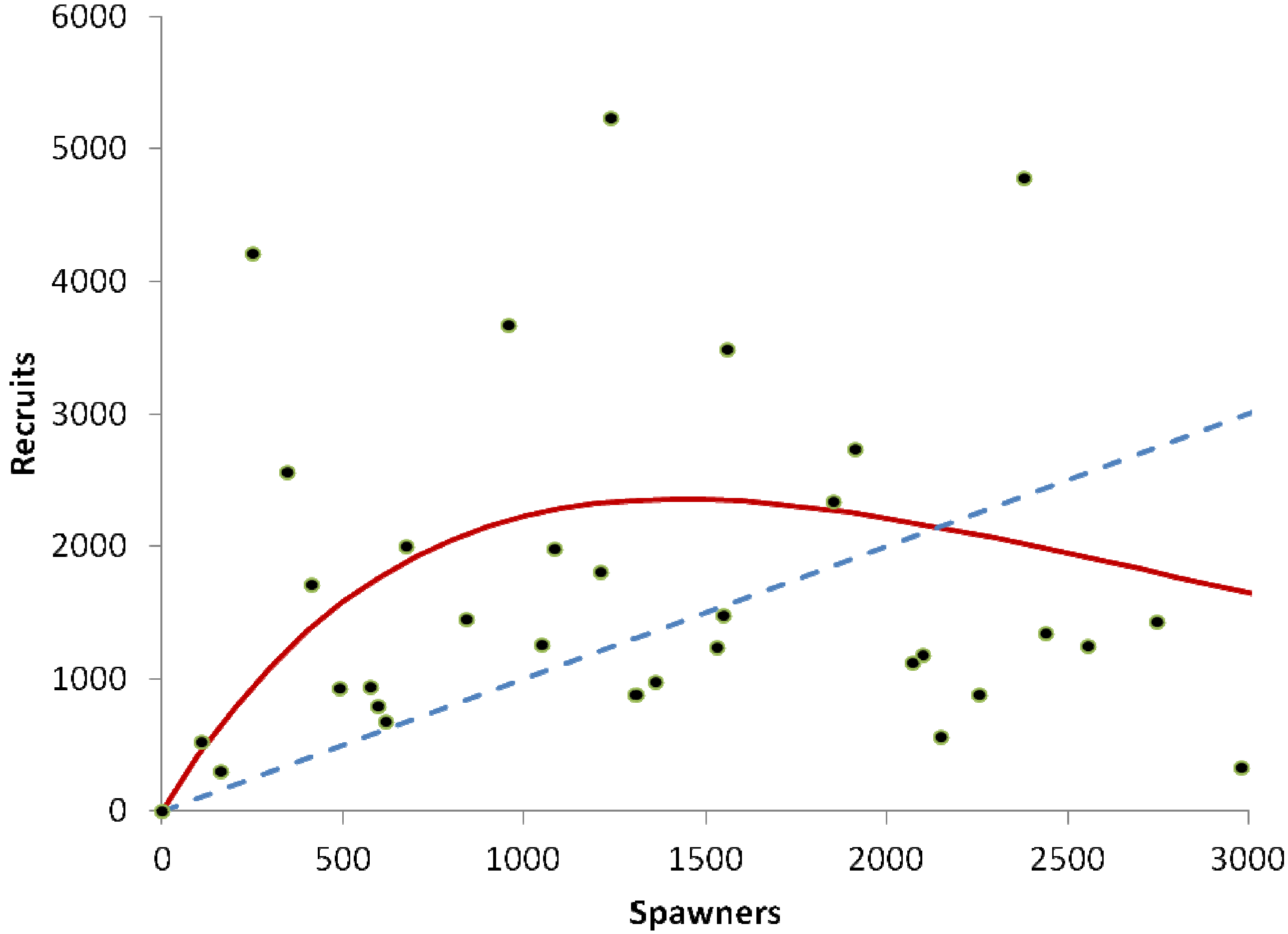
But if a population experiences over-fishing, does that mean immediate risk of extinction? Not necessarily ... But that depends on the balance between natural productivity and the imposed harvest rate.

