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SEI STOCKHOLM ENVIRONMENT INSTITUTE

Integrating Water Supply And Ecological Flow Requirements

EPA Grant # X3-83238601-0

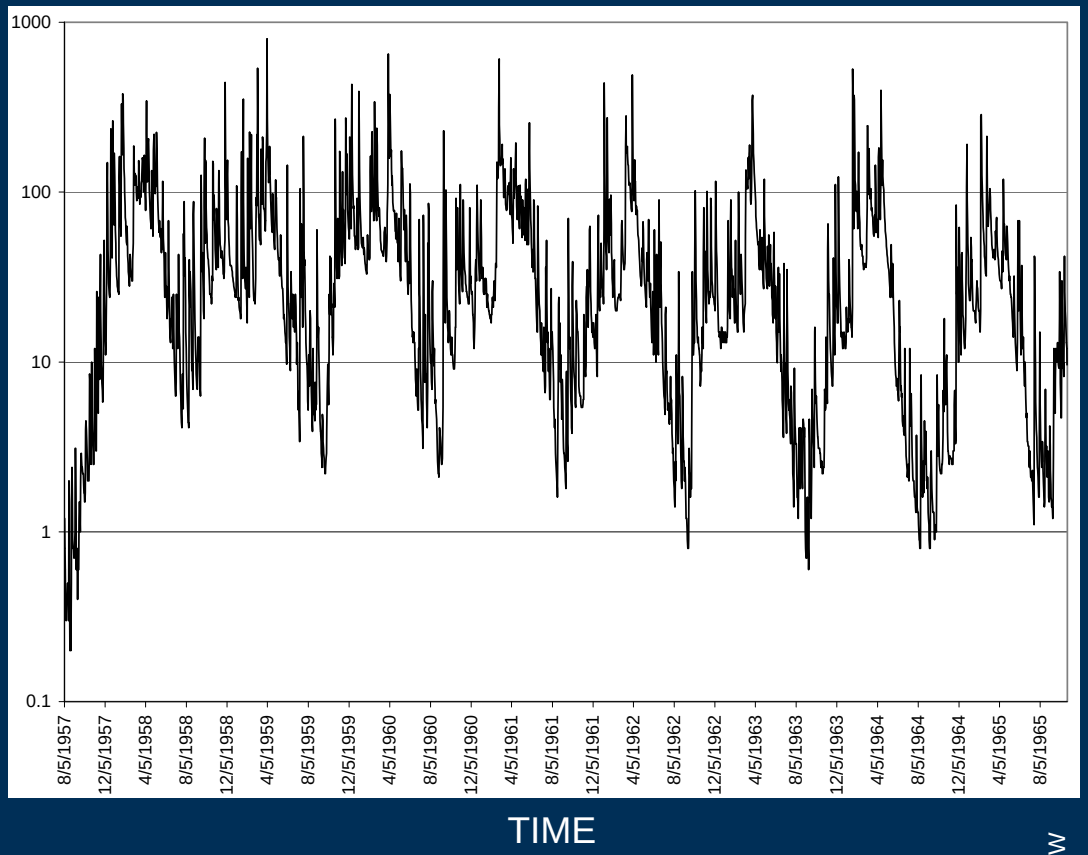
Collaborative Science and Technology Network for Sustainability Workshop

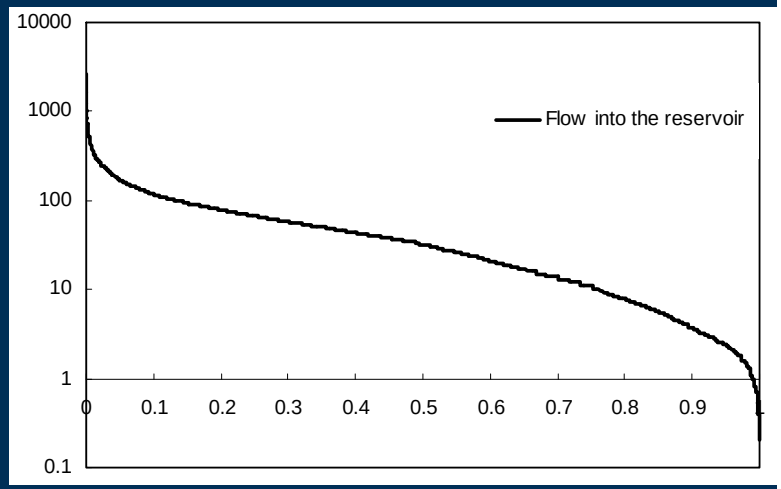
Washington, DC
November 8-9, 2007

Experiment Objectives

- Examine trade-offs between human and ecological demands for water for a wide range of reservoir-release policies and reservoir sizes
- Quantify effects of demand management on this tradeoff
- Apply results to real-world case studies
- Communicate results through publication

