Valuing multiple programs to improve fish populations

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Washington State regulations and benefit-cost analysis

- **RCW 34.05.328: Significant legislative rules, other selected rules.**
  - (1) Before adopting a rule described in subsection (5) of this section, an agency shall:
    - (d) Determine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented;

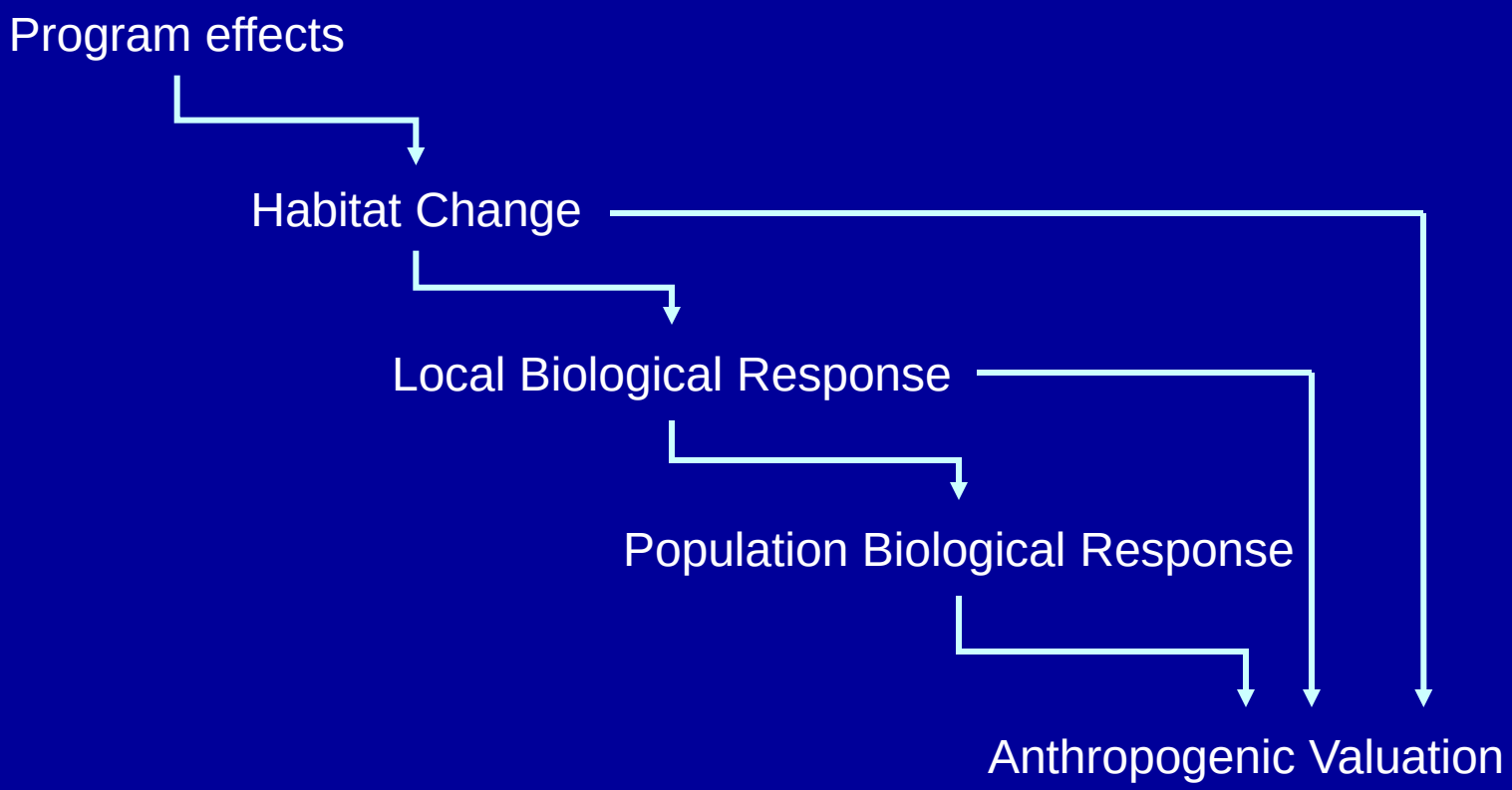
Five 1998 potential regulations affecting fish

- Department of Ecology
  - Toxics Control Program standards (indirect fish benefits)
  - Sediment Management Standards (indirect)
  - Water Quality Standards (direct)
  - Instream Flow Rules (direct)
- Department of Natural Resources
  - “Forest and Fish” rules for forest practices (direct)

Options for estimating benefits

1. Estimate value for each rule independently
   - Problem: “Too Many Proposals Pass the Benefit Cost Test” (Hoehn and Randall, 1989; Hoehn and Loomis, 1993)
2. Estimate value for combination of programs, but focus on habitat changes
   - Problem: Habitat is an “intermediate good” if fish populations are source of value (not always), and link between habitat and fish is murky

Habitat-Fish Linkages (1998)



