Equilibrium, Change, or Instability? Implications for salmon harvest strategies.

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Outline

Start off with some context

- My salmon journey so far
- What is the point of this talk?

Then it gets a bit philosophical…

- Things we need to think about
- Ideas for how to think about these things

Attempt to distill some advice

- Good news
- Bad news

Then some examples…

- General example: fixed escapement strategy vs. stepped ER strategy
- Specific example: evolution of Fraser Sockeye harvest strategies (so far)

My Salmon Journey So Far

Who am I?

- Have worked on salmon escapement goals and harvest rules for over 20 years (Fraser, Skeena, Nass, Atnarko, Taku, Stikine, Yukon)
- Focused on data/analysis/communication

What did I learn along the way?

Long-running debates with diverse folks about stock assessment, salmon status, harvest rules, simulation models, real fish, real people, and climate change.

In the last few years, the most intensive discussions have been with

- Ann-Marie Huang
- Brendan Connors
- Bronwyn MacDonald
- Carrie Holt
- Charmaine Carr-Harris
- Pete Nicklin
- Sue Grant

What's the point of this talk?

- Have been trying to connect all the ideas from these conversations
- Then the opportunity for this talk came along
- Session topic: ***New management strategies for uncertain times***

=> What you get today is me "thinking out loud" about the session topic with some examples

I offer these thoughts in the spirit of

Cunningham's Law: *the best way to get the right answer on the internet is not to ask a question; it's to post the wrong answer.*

=> Looking forward to the Q&A session, and follow up chats

Types of Thinking

Thinking Mode	Basic Concept
Stable Equilibrium	Identify basic mechanisms and try to understand their implications (What state does system settle into without disruptions?)
Uncertainty	How to account for uncertain data, uncertain model fits, uncertain in-season info, implementation uncertainty etc.?
Variability	How to deal with annual differences, assuming that the underlying mechanisms are stable?
Change	How to deal with long-term changes?
Instability	How to deal with extremes and break-downs in basic mechanisms?

Types of Thinking

Thinking Mode	Salmon Management
Stable Equilibrium	Spawner-recruit (SR) models, biological benchmarks (Smsy, Sgen)
Uncertainty	Bayesian estimates of SR model parameters and biological benchmarks
Variability	Planning for different pre-season and in-season scenarios
Change	Consider how to detect and respond to gradual changes (e.g. declining fecundity).
Instability	Rapid identification of problems, pre-planned guidelines for rapid responses

Types of Thinking

Thinking Mode	Salmon-related work being done
Stable Equilibrium	Most of us worked on these topics over the last 20 years, and are still working on them. Lots of evolution on "How To"
Uncertainty	
Variability	
Change	Research initiative led by **Carrie Holt** and **Brendan Connors** starting up -> chat with them to get details
Instability	Climate change discussion paper by **Bronwyn MacDonald** and **Sue Grant** (In Prep) -> chat with them to get details.

Types of Thinking

Thinking Mode
Stable Equilibrium
Uncertainty
Variability
Change
Instability

Important clarifications

- Neither of these "Thinking Modes" is better or more sophisticated than the others.
- They complement each other
- Need to think about salmon management from all these angles

- The distinction between these three is fuzzy and a bit arbitrary.
- For now, trying to tease it apart based on speed, magnitude, and direction of change

Tools

Typical fisheries tool kit:

- Simulation modelling
- Management Strategy Evaluation (MSE): sim model + process
- Adaptive Management
- Decision Analysis

Other fields:

- Choice Modelling (present lots of choices, extract preferences)
- First Aid (pre-planned guidelines for common scenarios)
- Emergency Preparedness (prepare for larger-scale stuff that happens sooner or later)
- Contingency Planning (prepare for unlikely, but catastrophic eventualities)

⇒ *Each has a large body of literature*
⇒ *In practice: lot of overlap in basic concepts*
⇒ *All share **2** basic ideas:*
  ⇒ *Consider alternative scenarios: ask "What if…?*
  ⇒ *Consider alternative objectives: "best" or "safest" or "most robust"*

Basic Idea 1: Alternative Scenarios (What if …?)

- Standard practice in all these tools: consider plausible alternative scenarios/assumptions
- **But:** climate instability means that we need to consider a much wider range of scenarios. "Plausible" means something else now…

Uncertainty and Variability Thinking

- What if the Ricker model is wrong for this stock?
- What if this year's run comes in at the low end of the forecast?

Change Thinking

- What if fecundity persistently decreases?
- What if recent low productivity persists?
- What if recent high migration mortality persists?

Basic Idea 1: Alternative Scenarios (What if …?)

Instability Thinking - Biological

What if:

- Earliest marine migration ever
- Latest marine migration ever
- Extreme shift in marine migration route
- Lowest overall productivity (R/S) ever
- Largest total return ever
- Smallest total return ever

Instability Thinking - Environmental

What if:

- Major landslide (migration success, spawning grounds)
- Large scale fires
- Record warm ocean

Basic Idea 1: Alternative Scenarios (What if …?)

Instability Thinking - Biological

What if:

- Earliest marine migration ever
- Latest marine migration ever
- Extreme shift in marine migration route
- Lowest overall productivity (R/S) ever ***2 times***
- Largest total return ever
- Smallest total return ever ***3 times***

Have seen all of these for Fraser Sockeye since I started working on them 20 years ago!

Instability Thinking - Environmental

What if:

- Major landslide (migration success, spawning grounds) ***at least 4 times***
- Large scale fires ***at least 4 times***
- Record warm ocean ***several years***

Basic Idea 2: Alternative Objectives

Equilibrium Thinking

- What is the optimal spawner abundance over the long-run in stable conditions?

Uncertainty and Variability Thinking

- What is the optimal range of spawner abundances over the long-run in stable conditions, given uncertain parameter estimates and year-to-year variation?
- Should spawning target respond to annual variation, given in-season uncertainty? If so, how?

Change Thinking

- Which strategy is robust to gradually changing conditions?

Instability Thinking

- Which contingency plan produces the least-bad outcomes across a range of extreme scenarios?

=> Try to avoid spectacular failures even under more extreme scenarios!

Summary

Good News

We have the conceptual tools to think about these challenges and prepare

Bad News

"What we do in fisheries is not rocket science. It is much harder!"

Mike Staley (and he knows. His brother is a rocket scientist, who teaches new rocket scientists)

Last bit of Philosophy

"The problem with the future is that it keeps turning into the present"

Calvin & Hobbes

So let's try to prepare for it!

What does all this mean for salmon harvest strategies?

Key points to consider

- How we calculate reference points (e.g., Smsy) vs. **how we use them**

- We have to think about preparing for unstable times:
  - Adjust what we consider plausible, but also remember that scenarios are not predictions!
  - Accept bounds on what is possible in the near and medium term

What does all this mean for salmon harvest strategies?

But what can we actually do right now?