If the harvest rate is 75%, then the *expected* return rate would be

R/A = (6 * (1-0.75))/2 = 0.75 recruits per spawner



Fitting Stock-Recruit Models to Data



Key data considerations

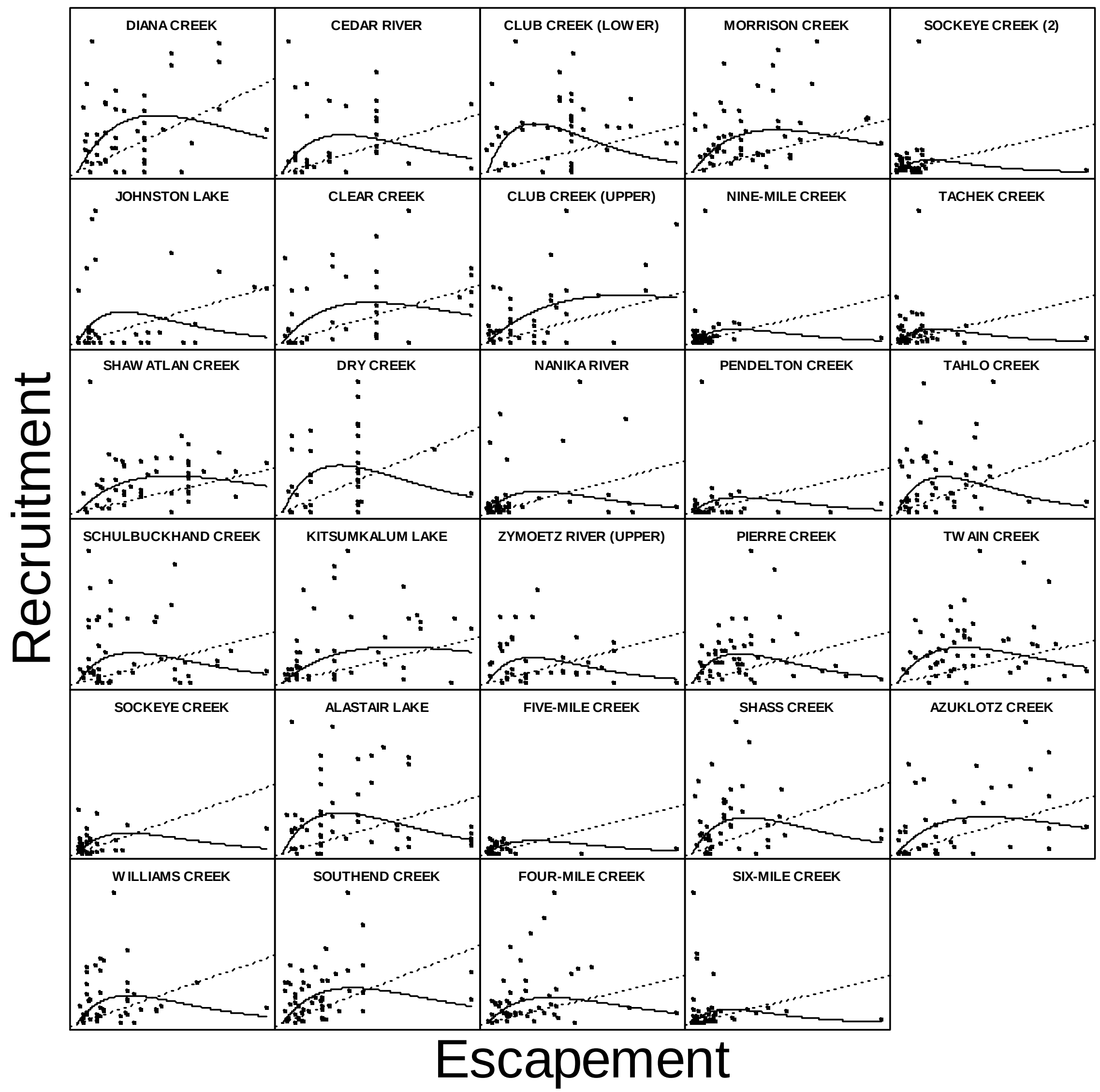
Definition of spatial units ➔ Conservation units (done?)

Uncertainty in data:

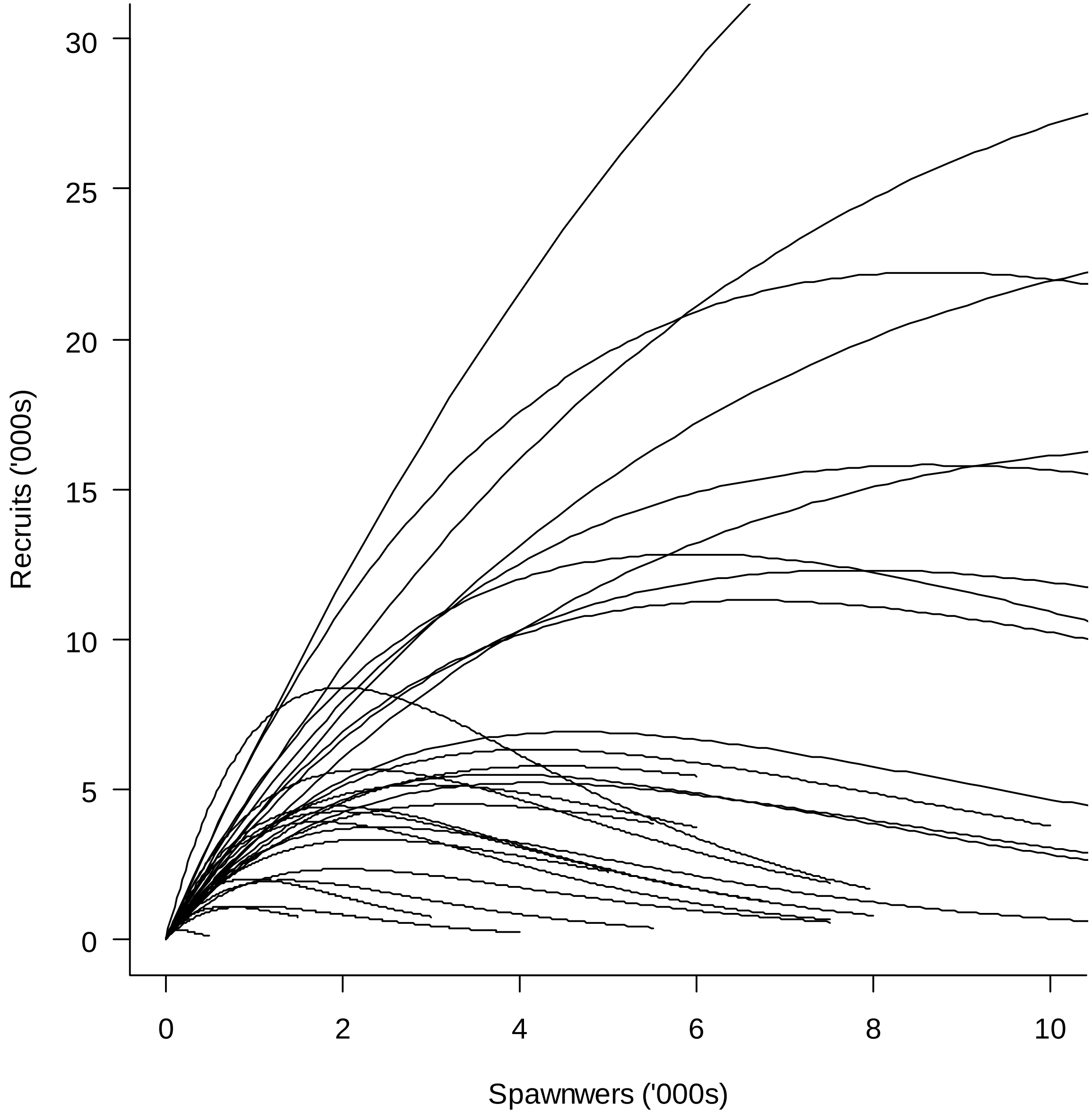
i. Shifting baselines
ii. Critical sources ... Estimation of spawners, estimation of recruitment, age structures (by sex?), environmental variation (noise &/or trends), incomplete data and methods for estimation.
iii. Biases (time series, estimation of parameters, ...)
iv. Models and analyses ... Key assumptions, verification, ...

Prediction ... S/R curves represent mean expected recruitment but with significant uncertainty around the mean ... Some environmental, some data quality, some estimation.