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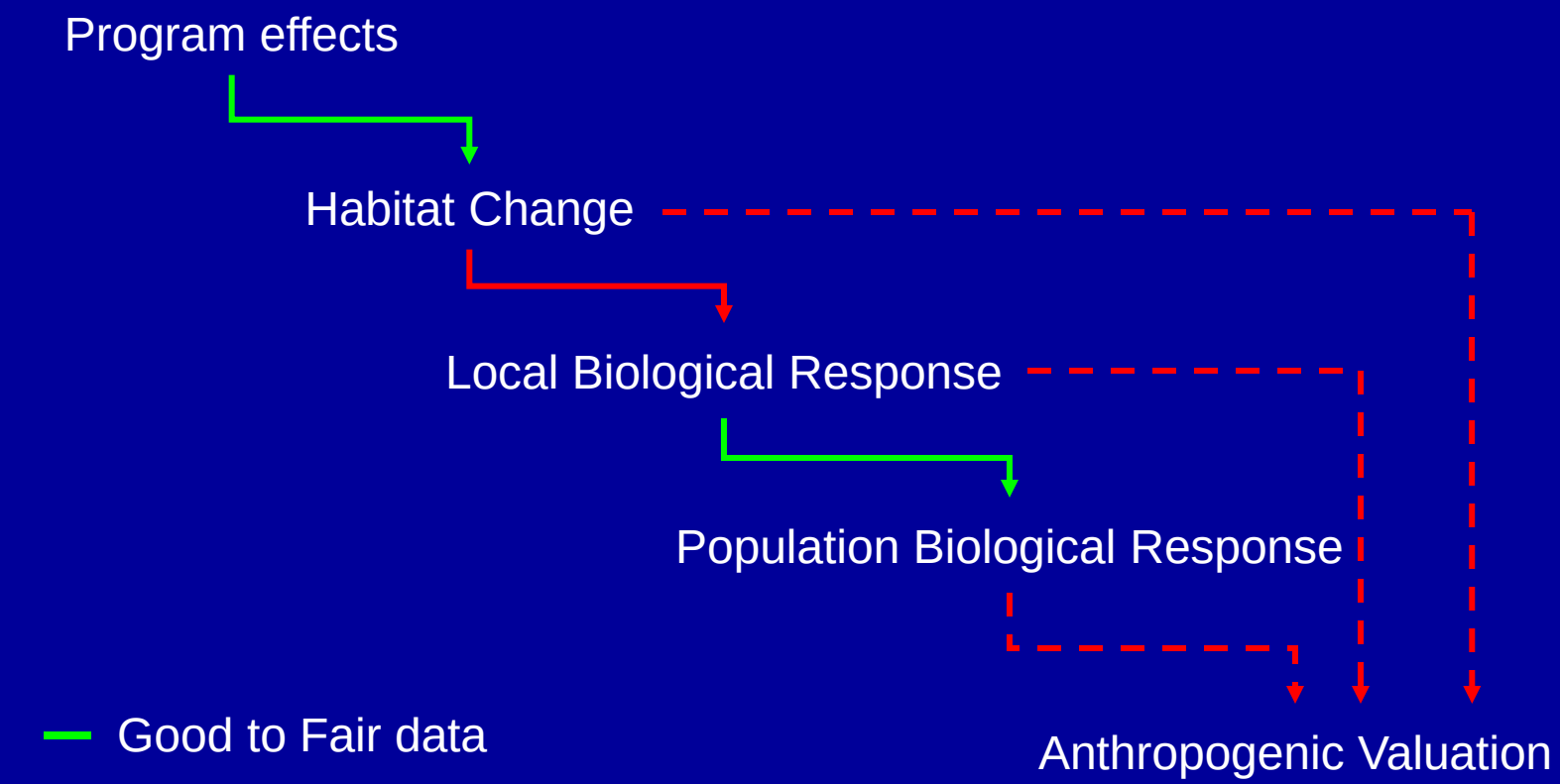

