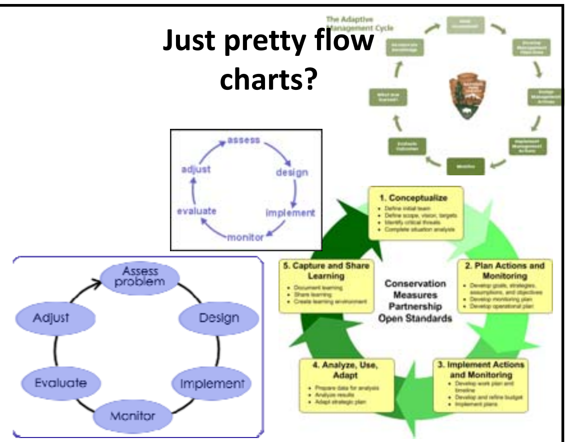
WF4313/6613-Fisheries Management

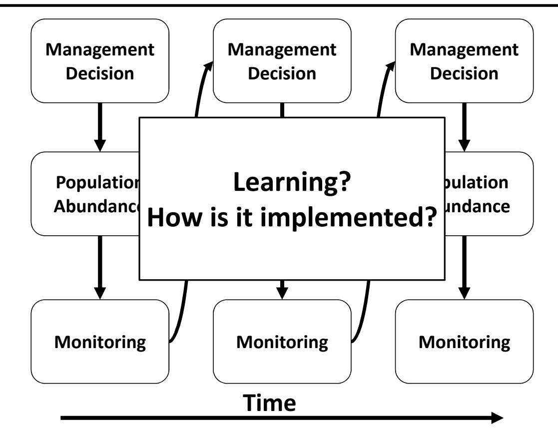
Class 28– Adaptive Management

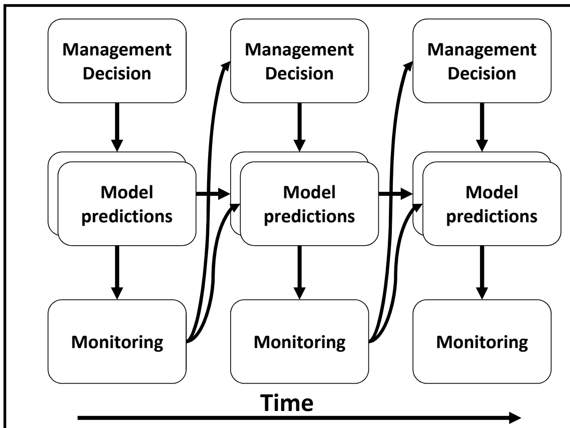
Announcements

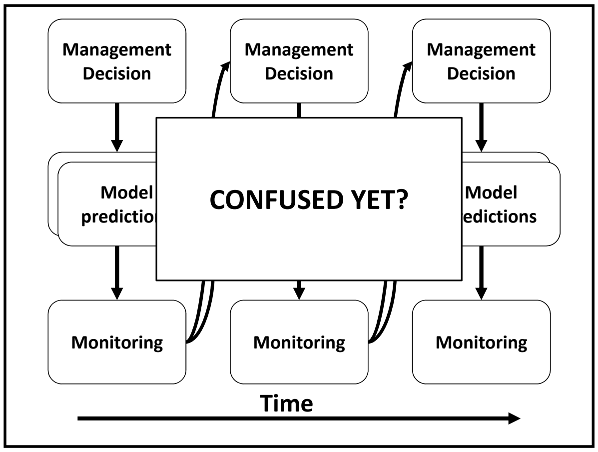
1 class left…
Brief presentations Nov. 28th
Final Exam December 5th @ 8am
Grades on BB

Just pretty flow charts?