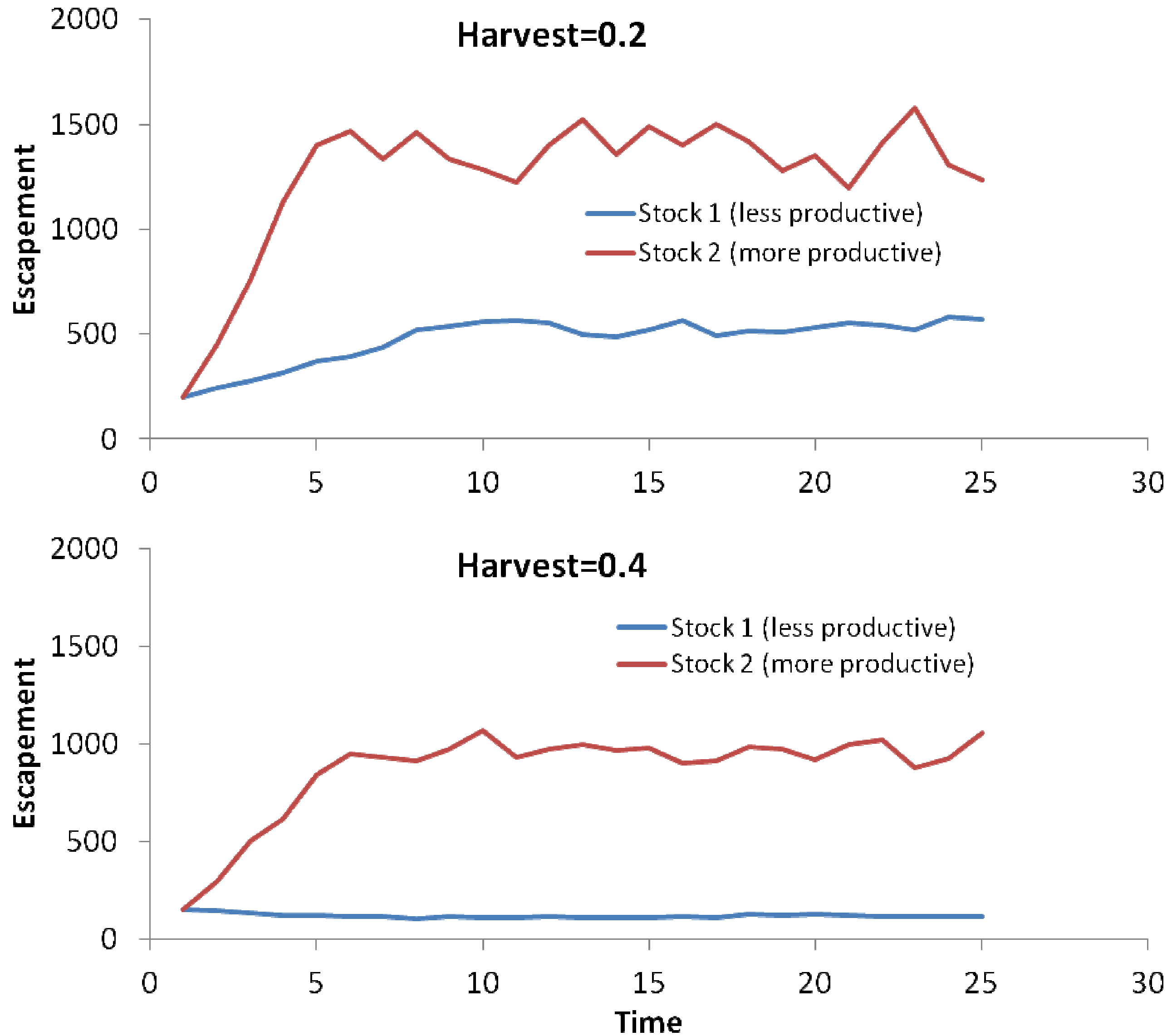
Multiple CU's within Skeena will show lots of variation in Productivity and Capacity