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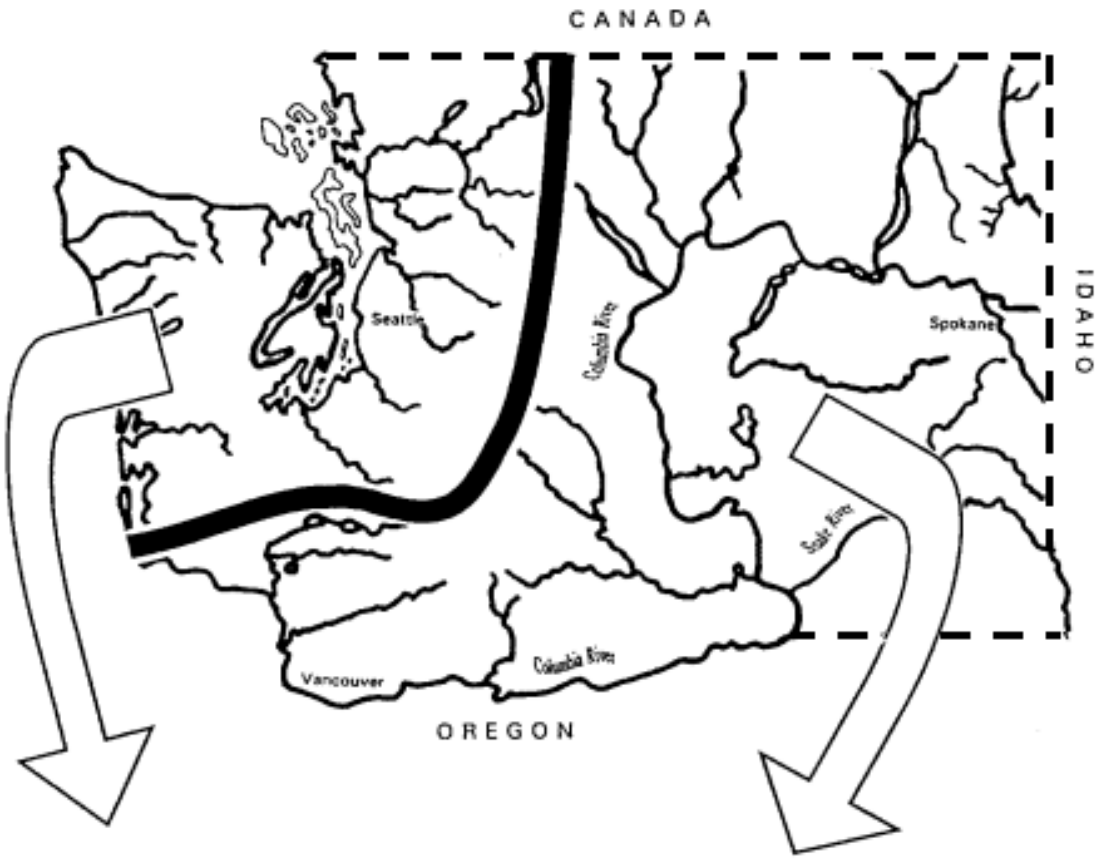
3. Estimate fish value function and let agencies establish link between habitat improvements and fish population changes
   - Problem: Fish is not the only valued output of programs, but can always add other values (carefully)

Study development

- Goal: Produce estimates of fish values that could be used for all five rules (and future regulations)
- Basic approach: Stated preference ratings survey of WTP for improvements to fish populations (Layton and Lee, 1998,2003)
- Coverage: 5 broad groups of fish populations, defined by
  - Type: Freshwater, Saltwater, Migratory
  - Region of state: Western Washington & Puget Sound, Eastern Washington & Columbia River



Western Washington and Puget Sound

- Freshwater Fish
- Saltwater Fish
- Migratory Fish

Eastern Washington and Columbia River

- Freshwater Fish
- Migratory Fish

Survey Design: Preliminaries

- "Warm up" questions
  - Knowledge of fish issues
  - Factors affecting fish populations
  - Government programs affecting water quality
- Household income reduction exercise
  - 4 ranges of monthly income reduction, possible changes in spending habits:
  - "If your household's income was reduced by $25 per month, what would you reduce your spending on?

Survey Design: Current Situation

- Describing state of fish populations was important to give respondents context:
  - Past trends: "Under the current set of Washington State programs and regulations, some fish populations, such as some salmon, steelhead and halibut, are declining. Other fish populations, such as perch and many trout are stable and in good shape."
  - Future trends: "Scientists cannot say with certainty how the population of each and every fish species will change over the next 20 years. Their best estimates of the past and future population trends under the current set of fishery programs are shown below for the two regions of the state."
- Future trends proved difficult to establish with certainty, so **two** scenarios were constructed (split sample)

Fish Population Trends

	Population 20 years ago	Population Today	Population in 20 years with no new programs
Western Washington & Puget Sound			
Freshwater Fish	93 million	70 million	High SQ: 70 million Low SQ: 53 million
Saltwater Fish	860 million	215 million	High SQ: 215 million Low SQ: 54 million
Migratory Fish	10 million	5 million	High SQ: 5 million Low SQ: 2.5 million
Eastern Washington & Columbia River			
Freshwater Fish	192 million	120 million	High SQ: 120 million Low SQ: 75 million
Migratory Fish	8 million	2 million	High SQ: 2 million Low SQ: 0.5 million

Survey Design:
Programs for Improving Fish Populations

- Presented each respondent with randomly generated set of "Four Possible New Programs Compared to the Current Situation"
- Focused on *effects*, not details of programs:

> The state of Washington is considering a variety of ways for improving fish populations, ranging from reductions in toxic contamination of water bodies to improvements in river flows and fish habitat. . . . We want your opinion of four possible new programs, which are listed below. ***Rather than spelling out each program in detail, we want you to focus on the effects they will have over the next 20 years***, which we have listed for each program. The effects listed are the best estimates fishery biologists can make.

