WF4313/6413-Fisheries Management

Class 23

Announcements

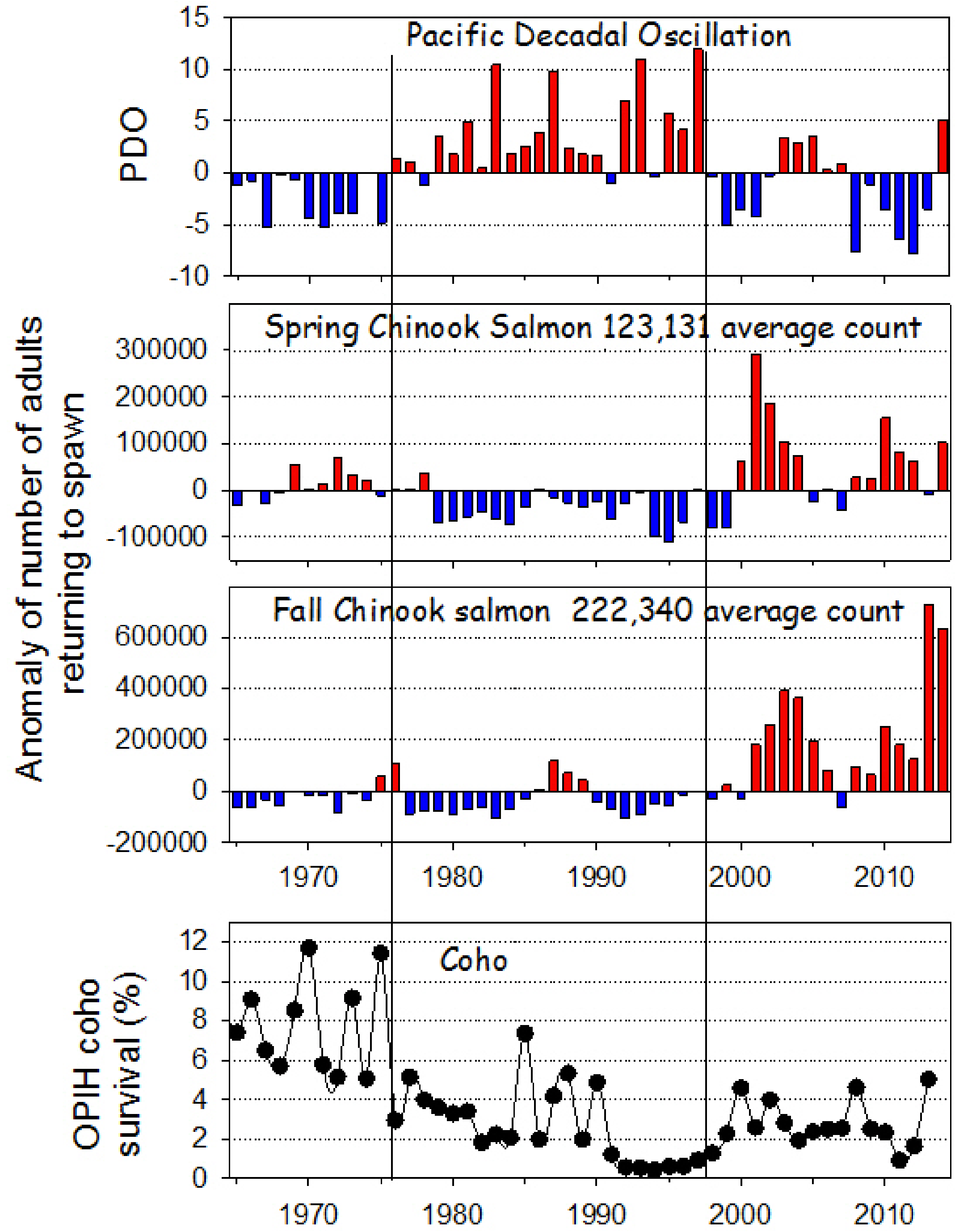
Revised Schedule

- ~~November 27th – No lab work on your briefs~~
- ~~DRAFT Due 11/30/2018~~
- Presentations email by 1 pm today or bring on usb drive tomorrow.
- December 4th Brief presentations during lab.
- Final Exam 12/11 @ 8am
- Final Briefs due 12/11 @ 11am


WHERE WE LEFT OFF

Salmon

- Columbia stocks
- Passing Bonneville Dam



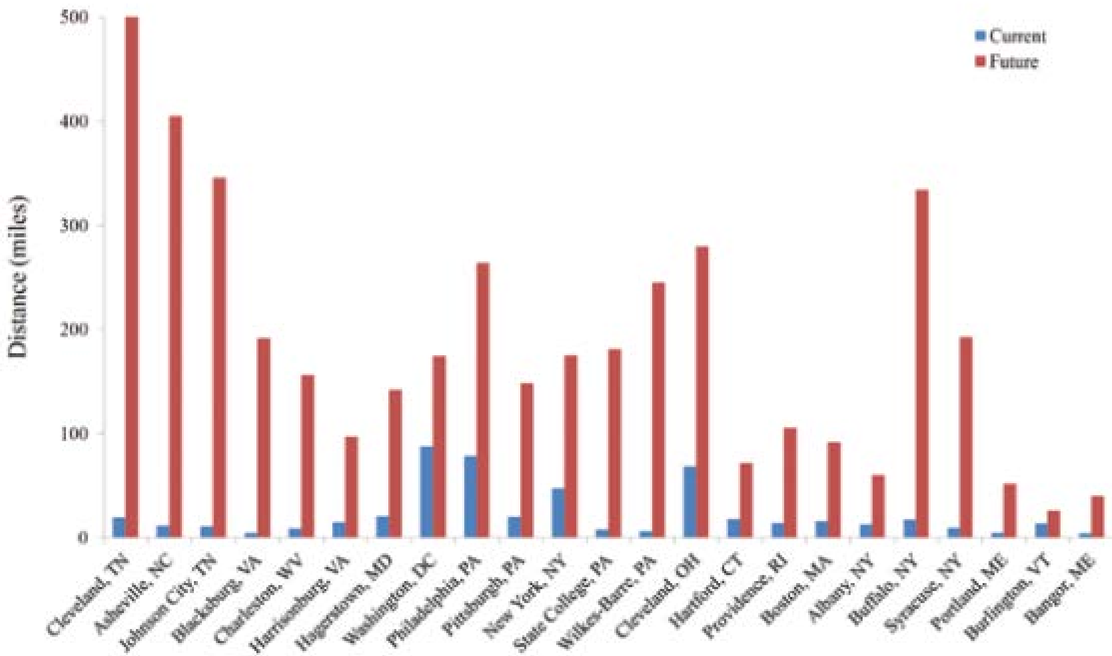
Researchers gathered sediment cores from lakes in 16 major watersheds in southwestern Alaska. ***Lauren Rogers/U of Washington***

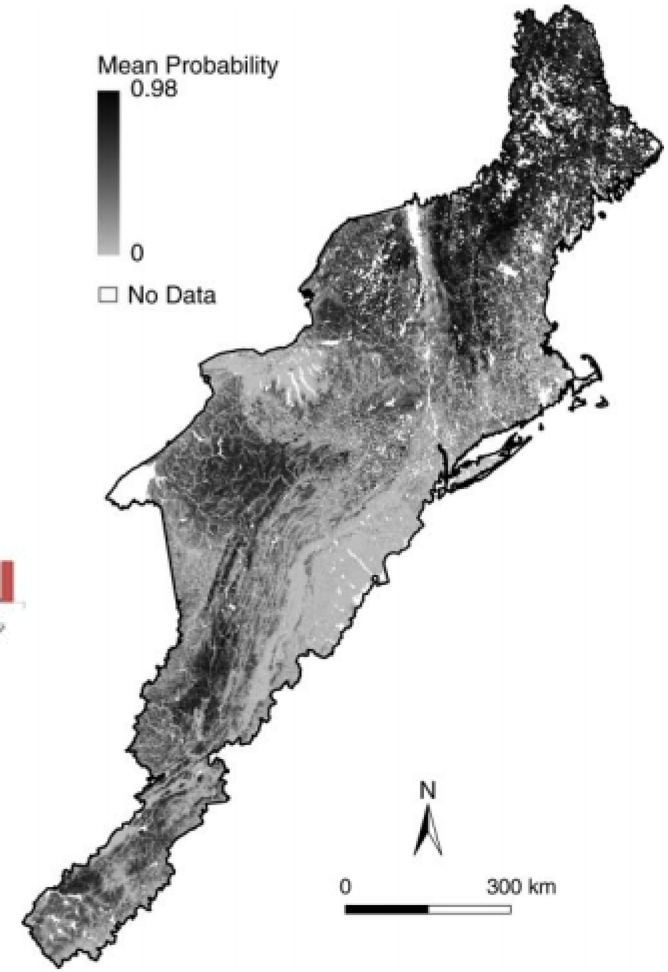
Cycles lasting up to 200 years were found while examining 500-year records of salmon abundance in Southwest Alaska. Natural variations in the abundance of spawning salmon are as large those due to human harvest.