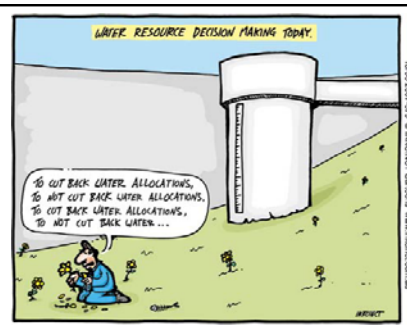




Lets see what this looks like as a formal process

Lets get under the hood, but we need to cover a few bases first

1. **What is decision analysis?**
2. **How do we implement learning?**
3. **Adaptive management process**



1. WHAT IS DECISION ANALYSIS?

A management decision is an irrevocable commitment of resources!

There is uncertainty surrounding most decisions!

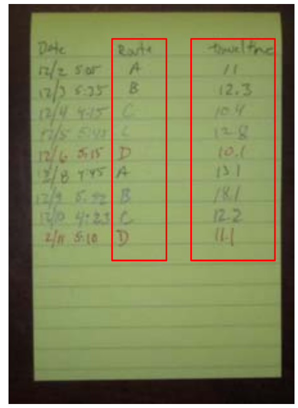
A decision model assimilates:

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

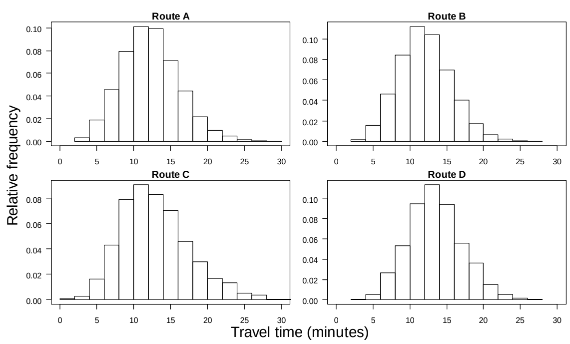
Lets give this a shot…
How should I get home from work?

Route	Distance (miles)
A	7.2
B	7.2
C	7.2
D	11.4

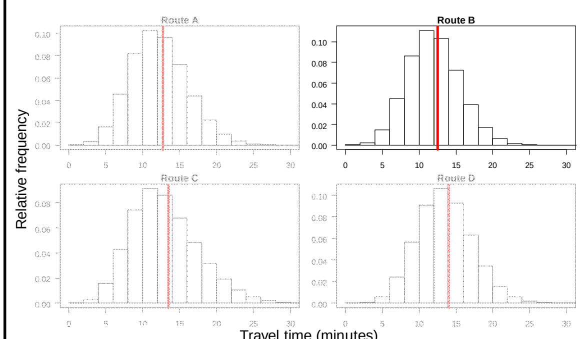
Objective: ***Minimize travel time!***



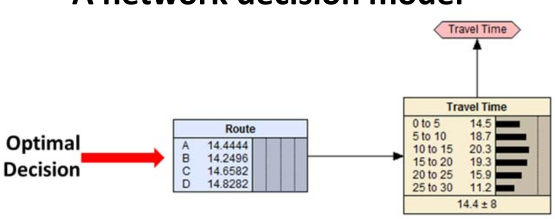
How to decide with this uncertainty?



How to decide with this uncertainty?

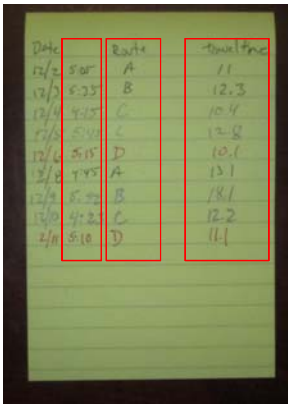


A network decision model



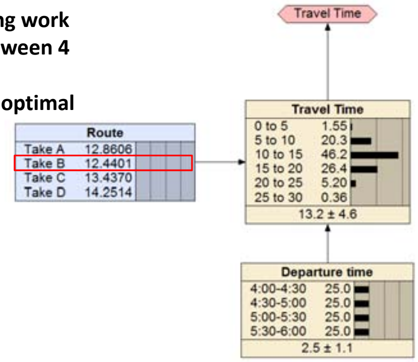
Factors that effect travel time?