Survey Design:
Programs for Improving Fish Populations

	Fish Populations in 20 Years		
	No New Programs	**New Programs (% increase over**	
		Program 1	**Program 2**
Western Washington & Puget Sound			
Freshwater Fish	70 million	81 million (+15%)	93 million (+33%)
Saltwater Fish	215 million	247 million (+15%)	286 million (+33%)
Migratory Fish	5 million	5.75 million (+15%)	6.65 million (+33%)
Eastern Washington & Columbia River System			
Freshwater Fish	120 million	120 million (+0%)	126 million (+5%)
Migratory Fish	2 million	2 million (+0%)	2.1 million (+5%)
Additional Cost of Program (Monthly for 20 years)	$0	$25	$45

Survey Design: Ratings Exercise

- Ratings exercise
  - We would like you to compare the effects and cost of each of the four possible new programs to the situation in which no new programs are implemented over the next 20 years. Remember, a new program will affect the state's fish populations but it will also impose some costs on your household
  - Using a rating scale from –5 to +5, please rate each Program compared to the situation of No New Programs. *(For each of the four programs, please circle a number from –5 to +5.)*

Survey Administration

- Survey mailed to randomly selected Washington State households during the spring of 1998.
- Of 2819 deliverable surveys, 1917 responses were received, for a response rate of 68%. Of these 1917 respondents, 1611 provided complete, useable responses to the fish valuation questions.
- 801 answered the High status quo version, and 810 answered the Low status quo version.

Data Analysis

- Censored ranking model (Layton and Lee, 1998, 2003)
- Random utility: Individual *i* evaluates utility of alternative *j*:

$$U_{ij} = V_{ij}(\text{Cost, PF, PS, PM, CF, CM}) + \varepsilon_{ij}$$

- Considered three specifications:
  - Linear
  - Log-linear
  - Modified log-linear (log-linear for 5%+, which was smallest positive increment; indirect utility for SQ normalized to equal zero; fish improvements measured as percentage increase above SQ)
- Last model had significantly best fit

WTP analysis

- Specification allowed for decreasing marginal value for a given fish population, but assumed independence *across* population groups

$$WTP = \frac{-\beta_{Fish}}{\beta_{Cost}} \ln(\%\ fish\ \ improvement)$$

- Confidence intervals for ratio ($\beta_{Fish}/\beta_{Cost}$) (Krinsky and Robb, 1986)

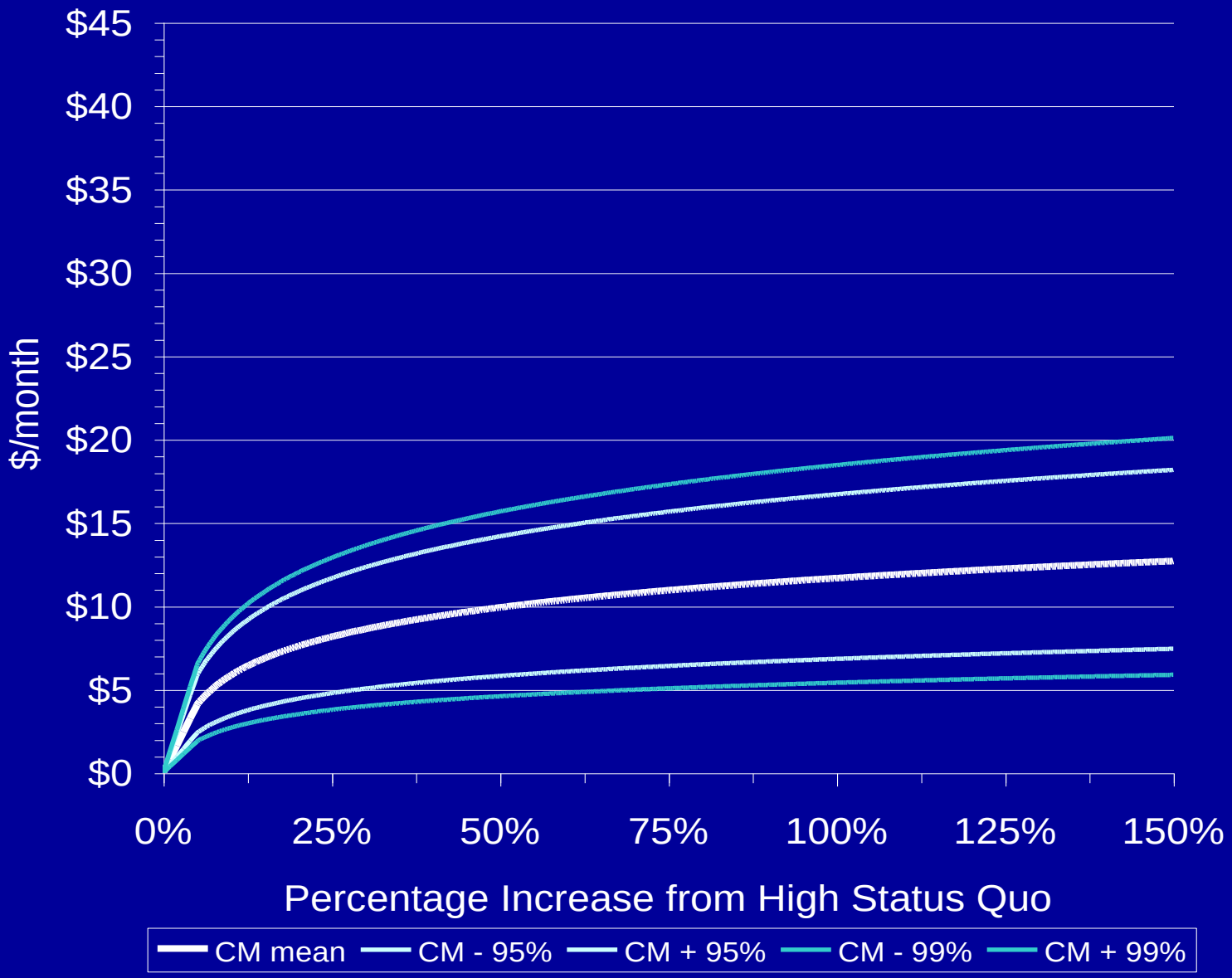
Results: Washington State WTP for Fish Population Increases

