FRSSI 101
Fraser River Sockeye Spawning Initiative

presented to: FN JTWG
date: 09-Mar-2015
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Outline

- Overview of FRSSI process & model
- FRSSI Model Features
  - FRSSI “does” and “does not”s
- TAMs Described
- FRSSI Model Description
  - *very general!!!*

FRSSI Overview

Model vs Process

- FRSSI Process
  - consultative process, workshops, etc.
  - Steering Committee, Working Group, Technical Working Group
  - This is where the decisions are made
- FRSSI Model – is used by the process
  - outputs are used by the FRSSI process to inform the decisions

Both Process & Model continue to evolve with feedback

Spawning Initiative Overview

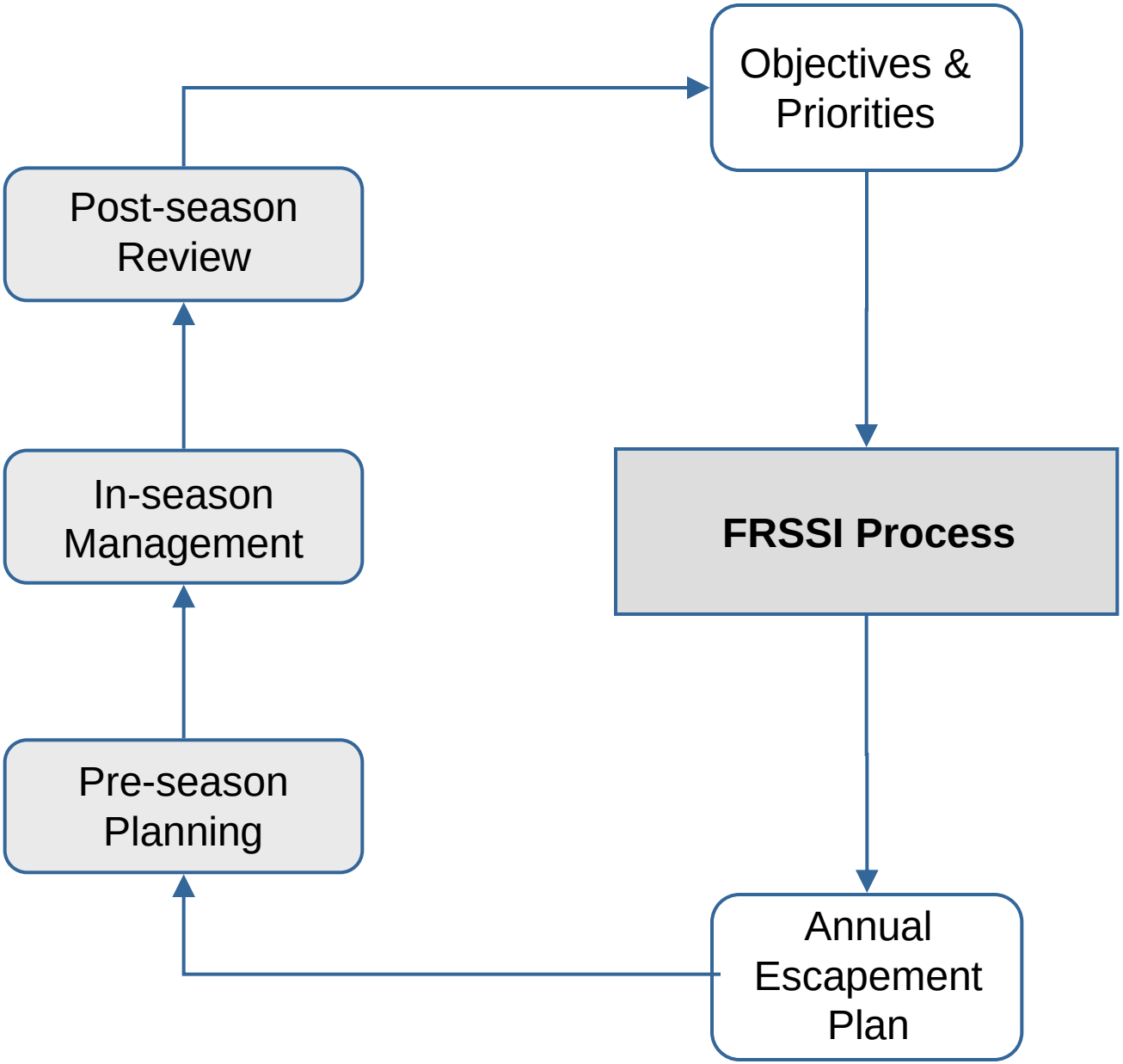
The Challenge

- Find a Balance between Catch and Escapement at different abundances

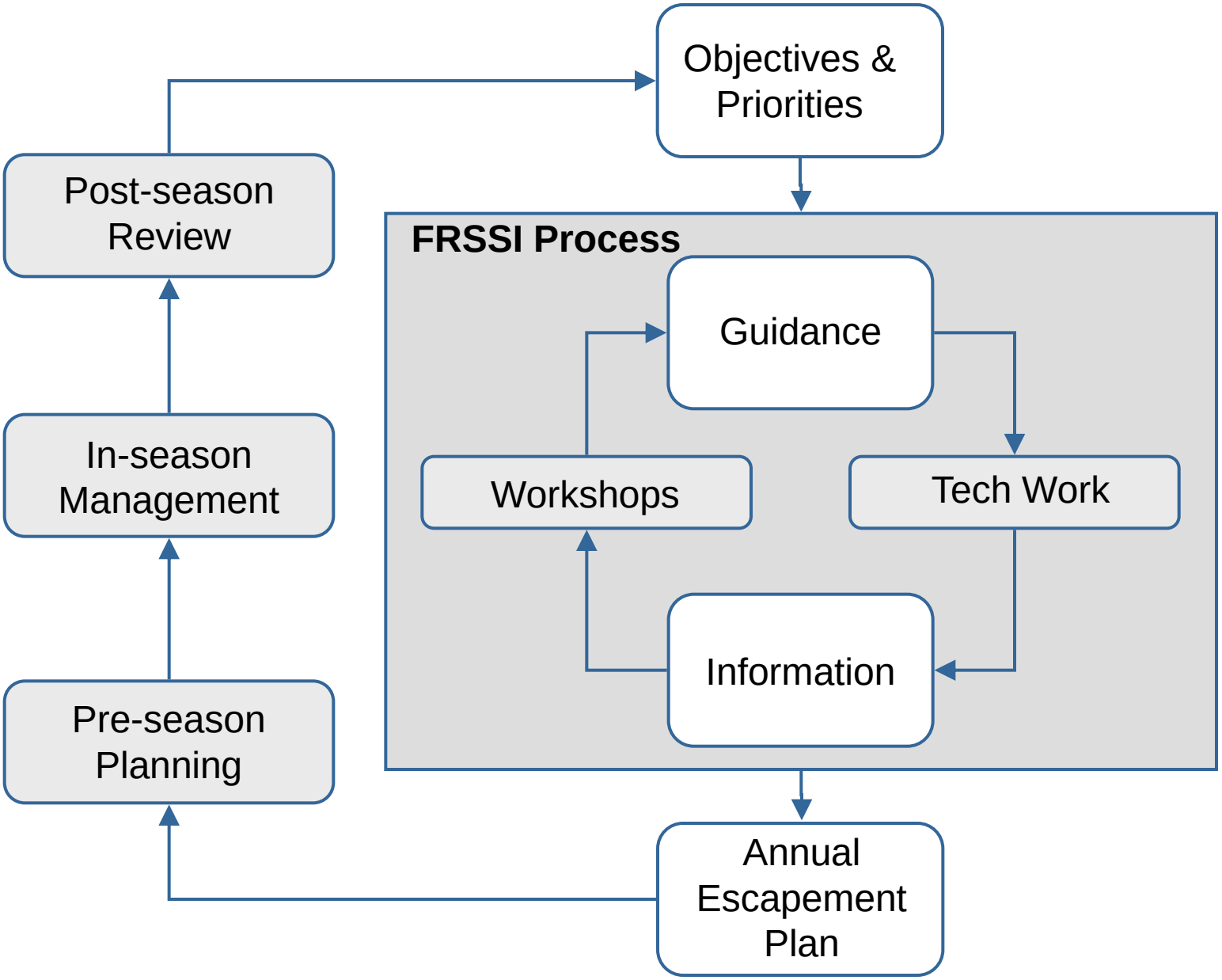
Goals

- Participatory process to develop a new set of guidelines for setting Fraser River sockeye escapement targets
- Long-term strategy based on clear objectives and assumptions
- Improve consultation by focusing on proactive discussion of escapement targets under different scenarios
- Implementation guidelines (in-season adjustment mechanisms)

Annual Cycle of Management



Annual Cycle of Management

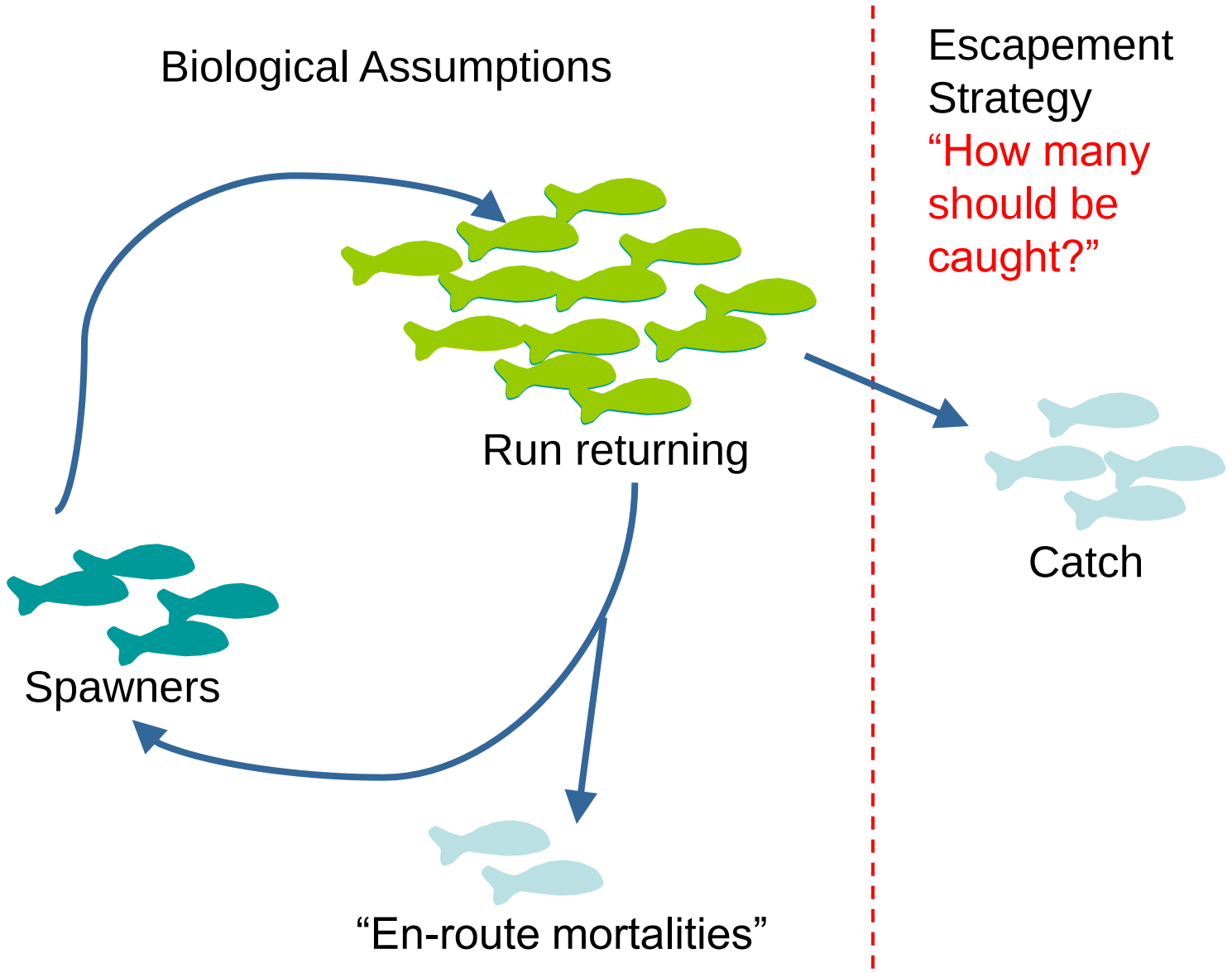


Model Features

“All models are wrong.
Some are useful.”

