

# Here's to Making Good Decisions: Structured Decision Making and Bull Trout Reintroduction

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# Rangewide Need for CPP?

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- Conservation Propagation Program (CPP)
- Recovery Plan - “Recommends ... study ... to determine the effectiveness and feasibility of using artificial propagation in bull trout recovery”
- USFWS HRT recommendation – Facility should ... “Implement a bull trout recovery program”

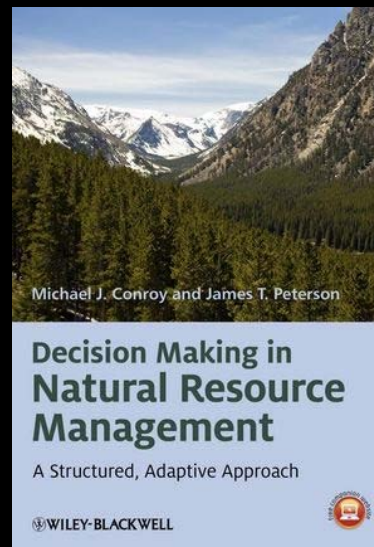
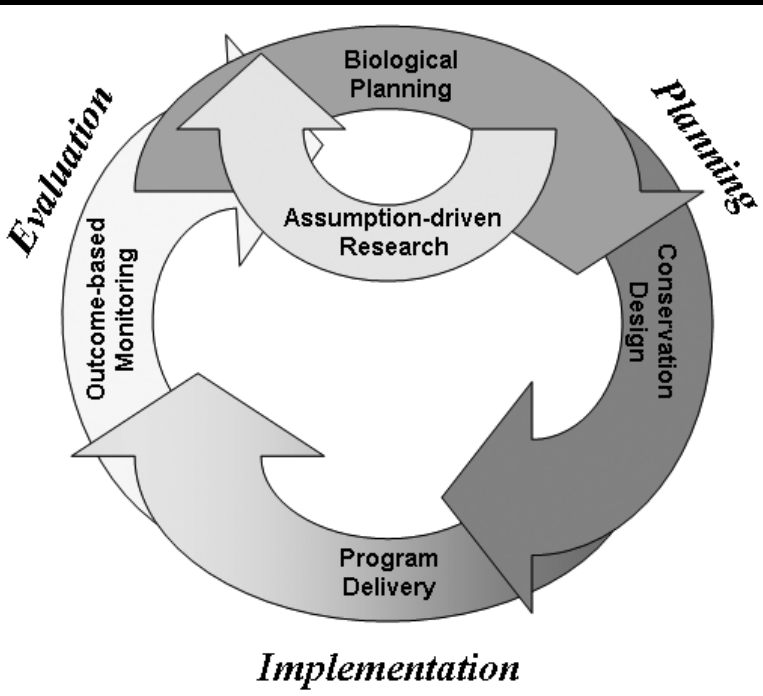
# Local Need?

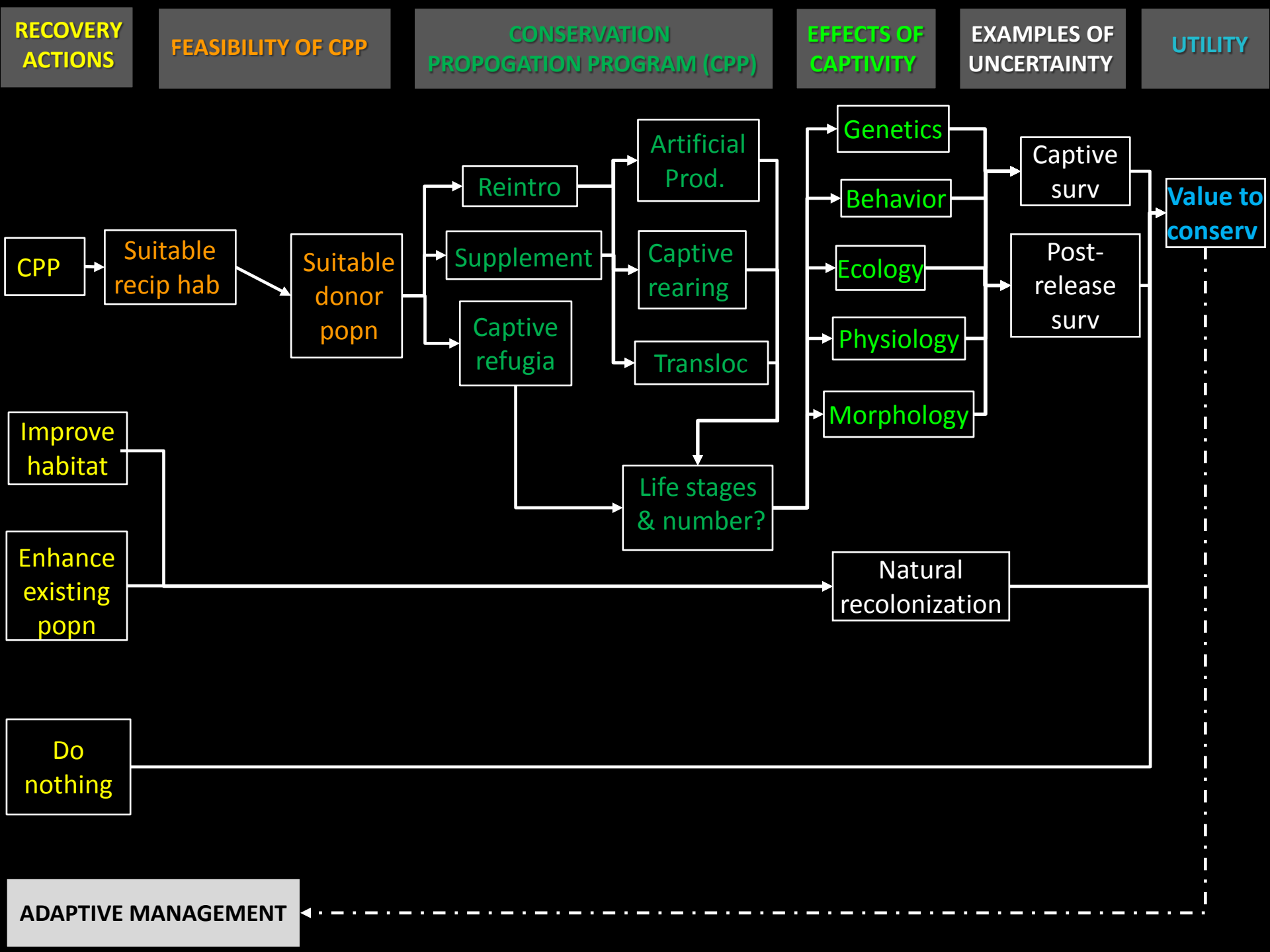
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- Mid-Columbia Recovery Implementation Plan (RUIP) – Recovery Task #4.2.7
  - RUIP recommends development of a feasibility assessment for reintroduction and translocation
- Yakima Action Plan (AP) – Multiple Population Action #4
  - AP recommends development of a feasibility assessment to evaluate supplementation, transplantation, and Reintroduction

# How to recover species?

- Structured Decision Making
- Adaptive Resource Management
- Strategic Habitat Conservation





# Objective

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- Determine how captive rearing environments affect the development and behavior of BT

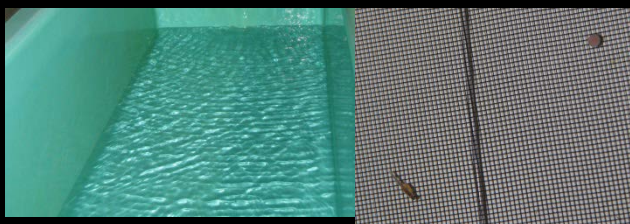




## Enhanced Habitat



## Conventional Habitat



## Fish Health

a.



b.



c.



d.