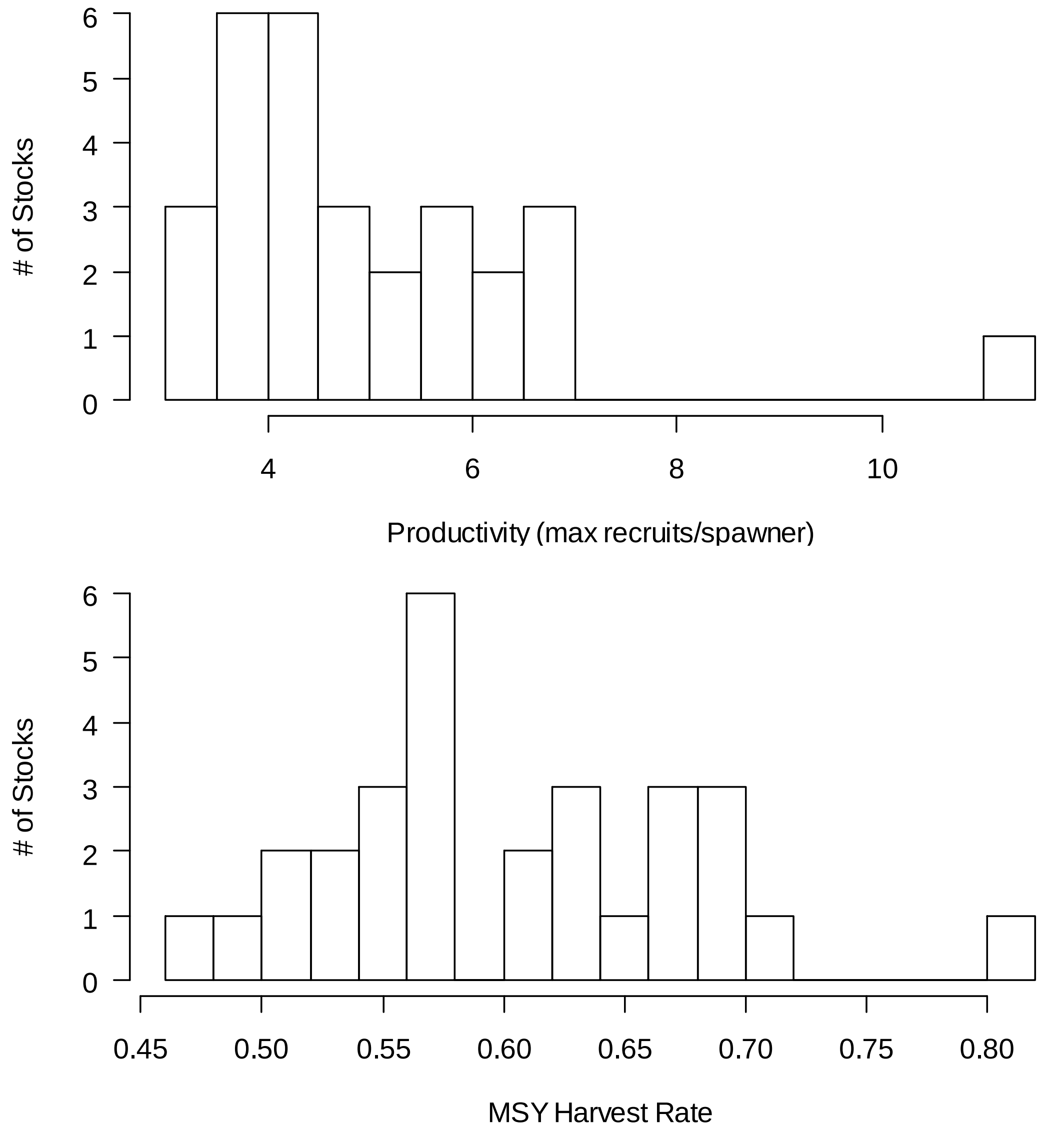
Big Range in Productivity and Capacity Among Stocks (con't)



Response of Escapement Trends to Harvest Depends on Productivity and Harvest Rate