- G.E.P. Box

Model Flow Diagram



How many should be caught vs. allowed to spawn?

- The answer depends on many considerations:
  - Biological considerations:
    - Assumptions about population dynamics (i.e. how much can a lake produce?)
    - Uncertainty about how many spawners produces largest harvest, or largest returns
    - Uncertainty about cause and implications of population cycles in Fraser sockeye?
  - Socio-economic based factors
    - Preferences for harvest/escapement
    - Social preferences
    - economic factors
    - risk tolerance
- The FRSSI model was developed to help address this question by providing information on the implications of different harvest strategies

Some Noteable Model Moments

- optimization “black box” → simulation only
- Ricker → 2 x Ricker → Larkin
- S-shaped TAM → hockey stick TAM → field hockey stick TAM

Note: all of the above changes were made due to feedback from the participants in the FRSSI process

Ricker vs Larkin

Current model CAN do:

- Simulate performance of long-term harvest strategies
- Track aggregate and stock-specific performance measures
- Assume linear or patterns of change in productivity
- Assume a minimum harvest rate (test fishing, by-catch)
- Apply management adjustment (Mission vs. Up-stream)
- Apply stock-specific escapement strategies (or mix)
- Simulate all stocks at same time to get at overlap constraints (currently, two methods to choose from)
- Evaluate the effect of aggregating stocks in non-traditional groupings (managing stocks in alternate management groups)

The model does NOT…

- Spatial Component
  - FRSSI outputs total allowable mortality, does not model *where* the mortalities take place (e.g. marine vs in-river / mixed stock fisheries vs terminal)
  - FRSSI will not develop an annual fishing plan
    - currently, annual fishing plans are evaluated using the Pacific Salmon Commission pre-season model and IFMP development
- calculate allocations
- make annual adjustments to escapement strategy based on forecast
  - e.g. will not model this year, Option 1; next year, Option 3…
- assume there is any implementation error in applying TAMs
  - i.e., assumes that if there are 52,631 fish to catch, then 52,631 fish will be caught
  - note that there IS implementation error in applying DBE/MA
- get used in season
  - TAMs are used in-season, the model is not

Total Allowable Mortality (TAM) Rules

or

"How many fish can be caught, taking into account that some fish won't survive to reach the spawning grounds?"

Long-term Strategies

3 Basic Types, Many Variations

Fixed Escapement

- Try to have same abundance of spawners every year
- Exploitation rate increases with run size

Fixed Exploitation Rate

- Try to harvest same proportion of run every year
- Spawner abundance increases with run size

Abundance-Based Strategies

- Manage small runs different from large runs

Abundance-Based Strategy

Small Run

- Maximize spawner abundance
- Minimize directed harvests, but retain test fisheries (e.g. fixed 2% ER)
- Spawner target increases with run size

Moderate Run

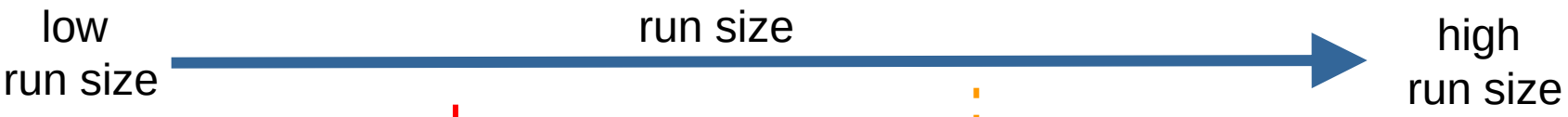
- Manage towards a specific spawner target
- Exploitation rate increases with run size

Large Run

- Cap on exploitation rate to protect less productive populations
- Spawner target increases with run size

If you replace **ER** with **Allowable Mortality** to build in a buffer against in-river mortality => **TAM Rule**

TAM Concepts



Low Abundance Zone

- ideally, every fish that returns goes to the spawning grounds
- no directed fisheries, except test fisheries and potentially minimal FSC
- exploitation rate close to 0%