Can use a simple interactive app to:

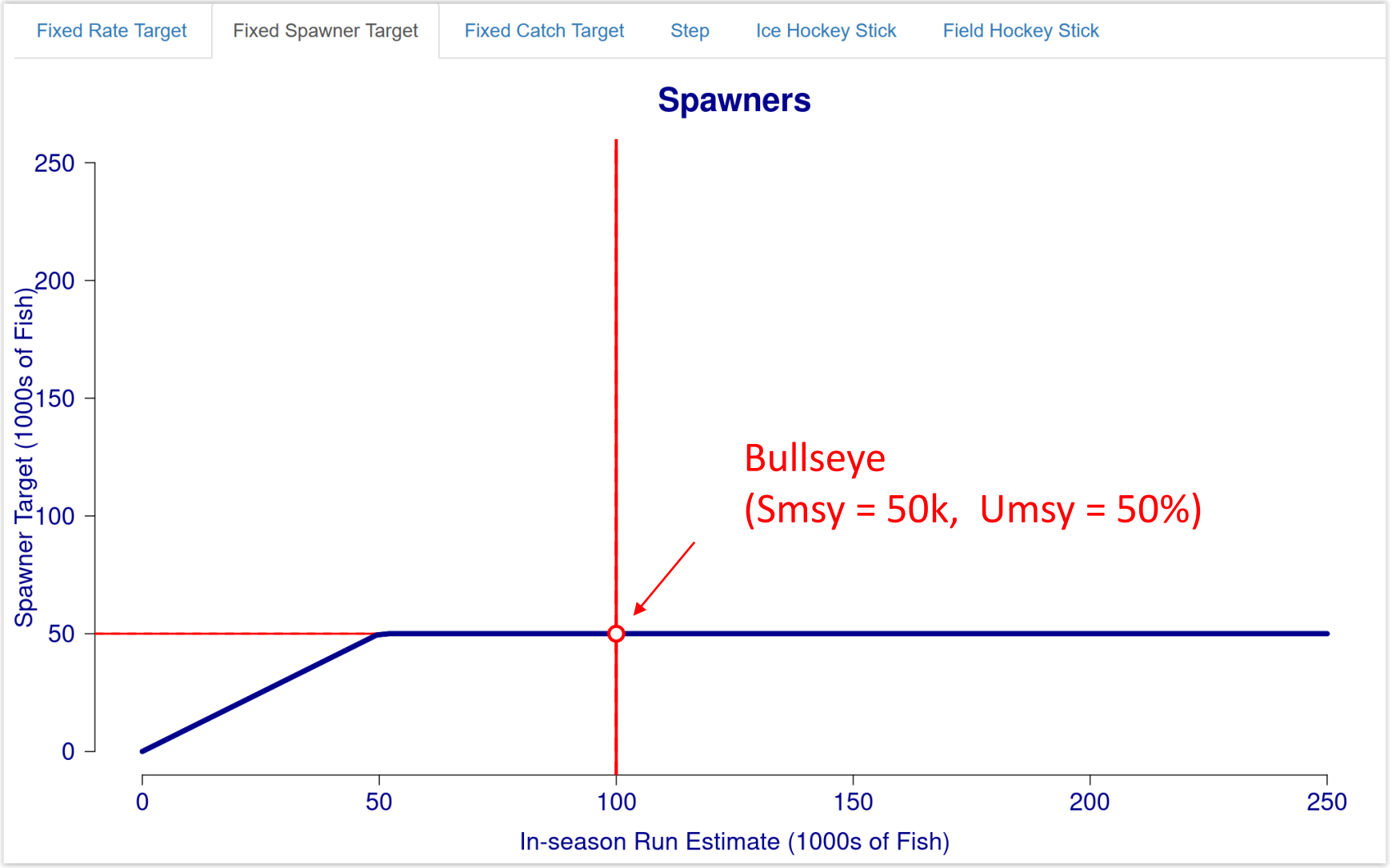
- Think about these types of questions
- Scope out general options for contingency plans
- Identify scenarios and candidate strategies for detailed simulation testing in an MSE
- Communicate the rationale for a candidate strategy to elicit constructive feedback *("does this strategy basically make sense?")*

-> Will give a quick illustration of an interactive app prototype

-> app is available online: ***https://solv-code.shinyapps.io/harveststrategytypes/***

-> "About" tab in the app has links to the source code, worked examples, further reading, and discussion threads.

Fixed Spawner Target at Smsy – Equilibrium Run Size



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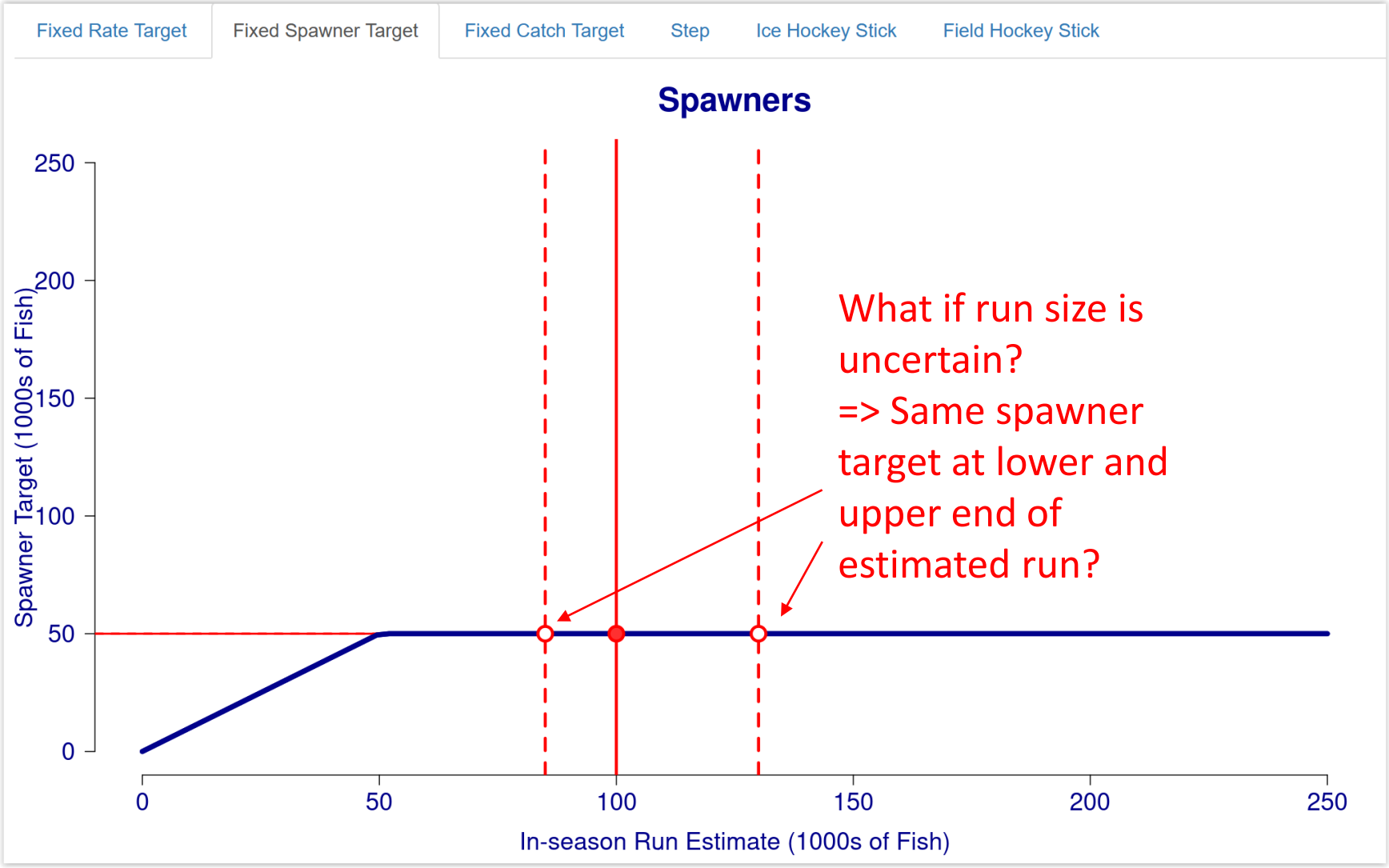
Fixed Spawner Target at Smsy – Uncertain Run Size