Effects on fish & fisheries

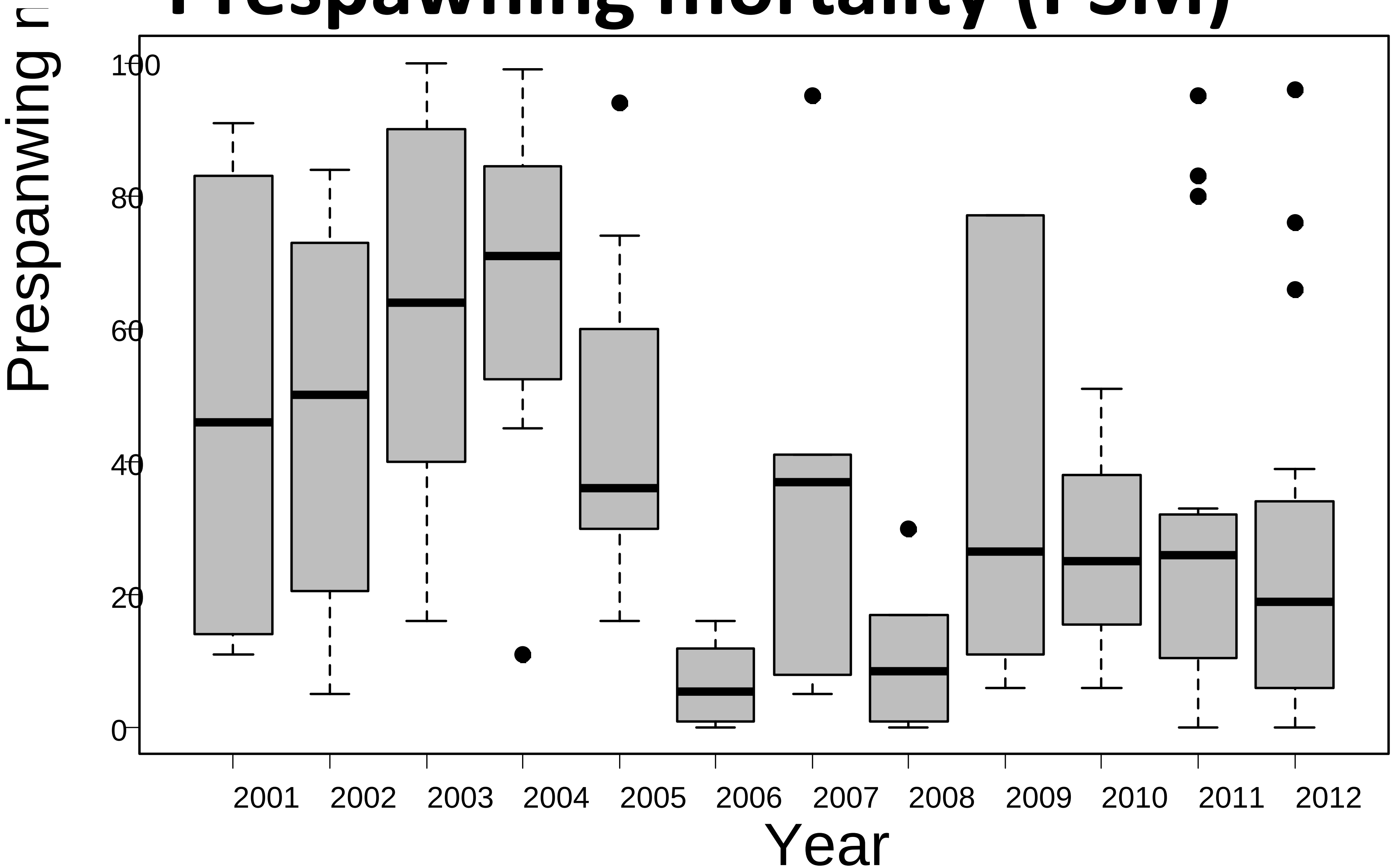
1. Fishery closures
2. Movement of fish stocks
3. Disease
4. And more…

Effect on fisherman

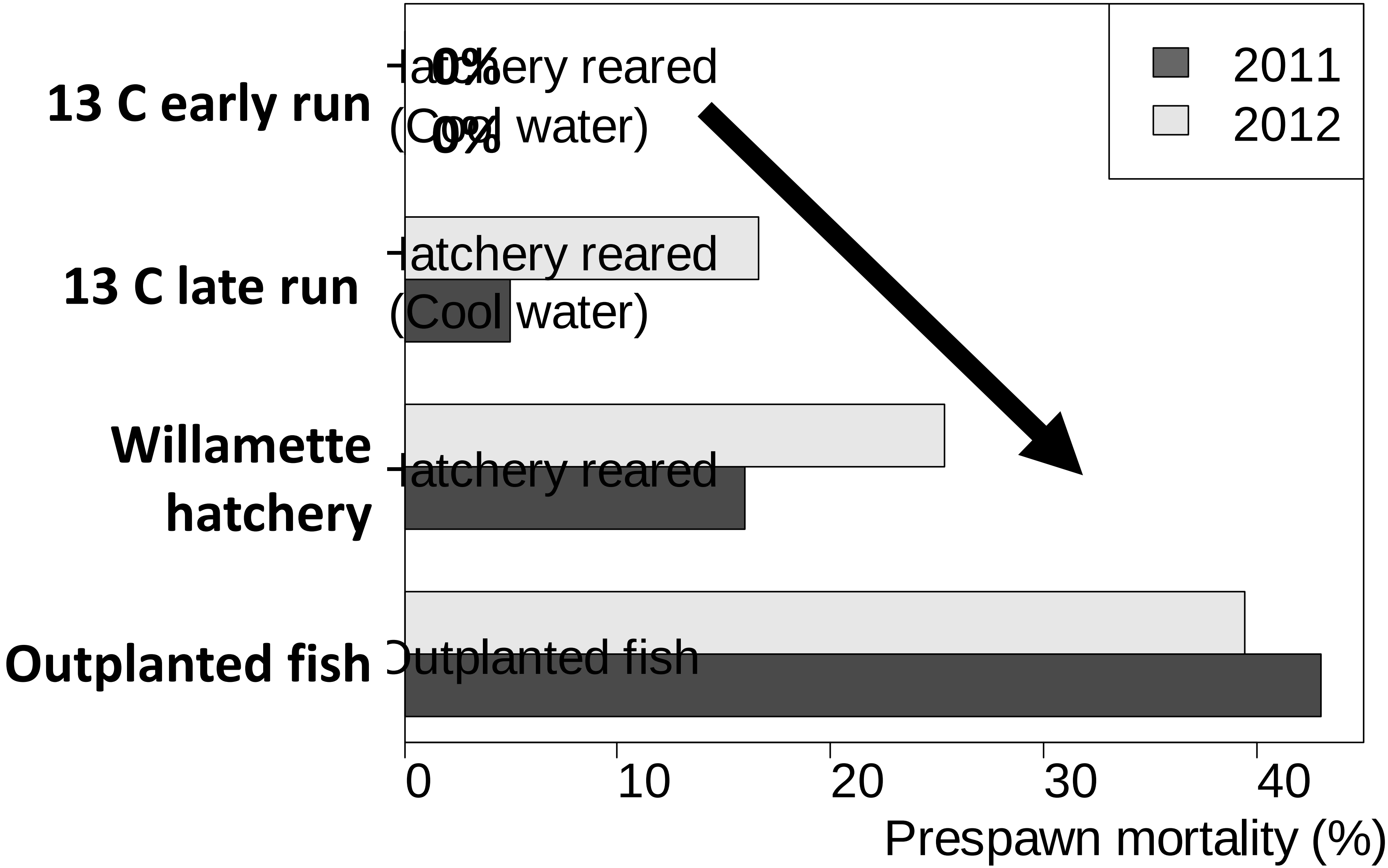




Prespawning mortality (PSM)