# The Hunger Games

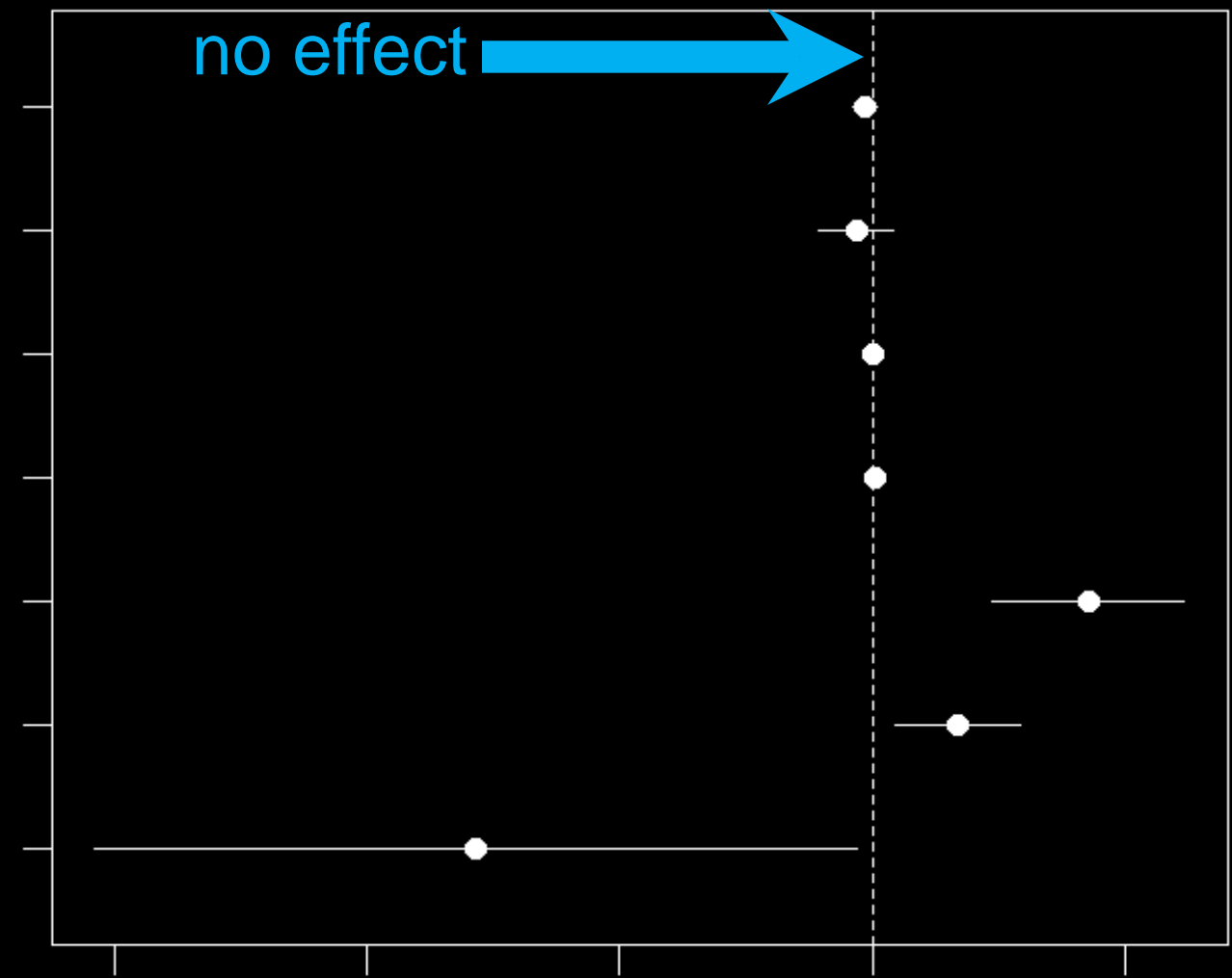
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# Influence on Predation

no effect 

Avg Prey Length  
Prey Habitat  
Weight  
Length  
Wild  
Enhanced  
Conventional