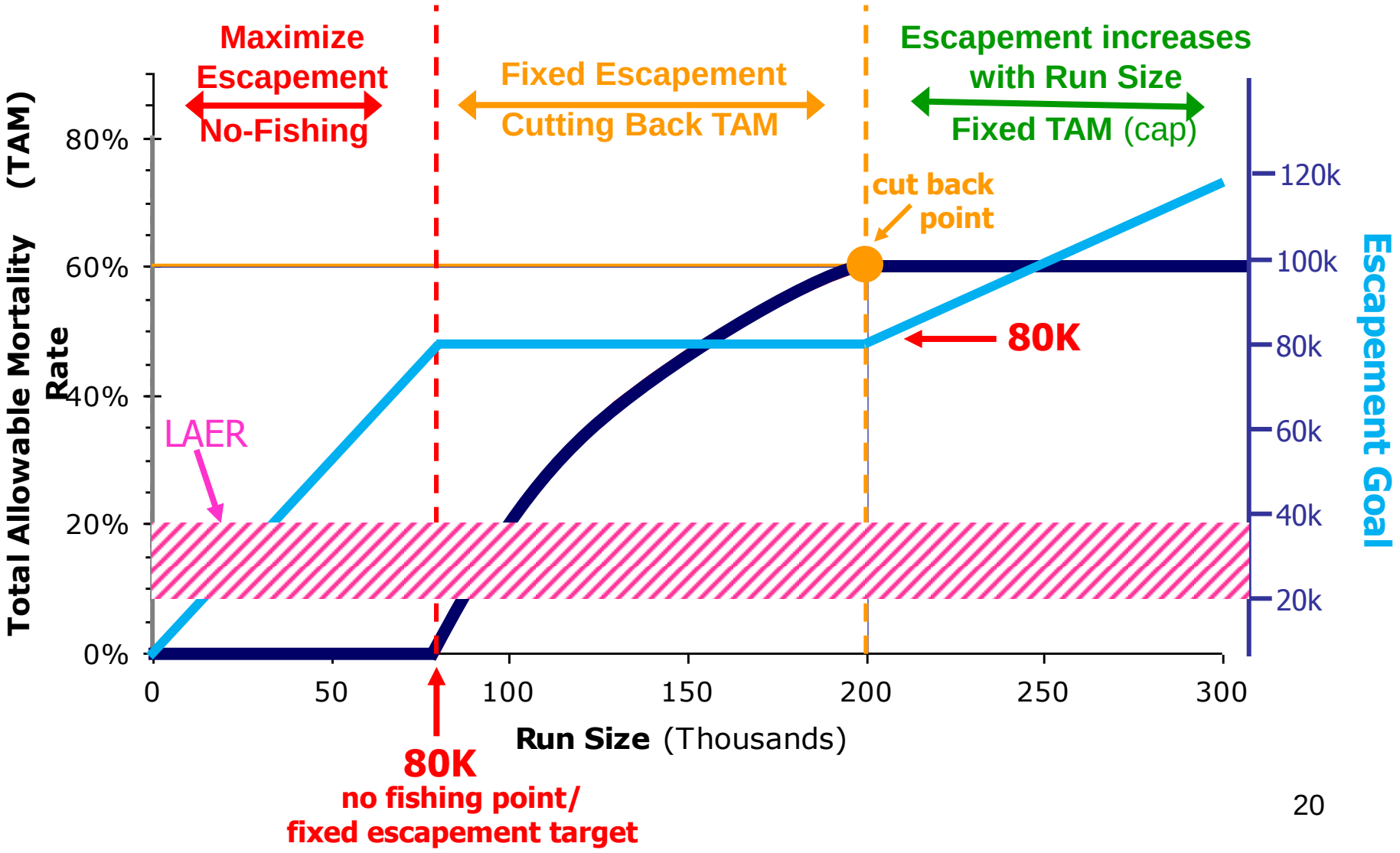
Moderate Abundance Zone

- spawning escapement target does NOT change with run size
- directed fisheries potentially occurring, depending on allowable ER
- exploitation rate will vary with run size (& management adjustments)

High Abundance Zone

- spawning escapement target is fixed as a proportion of total run size
- directed fisheries likely occurring
- exploitation rate will vary with management adjustment (but not with run size)

From TAMs to Escapement



Run Size = 100K

Esc. Goal = 1-TAM = 40K fish

pMA = 30% = esc.goal*30% = 12K fish

TAM = 60% = 60K fish

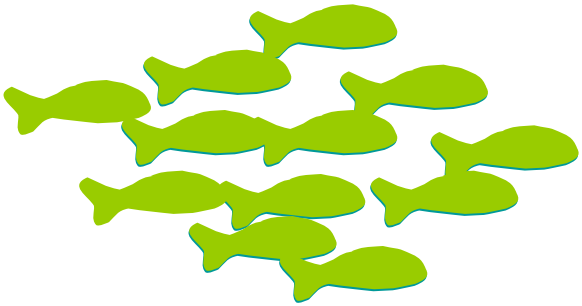
ER = run size – (esc. goal + MA) = 48K fish = 48%

Model Description

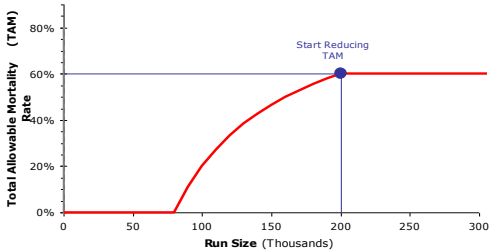
(or, “Where do escapement options come from?”)