WTP (Millions $1999)	Increase in Fish Population in 20 years (above status quo level)			
Fish Population:	10%	25%	50%	100%
High Status Quo: Without new programs, fish populations are stable at current levels				
Western Washington & Puget Sound				
Freshwater (PF)	$240	$336	$408	$480
Migratory (PM)	$322	$450	$547	$644
Saltwater (PS)	$326	$456	$554	$652
Eastern Washington & the Columbia River				
Freshwater (CF)	$221	$309	$375	$441
Migratory (CM)	$153	$214	$261	$307

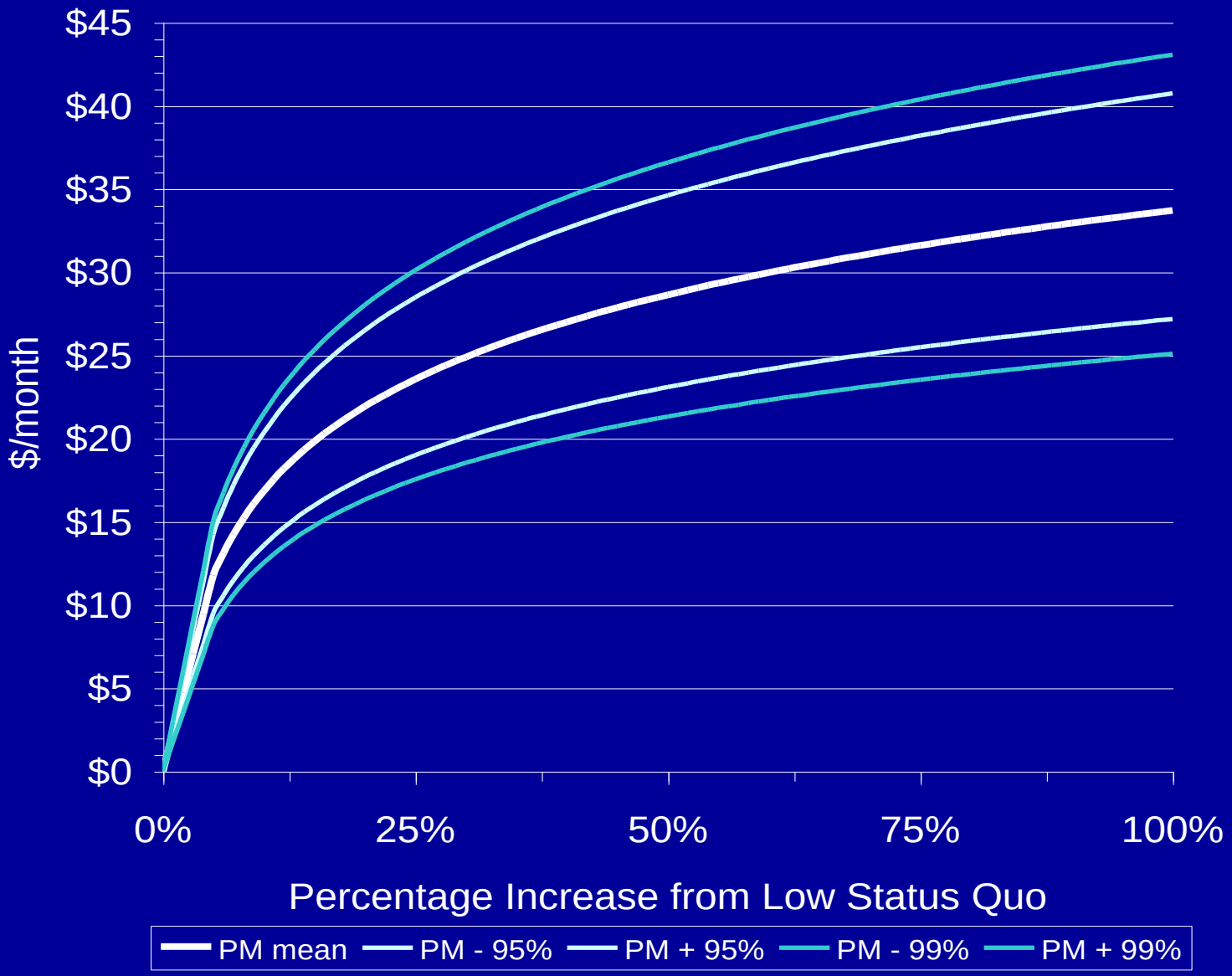
Results: Washington State WTP for Fish Population Increases