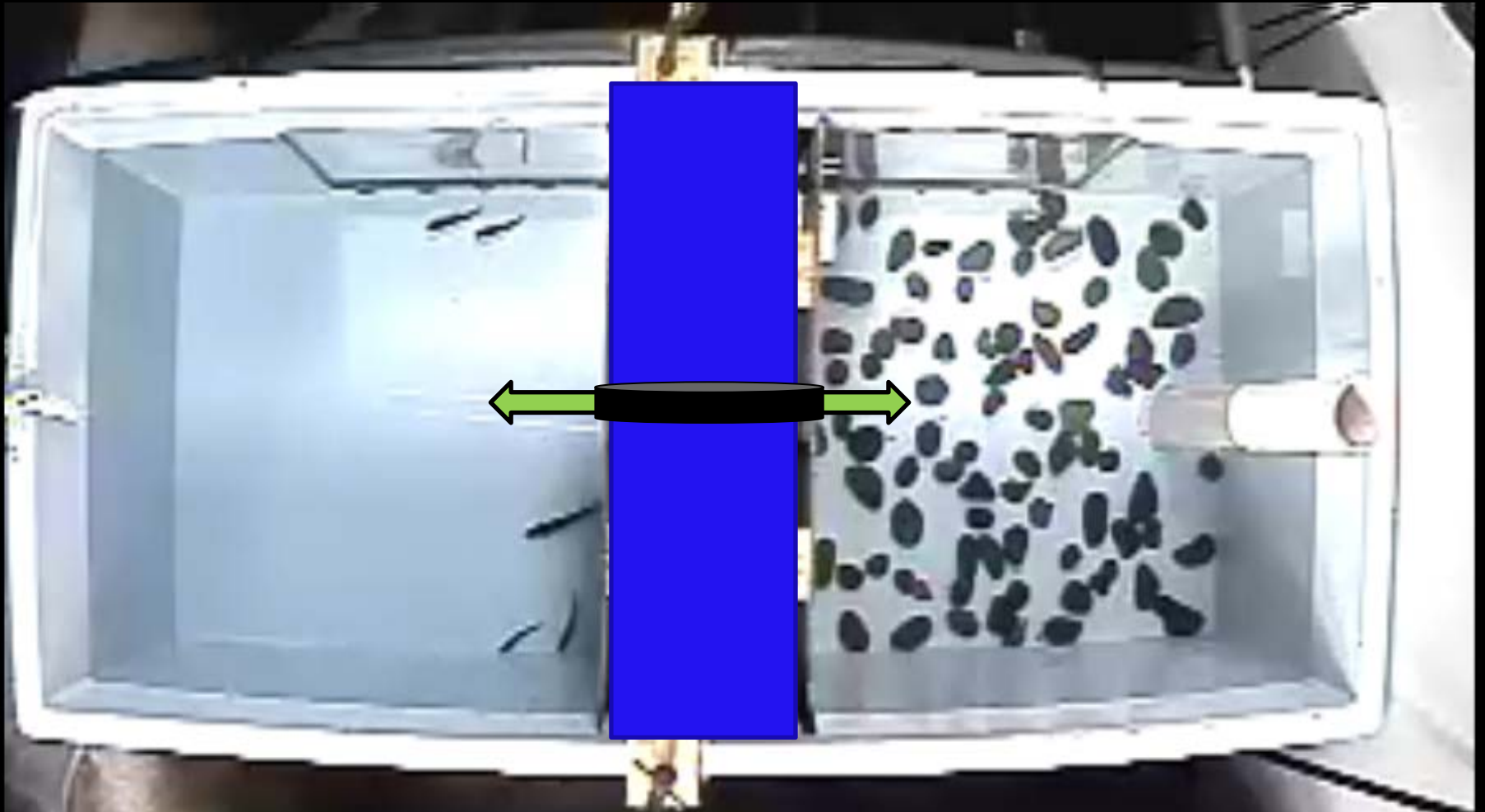


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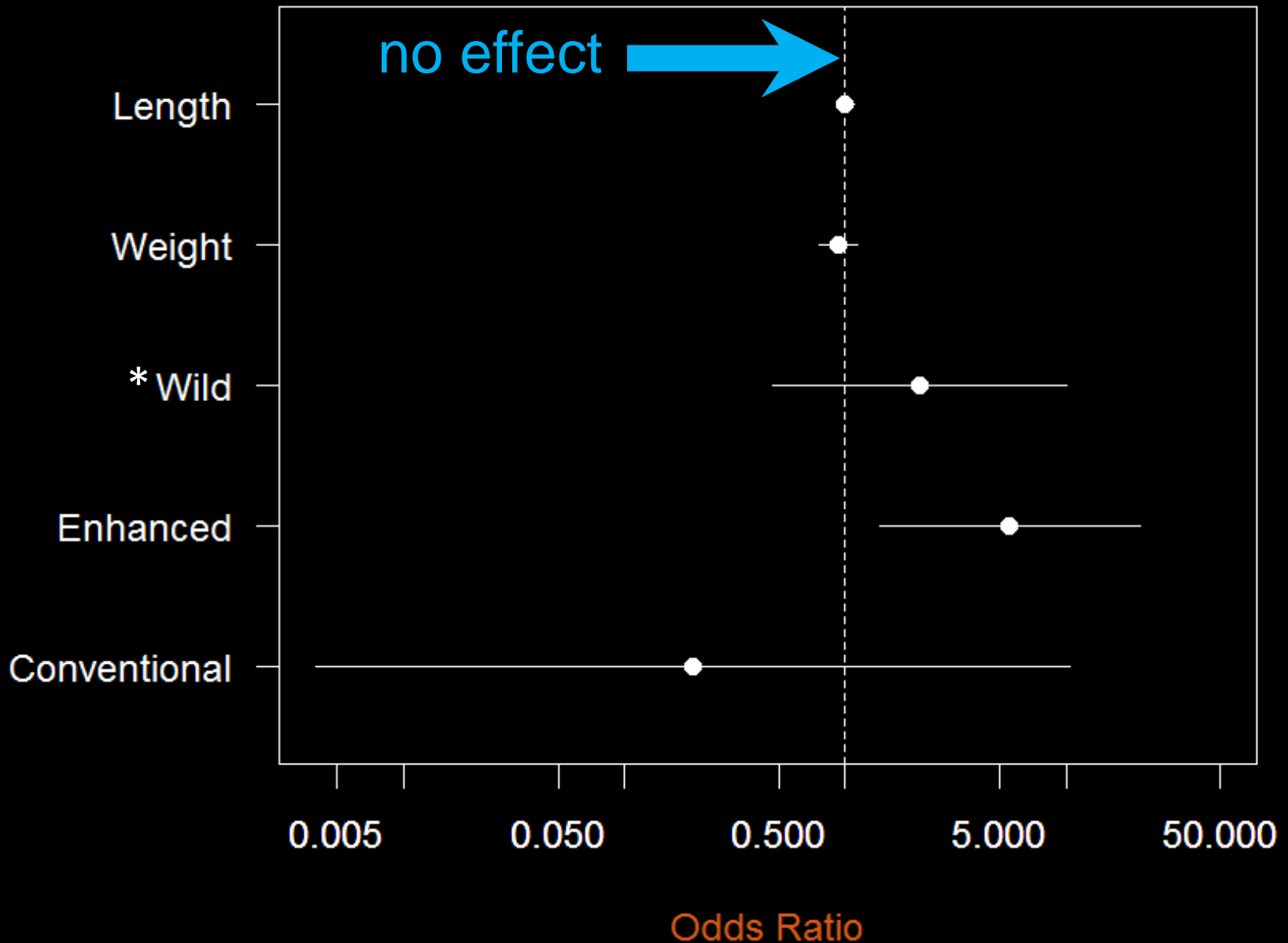
Odds Ratio

# “Boldness” Behavior

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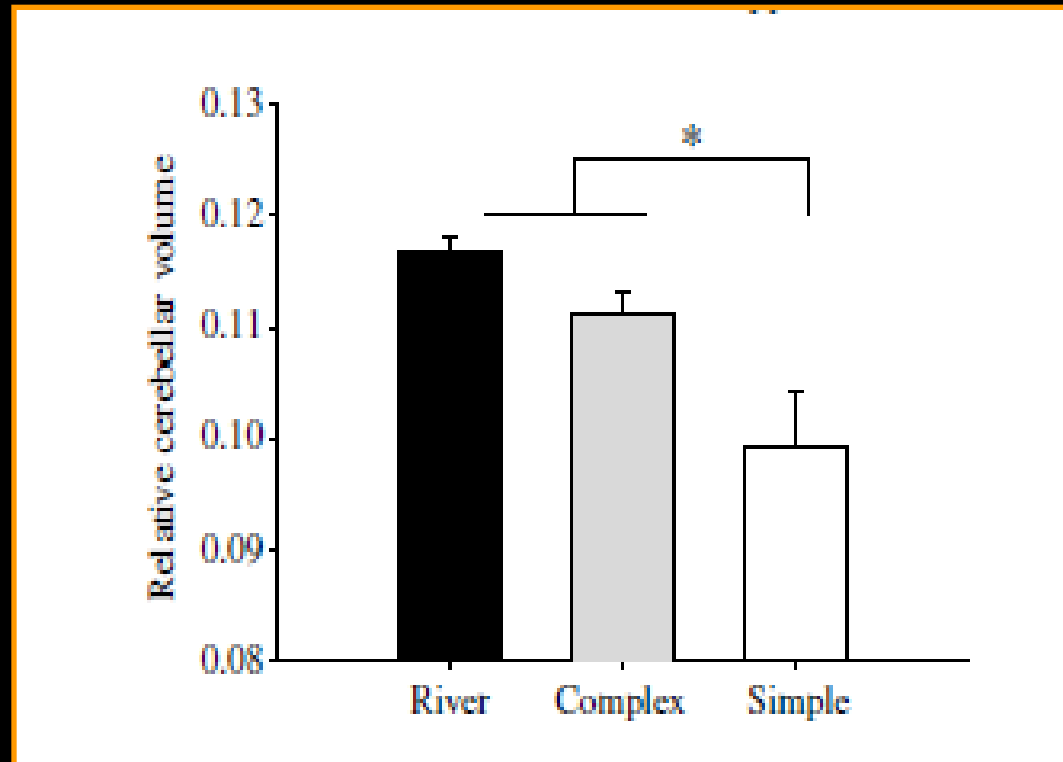