- Distance…. Can't change distance for each route
- Traffic…rush hour… lights



I will be leaving work sometime between 4 and 6 pm

-Route B is optimal

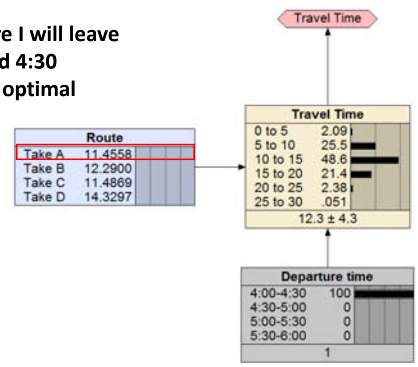


We can make better decisions if things are known with certainty

What time will I leave work?

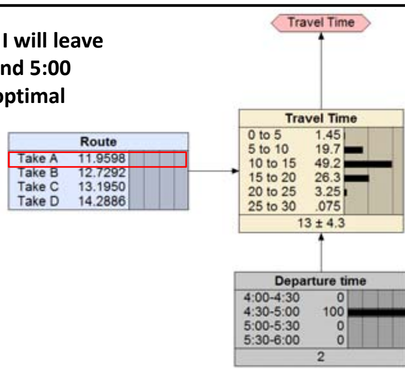
I am 100% sure I will leave between 4 and 4:30

-Route A is optimal



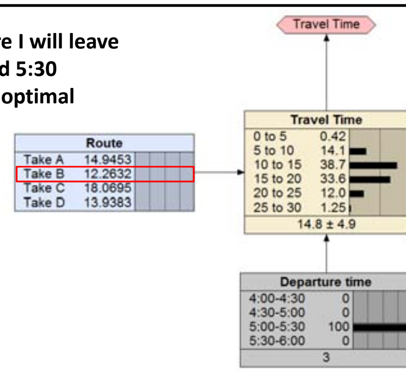
I am 100% sure I will leave between 4:30 and 5:00

- Route A is optimal

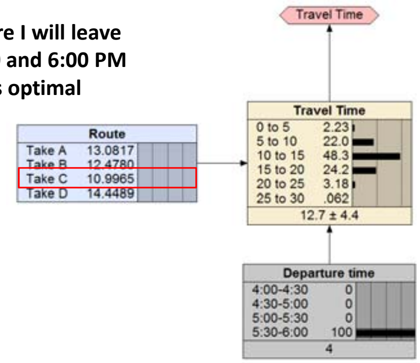


I am 100% sure I will leave between 5 and 5:30

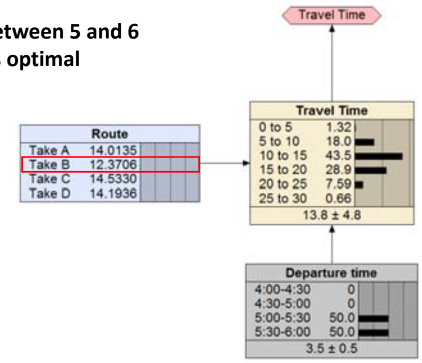
-Route B is optimal



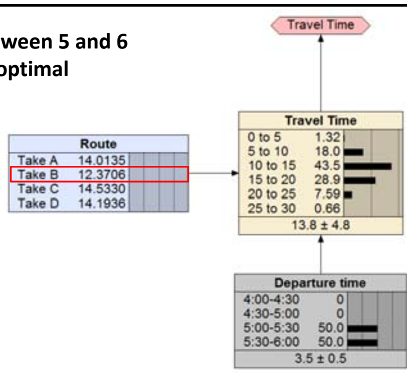
I am 100% sure I will leave between 5:30 and 6:00 PM
- Route C is optimal



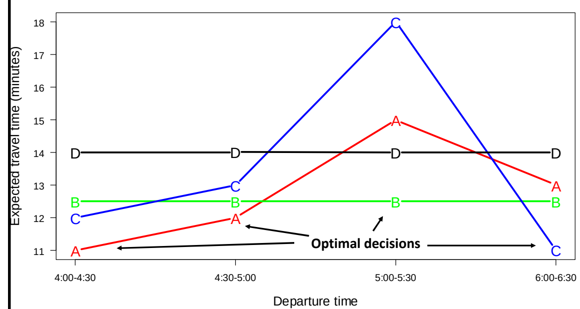
I will leave between 5 and 6
-Route B is optimal