Inflows to the reservoir





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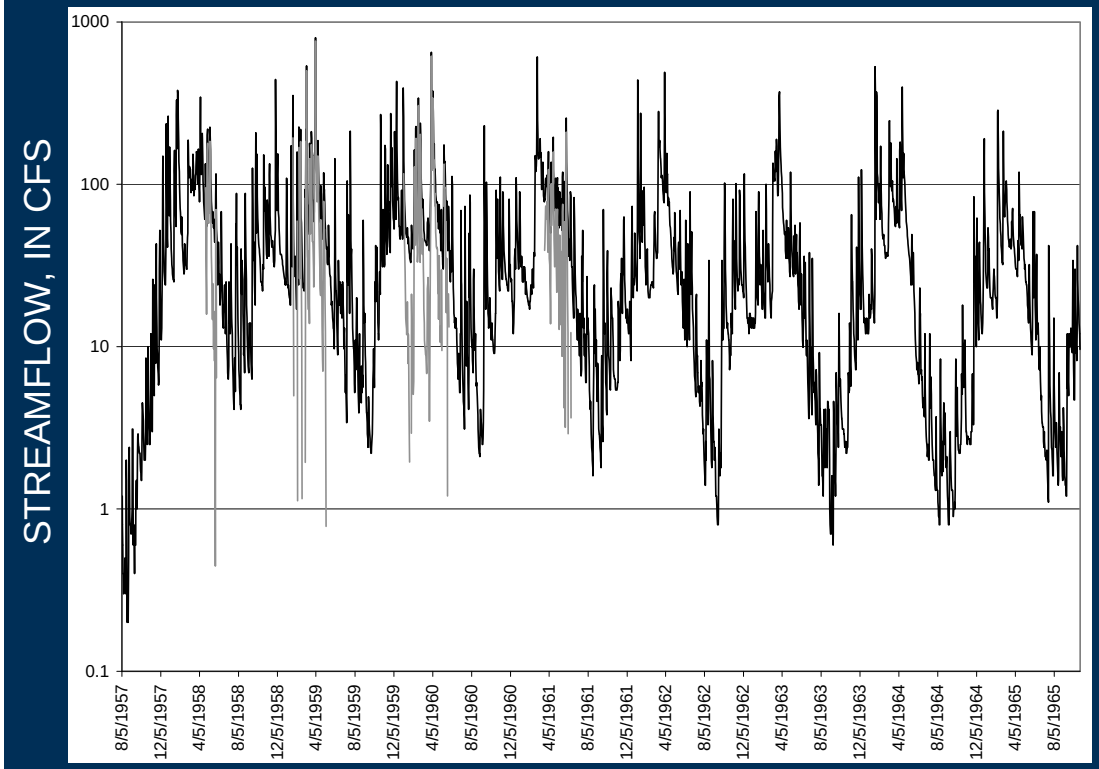
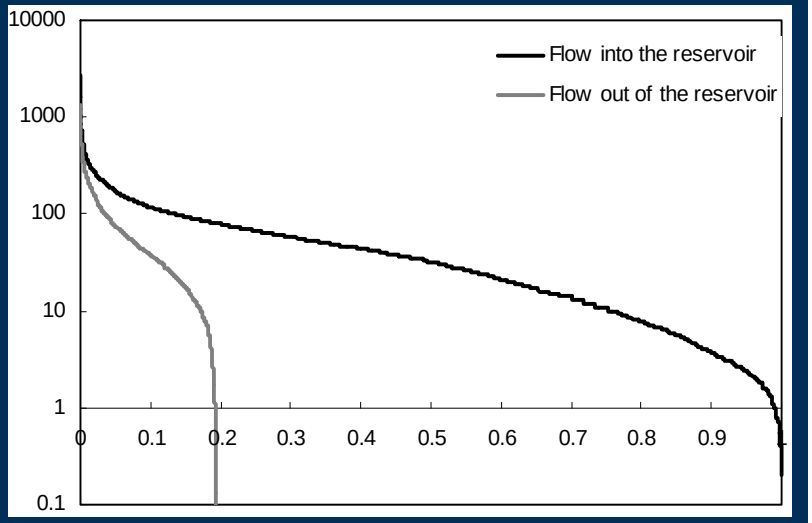
Downstream Flow with No Release Required