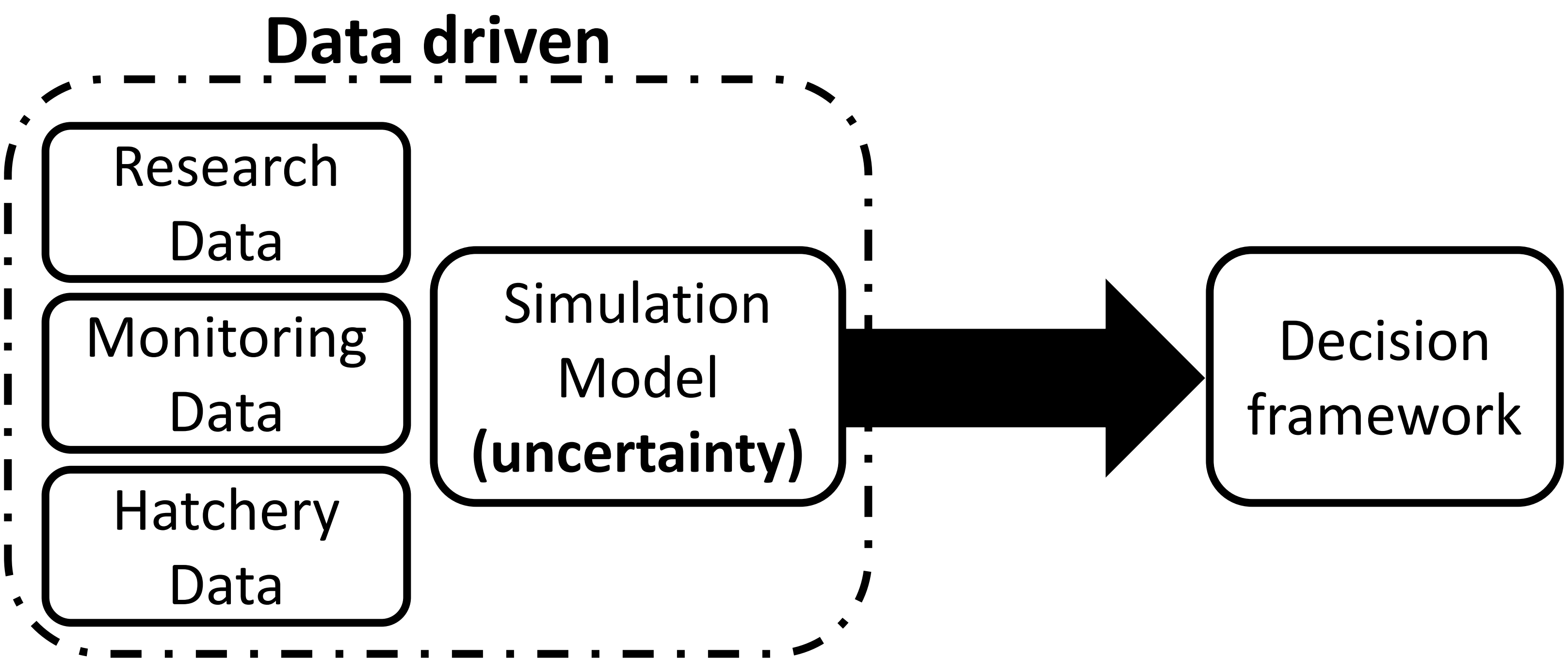
PSM and thermal exposure



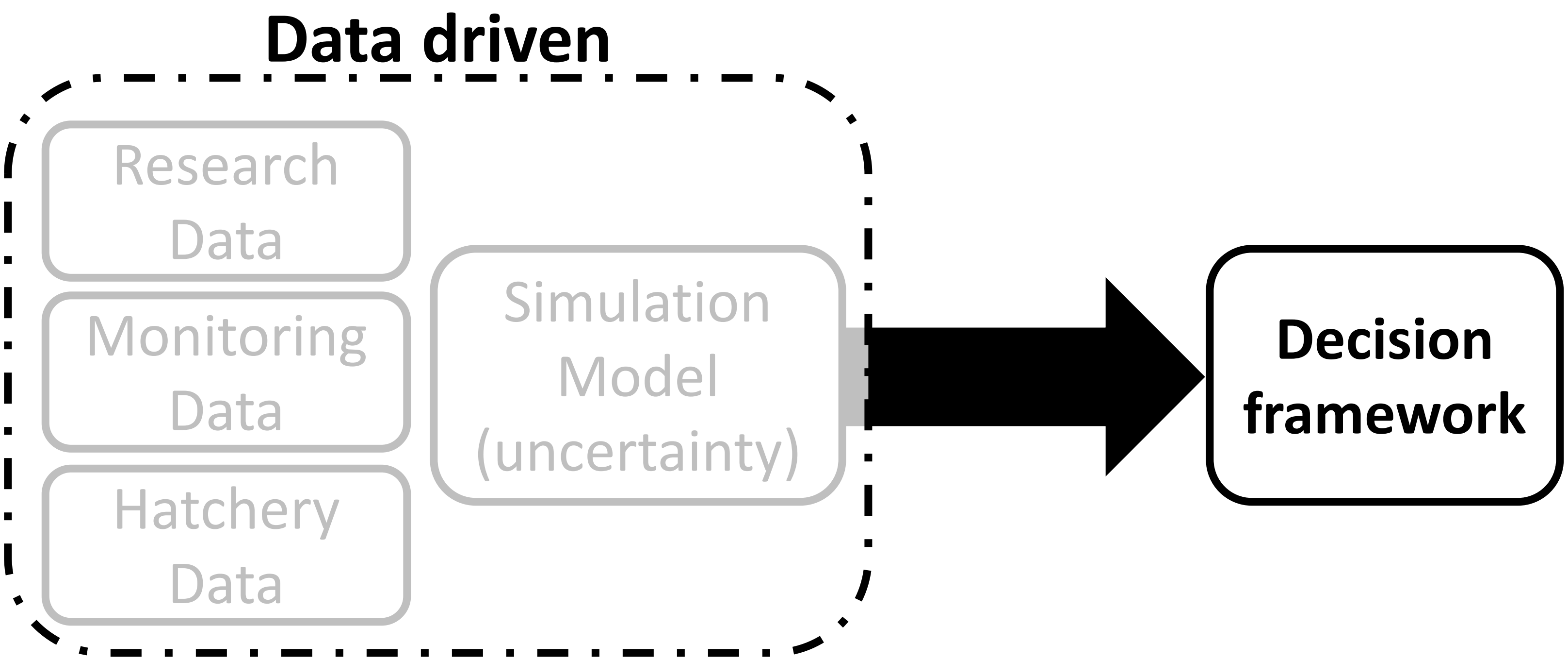
A decision framework

Structured decision making approach

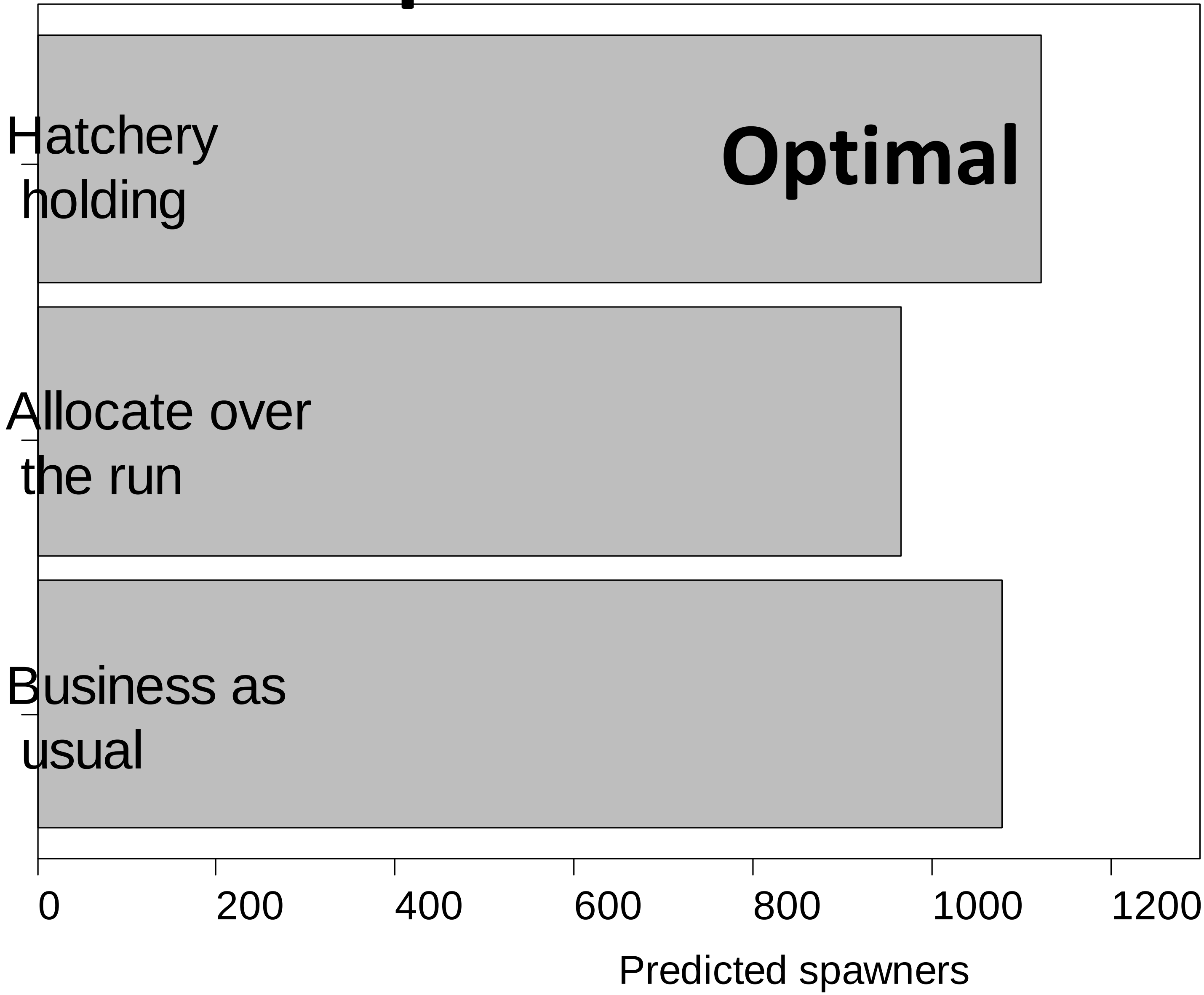
1. Simulation model
2. Decision model



How do we decide?

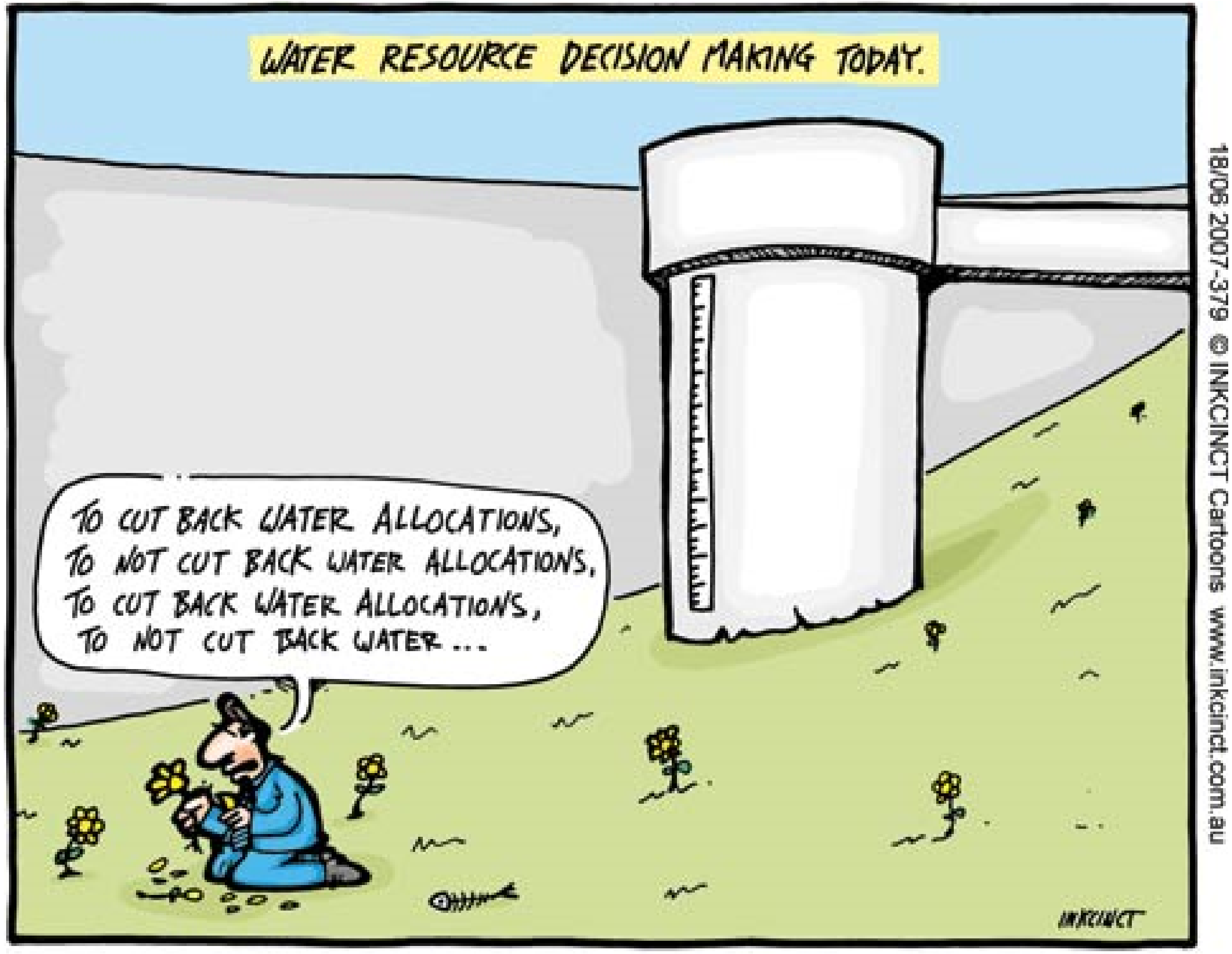


What is the optimal decision?



HOW DO WE MAKE A MANAGEMENT DECISION?

Case study: Length limits decision analysis for West Point Lake, GA.



WHAT IS DECISION ANALYSIS?

A management decision is an irrevocable commitment of resources!

There is uncertainty surrounding most decisions!

A decision model assimilates:

- Decision Alternatives
- Understanding
- **Uncertainty**
- Utility/Reward/ Value/Objectives

This is called **structured decision making.**

fisheries management

feature

Quantitative Decision Analysis for Sport Fisheries Management

ABSTRACT

Fisheries managers often are faced with difficult decisions on how to satisfy needs of the public while maintaining or restoring important sport fisheries. Such decisions are fraught with complexity and uncertainty associated with both ecological systems and multiple management objectives and alternatives under consideration. Quantitative decision analysis provides a means to formalize these complexities into a framework consisting of probabilistic relationships among management actions, sources of uncertainty, and management outcomes. We present an example of quantitative decision analysis for managing largemouth bass (*Micropterus salmoides*) in West Point Reservoir, Georgia. We developed the decision model to choose among four length limit alternatives: no minimum, 305-mm, 356-mm, and 406-mm minimum total length limits. The model consisted of population dynamics components from published studies, estimates of future reservoir trophic status, and a composite angler satisfaction score. The model indicated that a 305-mm length limit would result in the greatest angler satisfaction, but the model was very sensitive to estimates of angling mortality. To minimize the potential risks of error in the angling mortality estimates, we suggested a 356-mm length limit that was adopted by the Georgia Department of Natural Resources. The model transparency also helped biologists illustrate the decision-making process to the public, garnering support for the length limit change. We believe that decision analysis is a useful tool for fisheries management and encourage its use by fisheries biologists.