I will leave between 5 and 6
-Route B is optimal



Decision uncertainty: The optimal decision varies with departure time



Decision model

Decision Alternatives
- 4 routes

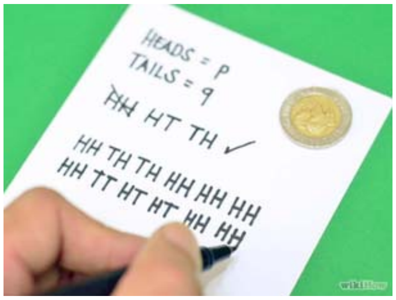
Understanding
- Effect of departing time

Uncertainty
- Accounted for uncertainty in travel times

Utility/Reward/Value/Objectives
- Minimize travel time

2. HOW DO WE LEARN BY DOING?

We could flip the coin many times and calculate the probability of heads.



We can use each flip to learn… Learning by doing!

Hypotheses

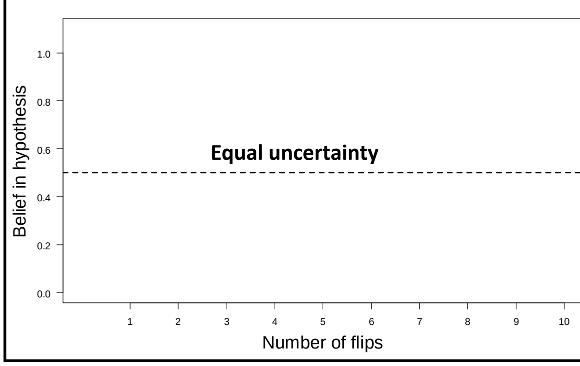
1. Fair: probability of head = 0.5
2. Unfair: probability of heads = 0.3

***Each** flip provides additional information to learn from.*

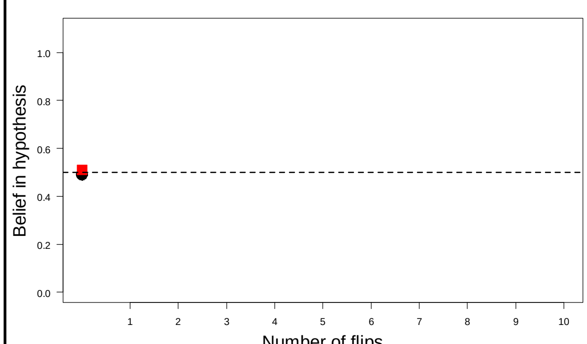
We begin completely uncertain about each hypothesis.