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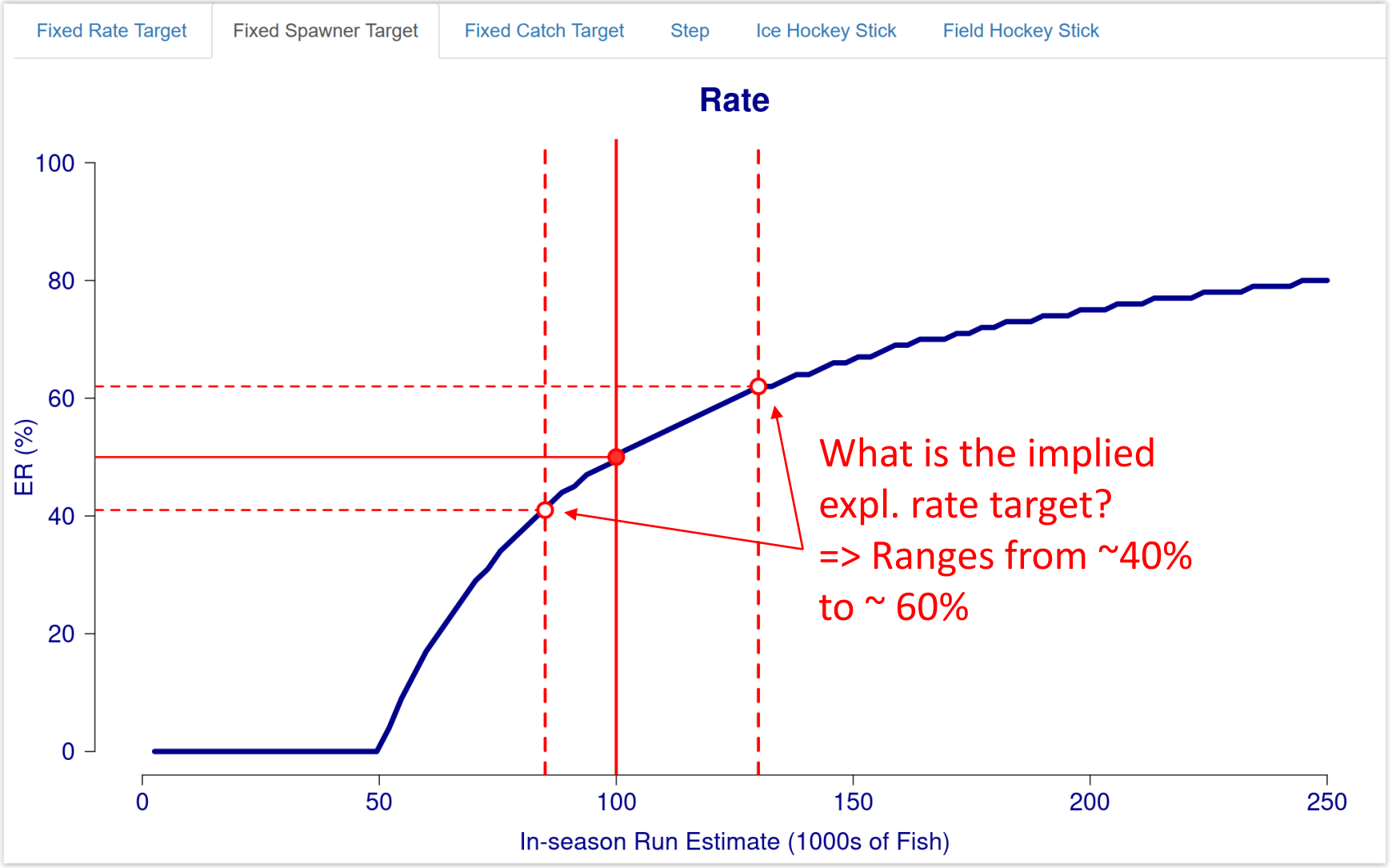