James T. Peterson
James W. Evans

Peterson is assistant unit leader and assistant professor at the U.S. Geological Survey, Georgia Cooperative Fish and Wildlife Research Unit, Warnell School of Forest Resources, University of Georgia, Athens. He can be contacted at peterson@smokey.forestry.uga.edu. Evans is senior biologist in Fisheries Management, Wildlife Resources Division, Georgia Department of Natural Resources,Fort Valley.

Introduction

Fishery managers often are faced with difficult decisions on how to satisfy the socioeconomic need of the public while maintaining or restoring properly functioning aquatic systems. Such decisions are fraught with the complexity and uncertainty associated with ecological systems, multiple management objectives, and the alternatives under consideration (Varis and Kuikka 1999). To aid the decision-making process, managers need tools that formalize these complexities into a common framework consisting of relationships among management actions, sources of uncertainty, and management outcomes. Decision analysis is one such tool.

Decision analysis is the use of explicit, quantitative methods to examine the influences of various sources of uncertainty on (management) decisions (Clemen 1996). It allows natural resource managers to examine the expected effects of different management strategies, incorporate multiple objectives and values of stakeholders, determine the relative influence of various sources of uncertainty, and estimate the value of collecting additional data (e.g., monitoring). Additional advantages of using decision analysis include the ability to incorporate empirical models, meta-data, and subjective probabilities from experts into a single model (e.g., Haas 2001), integrate information from several disciplines (e.g., Rieman et al. 2001), incorporate multiple management objectives (e.g., Varis and Kuikka 1999), and quantitatively incorporate human dimensions. Decision analysis provides a framework for interdisciplinary research and management teams to cooperate to create the most effective management strategies.