Hypothesis	Prior Probability
Fair coin	***0.5***
Unfair coin	***0.5***

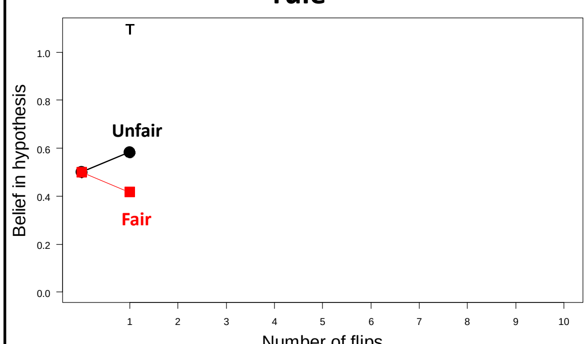
Equal uncertainty



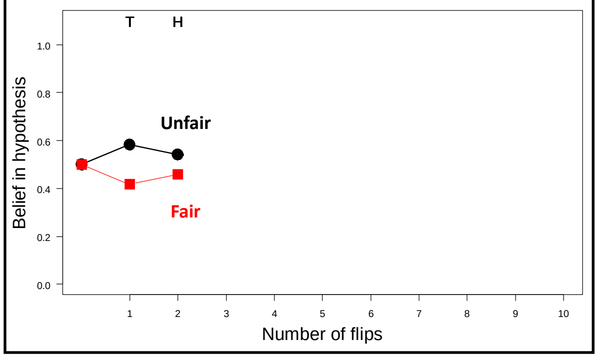
Start with prior beliefs…



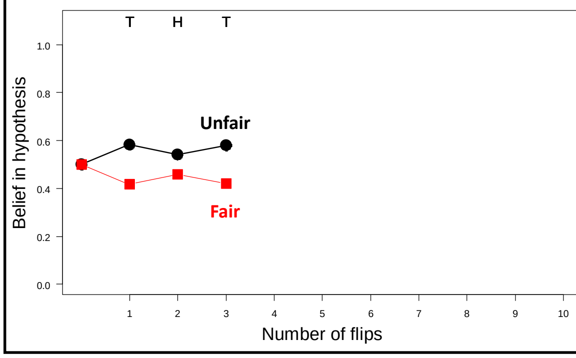
Flip, get a tail and update with Bayes rule