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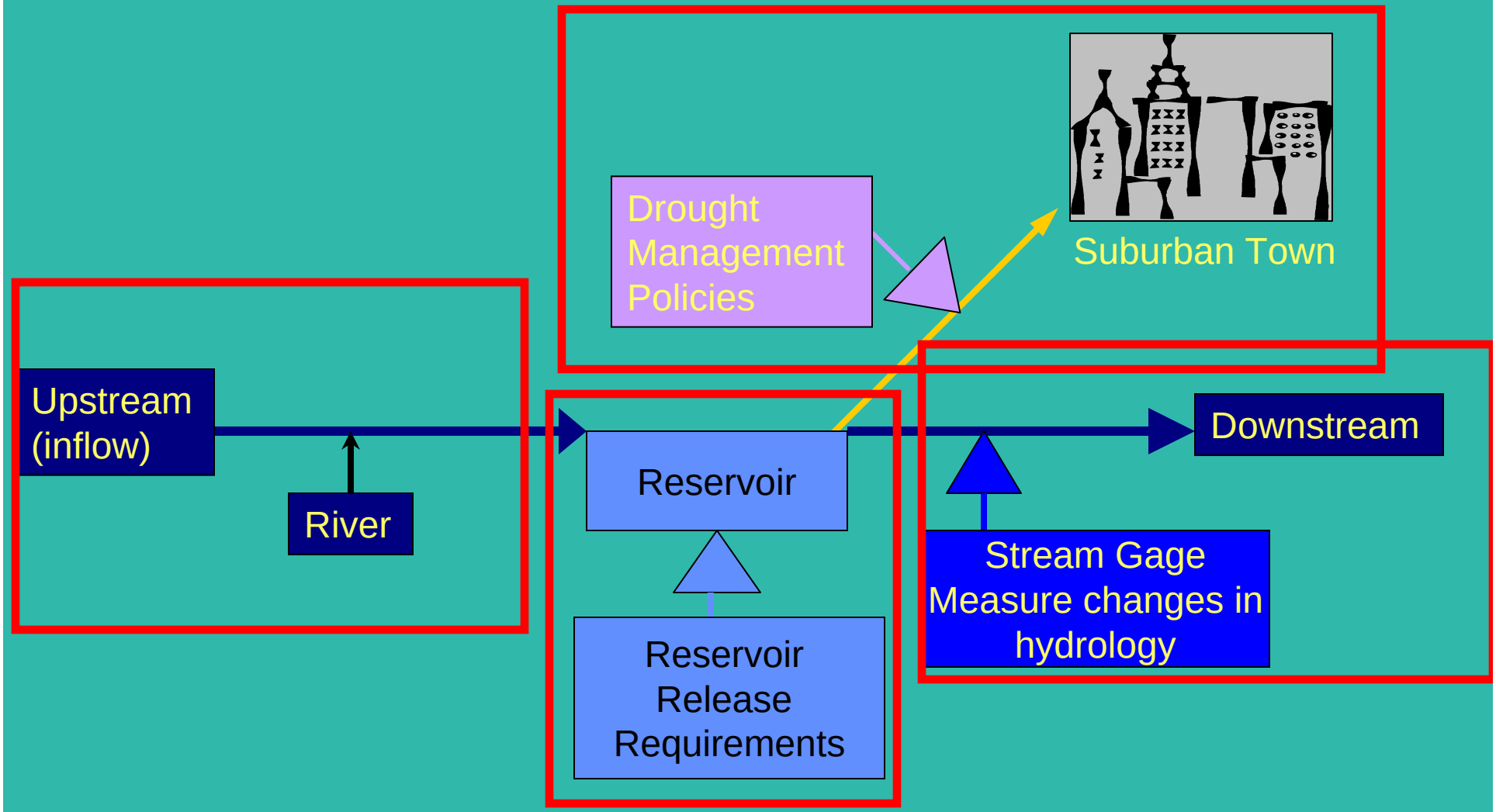
Model Overview