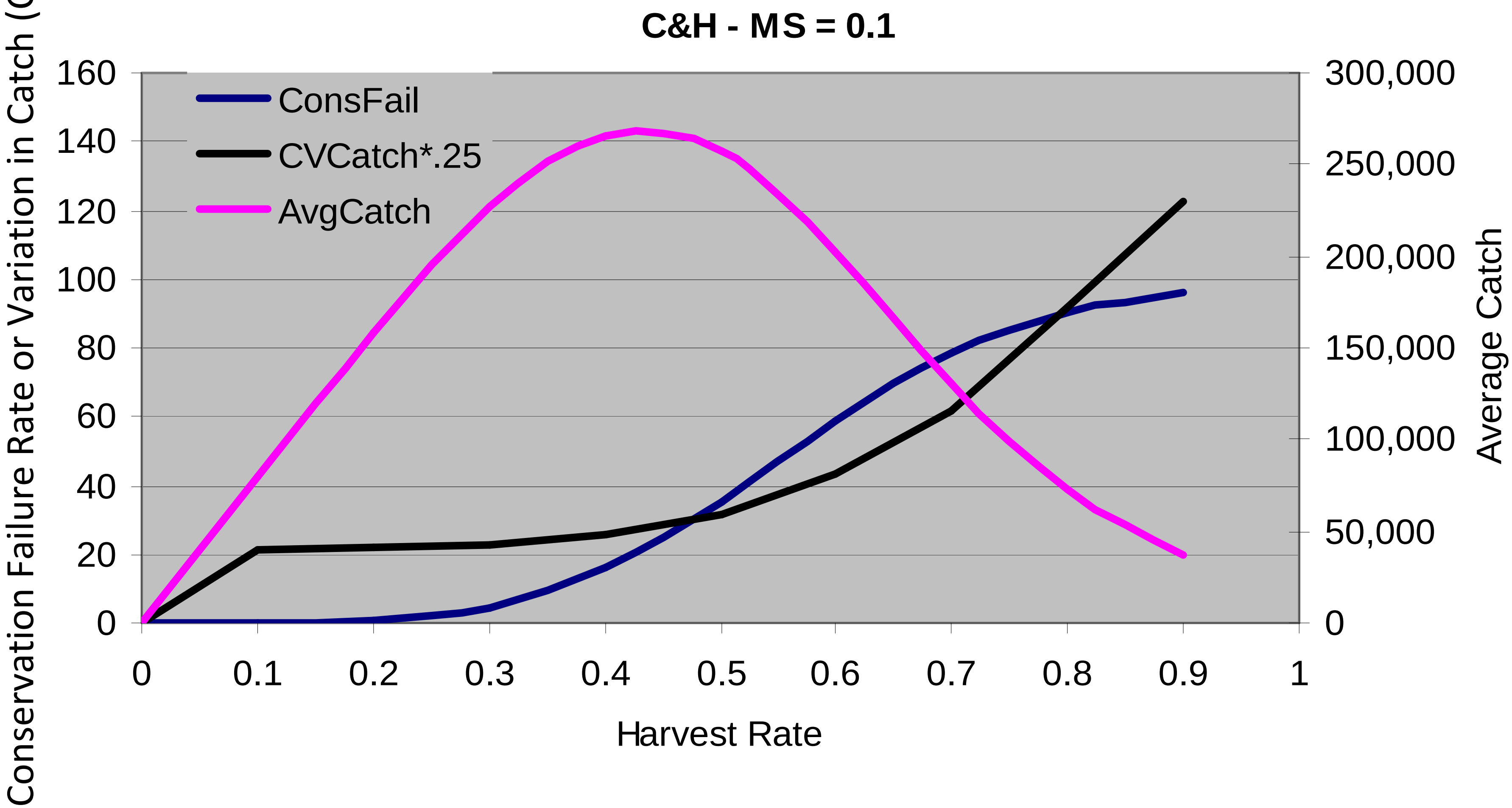


At most Harvest Rates, some Stocks will be Overexploited, and some will be Underexploited