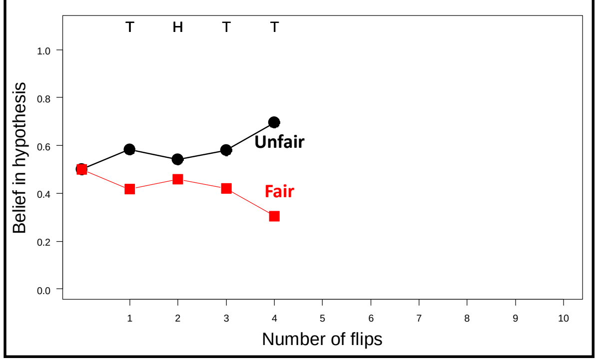
Fair versus unfair, flip #2



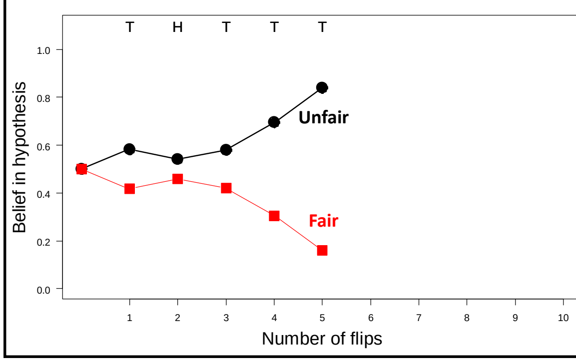
Fair versus unfair, flip #3



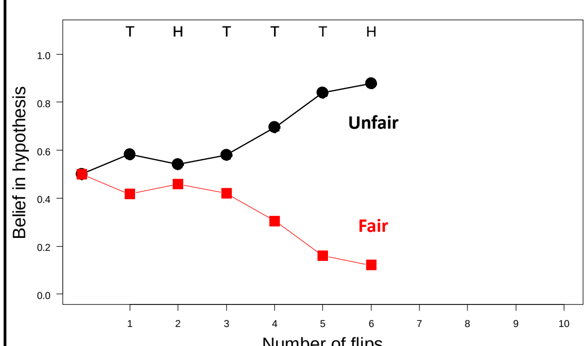
Fair versus unfair, flip #4



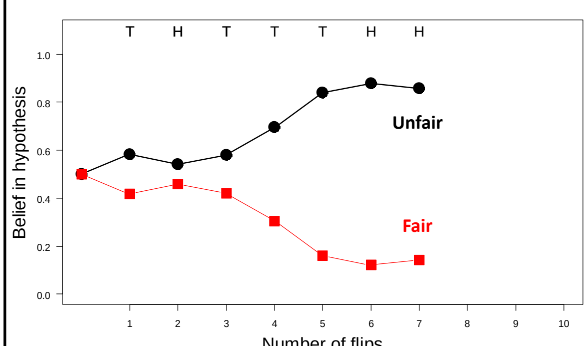
Fair versus unfair, flip #5



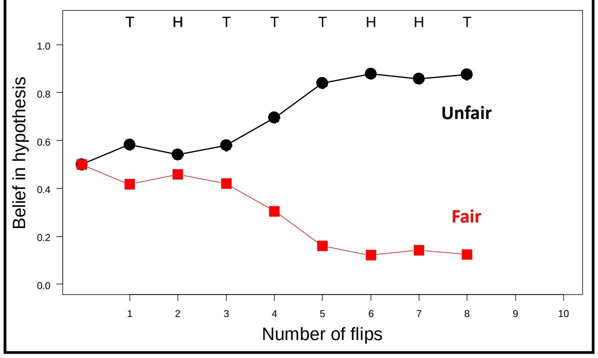
Fair versus unfair, flip #6



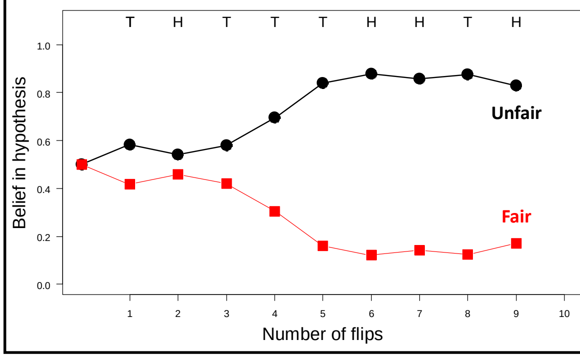
Fair versus unfair, flip #7



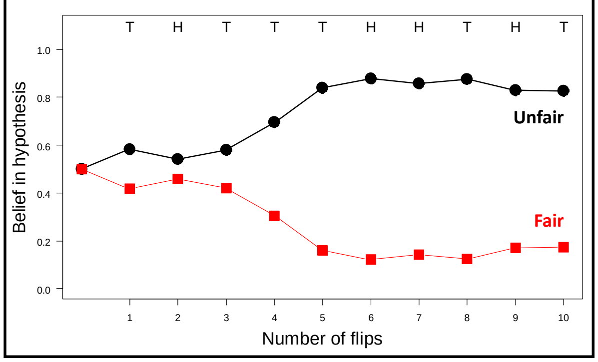
Fair versus unfair, flip #8



Fair versus unfair, flip #9

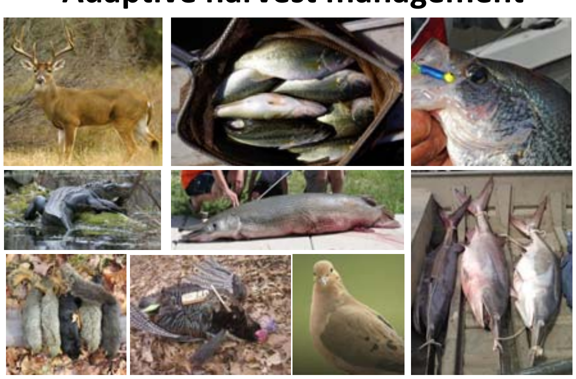


Strong support for an unfair coin!

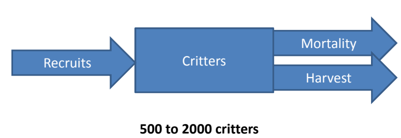


BRIDGE TO MANAGEMENT

Adaptive harvest management



A population of harvestable critters



Some preliminaries

- Harvest rate decisions

  0.1, 0.2, 0.3, & 0.4

Sustainable… evaluate over an **"infinite" time horizon

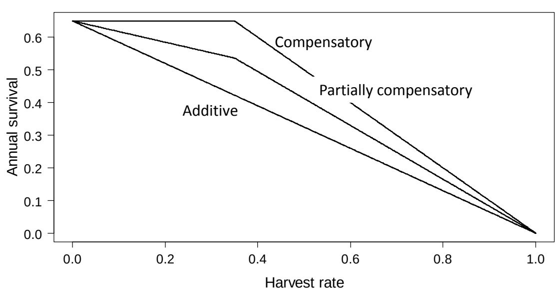
Abundance	Optimal** harvest rate
500-750	?
750-1000	?
1000-1250	?
1250-1500	?
1500-1750	?
1750-2000	?