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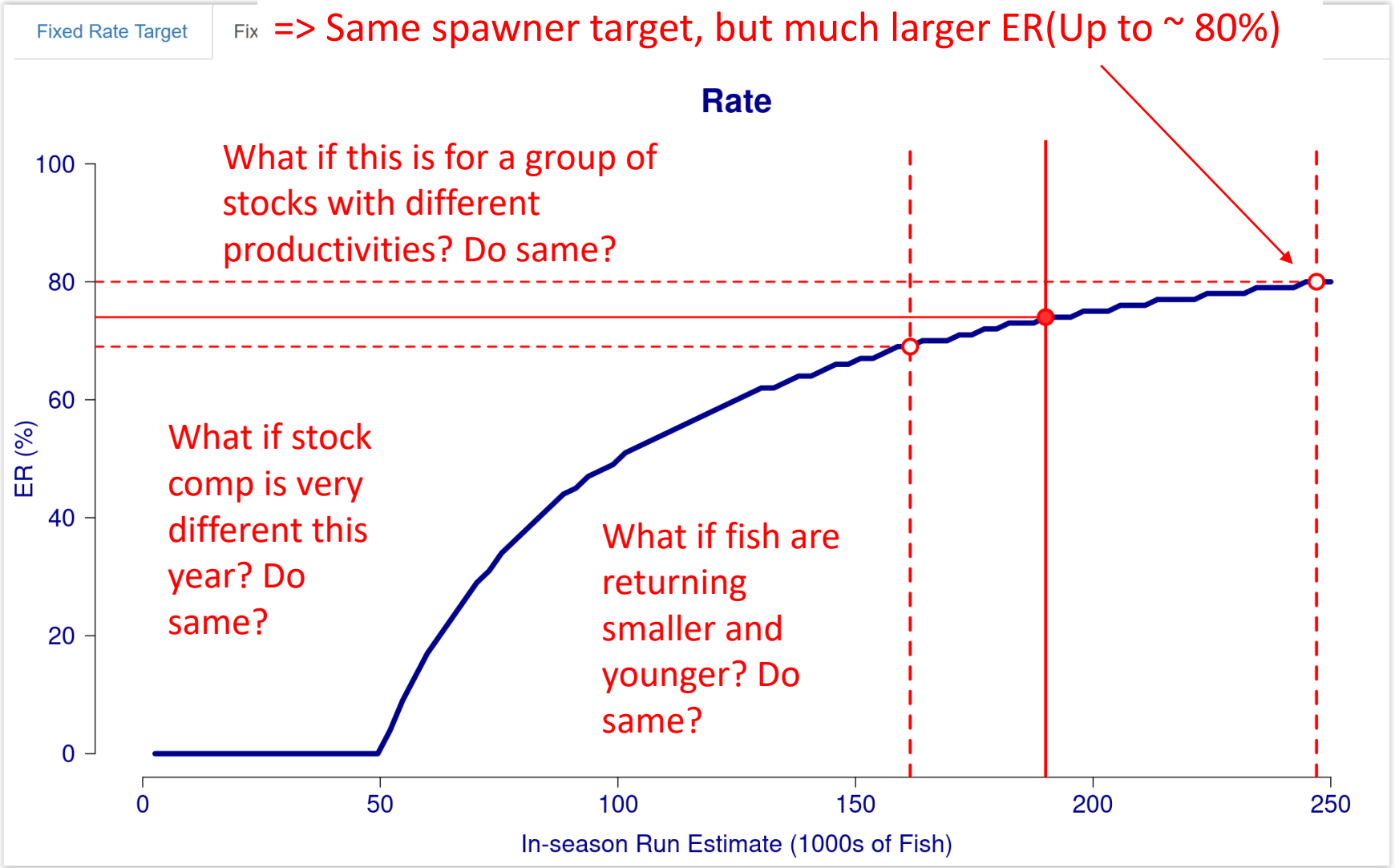
Fixed Spawner Target at Smsy – Large Run Size

What if run size is much larger?
=> Same spawner target, but much larger ER(Up to ~ 80%)



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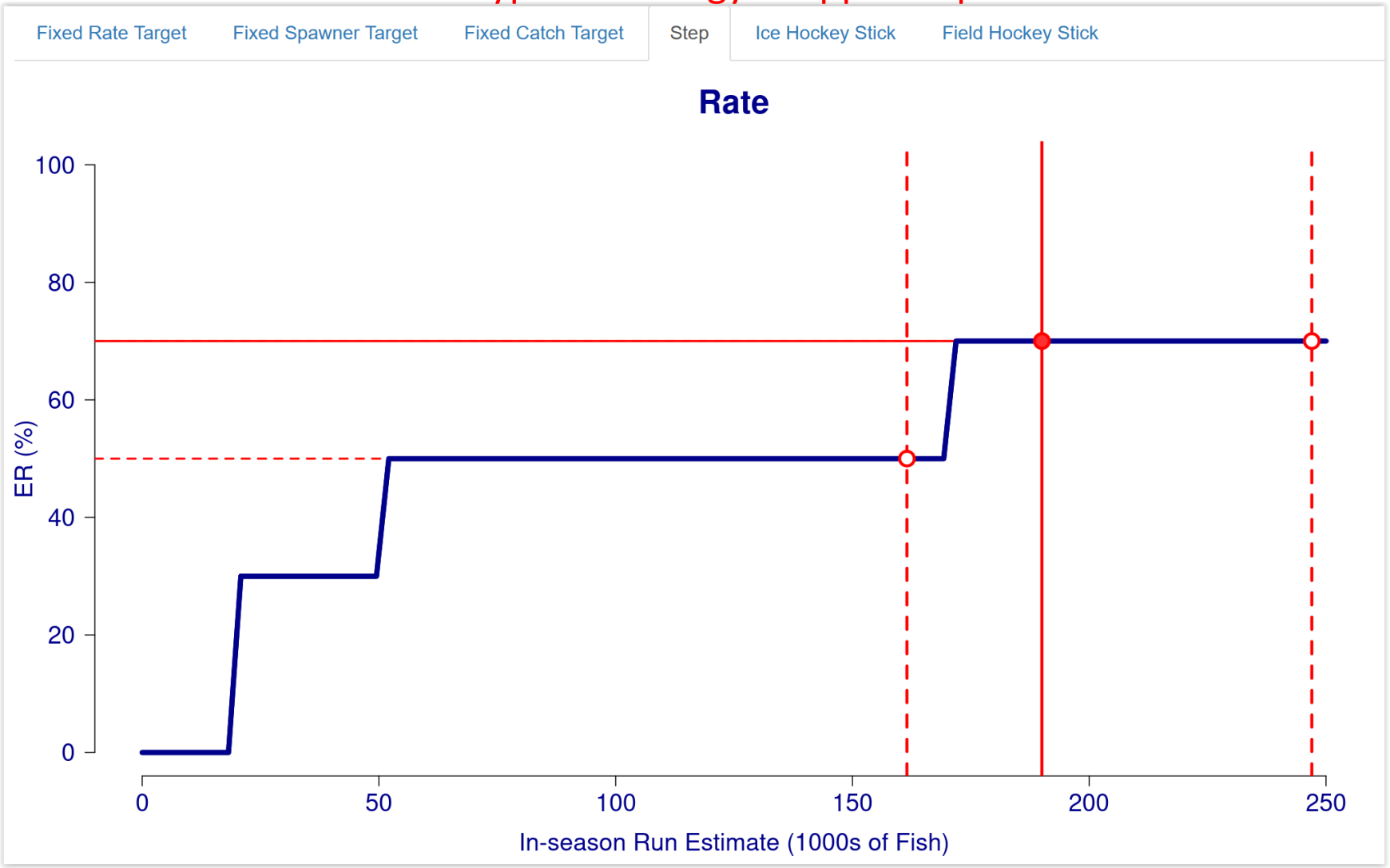
Stepped ER Target – Large Run Size

