

Assessing and Reducing Ecological Risks of Hatchery Operations Using PCD Risk 1

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Approaches to Ecological Risk Assessment

- SIWG (1984) Interactions table
- WDFW's BRAP (1992)
- Expert-based Approach (e.g., Pearsons and Hopley 1999)
- Risk-based research (e.g., Sharpe et al. 2008)

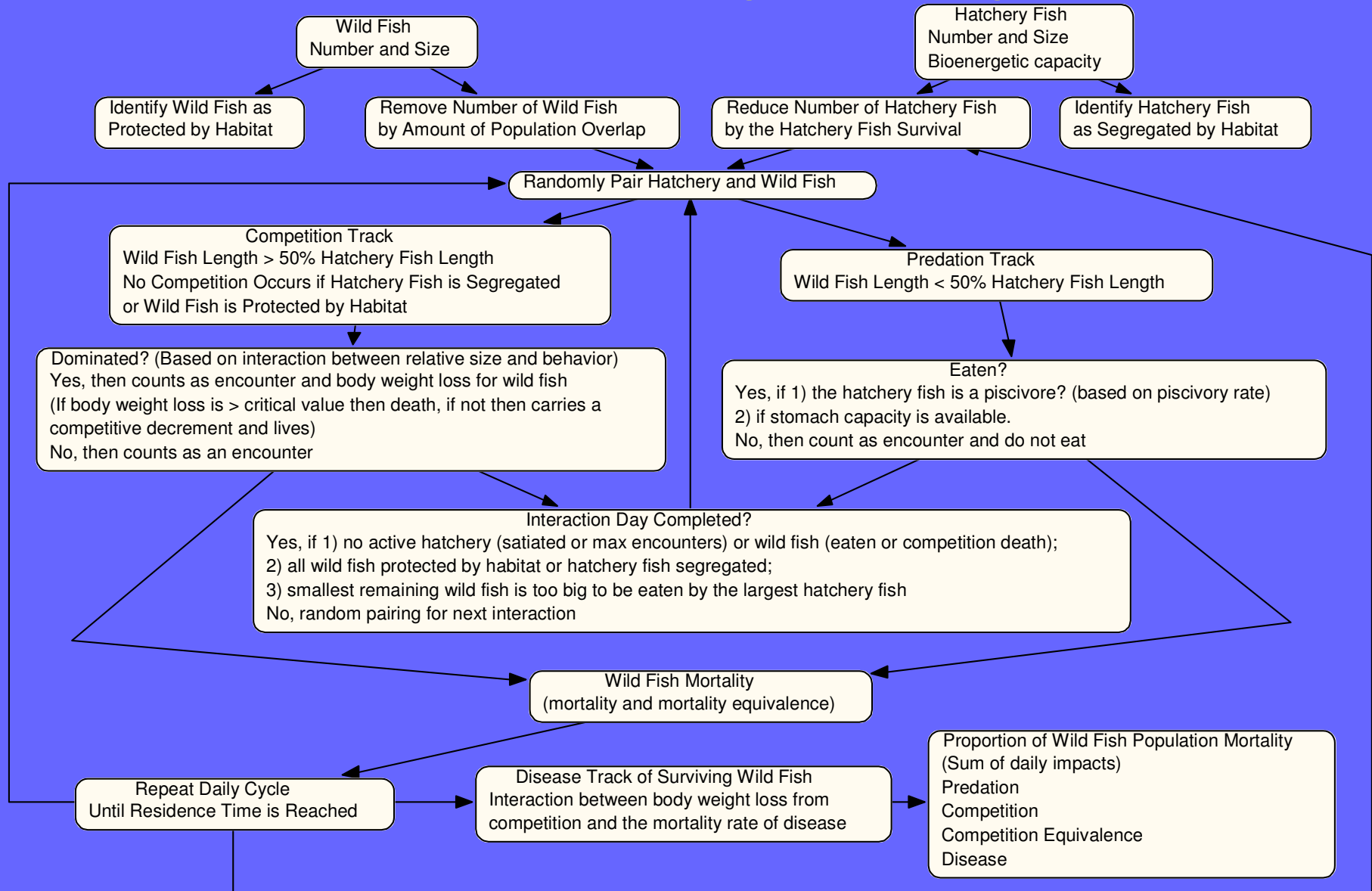
Approaches to Ecological Risk Reduction

- Size, time, and place of release
- Adaptive stocking
- Residualism reduction methods
- Disease guidelines
- Interactions indices