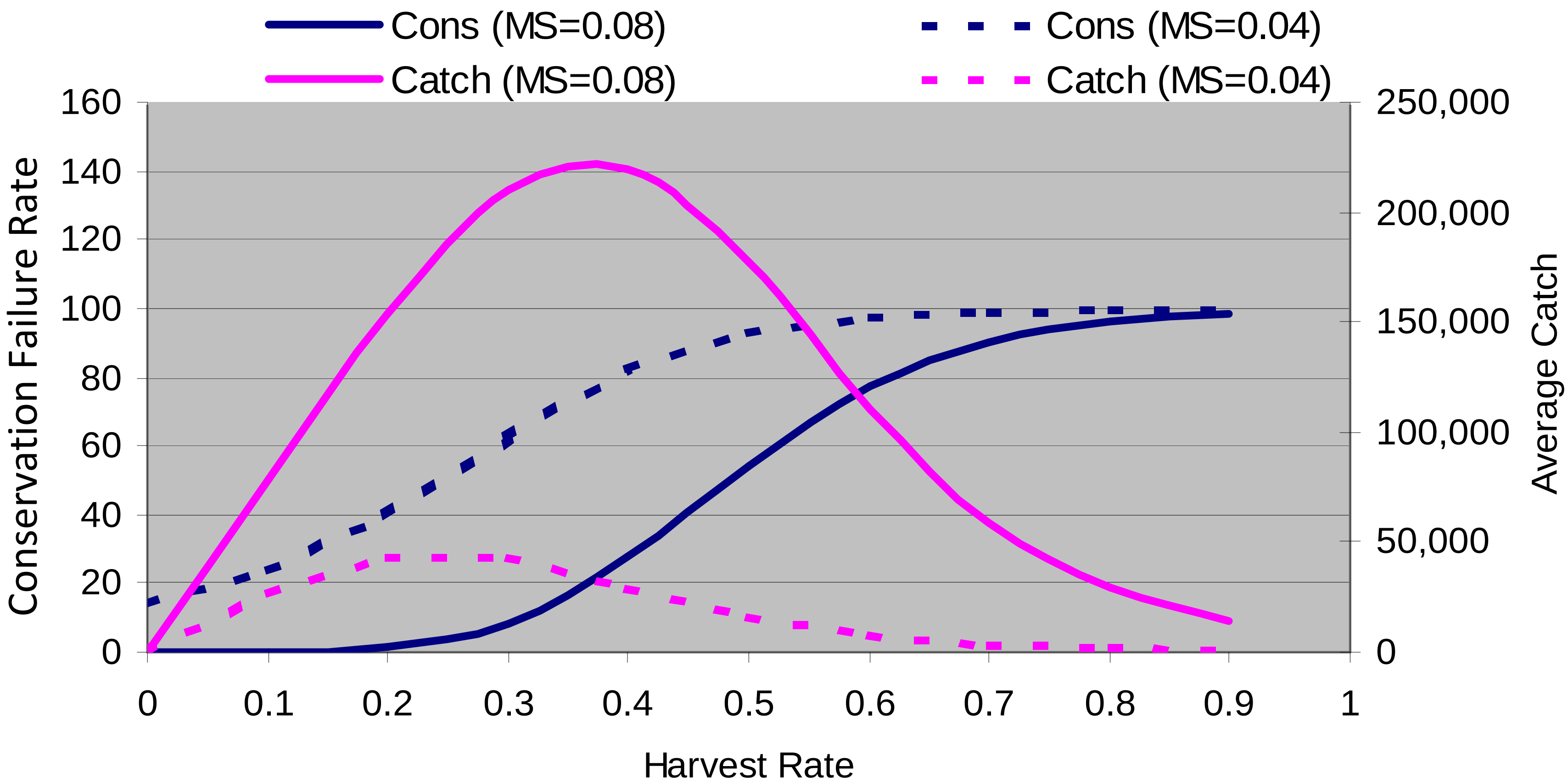


Tradeoff Between Conservation and Yield:

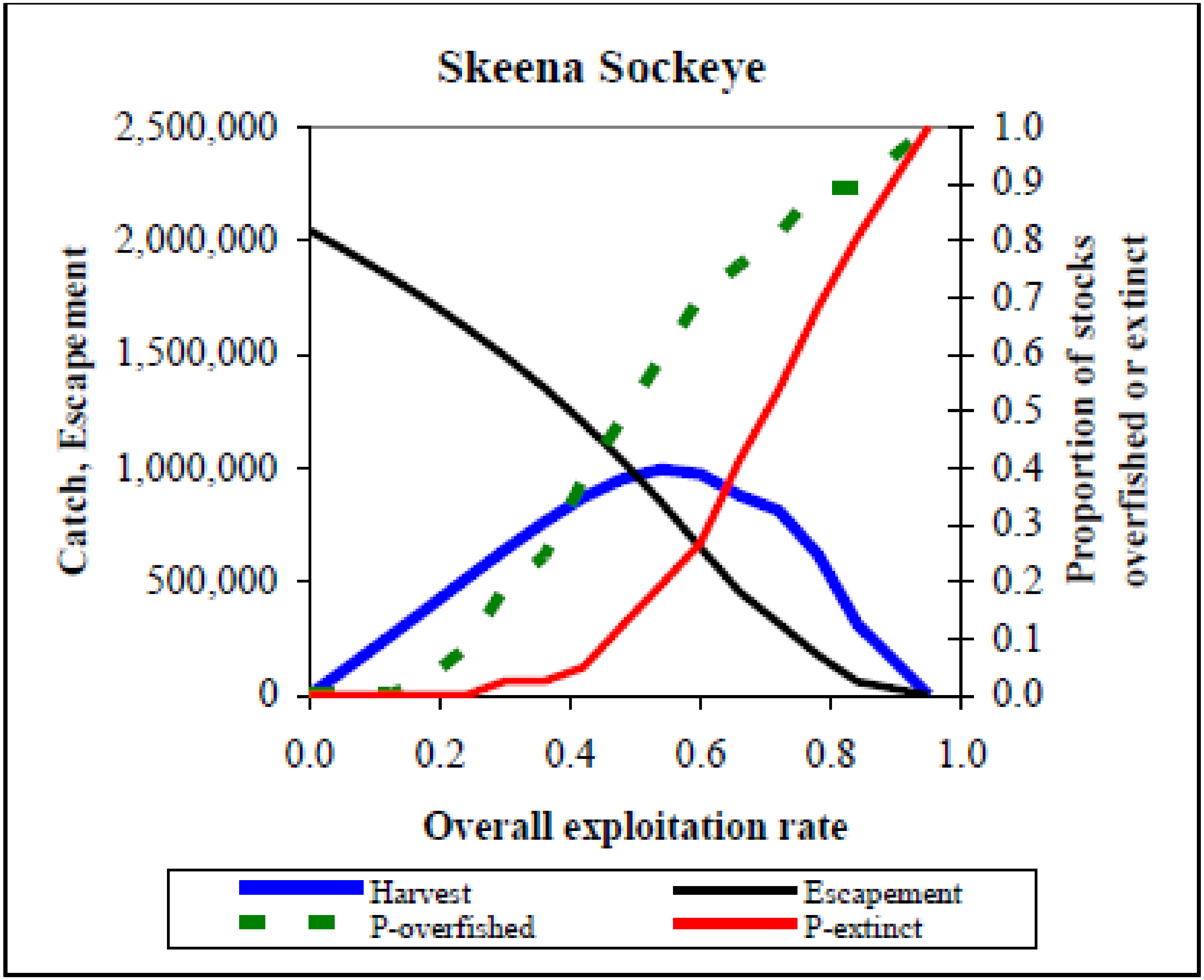
Example Output from a Management Strategy Evaluation Model for South Coast Coho