To evaluate the performance of *one* TAM rule for *one* stock…

FRSSI Flow Diagram

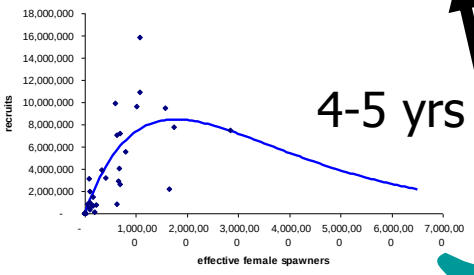


run returning

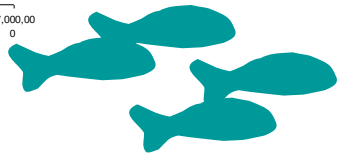


TAM Curve + MA

Repeat for 48 years



4-5 yrs



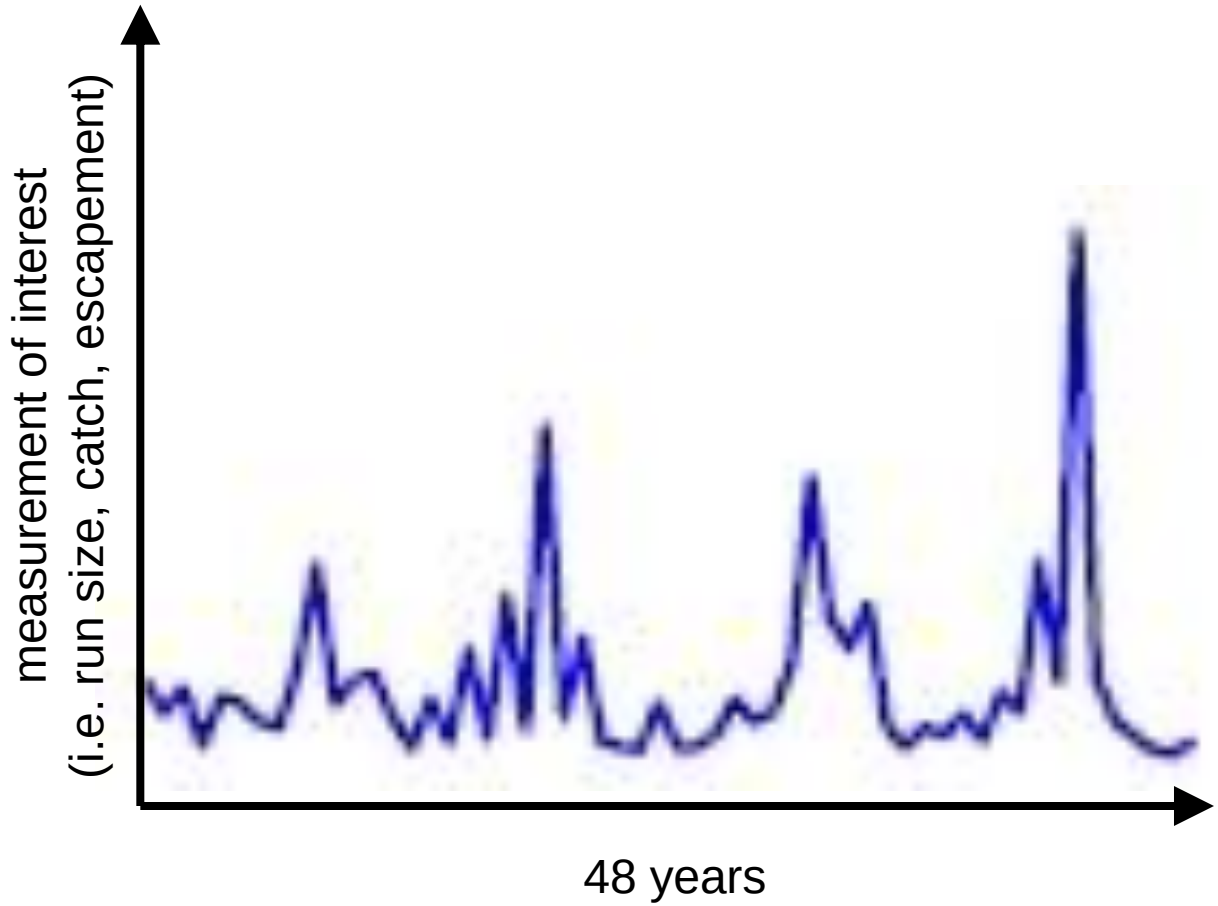
spawners

DBE

catch

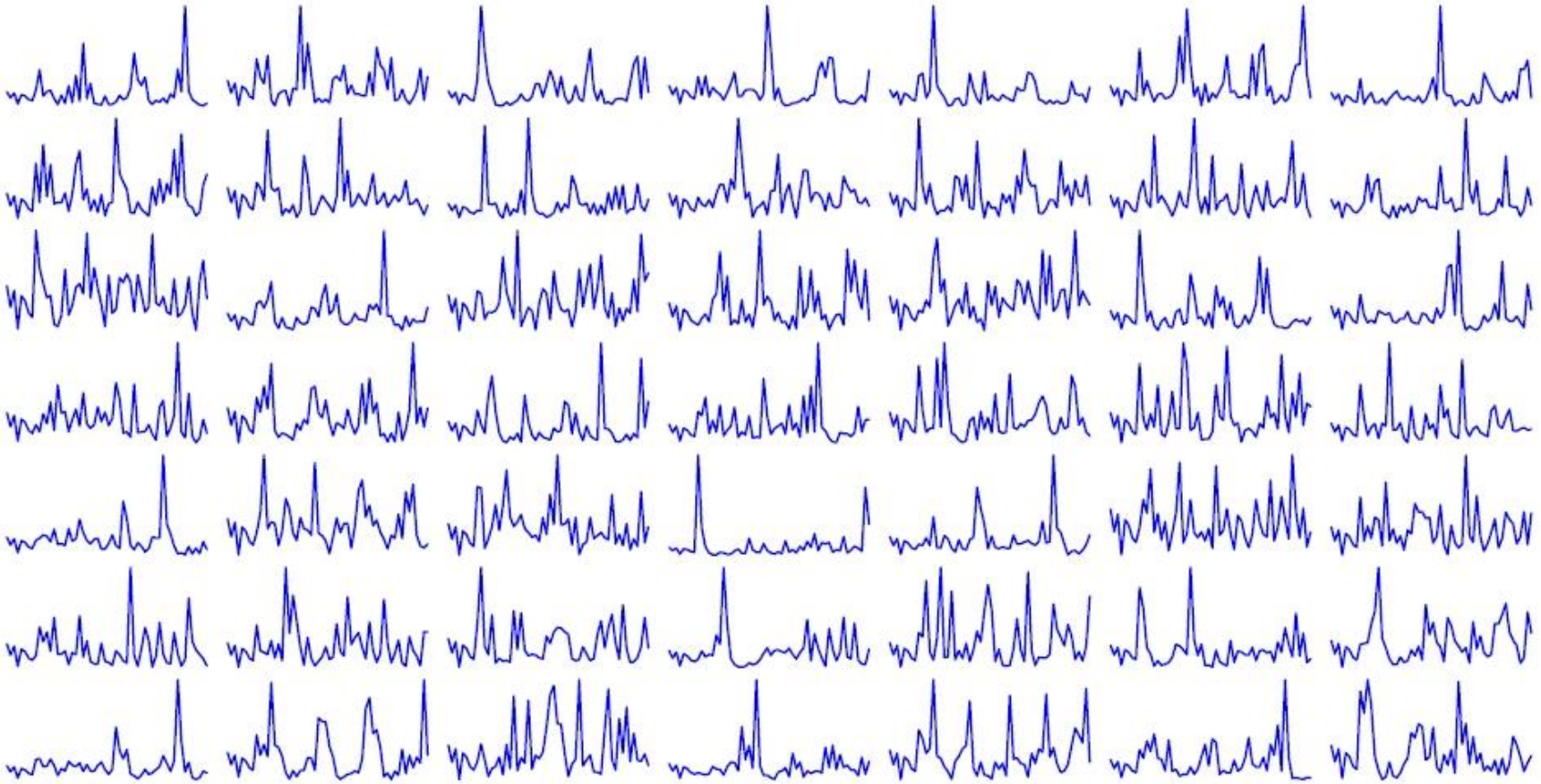
"en-route mortalities"

What one trajectory looks like:



Repeat 500 times (this is where computers come in really handy!)