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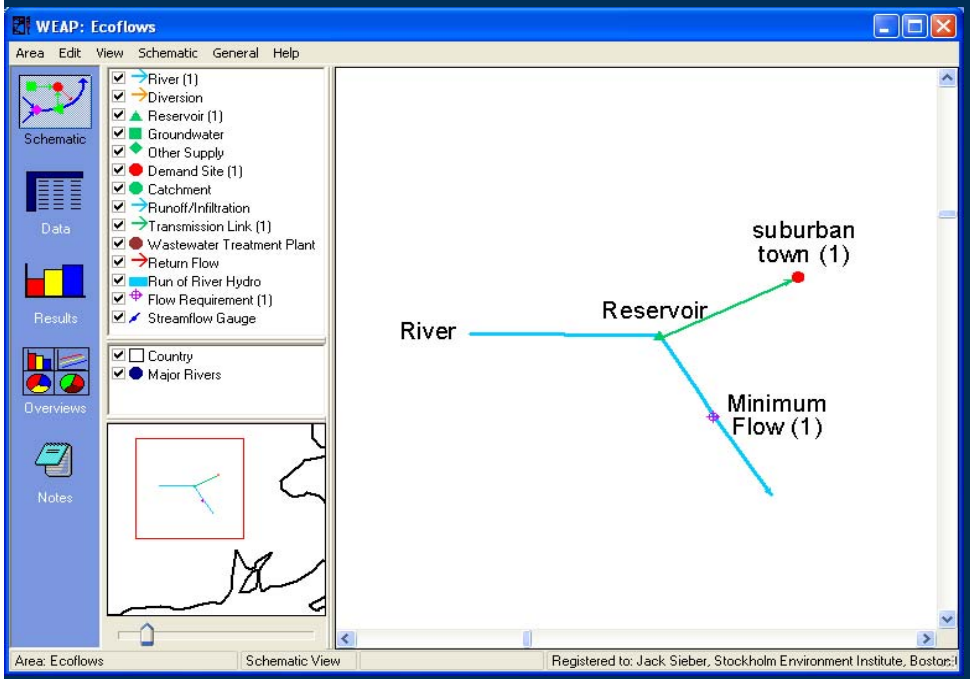
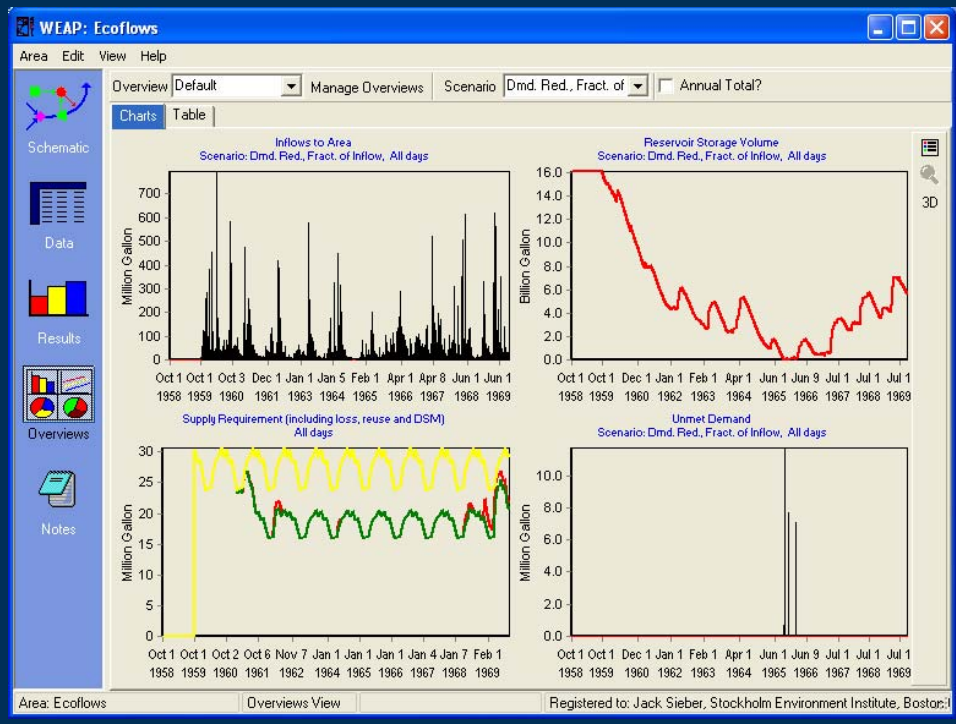
Model Platform

Water Evaluation and Planning model (WEAP)