# Influence on Boldness



\* 2 fish passed multiple times

# Brain Development



**Early rearing environment impacts cerebellar growth in juvenile salmon**

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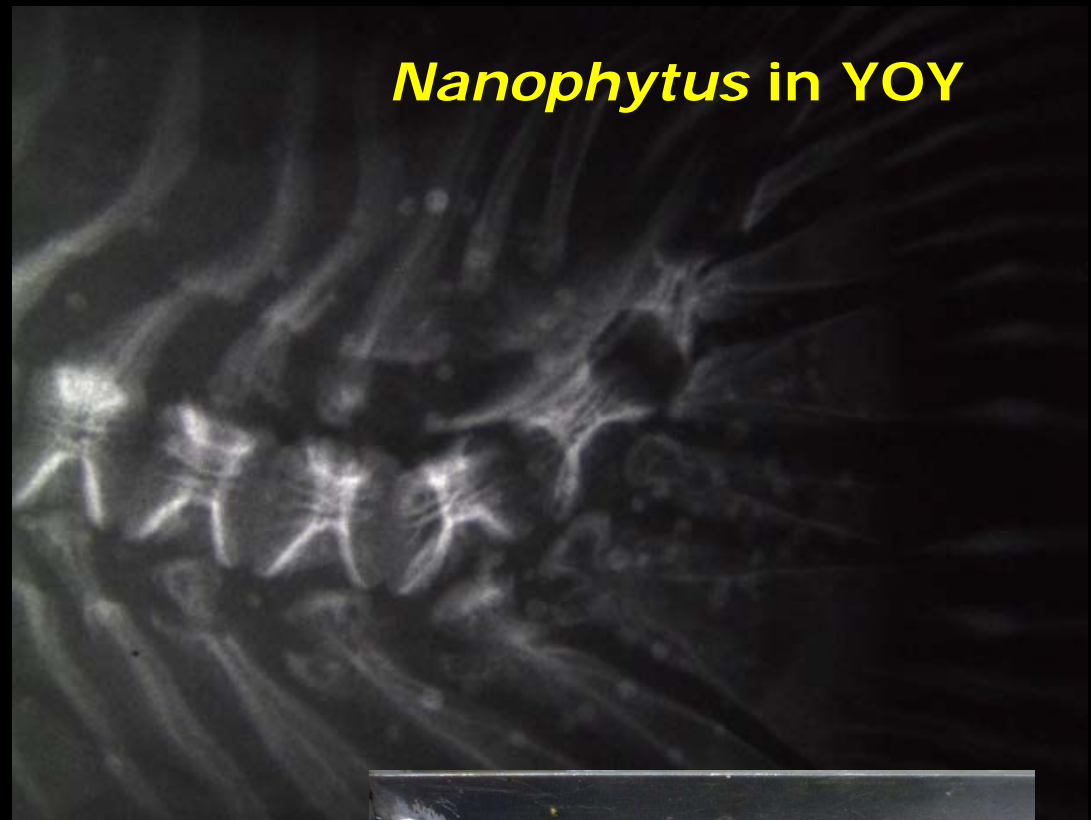
# Additional lessons learned

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- Embryo collection methods
- Transport methods
- Basic husbandry
- Captive survival
- Fish Health
- Temperature and egg incubation
- Bull trout stress tests
- Eye development