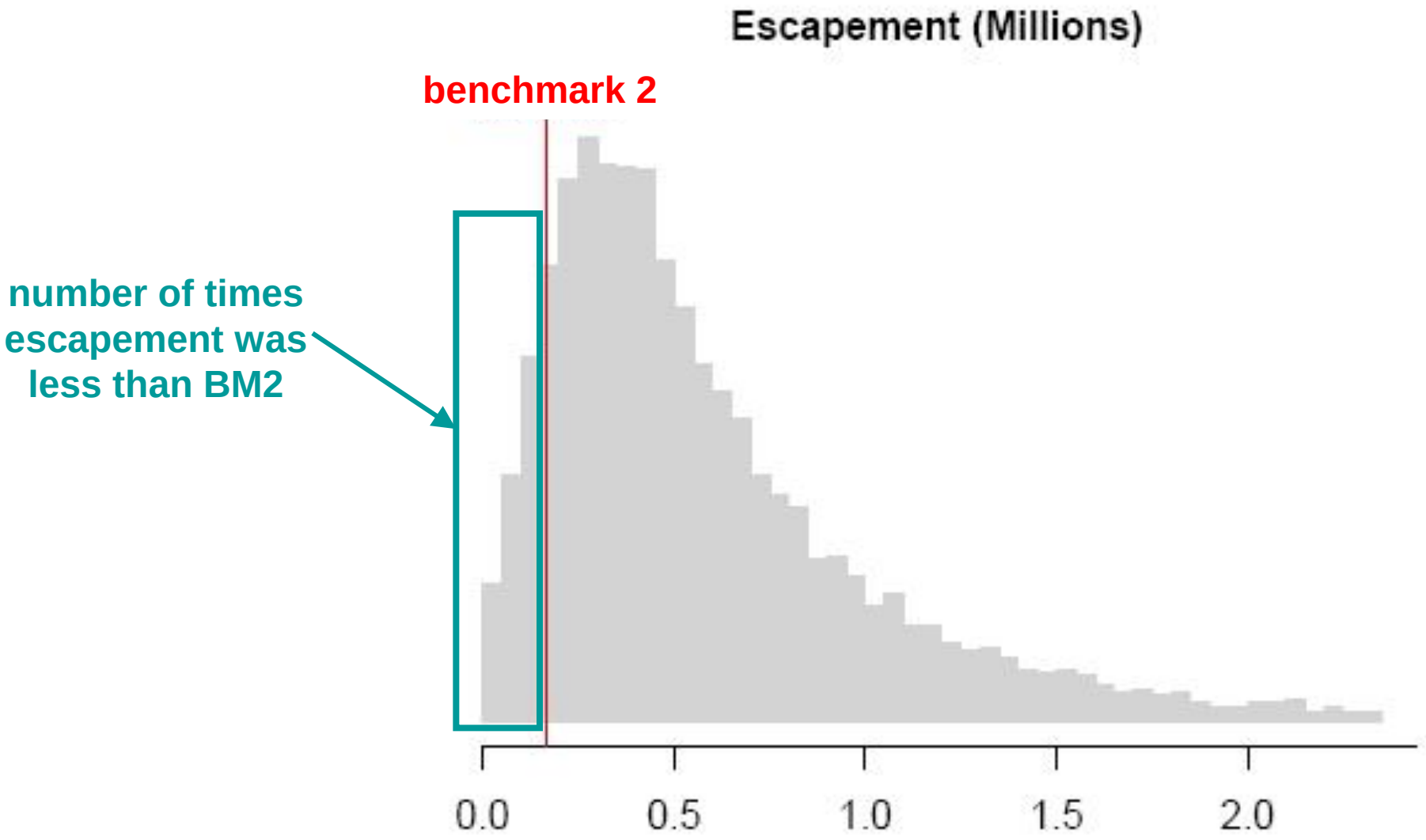
What a bunch of trajectories look like:



For a given performance measure
(e.g. Escapement below a benchmark)

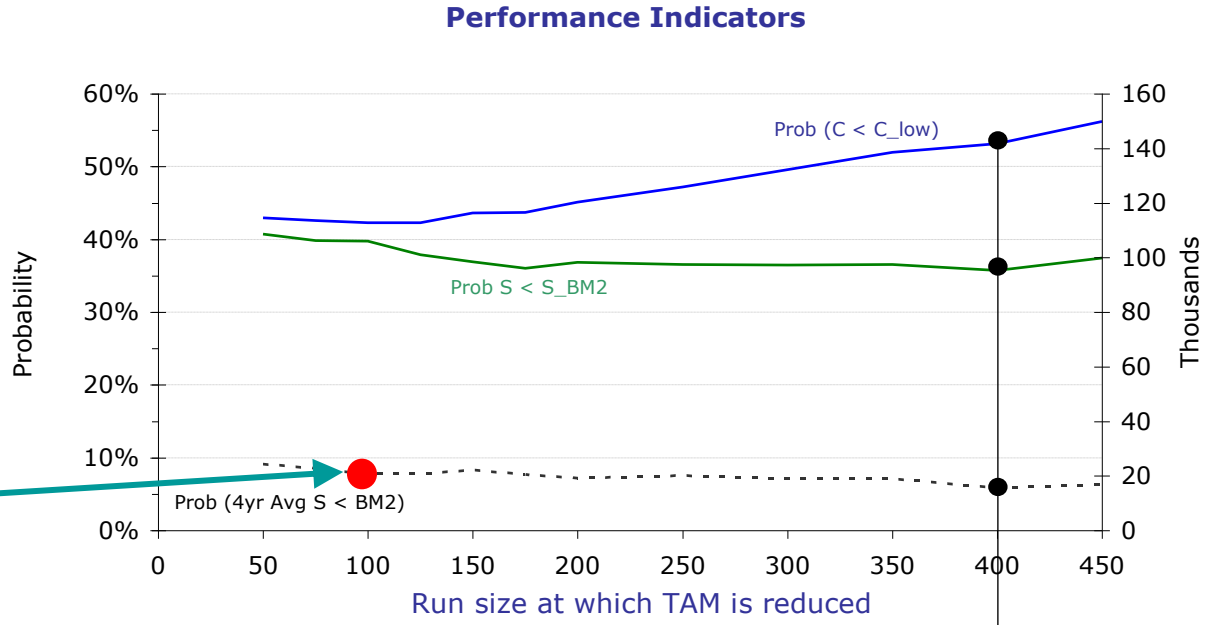
- for each group of 500 simulated trajectories, keep track of the escapement in each year
- get a distribution of escapements from 2400 years (i.e. 48 years x 500 simulations)
- and count how many times the escapement was below a certain benchmark (e.g. below benchmark 2)