WTP (Millions $1999)	Increase in Fish Population in 20 years (above status quo level)			
Fish Population:	10%	25%	50%	100%
Low Status Quo: Without new programs, fish populations continue to decline at their present rate				
Western Washington & Puget Sound				
Freshwater (PF)	$446	$624	$758	$892
Migratory (PM)	$443	$619	$752	$886
Saltwater (PS)	$484	$676	$822	$968
Eastern Washington & the Columbia River				
Freshwater (CF)	$225	$315	$382	$450
Migratory (CM)	$293	$410	$498	$587

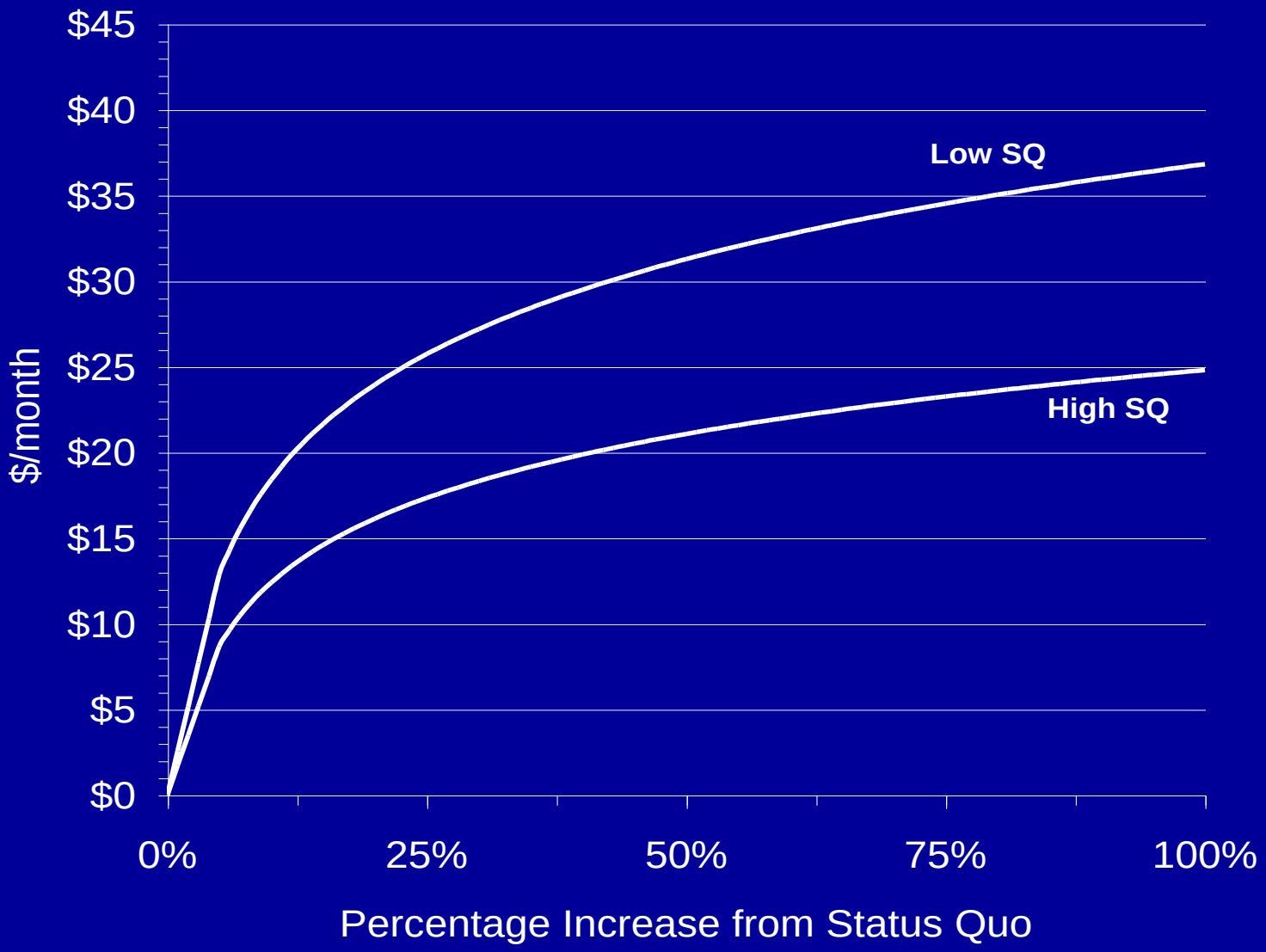
Household WTP ($/month) for Eastern Washington & Columbia River Migratory Fish