Tradeoff will Vary with Productivity of Stocks



Walters et al. ISRP Analysis



Multi-CU deliberations anticipated in the Wild Salmon Policy,
(small, unproductive populations will be serious limiting factors)

1. CU's can not be 'managed' to extinction ...
    - Unless explicitly determined through a public process
    - Respectful of First Nations

2. CU's status and 'Response Teams"
    - CU's in the Red zone are likely to be limiting factors to fishers
    - Required to develop a response plan to at least recover to Amber status
        - time element not specified
        - all CU's do not have to be at equal status
    - Seek common objectives through a regional consultative process

3. Structured Decision Making (SDM) was presented as an example of a consultative process but requires representative involvement. Recommendations are advisory to the Minister of Fisheries.

Structured Decision Making (SDM) Helps Articulate the Decision

	Harvest Rate		
Indicators	**0.2**	**0.4**	**0.6**
Escapement (stock A)	500	400	300
Escapement (stock B)	300	200	10
Total Yield	500	2000	1000
Variation in Yield	10%	30%	70%
Rankings			
Fisher	3	1	2
Conservationist	1	2	3
DFO	OK	OK	Not acceptable

Where Do Benchmarks Fit In?

- Lower (don't go below this or there may be consequences to sustainability of stock)-conservation based.
- Upper (no point in going above this point in terms of yield) – management based.
- Can use these benchmarks (at least lower one) to compute indicators (like conservation status) for Management Strategy Evaluation (MSE) model.
- If going with MSE-type approach, don't really need them except to define indicators.
- Wild Salmon policy requires benchmarks, but unclear how useful they are if using multi-stock MSE approach (aside from helping to define what different levels of escapement mean for model).

Do Data From the Past Represent Future Conditions?

- Reduced marine survival over the last 5+ years indicates there can be periods of reduced productivity.

- The key assumption behind the stock-recruit and Management Strategy Evaluation modelling approach is that, in the long term, historical data represents future conditions.

- However, stakeholders must recognize this key assumption, at least over the short-term.

- Best approach is to take a long time frame when evaluating harvest policies, then implement and monitor.

Past and Future Modelling Efforts

- Holtby and others (multi-stock stock-recruit analysis for coho).
- Cox-Rogers risk analysis for Skeena Sockeye (MSE type model).
- Walters ISRP model (another MSE-type model without explicit spatial-temporal details.
- Korman (improve on past stock-recruit analysis (HBMs, better data).
- Walters/Hawkshaw. Use improved stock-recruit curves and develop a spatial-temporally explicit model
  - Account for run-timing of individual stocks
  - Accounts for spatial distribution of stocks
  - Vary fishery over space and time to avoid weak stocks, but there are limits due to the biology, our knowledge, and allocation among fisheries.

Anticipated Outcomes

- Lots of uncertainty in data, therefore need modelling approaches and harvest strategies that account for this.

- Based on ISRP analysis, harvest rates in the range of 20-40% likely produce a pretty acceptable set of outcomes and a reasonable balance.

- Time-area closures can be used to increase harvest on strong stocks and reduce conservation risk for weak ones.

- Fixed harvest rate strategies likely will perform better than abundance-based strategies, especially given data poor situation.
  - Its a lot easier to use time-area closures to achieve a harvest rate, rather than forecasting run size to achieve a catch and escapement.

Responsibilities

- Biologists/Analysts
  - Estimate stock-recruit curves and distribution of productivity/capacity (Korman)
  - Develop Management Strategy Evaluation (MSE) model to describe trade-offs (Walters/Hawkshaw)
- Stakeholders
  - Specify values (conservation, fishery)
  - Specify planning horizon and range of harvest options
  - Rank alternatives based on outcomes and values

Walters et al. ISRP Analysis