Consider a another type of strategy: stepped exploitation rate



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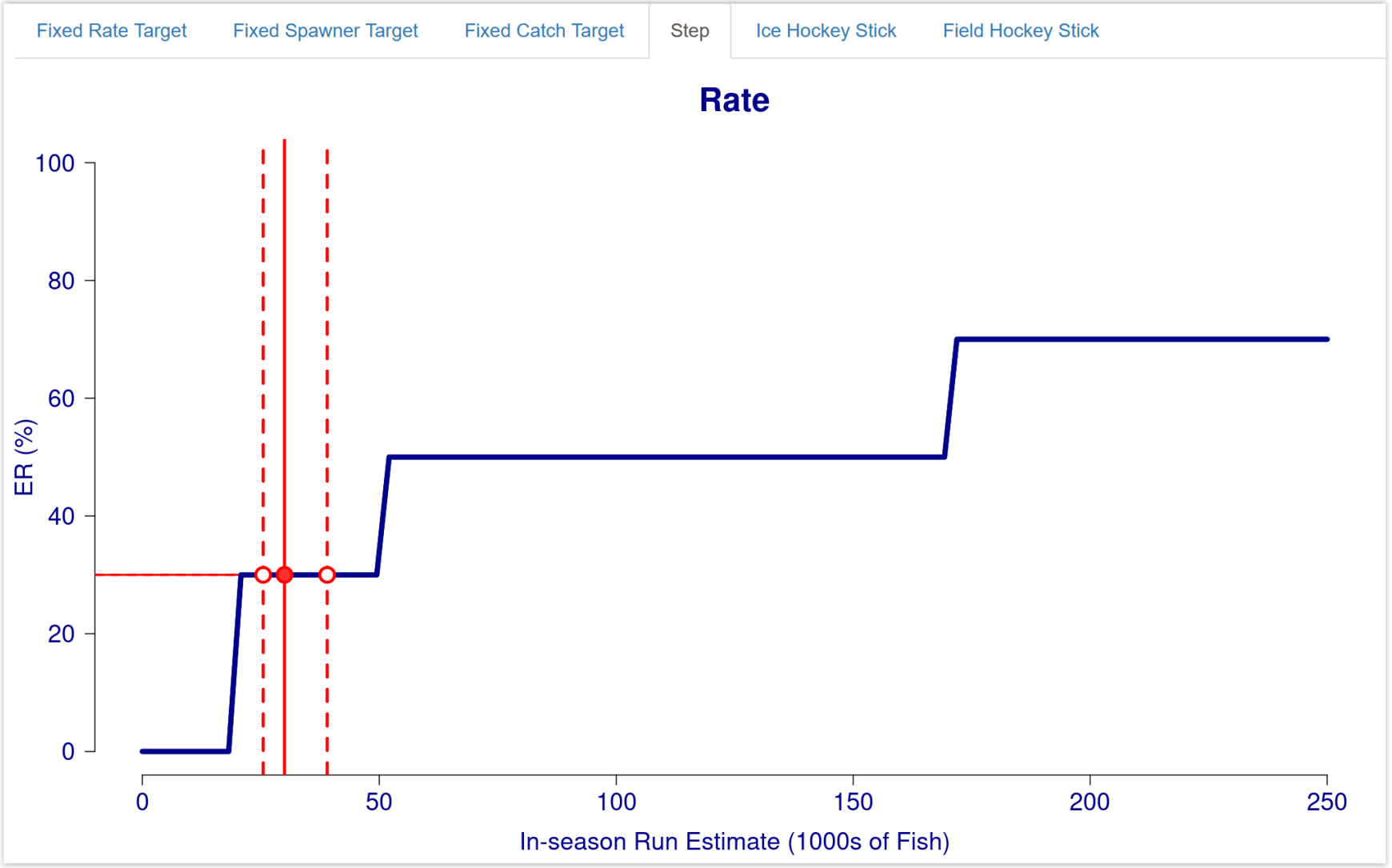
Stepped ER Target – Small Run Size



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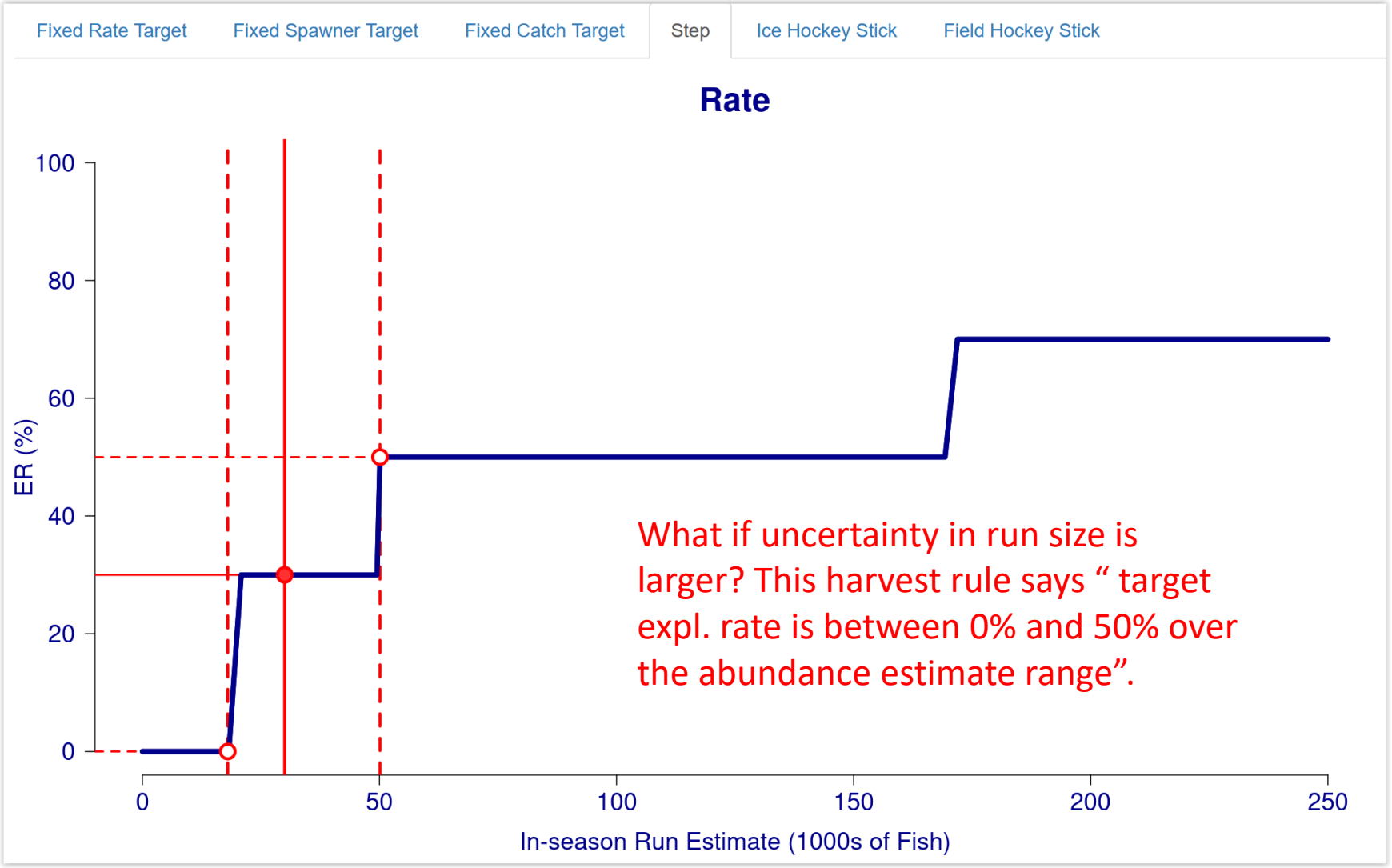
Stepped ER Target – Small Run Size