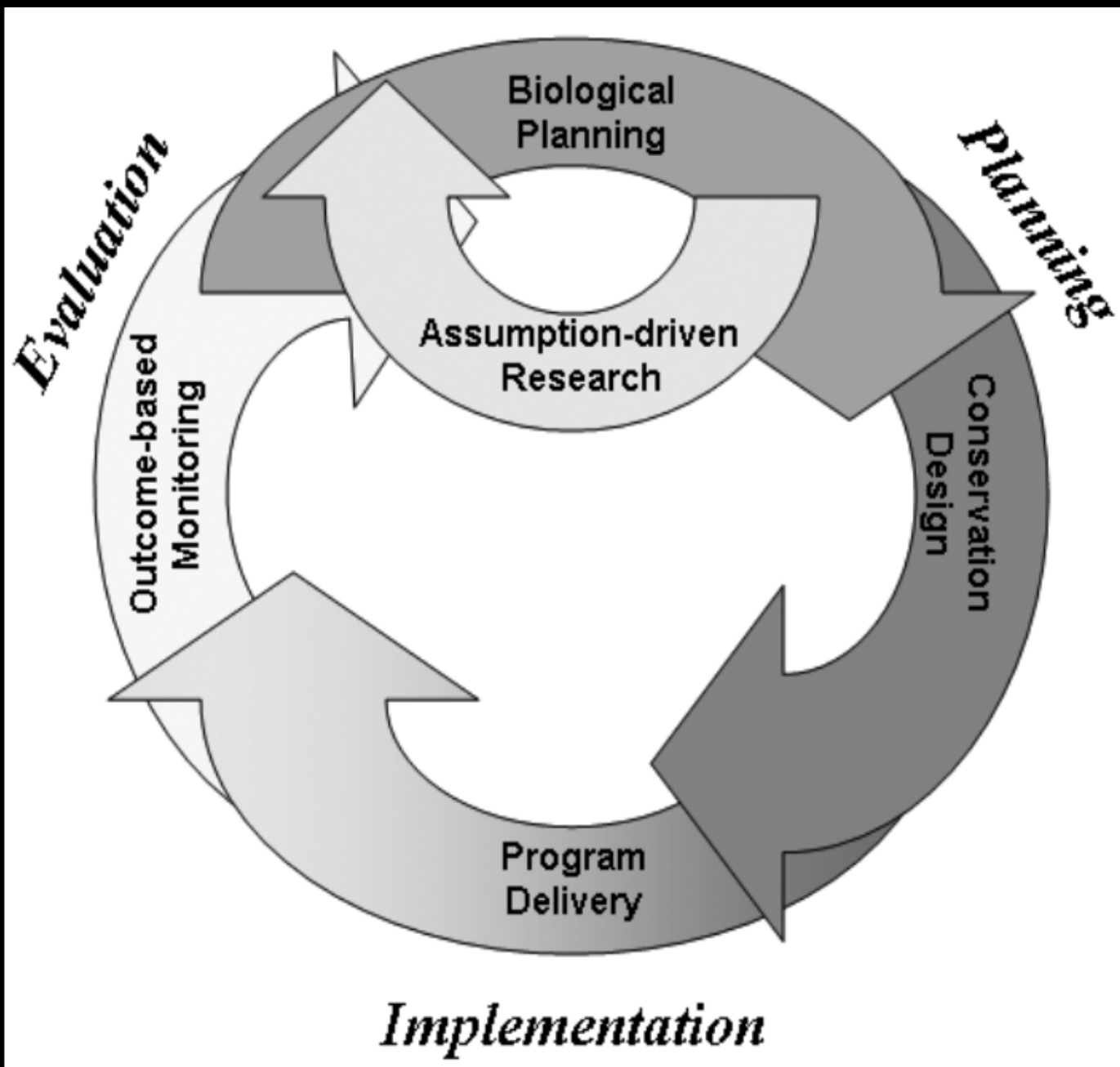
# Uncertainty

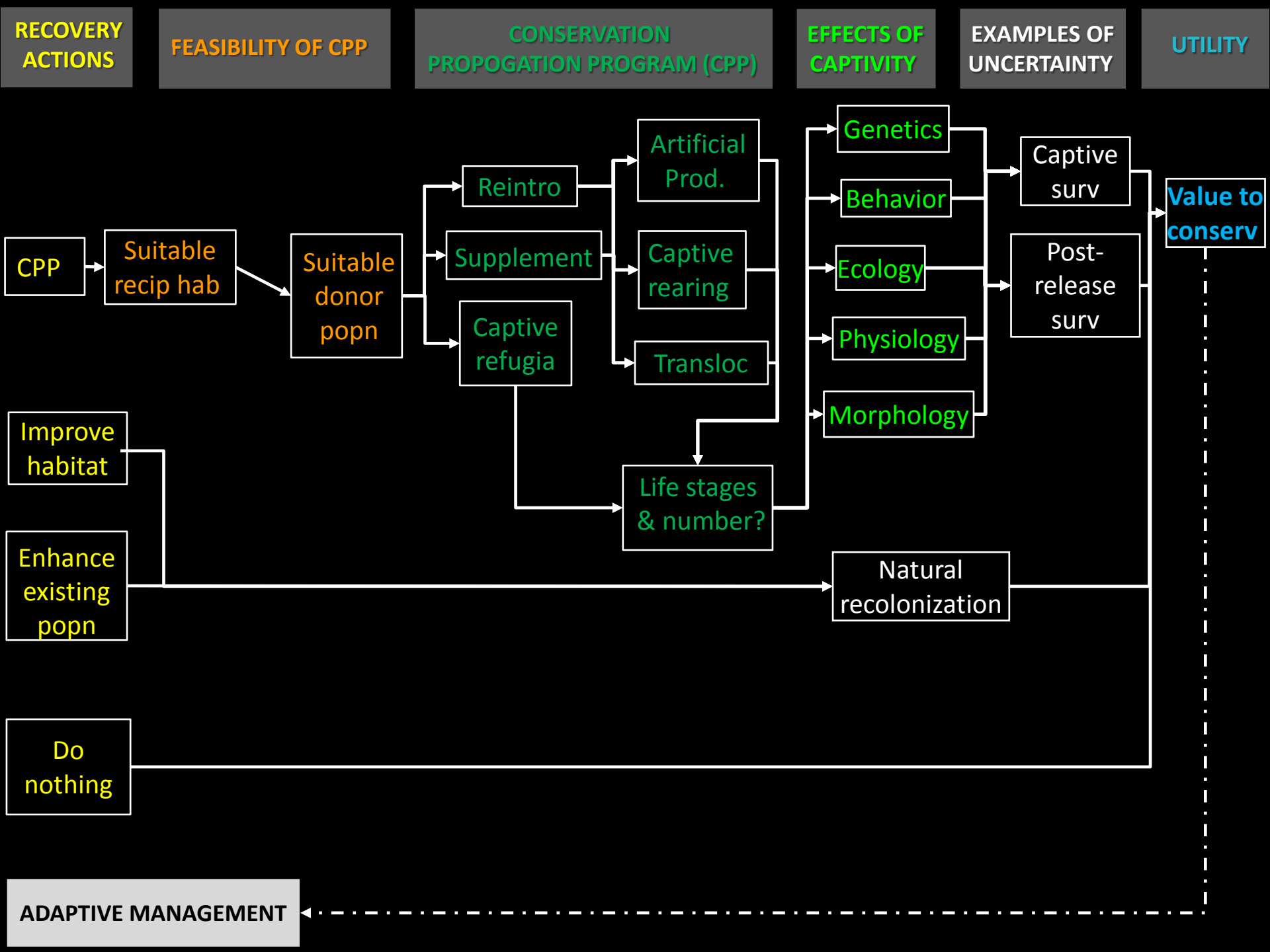
- Disease
- Density
- Flow
- Nutrition
- Rearing hab.
- Scale-up
- Genetics
- CPPs in action
- Monitor