Structural uncertainty

Where learning occurs

- *Effect of harvest: Additive, Compensatory, Partially compensatory (**3 competing Hypotheses**)*
- *Why is this important?*

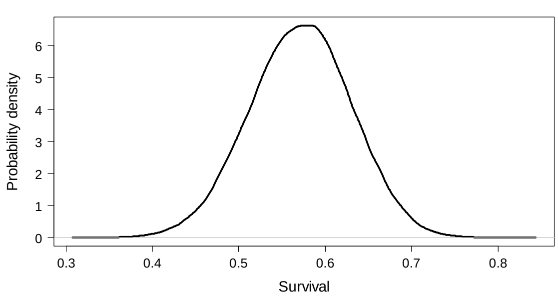
Learning: 3 hypotheses of the effect of harvest on a population



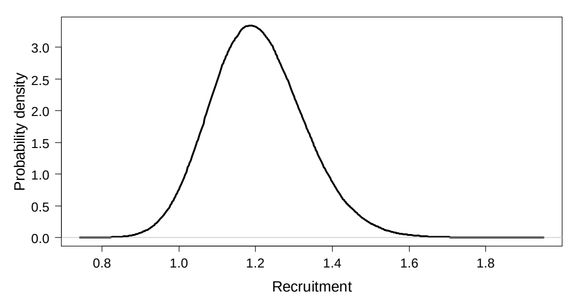
Parameter uncertainty

- *Survival*
- *Recruitment*
- *Current population abundance*

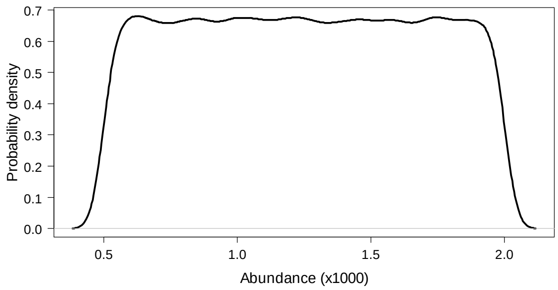
Survival uncertainty



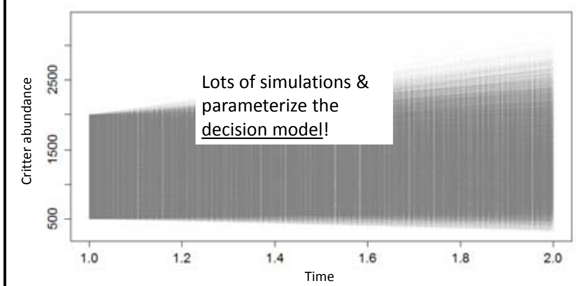
Recruitment uncertainty



Current population abundance



Optimal harvest policies given uncertainty



Optimal harvest policies

Abundance	Optimal harvest rate
500-750	0.1
750-1000	0.1
1000-1250	**0.1**
1250-1500	0.3
1500-1750	0.3
1750-2000	0.3

Optimal sustainable harvest rates given uncertainty from decision model

Implement decision, monitor, and compare

Monitoring data

Critter abundance	1200
Additive	0.33
P. Compensatory	0.33
Compensatory	0.33

Prior beliefs

Now implement harvest decision

Implement decision, monitor, and compare

Monitoring data

Critter abundance	1200	900	
Additive	0.33	933	0.01
P. Compensatory	0.33	988	0.76
Compensatory	0.33	1037	0.24

Learning

Model predictions

Update optimal harvest policies given our learning

	Abundance	Optimal harvest rate	
	500-750	0.1	
Current state	**750-1000**	**0.1**	
	1000-1250	*0.2*	Learning
	1250-1500	0.3	
	1500-1750	0.3	
	1750-2000	0.3	

Can harvest more since there is evidence for partial compensation

Implement decision, monitor, and compare

Critter abundance	1200	1000	1183			
Additive	0.33	933	0.01	1001	0.00	
P. Compensatory	0.33	988	0.76	1158	0.99	
Compensatory	0.33	1037	0.24	1289	0.00	