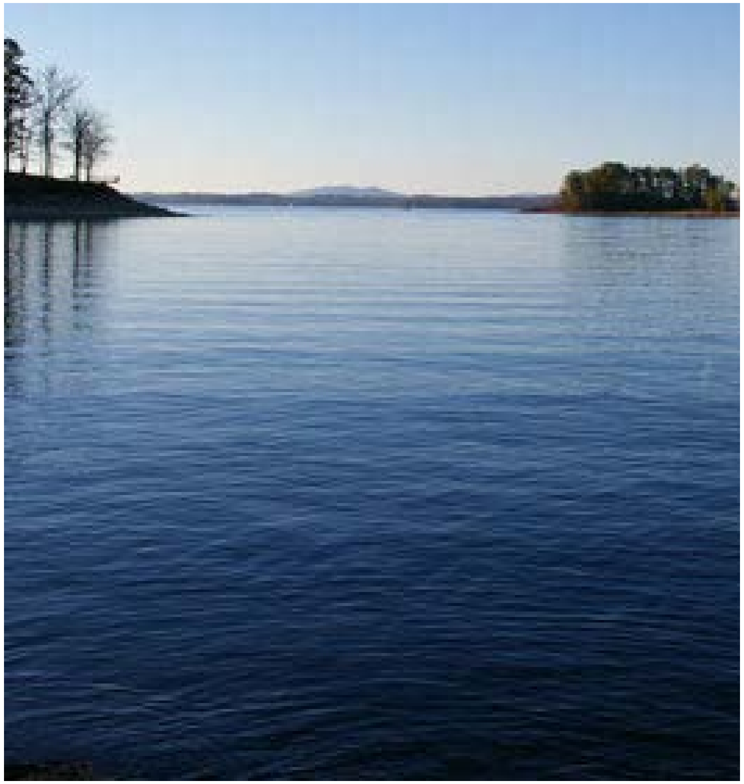
Despite its potential advantages, decision analysis is not used widely in natural resource management (but see Reckhow 1999; Marcot et al. 2001; Rieman et al. 2001). Therefore, most natural resource professionals have never been exposed to the concepts. Here, we describe the development and use of a quantitative decision model as applied to typical decision faced by sport fisheries managers. Our objective is to demonstrate the general utility of decision analysis for sport fish management.

A length-limit decision for largemouth bass in West Point Reservoir, Georgia

Background

West Point Reservoir in Georgia and Alabama was once a highly productive largemouth bass (*Micropterus salmoides*) fishery. Largemouth bass (LMB) angler harvest rates during the early 1990s, 10 kg/ha, exceeded those of most reservoirs in the United States (Ager 1992). High productivity was attributed to accelerated anthropogenic eutrophication, associated with the growth of the Atlanta metropolitan area during the 1980s (Maceina and Bayne 2001). In 1990, increased water quality con-

West Point Lake, GA



Georgia®

Problem

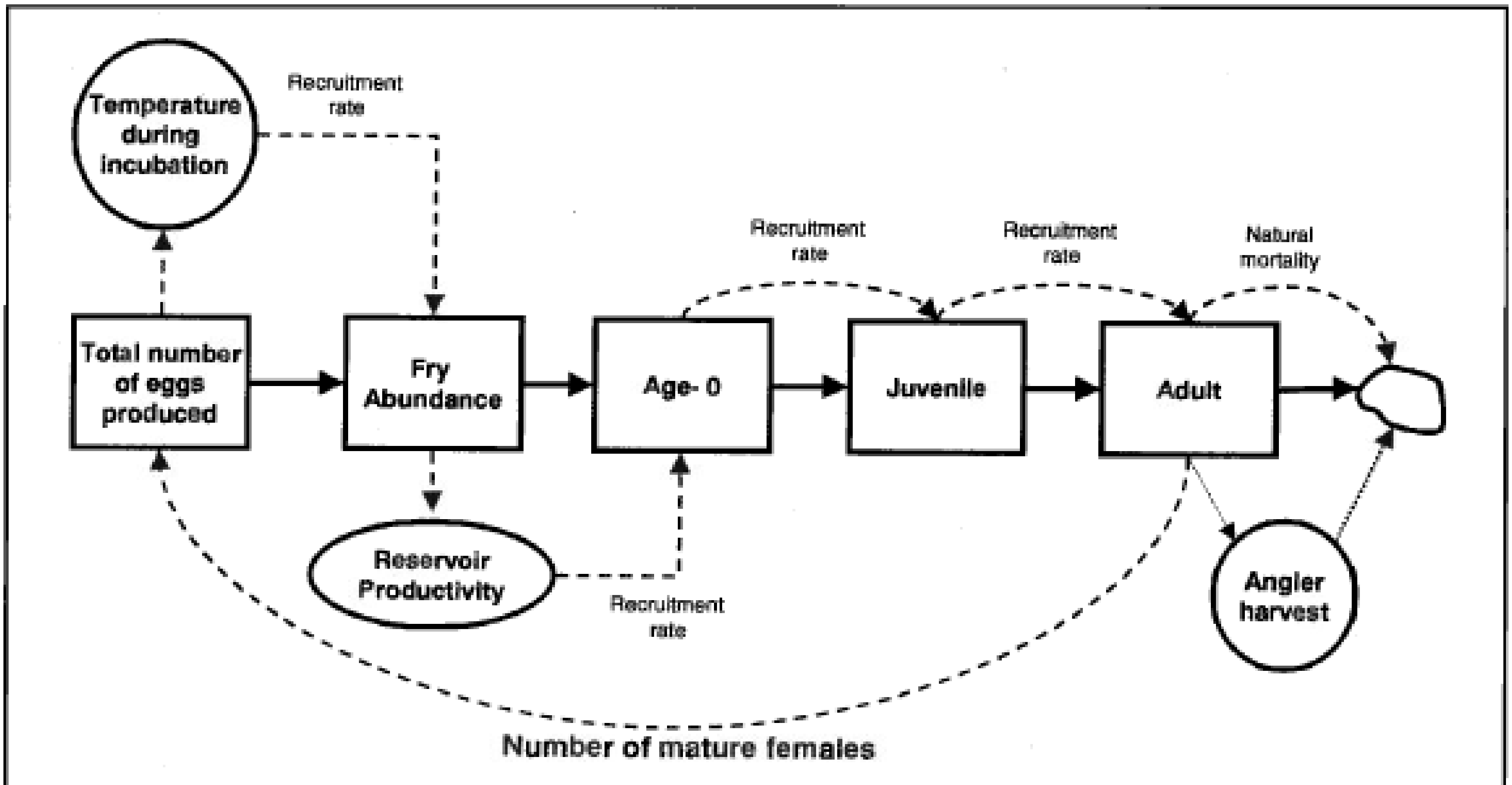
- Declining catches and size structure-Clean water act reduced reservoir productivity