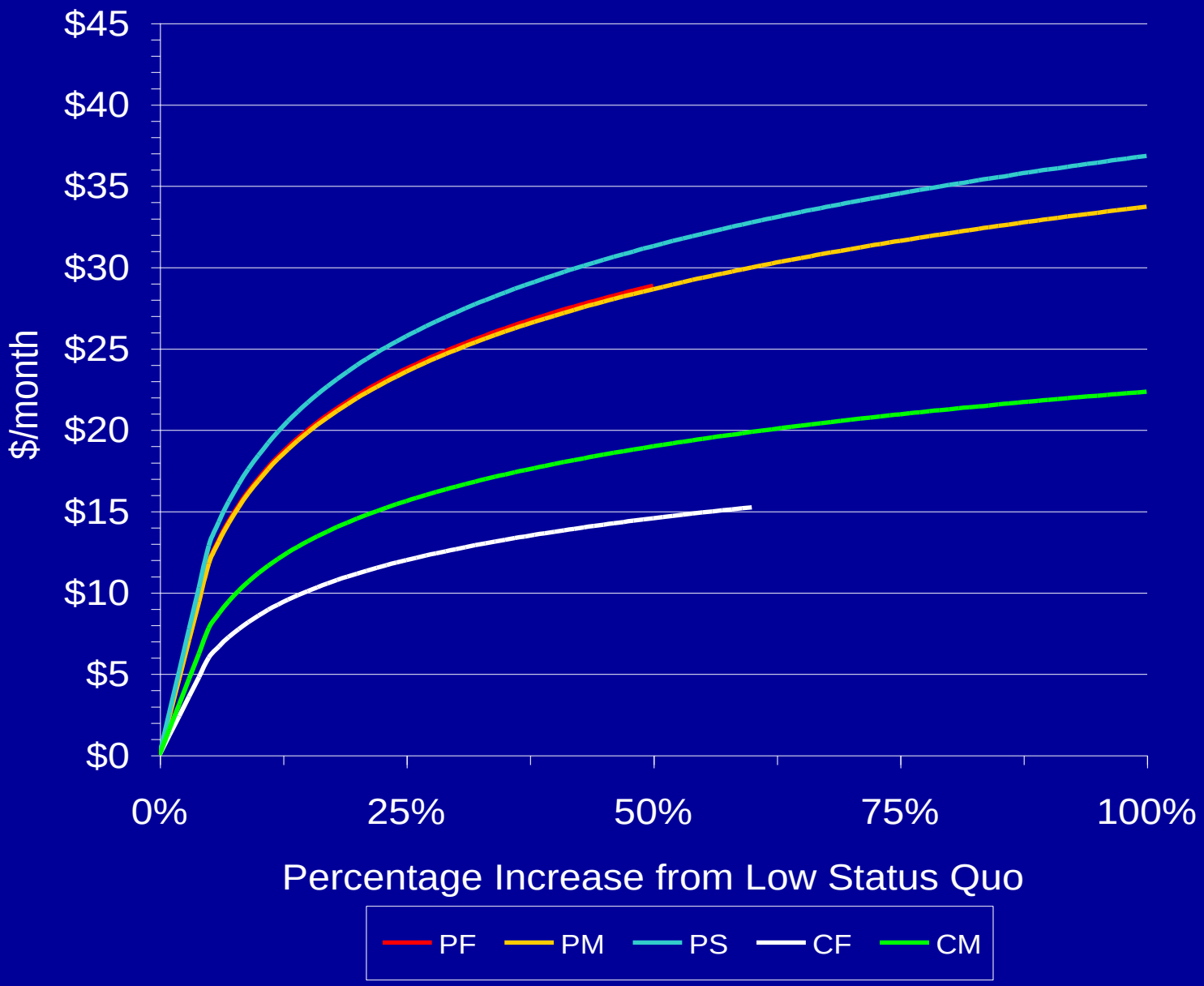
Household WTP ($/month) for Western Washington & Puget Sound Migratory Fish