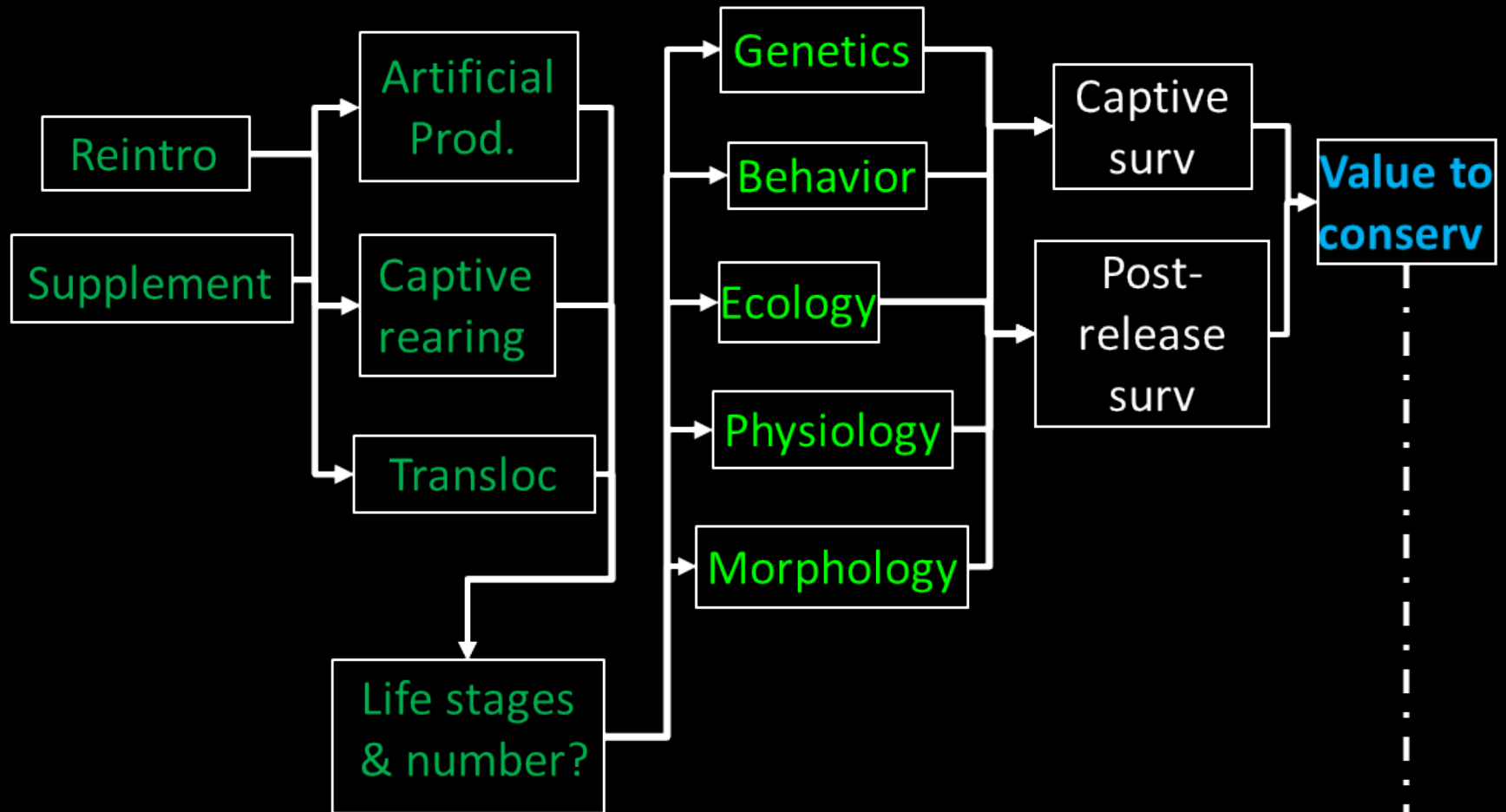


**CONSERVATION  
PROPOGATION PROGRAM (CPP)**

**EFFECTS OF  
CAPTIVITY**

**EXAMPLES OF  
UNCERTAINTY**

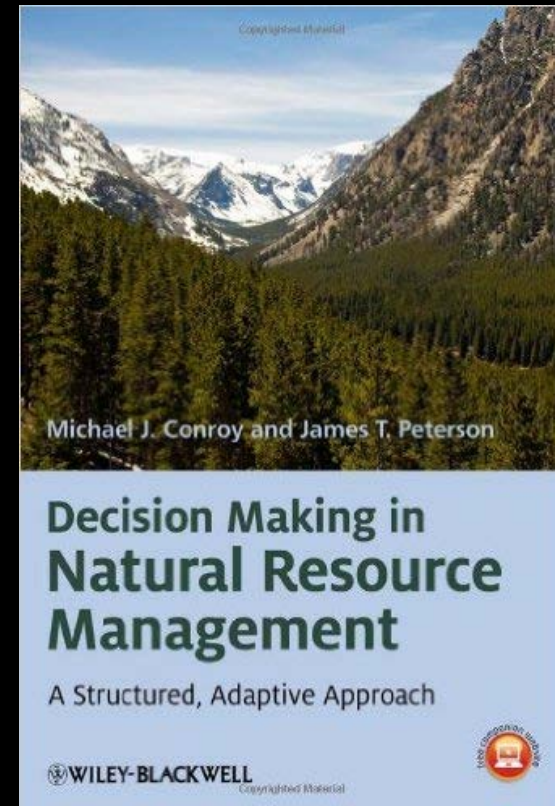
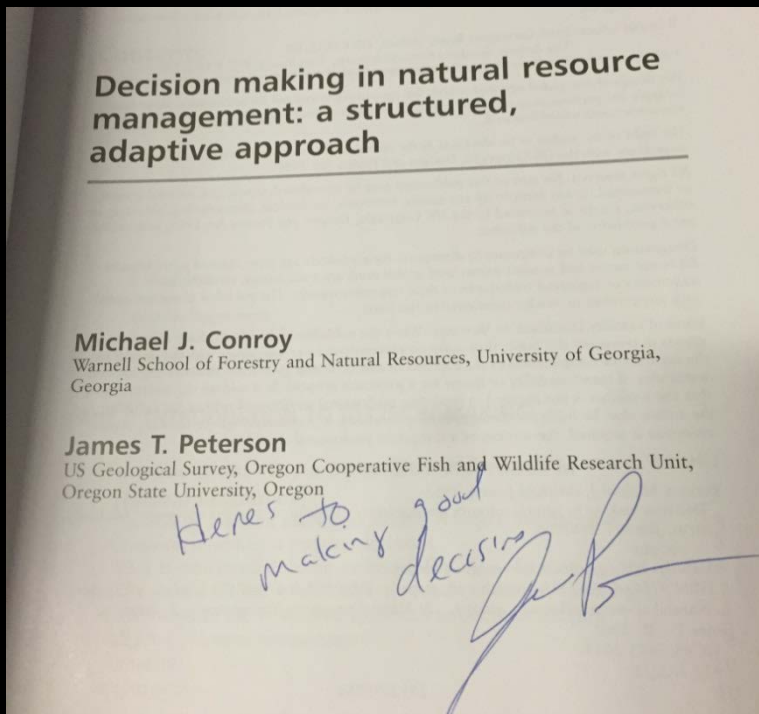
**UTILITY**



**ADAPTIVE MANAGEMENT**

# Objective

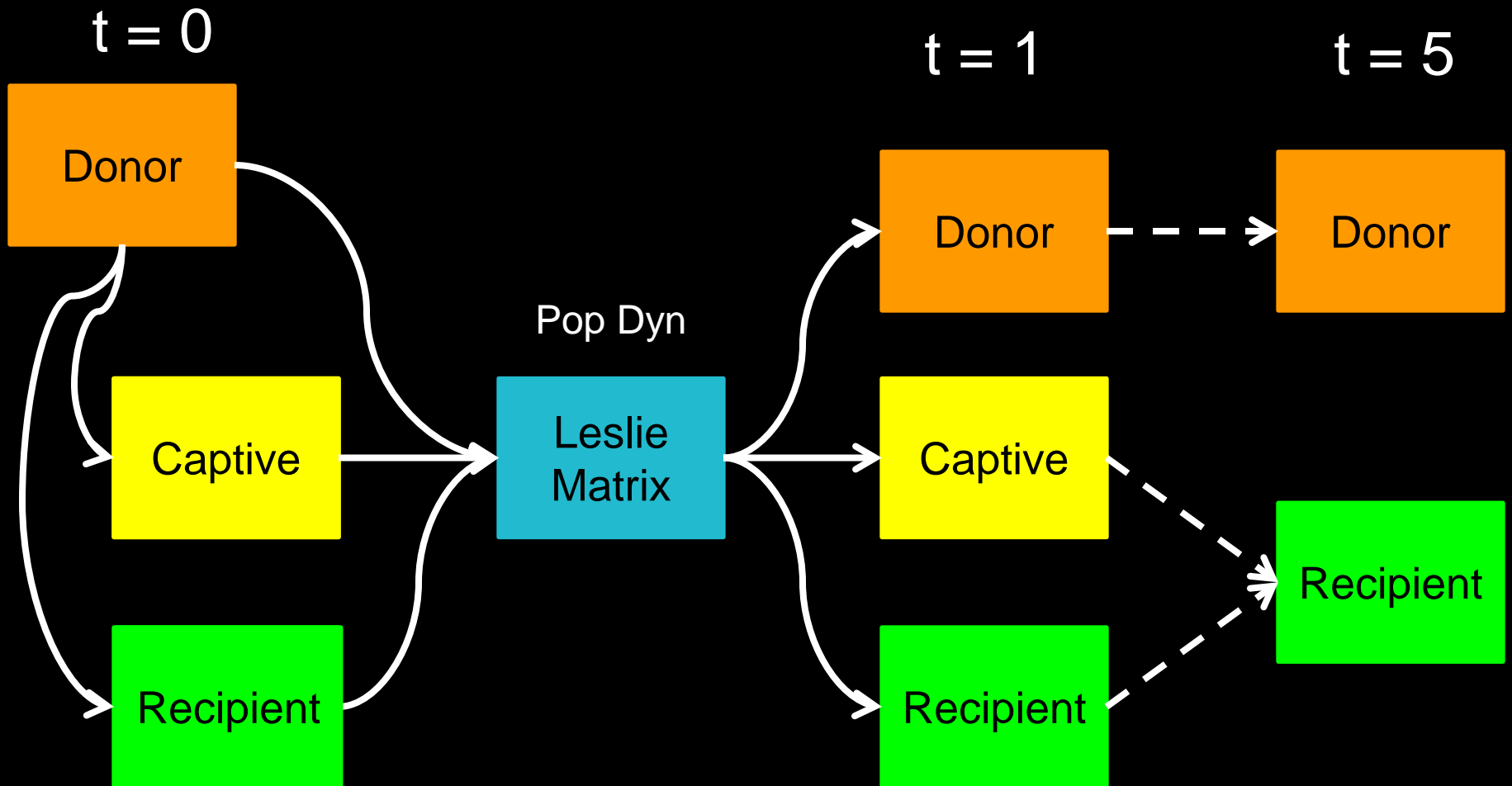
- Develop a decision model to evaluate the tradeoffs of alternative bull trout reintroduction strategies