Decision alternatives

- No limit
- 12 inches
- 14 inches
- 16 inches

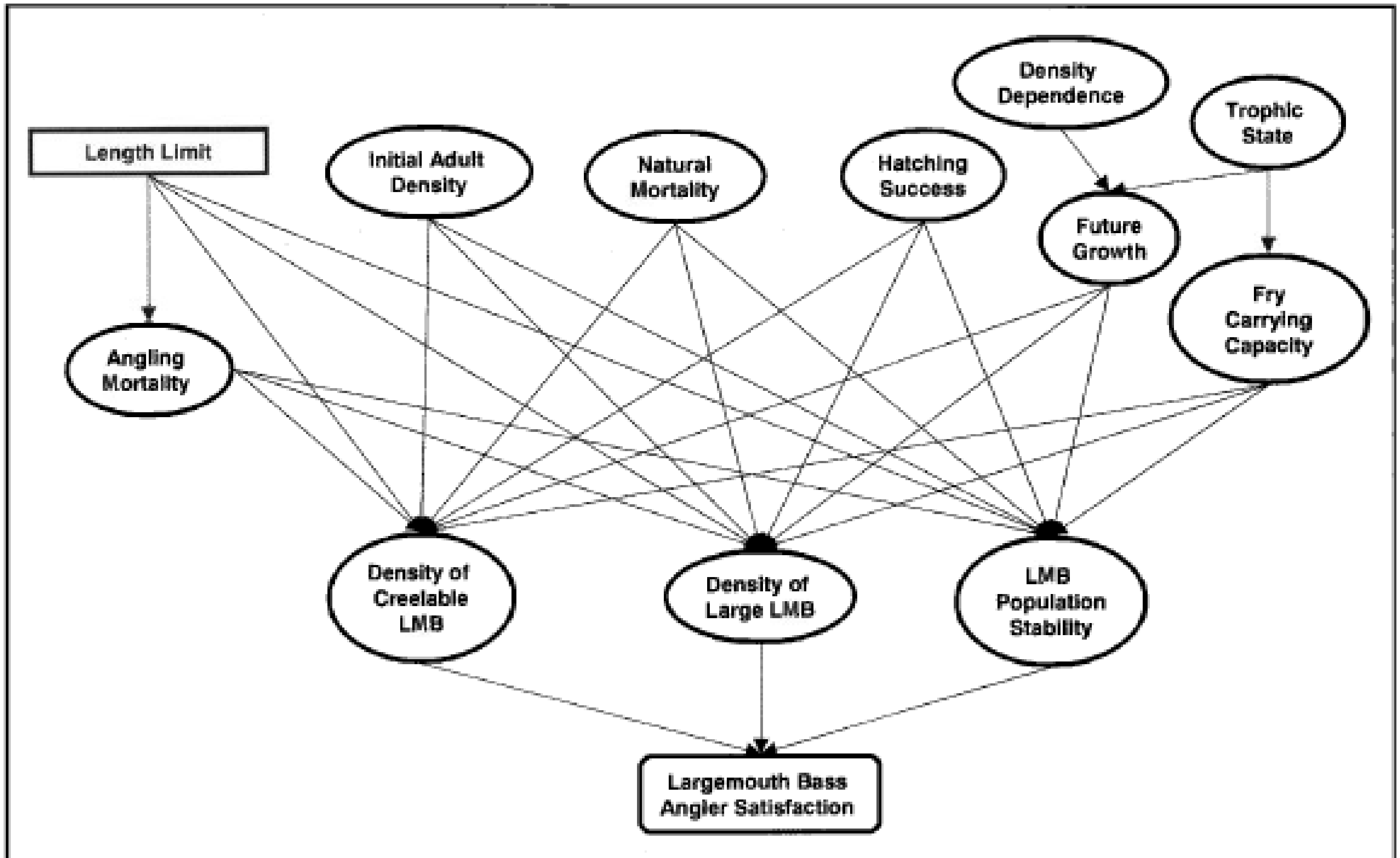
Model to predict outcomes

Figure 4. Flow chart of basic structural relationships of the largemouth bass population model using conventional symbols for rates, levels, sinks, and variables. Solid lines represent flow of material, and broken lines represent information links.



Influence of decision

Figure 5. Influence diagram of West Point Reservoir largemouth bass length limit decision using the notation of Clemen (1996). The description of the model component states and their values are in Table 4. Natural mortality rates were modeled separately for fry, juvenile, and adult age classes but are represented as a single node for simplicity.



Human dimensions

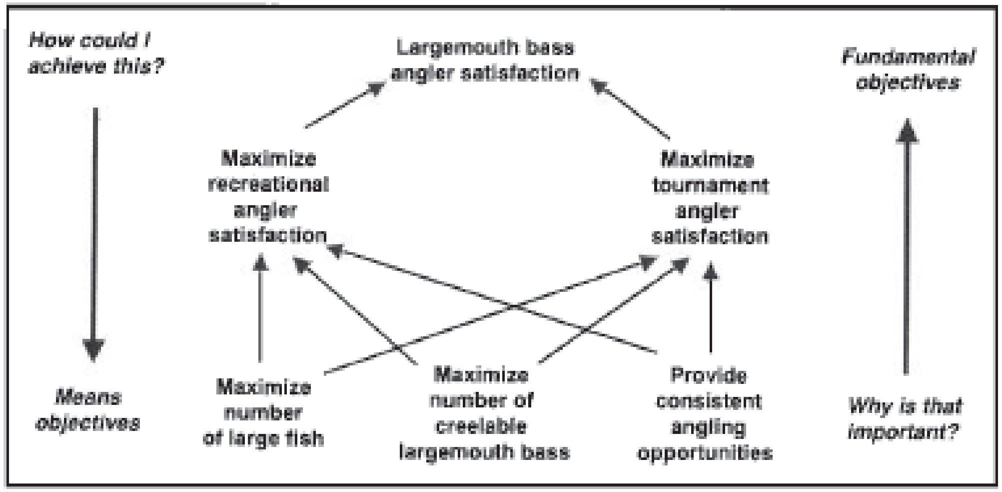
		Percent of Respondents	
		Tournament anglers	Recreational anglers
How many times per year do you fish West Point?	less than 10	22.2	21.4
	more than 20	48.1	42.9
If the bass length limit were reduced, how much more (as a percentage) would you fish at West Point?	0	68.5	85.7
	10	11.1	7.1
	30	3.7	2.4
	50	14.8	4.8
	100	1.9	0.0
What percentage of harvestable bass (>16 in.) do you currently keep?	0	79.6	78.6
	10	14.8	14.2
	50	0.0	2.4
	100	5.6	4.8
If the length limit were reduced, would you keep:	fewer bass	1.9	2.4
	same number	90.7	76.2
	more bass	7.4	21.4
Rank in order of importance to you the following qualities of a bass fishery (3 = most important, 1 = least)[1].	Consistency in the fishery year after year	2.55 (0.12)	2.59 (0.10)
	More bass above the length limit, but fewer very large bass	1.81 (0.10)	1.66 (0.08)
	More large bass, but fewer bass overall	1.64 (0.12)	1.74 (0.09)

[1]Average ranks and standard errors (in parenthesis).

Dealing with uncertainty

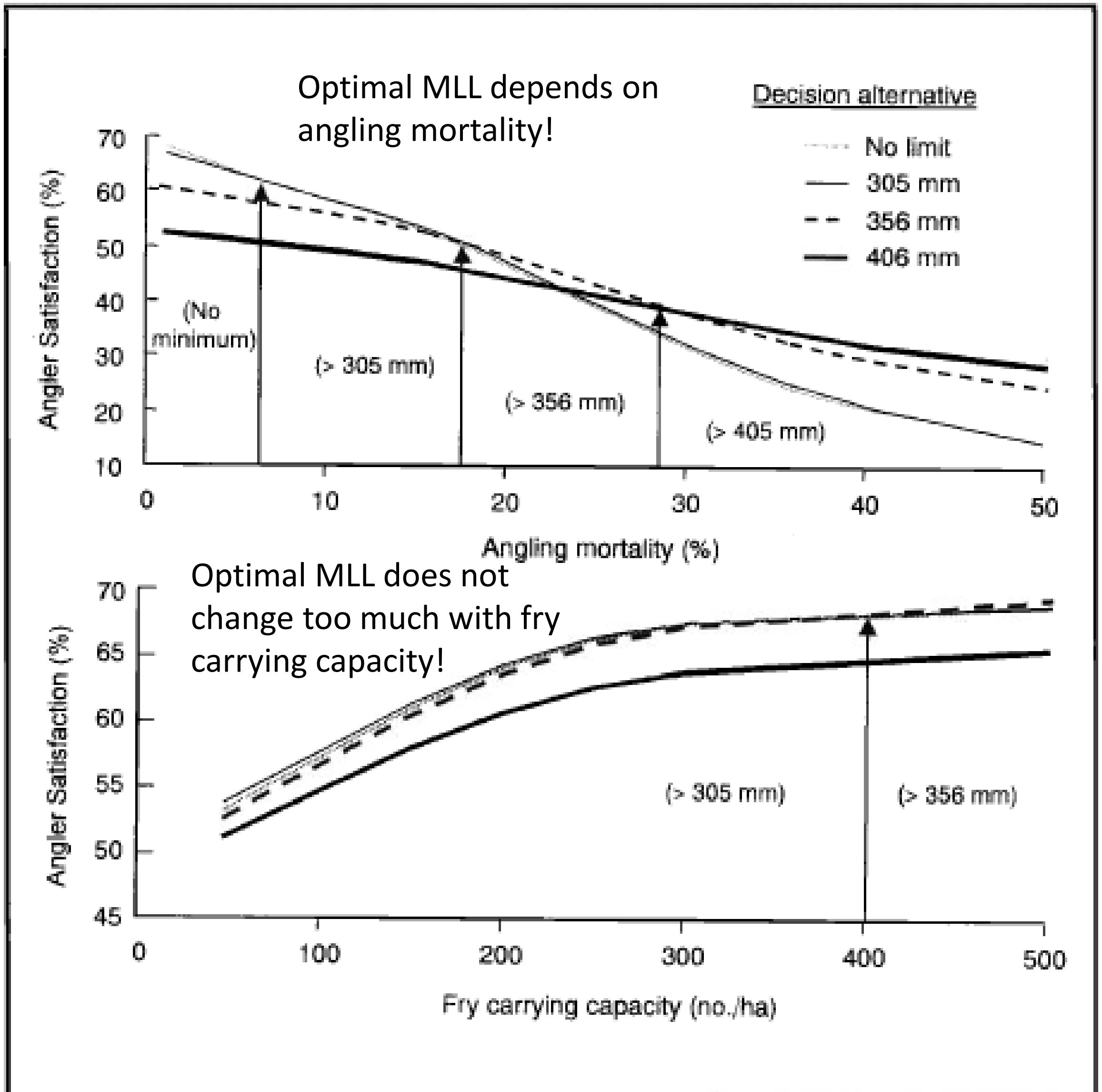
		Probability of future growth	
Trophic status	Density dependence	Unchanged	Increased
Oligotrophic	Yes	40	60
	No	100	0
Mesotrophic	Yes	30	70
	No	50	50
Eutrophic	Yes	0	100
	No	20	80