Household WTP ($/month) for Western Washington & Puget Sound Saltwater Fish



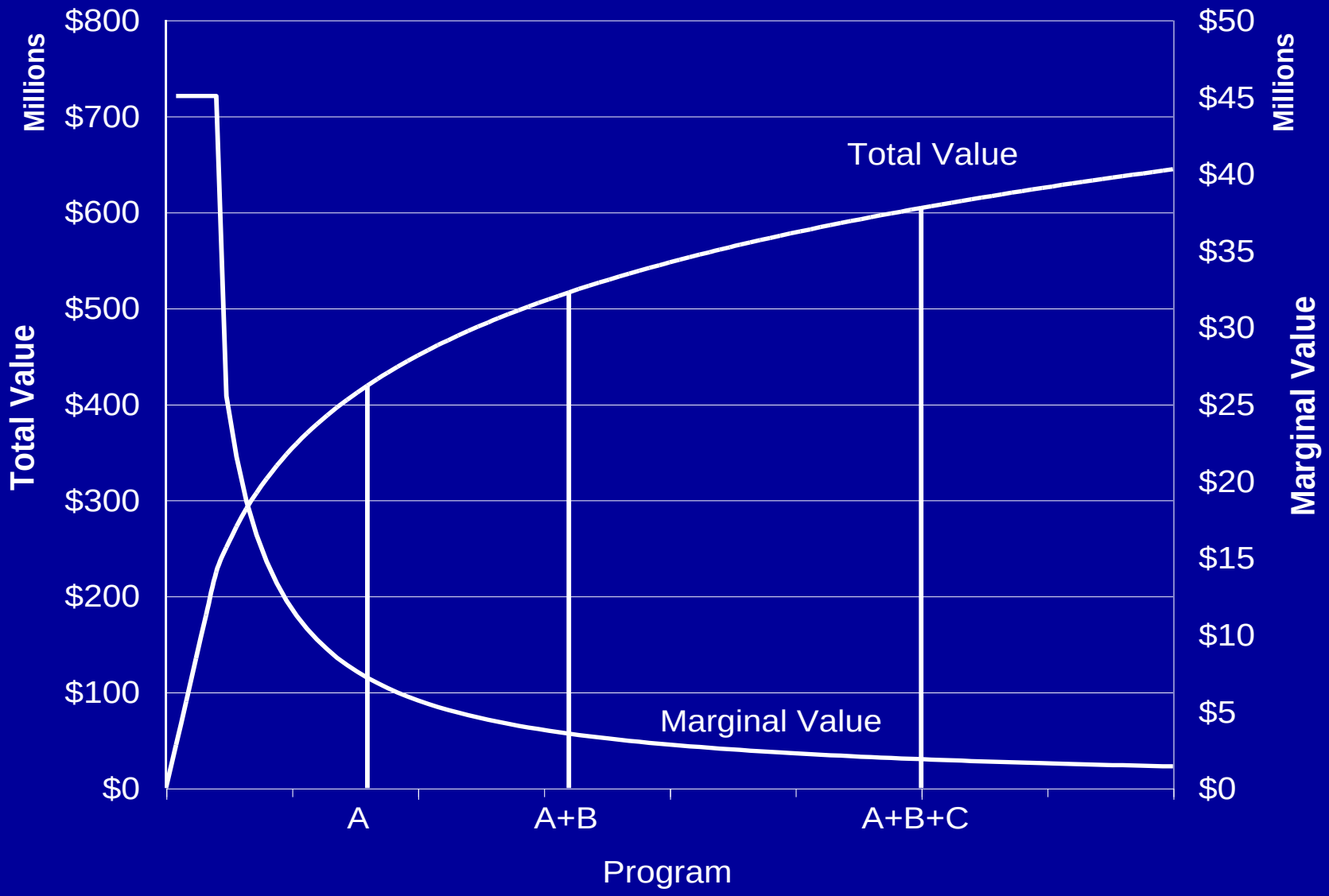
Household WTP ($/month) for Five Fish Population Groups



Multiple Programs

Program	Effects on Western Washington & Puget Sound Migratory Fish Populations	Population in 20 years (cumulative)	Cumulative % increase over status quo population
Status Quo (High)	Population stable	5,000,000	–
Program A	Will improve **coastal** populations by 1,000,000 fish	6,000,000	20%
Program B	Will improve **northern Puget Sound** populations by 1,000,000 fish	7,000,000	40%
Program C	Will improve **southern Puget Sound** populations by 1,750,000 fish	8,750,000	75%

Annual WTP for Western Washington & Puget Sound Migratory Fish



Epilogue

- The WTP function is like a *non-renewable resource*
  - Values are cumulative => As actions are taken to improve fish populations, movement up the curve effectively changes baseline for subsequent actions (*assuming* WTP is in fact extracted from population, otherwise values wander off the curve).
  - Non-linearity means that early rules have relatively large values (decreasing marginal WTP)
  - Order is therefore important => Race to use WTP values?

Epilogue

- Has Washington State used the 1999 estimates in BC analysis?
  - Department of Natural Resources, Forest Practice Rules (adopting the “Forests and Fish Report”), 2001 => 5% improvement in W. and E. migratory and freshwater fish populations
  - Department of Ecology adopted water temperature standards in the Water Quality Standards rule, => 0.76% improvement in W. and E. migratory and freshwater fish populations
  - Various individual Water Resource Inventory Areas, water allocation rules => *Reductions* in fish populations