# Management alternatives

	<b>strategy</b>	<b>Embryo</b>	<b>Juvi</b>	<b>Sub-adult</b>	<b>Small adult</b>	<b>Adult</b>
<b>1</b>	Do nothing	0	0	0	0	0
<b>2</b>	Transloc.	0	1000	0	0	0
<b>3</b>	Transloc.	0	0	0	30	30
<b>4</b>	Transloc.	0	1000	60	20	20
<b>5</b>	Captive rearing	20k	0	0	0	0
<b>6</b>	Artificial prop.	0	0	0	30	30

# Model structure



# Model ~ 35 parameters

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- Growth
- Survival
- Fecundity
  - Sex ratio
  - Eggs/♀
- DD function
  - Juvenile CC
  - Max egg survival
- Annual spawning
- Rapid captive growth
- Naïve penalty
- Strategy penalty



# Utility

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What we care about most  
Explicit quantifiable objective

Build a recipient popn

DO NOT crash donor popn

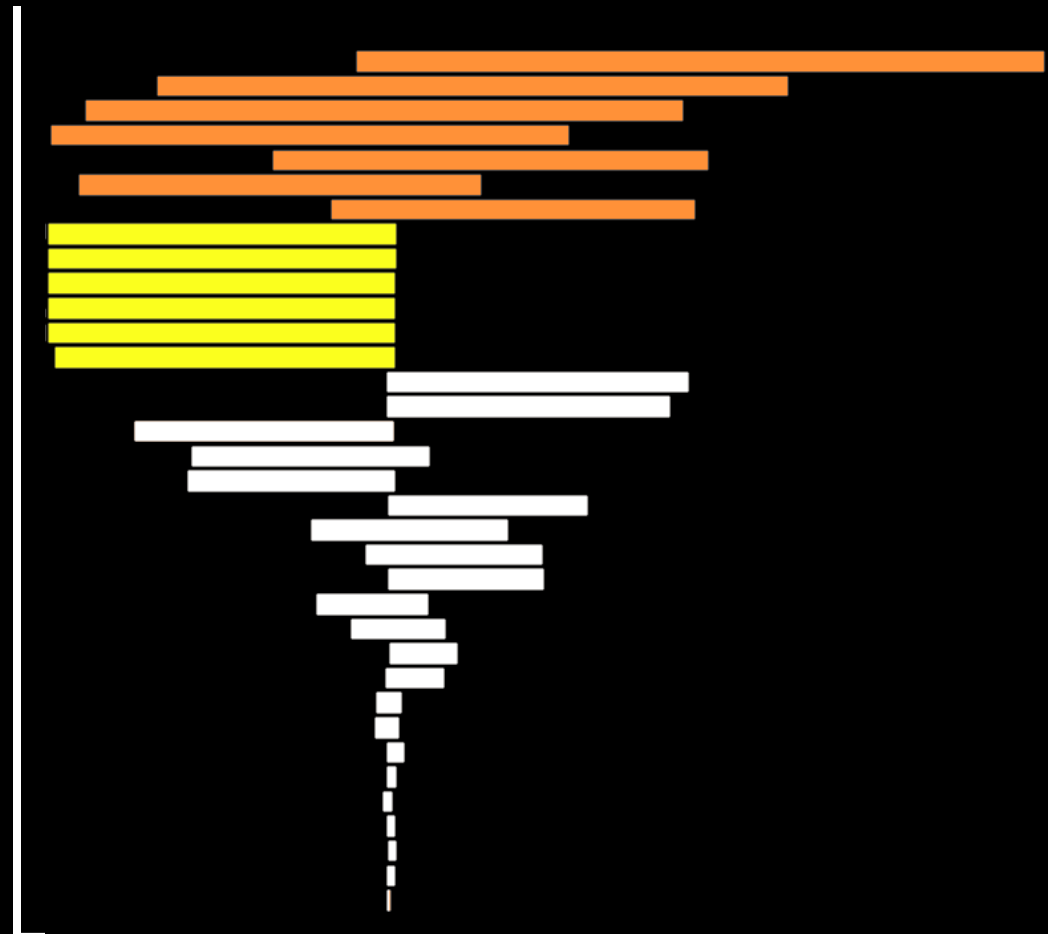
Are they equal?





# One way sensitivity

- Recip adult G/P
- Recip DD egg surv
- Sex ratio
- Fecundity
- Donor adult G/P
- Donor DD egg surv
- Starting donor popn
- Captive G/P
- Annual spawning
- Rapid captive G
- Naïve penalty
- Strategy penalty