PCD RISK 1

- Individual-based model, simulates predation, competition, and disease impacts in freshwater on natural-origin (NO) juveniles caused by hatchery-origin (HO) juveniles
- Simulates impacts from single HO species on single NO species
- Assumes the groups are continuously accessible to each other under specified conditions, over specified time period
- Uses replicate runs to simulate uncertainty

PCD Risk Program Logic



Effect of Increases in Key Variables on Impacts

- Number of hatchery fish – increase
- Size of hatchery fish – increase or decrease
- Hatchery fish residence time – increase
- Population overlap – increase
- Habitat complexity – decrease
- Habitat segregation – decrease
- Daily encounters - increase
- Piscivory rate – increase
- Temperature - increase

Deterministic Mode Input Screen

Deterministic Input Screen

Number of Iterations: 30

Scaling Factor: 0.1

Hatchery Species: coho

Natural Species: chinook

Number of Hatchery Fish: 50000

Number of Natural Fish: 50000

Hatchery Fish Details

	Mean L	CV	Minimum L
	130	0.10	30

Natural Fish Details

	Mean L	CV	Prop. in Class
Age Class 1	60	0.15	1.0
Age Class 2	0	0.0	0.0
Age Class 3	0	0.0	0.0
Age Class 4	0	0.0	0.0
Age Class 5	0	0.0	0.0
Minimum L	25		

OK

Name of Output File: PCDRISK1.out

Name of Cumulative Output File: PCDRISKcum1.out

Hatchery Fish Residence Time: 10

Hatchery Fish Survival Rate: 0.6

Percentage Habitat Complexity: 50

Percentage Population Overlap: 100

Percentage Habitat Segregation: 20

Probability Dominance Results in Body Weight Loss: 0.1

Dominance Mode: 2

Percentage of Body Weight Loss Causing Death: 5

Maximum Daily Encounters per Hatchery Fish: 5

Piscivory Rate: 0.001

Temperature (Celsius): 12

Disease Mortality Rate for Fish with No Dominance Encounters: 0.0001

Disease Mortality Rate for Fish with Max Dominance: 0.5

Probabilistic Mode Input Screen

W Probabilistic Input Screen

Number of Iterations: 100

Scaling Factor: 0.1

Hatchery Species: coho

Natural Species: chinook

Number of Hatchery Fish: 50000

Number of Natural Fish: 50000

Hatchery Fish Details

	Mean L	CV	Minimum L
	130	0.10	30

Natural Fish Details

	Mean L	CV	Prop. in Class
Age Class 1	60	0.15	1.0
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Age Class 4	0	0.0	0.0
Age Class 5	0	0.0	0.0
Minimum L	25		