Stakeholder values

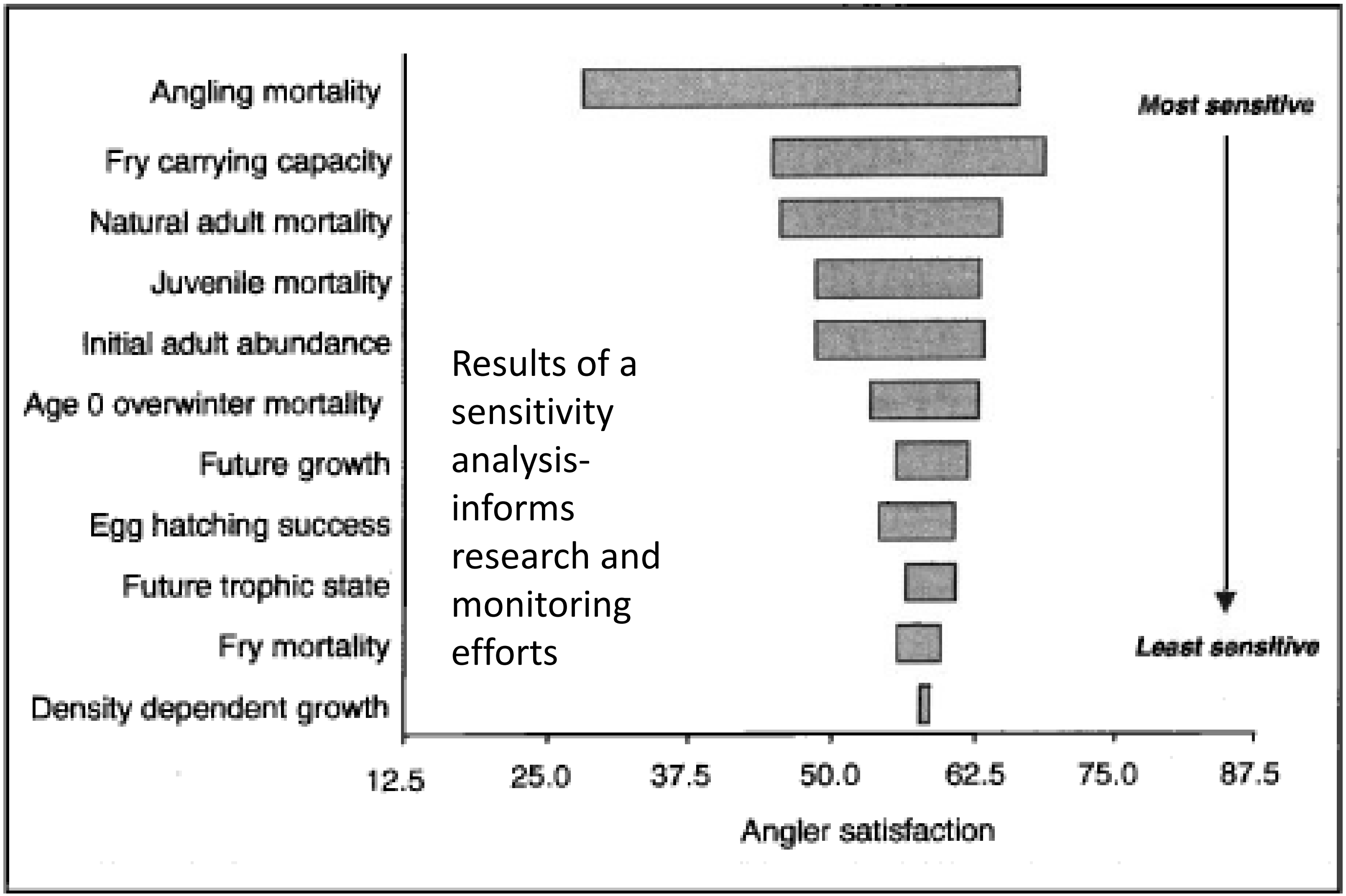


$$V_{h,l,s} = H^{*}rank_{h} + L^{*}rank_{l} + S^{*}rank_{s},$$

Decision uncertainty



What is important to know



Another natural resource example

Suppose your agency is going to stock rainbow trout into a lake to provide a new opportunity to anglers…