Distributions

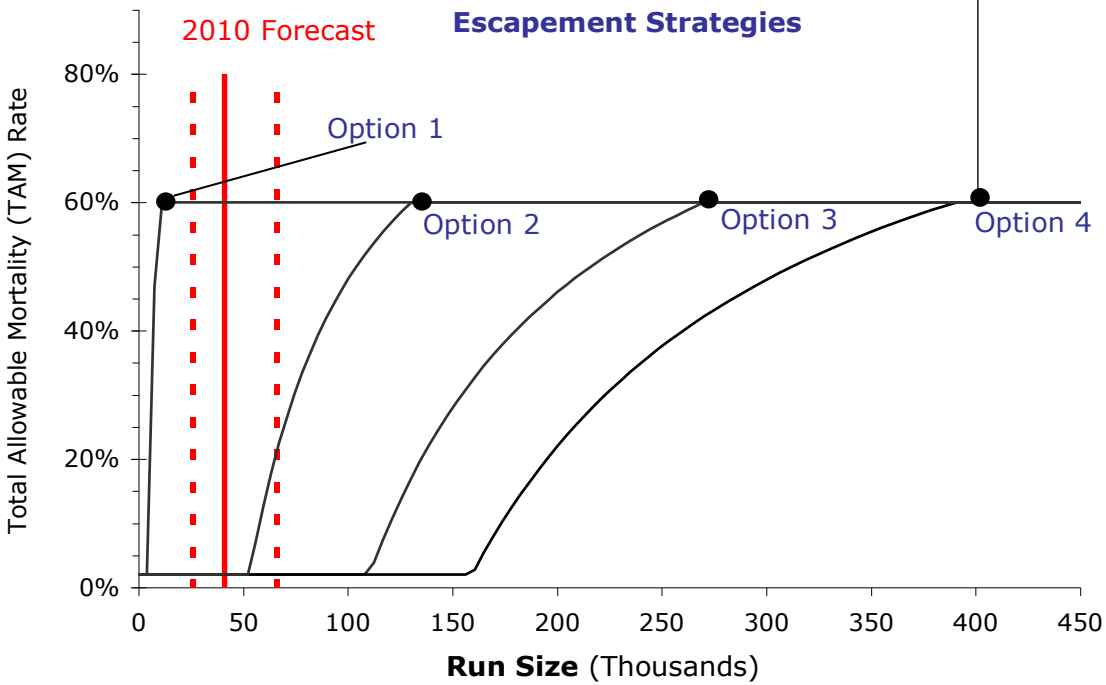


Performance Summary

…and all of that is shown by this one little dot here



(to fill in the rest of the line, repeat ***all*** of the above, but choose a TAM rule that starts cutting back at a run size that is a little bit higher than the last. Then another, and another, and…)



2015/16 Timelines

- March – agenda “small group”
  - input into April Agenda
- April 16/17 – expanded steering committee meeting
  - setting priorities for the technical work
- 2016 spring – workshop(s)(?)
  - reporting out from technical group re: outcomes

Extra Slides

A bit of history…

Cass Model (2001-2002)

- Bayesian population model
- Optimizing control rules

FRSSI brings model into planning (2002-2010)

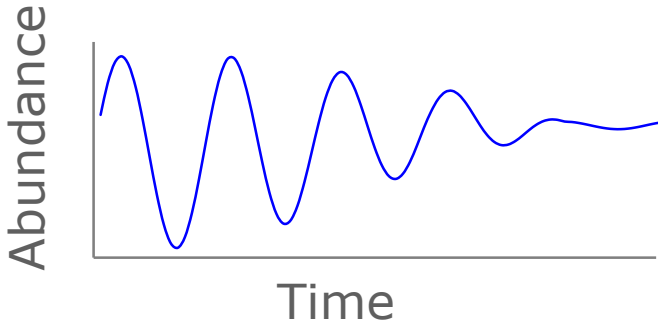
- 2004 review by PSARC
- Adapt to workshop setting (presentation of results)
- Develop performance measures
- Additional stocks (12 -> 19)
- Additional mechanisms (en-route mort, timing overlap)
- Move away from optimization
- 2006/2007 Structured Decision Making process (as for Cultus)
- Model rewrites (Borland Delphi -> S-Plus -> R -> R*)

Conceptual Changes: Population Model

Issue: How to capture observed 4-year cycles in abundance of some stocks? Caused by biological mechanisms or by past harvest patterns, or a combination of both?