OK

Name of Output File: PCDRISK1.out

Hatchery Fish Residence Time: 5 10 20

Hatchery Fish Survival Rate: .5 .6 .7

Percentage Habitat Complexity: 20 50 100

Percentage Population Overlap: 100

Percentage Habitat Segregation: 10 20 90

Probability Dominance Results in Body Weight Loss: 0 .1 .9

Dominance Mode: 2

Percentage of Body Weight Loss Causing Death: 1 5 74

Maximum Daily Encounters per Hatchery Fish: 1 5 10

Piscivory Rate: 0 .001 .1

Temperature (Celsius): 12

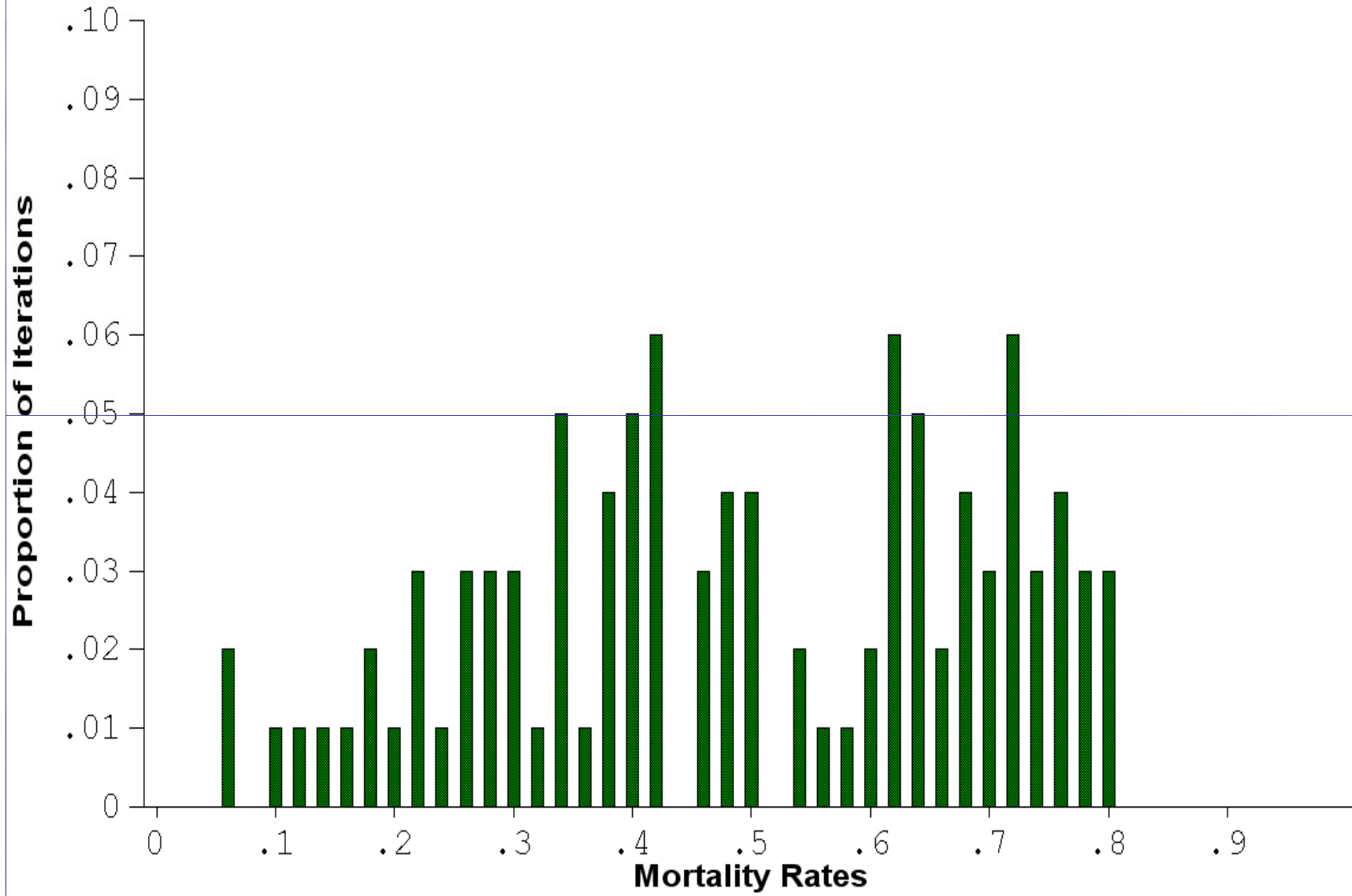
Disease Mortality Rate for Fish with No Dominance Encounters: 0 .0001 .1