Management objectives

1. Minimize predation of native amphibians
2. Maximize angler satisfaction
3. Maximize filling bag limits



Decision Alternatives

1. Stock 100 Trout
2. Stock 300 Trout
3. Stock 1000 Trout

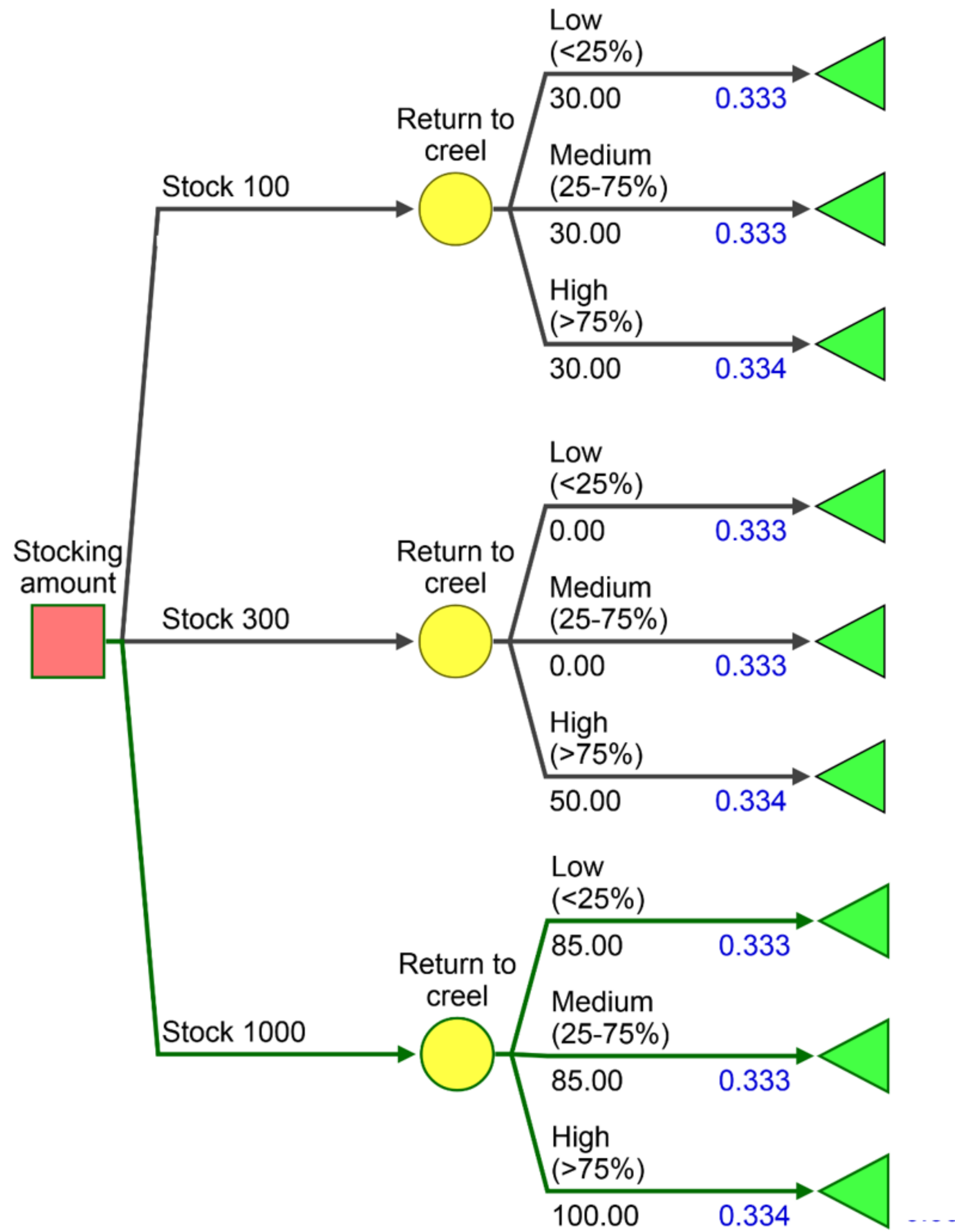
Uncertainty - return to creel

Return to creel – completely uncertain

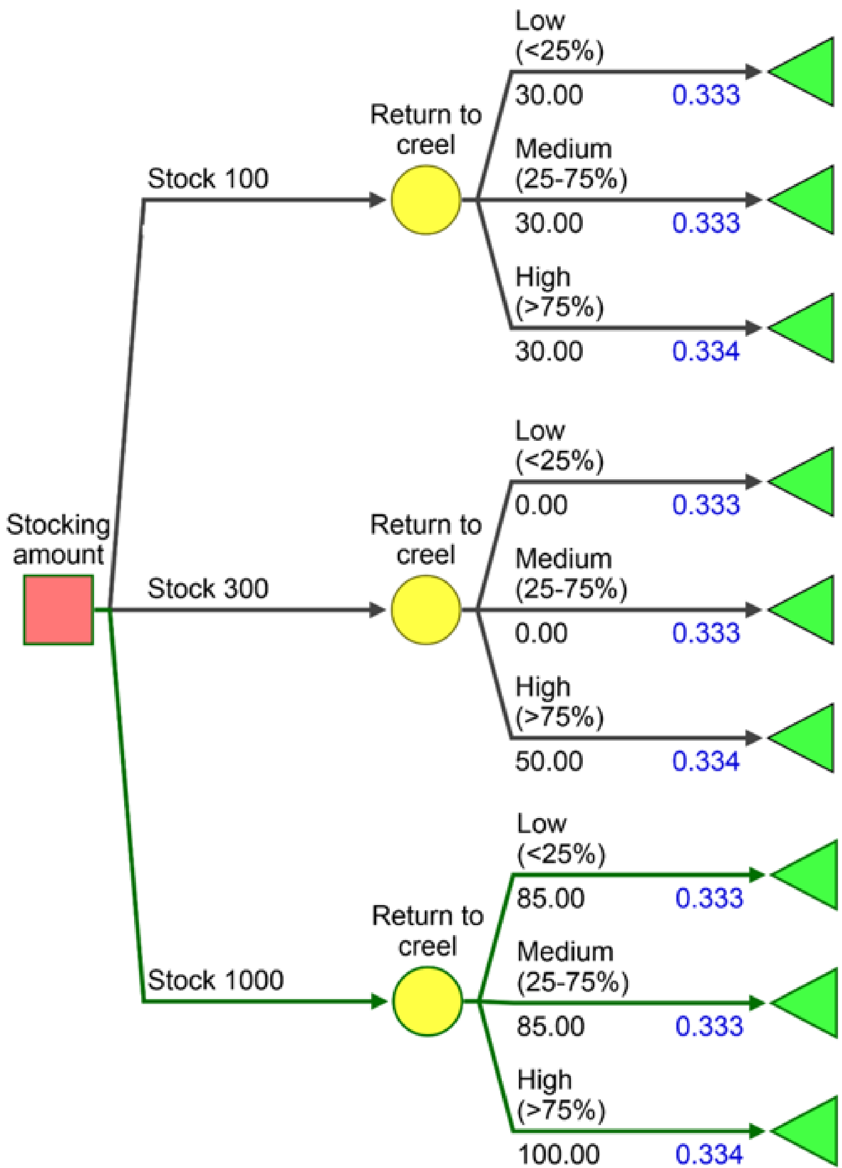
- Low (0 to 25% creeled) – 0.33%
- Medium (25 to 75% creeled) – 0.33%
- High (75%+ creeled) – 0.33%

New system to stock-we have no idea what the return to creel might be!

Visualizing the decision



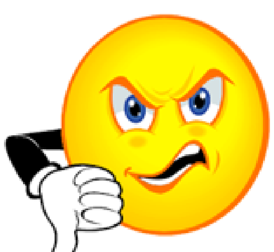
Outcomes



Min. Predation	Satisfaction	Bag
1. High	Low	Low
2. High	Low	Low
3. High	Low	Low
4. Medium	Low	Low
5. Medium	Low	Low
6. Medium	Medium	Medium
7. Low	High	Medium
8. Low	High	High
9. Low	High	High

Ranking the outcomes

Min Predation	Angler Satisfaction	Bag limit
8. Low	High	High
9. Low	High	High
7. Low	High	Medium
6. Medium	Medium	Medium
1. High	Low	Low
2. High	Low	Low
3. High	Low	Low
4. Medium	Low	Low
5. Medium	Low	Low



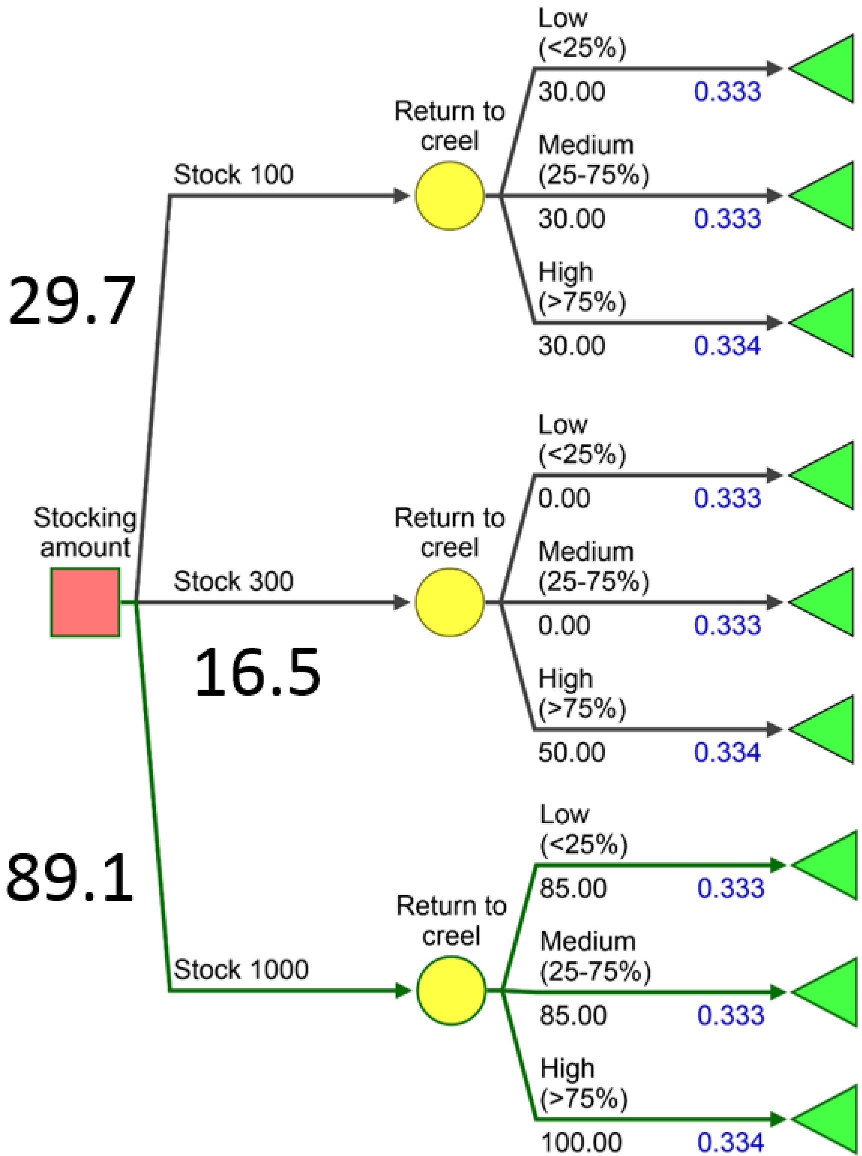
Scoring the outcomes

Min Predation	Angler Satisfaction	Bag limit	Score
8. Low	High	High	100
9. Low	High	High	100
7. Low	High	Medium	????
6. Medium	Medium	Medium	????
1. High	Low	Low	????
2. High	Low	Low	????
3. High	Low	Low	????
4. Medium	Low	Low	0
5. Medium	Low	Low	0

Scoring the outcomes

Min Predation	Angler Satisfaction	Bag limit	Score
8. Low	High	High	100
9. Low	High	High	100
7. Low	High	Medium	85
6. Medium	Medium	Medium	50
1. High	Low	Low	30
2. High	Low	Low	30
3. High	Low	Low	30
4. Medium	Low	Low	0
5. Medium	Low	Low	0

Visualizing the decision



Outcome	Score	Expected value
1.	30	0.33*30=9.9
2.	30	0.33*30=9.9
3.	30	0.33*30=9.9
4.	0	0.33*0=0
5.	0	0.33*0=0
6.	50	0.33*50=16.5
7.	85	0.33*85=28.05
8.	85	0.33*85=28.05
9.	100	0.33*100=33