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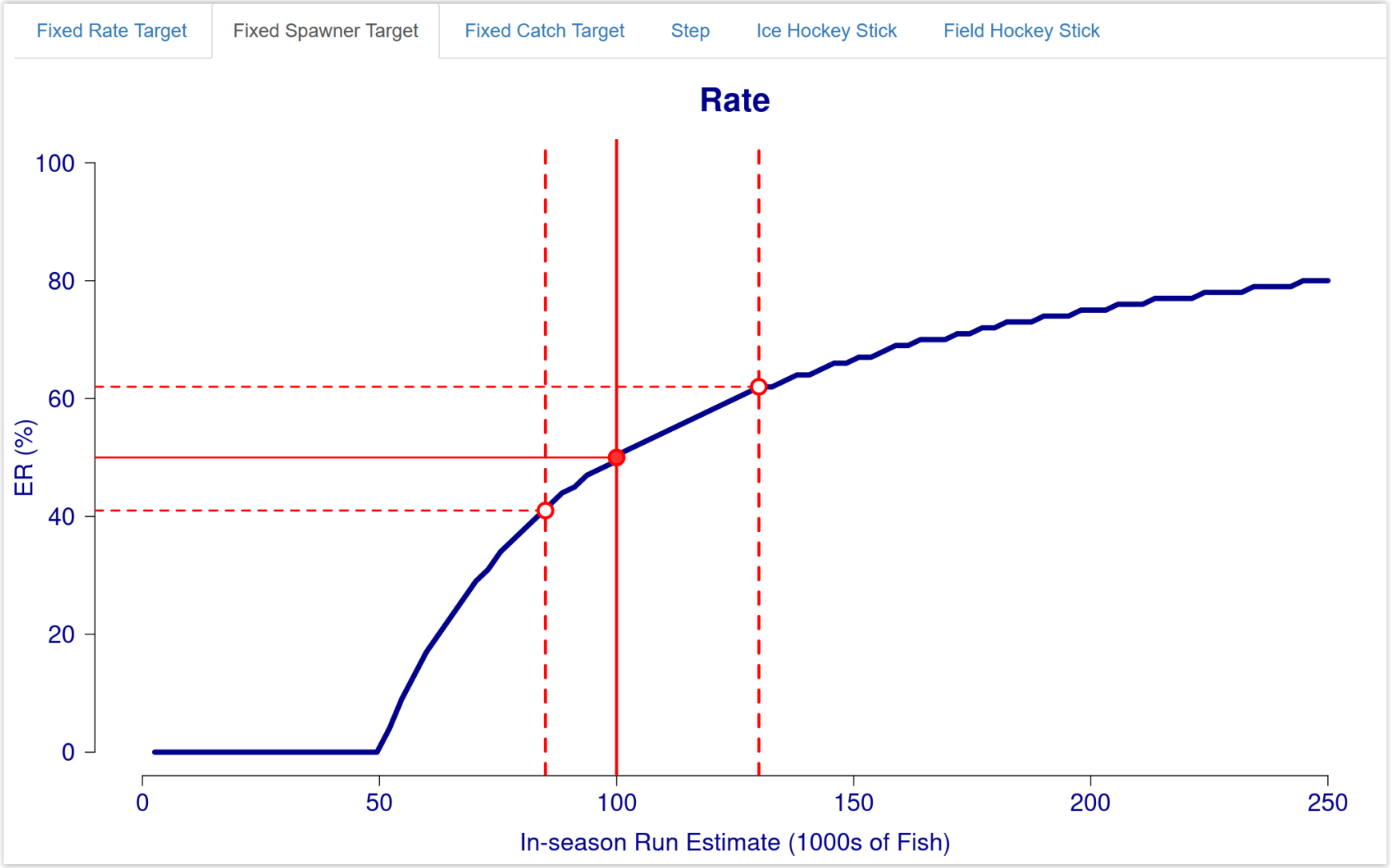
Evolution of Fraser Sockeye harvest strategies (So Far)

Context

- 4 management units (MU): originally based on migration timing, some tweaks over time
- 1980s Rebuilding Plan: MU spawning target = at least as much as brood year
- Early 2000s: started review of spawning targets in response to observed changes in migration timing, in-river mortality, abundance, productivity etc.
- Since 2007: have managed to abundance-based harvest rules, key features have stayed the same, but details are tweaked every year based on pre-season expectations.

⇒ *15+ years of intensive process and modelling*
⇒ *Management Strategy Evaluation (MSE) is a journey*

1980s Rebuilding Plan: Fixed* Escapement Policy



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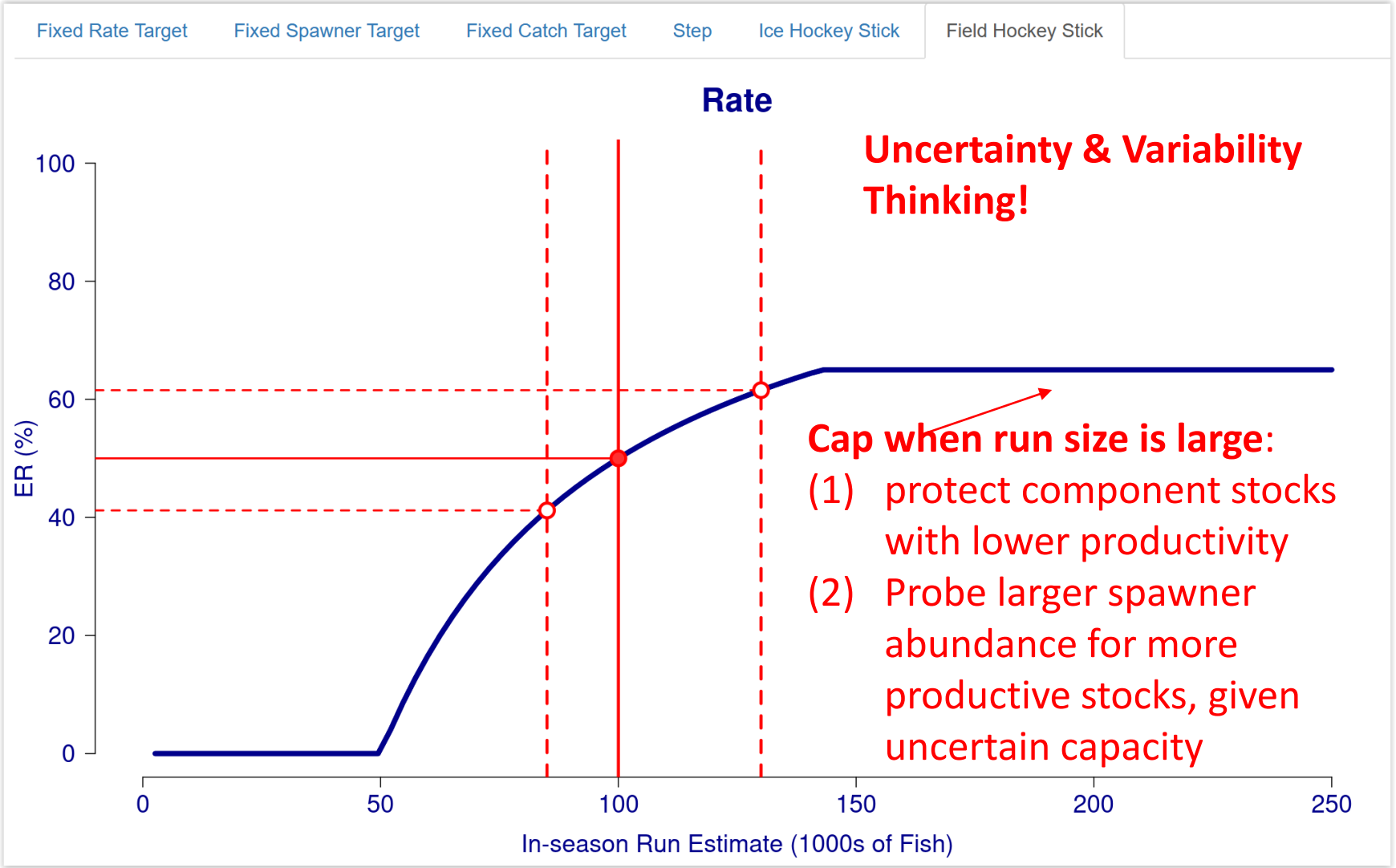
“Field Hockey Stick” Since 2007