Disease Mortality Rate for Fish with Max Dominance: 0 .5 1

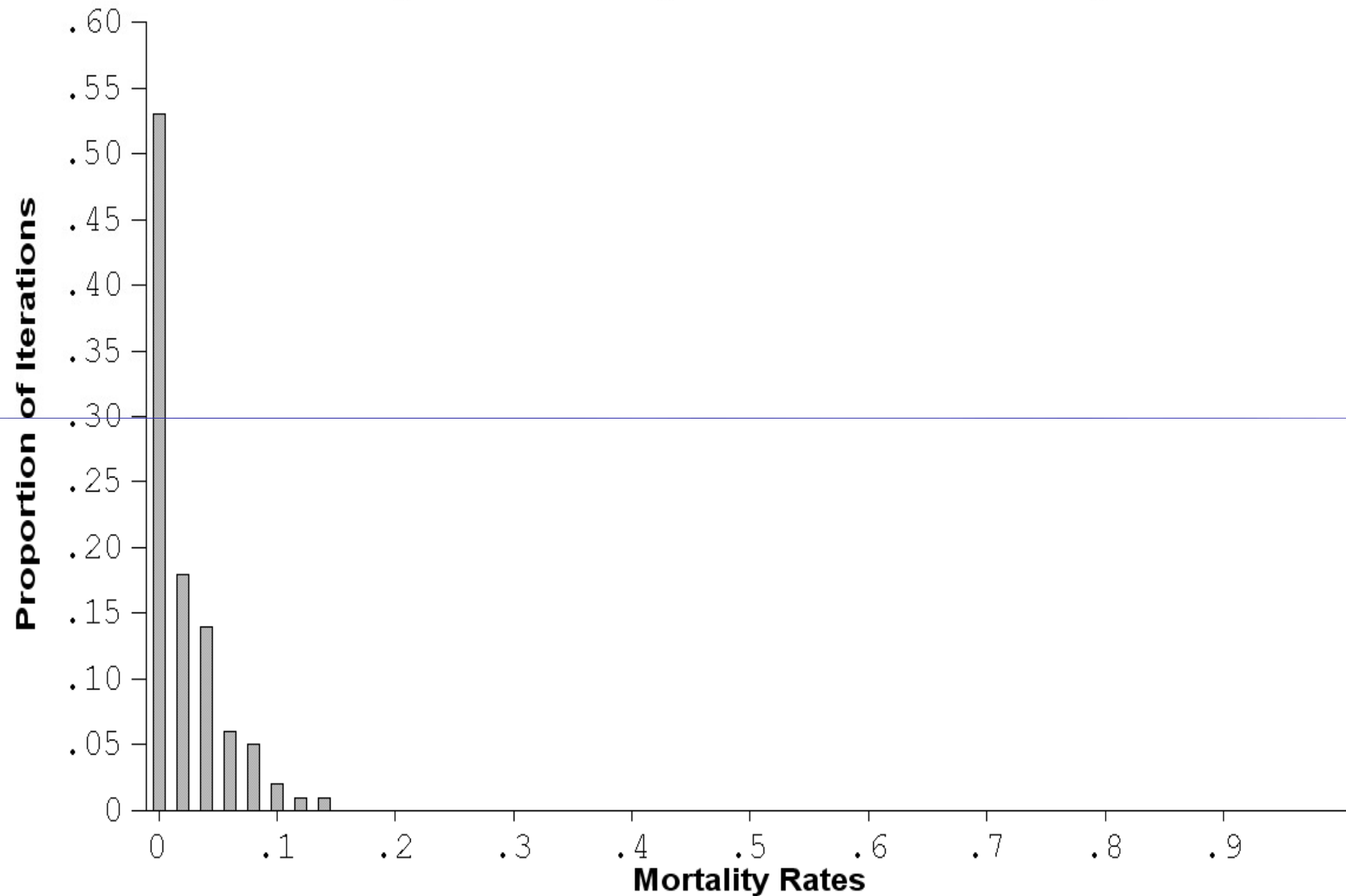
Tabular Output

W PCDRISK 1 Output Summary								
	Absolute				Rate (%)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Predation Mortality	25541.0	9892.3	4580.	40780.	51.1	19.8	9.2	81.6
Competition Mortality	202.8	1795.2	0.	14930.	0.6	3.6	0.0	29.9
Competition Mortality Equivalents	2348.6	1617.1	0.0	8013.9	4.7	3.2	0.0	16.0
Disease Mortality (Delayed)	2696.2	1734.8	150.	9900.	5.4	3.5	0.3	19.8
Total Mortality	30868.6	9621.1	8380.	46370.	61.7	19.2	16.8	92.7