Update optimal harvest policies given our learning

Abundance	Optimal harvest rate
500-750	0.1
750-1000	*0.2*
1000-1250	***0.2***
1250-1500	0.3
1500-1750	0.3
1750-2000	*0.4*

Can harvest more since there is evidence for partial compensation

Implement optimal decision

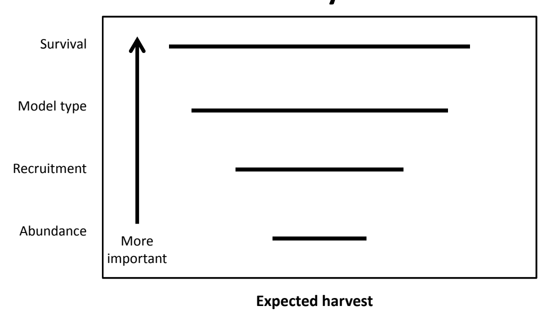
Critter abundance	1200	1000	1183		
Additive	0.33	933	0.01	1001	0.00
P. Compensatory	0.33	988	0.76	1158	0.99
Compensatory	0.33	1037	0.24	1289	0.00

Abundance	Optimal harvest rate
500-750	0.1
750-1000	**0.1**
1000-1250	0.2
1250-1500	0.3
1500-1750	0.3
1750-2000	0.3

Update learning and make better decisions

There we go, we are learning by doing!

Integrating research and monitoring: Sensitivity



Closing. The Process provides a means to

- Use management actions to learn
- Integrate monitoring data
- Inform research needs
- Improve decisions
- Include public participation & values

In the context of your decisions!

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.

Introduction

James T. Peterson
James W. Evans

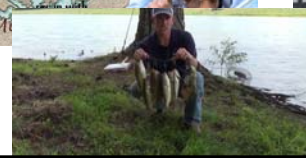
A length-limit decision for largemouth bass in West Point Reservoir, Georgia

Background

West Point Lake, GA

Problem

- Declining catches and size structure-Clean water act

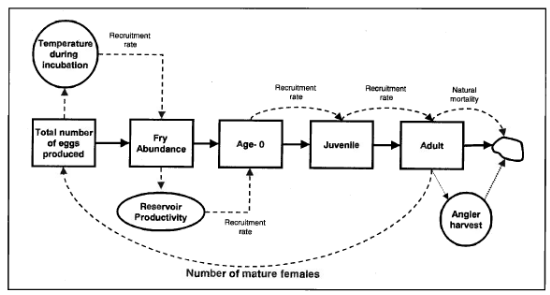


Decision alternatives

- 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

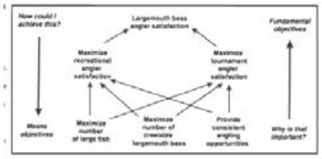
		Percent of Respondents: Tournament anglers	Percent of Respondents: Recreational anglers
How many times per year do you fish West Point?	less than 10	22.2	21.4
	more than 20	48.1	42.9
If the bass length limit were reduced, how much more (as a percentage) would you fish at West Point?	0	68.5	85.7
	10	11.1	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

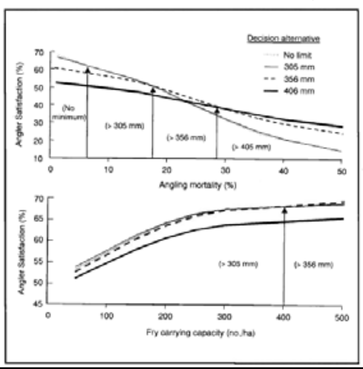
Trophic status	Density dependence	Probability of future growth: Unchanged	Increased
Oligotrophic	Yes	40	60
	No	100	0
Mesotrophic	Yes	30	70
	No	50	50
Eutrophic	Yes	0	100
	No	20	80

Stakeholder values



$$V_{h,l,s} = H*rank_h + L*rank_l + S*rank_s,$$

Decision uncertainty



What is important to know