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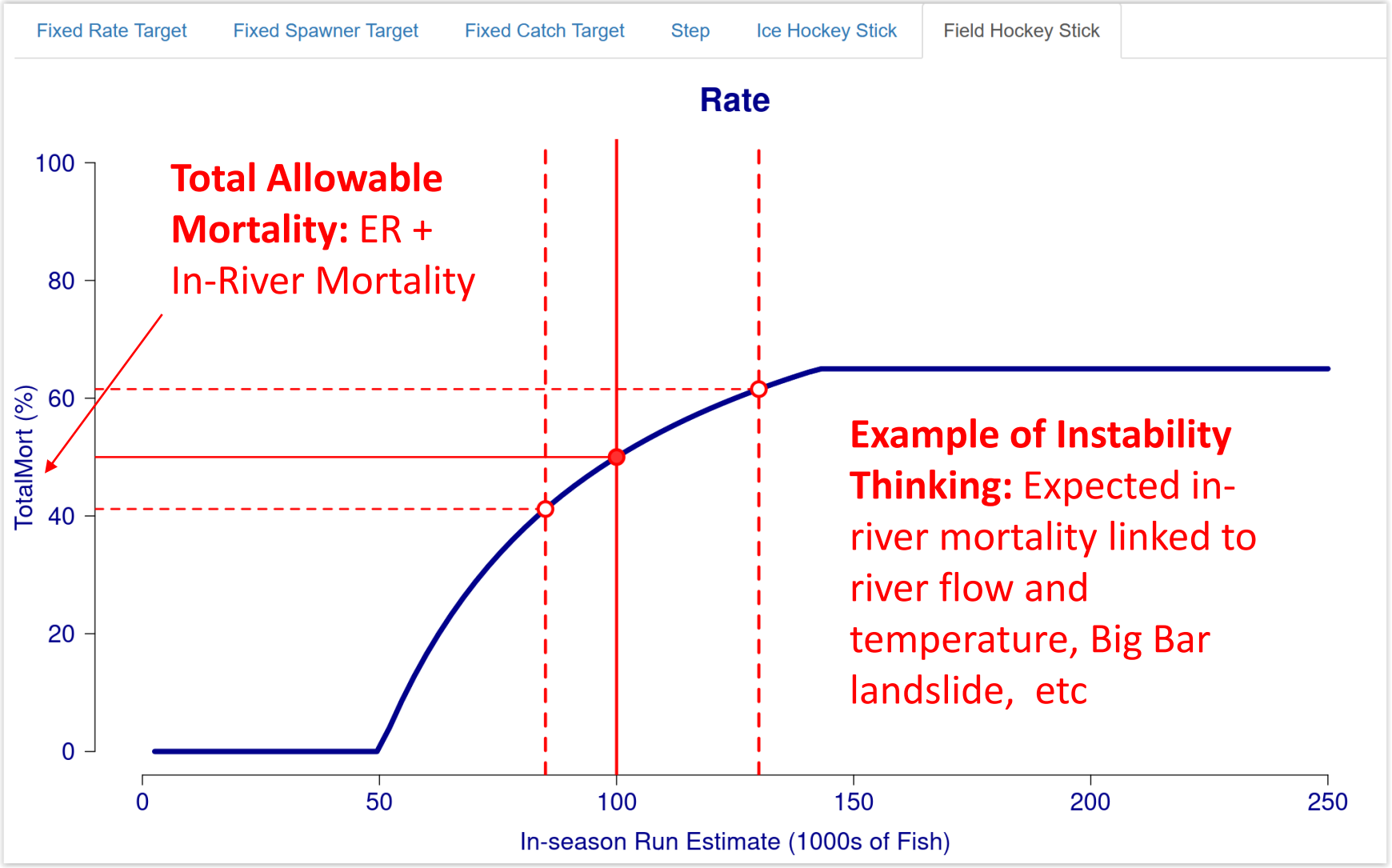