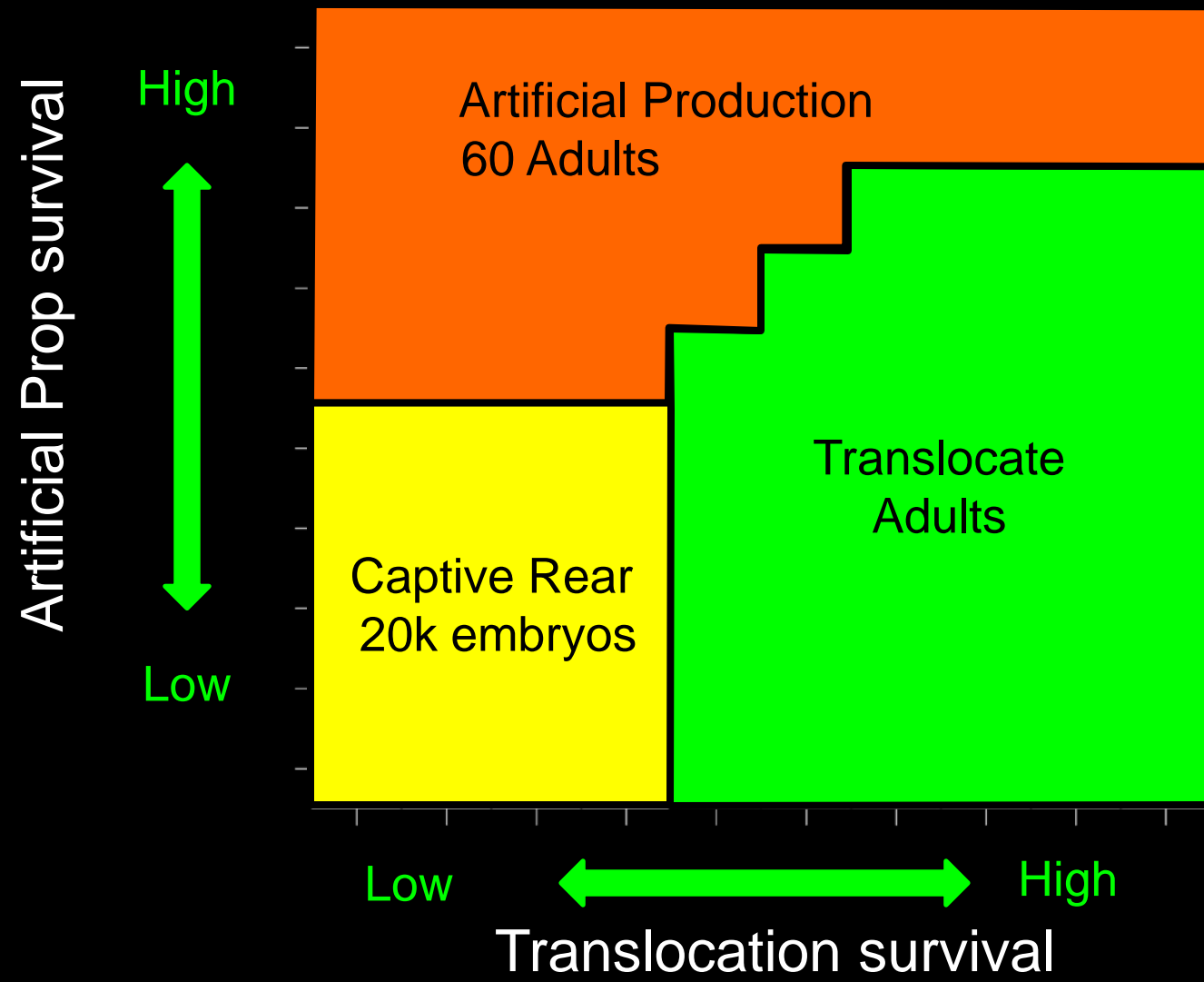
50 100 150

Relative value

Most sensitive

Least sensitive

# Two way sensitivity



# Two way sensitivity

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- **Adult growth**
  - Donor
  - Recipient
- **Adult survival**
  - Donor
  - Recipient
- **DD parameters**
- **Fecundity**
- **Naïve penalty**
  - Captive
  - Recipient
- **Rapid growth**
- **Annual spawning**
- **Strategy penalties**

# State Dependent Policy

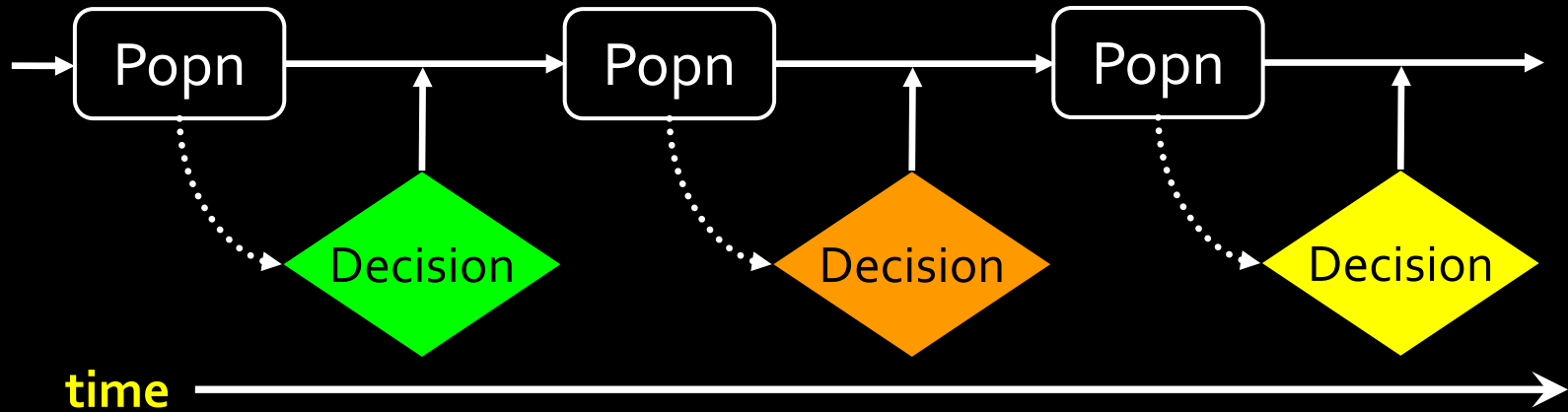
## Recipient popn

Donor popn

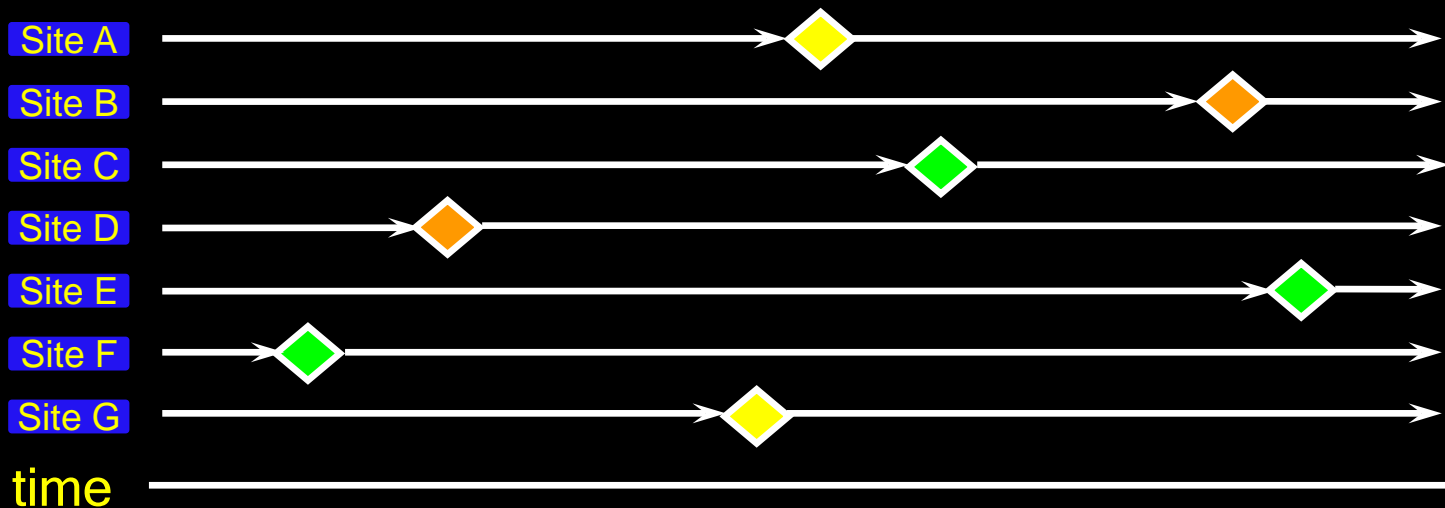
	0 - 50	50 - 300	300 - 500	> 500
0 - 100	1	1	1	1
100 - 300	2	1	1	1
300 - 500	4	2	1	1
500 - 800	3	3	4	1
> 800	3	3	3	1

# Sequential decision making

## Through time



## Space and time



# Questions

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