Predation Mortality Rates



Competition Equivalent Mortality Rates



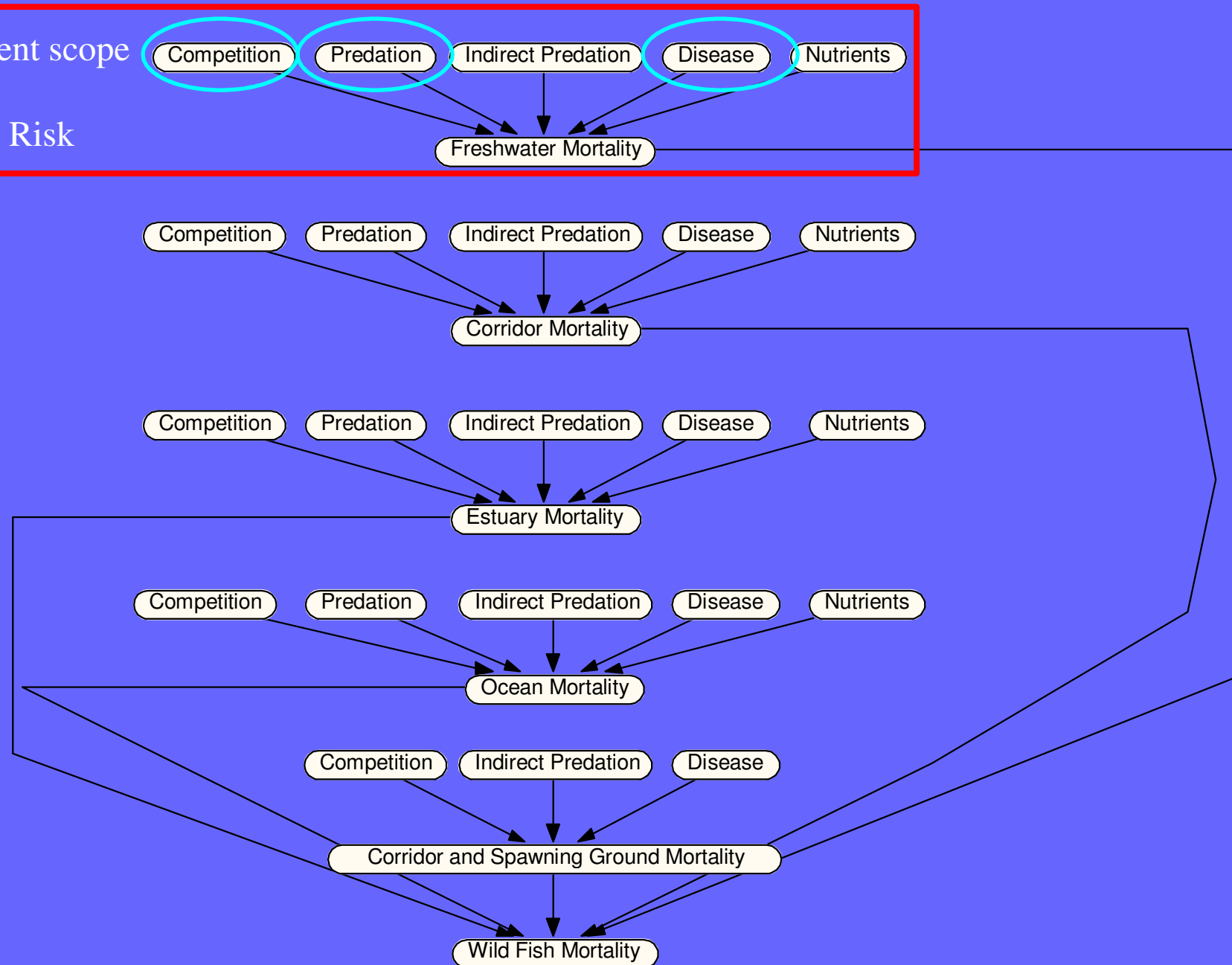
PCD Risk Strengths

- Easy to use
- Transparent and repeatable
- Science-based and reviewed by experts
- Uses readily available data
- Provides outputs that are useful to decision makers
- Very flexible, allowing a variety of scenarios to be examined
- Free

PCD Risk Caveats

- Untested empirically
- Heavy burden on the user for providing inputs when little empirical data is available (disease)
- Assumes no exploitative competition, no compensatory survival, fish <50% the hatchery fish length do not experience competition
- Not an ecosystem model (does not include many indirect interactions that could occur)
- Does not include other mechanisms and environments

Current scope
of
PCD Risk



Qualifications

- Model is a greatly simplified mathematical approximation of nature
- Mechanisms of impact don't always express themselves in measurable impacts
- Model does not replace real data collection. Model outputs are only hypotheses which can (and should) then be tested

PCD RISK 1 Availability

Downloadable from the BPA website

<ftp://ftp.bpa.gov/pub/efw-RAMP/>

Future Directions

- Empirically test model outputs
- Develop indirect predation and nutrient dynamics model
- Develop models for estuary, ocean, and spawning grounds
- Integrate ecological, genetic, and facilities risks and potential benefits into single model
- Other ideas from this meeting

The background of the slide is a photograph of a fish, likely a salmon, swimming in clear, greenish water. The fish is positioned horizontally, facing right, with its tail on the left and head on the right. The water has a slightly grainy texture, and there are some faint, darker spots visible in the background.

Acknowledgments

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