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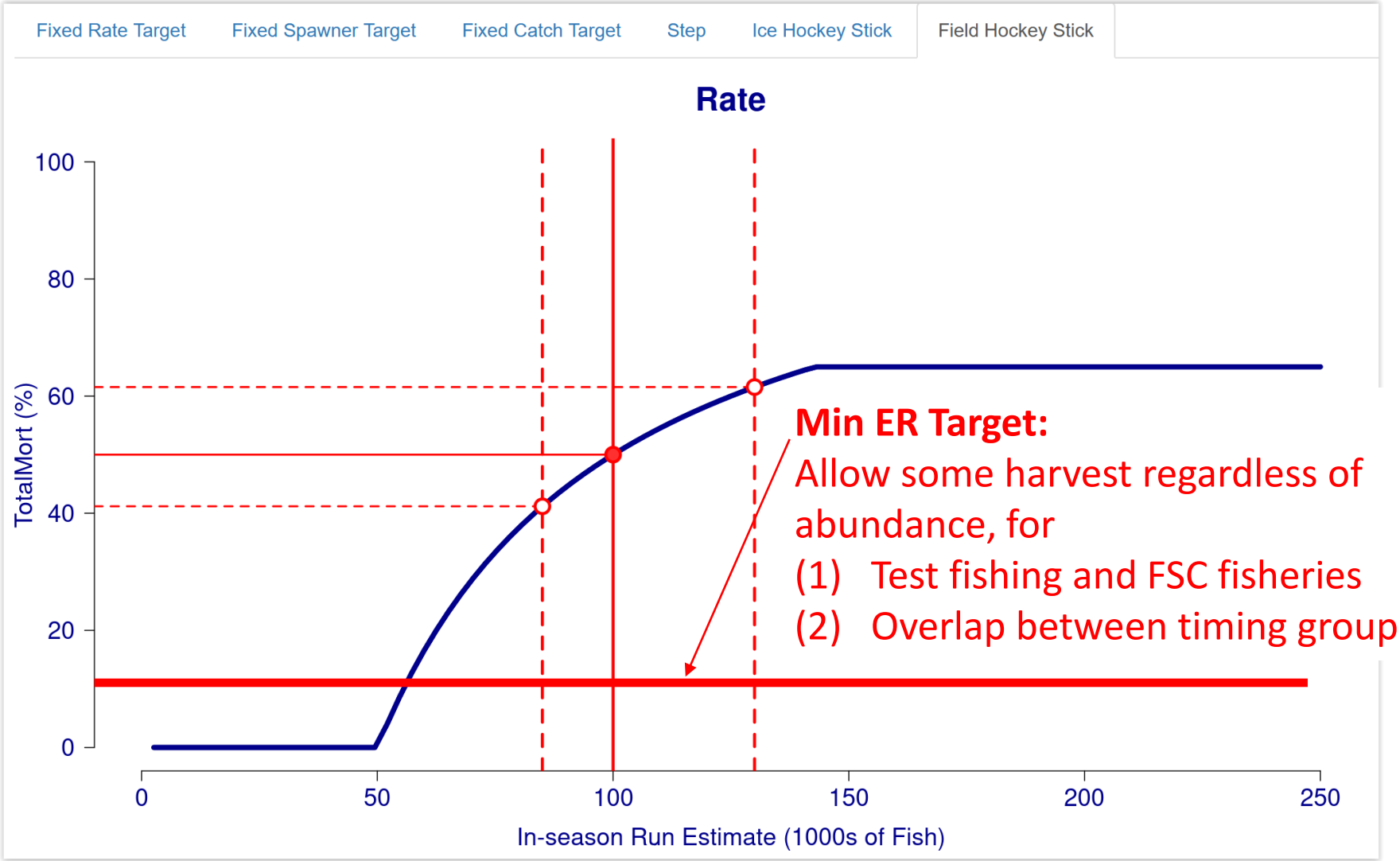

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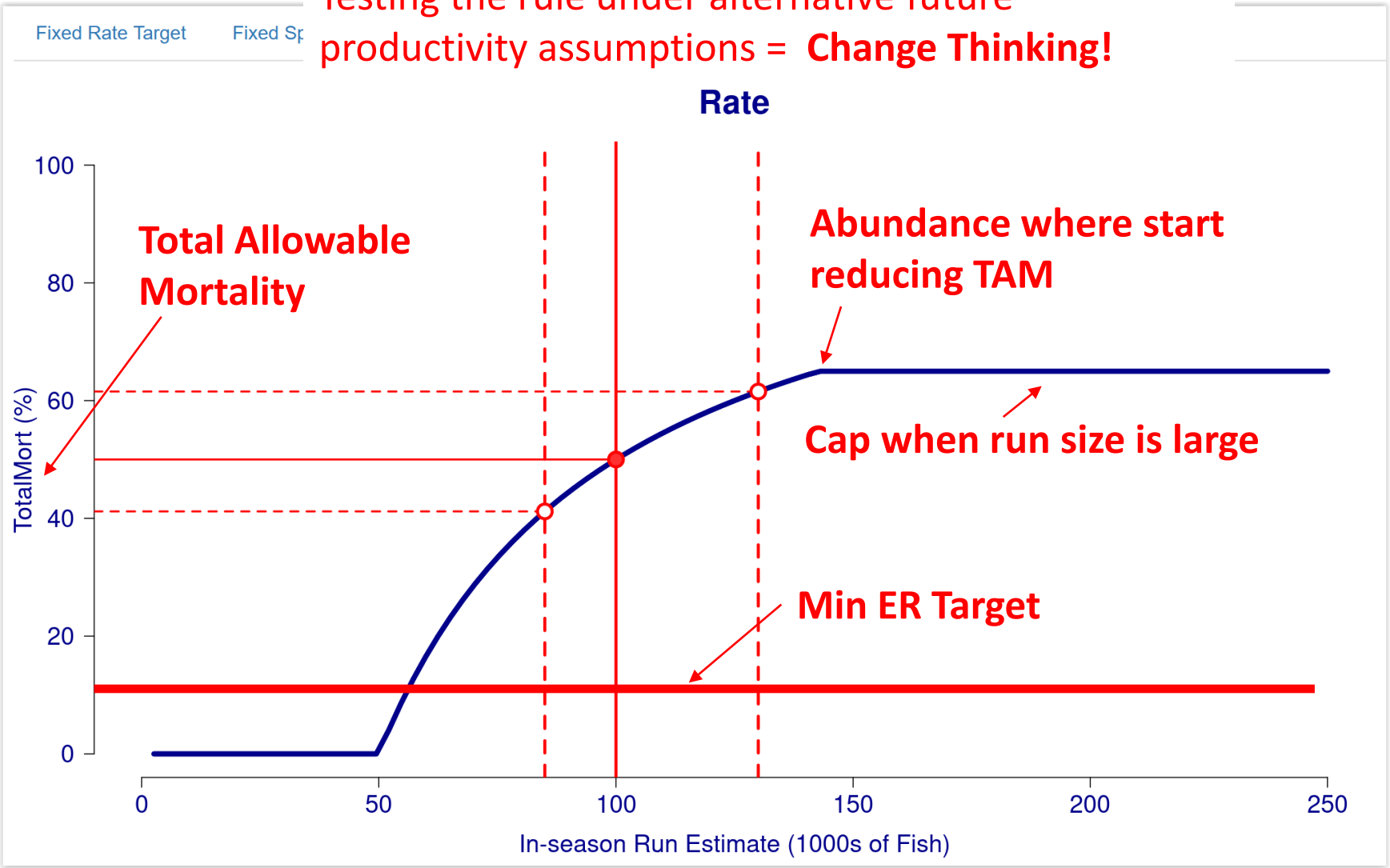
"Field Hockey Stick" Since 2007

Testing the rule under alternative future productivity assumptions = **Change Thinking!**



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Thank You!

App

https://solv-code.shinyapps.io/harveststrategytypes/

Github Repository (code, worked examples, discussion threads)

github.com/SOLV-Code/Harvest-Strategy-Types

Special Thanks to Ann-Marie Huang and Charmaine Carr-Harris for greatly improving and streamlining the material in this talk.