1

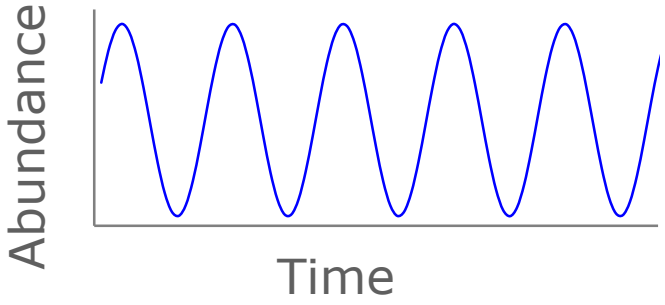
Ricker model



Assumes off-cycles **can** rebuild

2

Cycle aggregate model



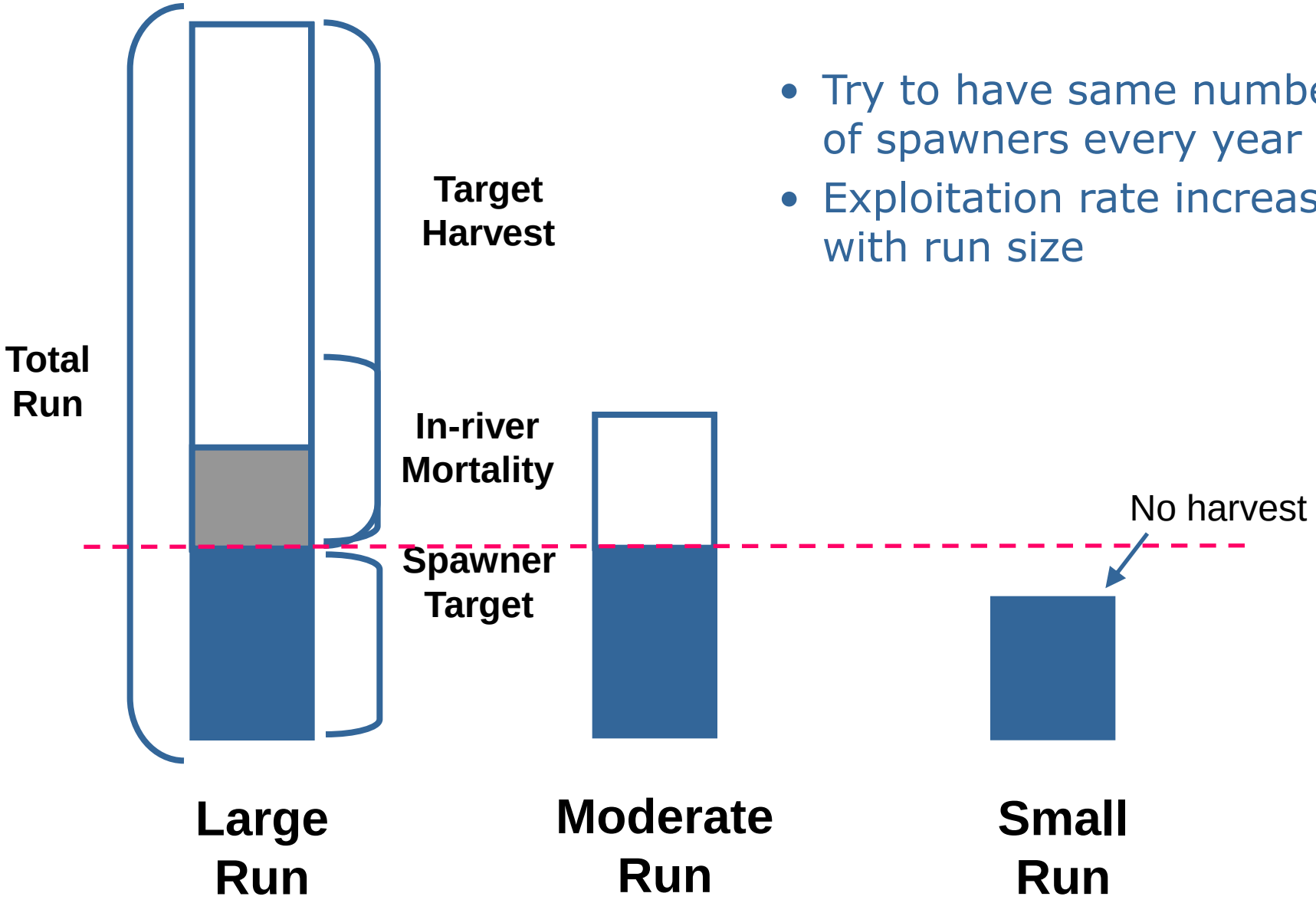
Assumes off-cycles **can not** rebuild

3

Larkin model

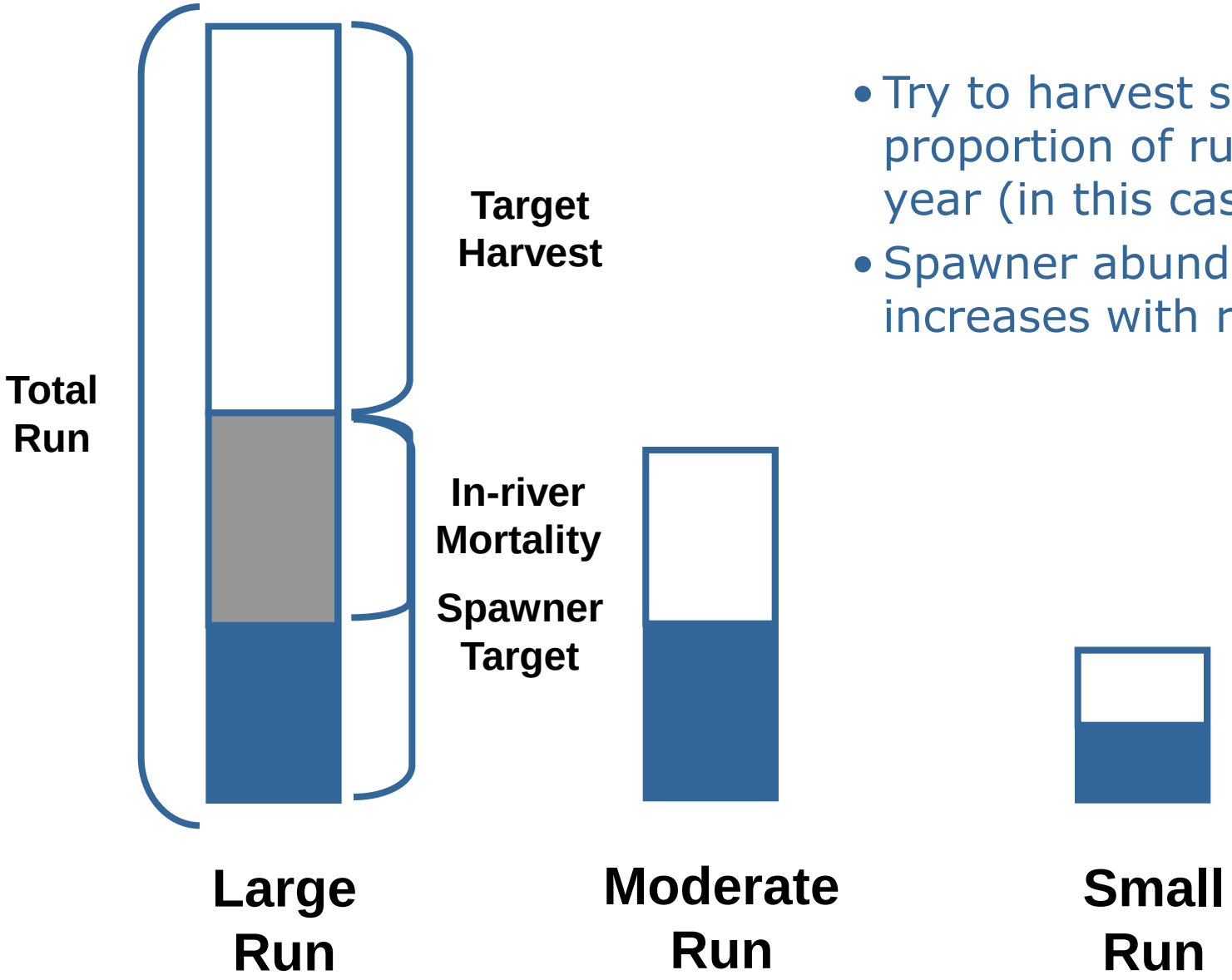
Estimates level of cyclic interaction for each stock

Comparison – Fixed Escapement



- Try to have same number of spawners every year
- Exploitation rate increases with run size

Comparison – 50% Fixed ER



- Try to harvest same proportion of run every year (in this case, half)
- Spawner abundance increases with run size