- Developed by Stockholm Environment Institute





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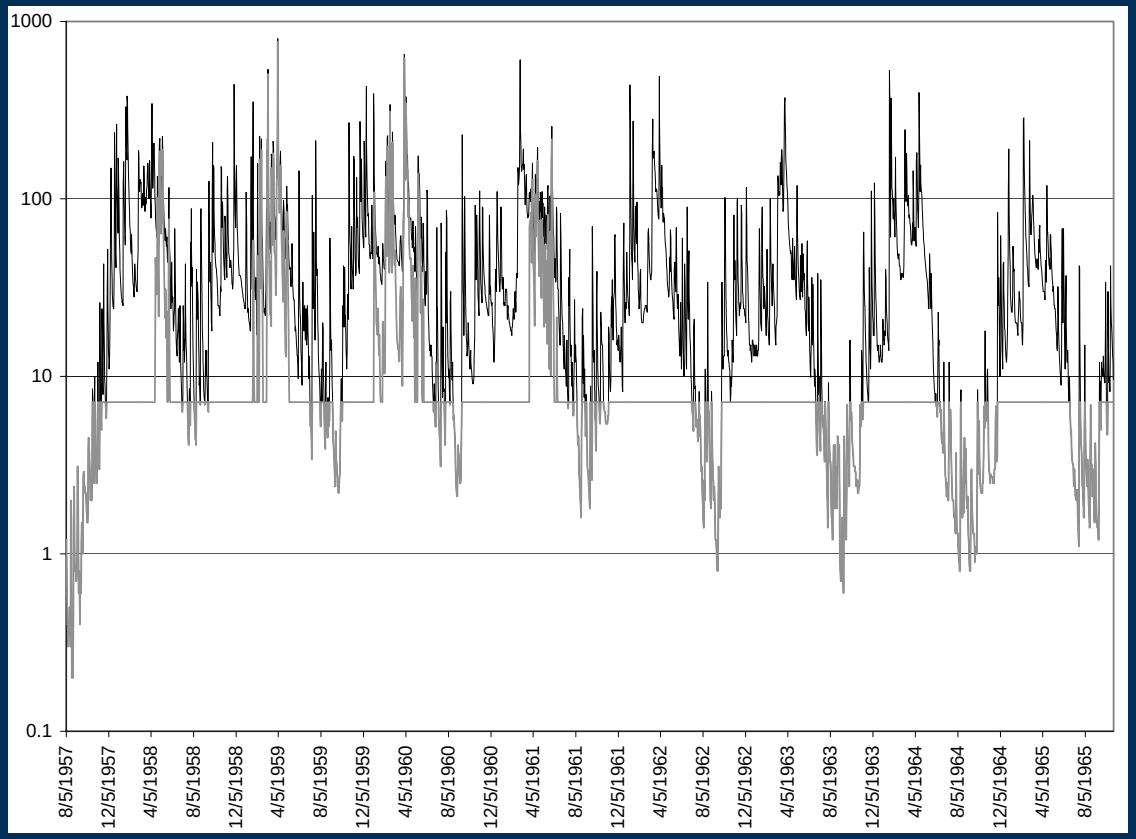
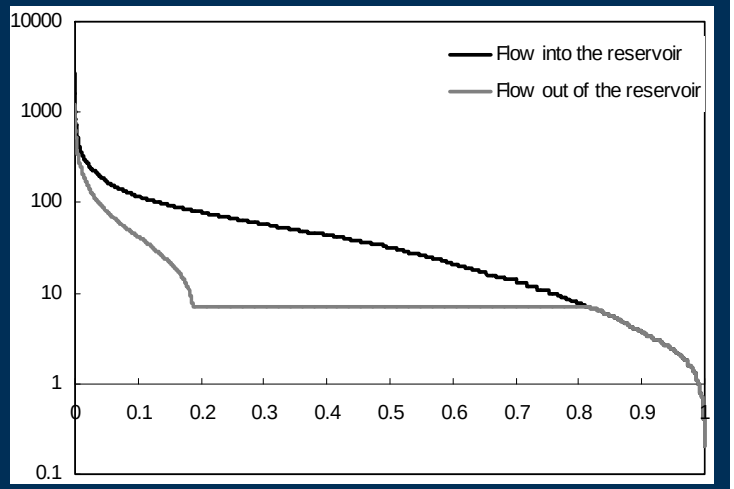
Release Policies Simulated

- No Release Required
- Minimum flows
- Seasonal minimum flows
- Seasonal minimum flows with high pulses
- Adaptive seasonal minimum flows
  - based on reservoir level
- Fraction of inflow
- Fraction on inflow with low flow protection

Flow Policy: Minimum release





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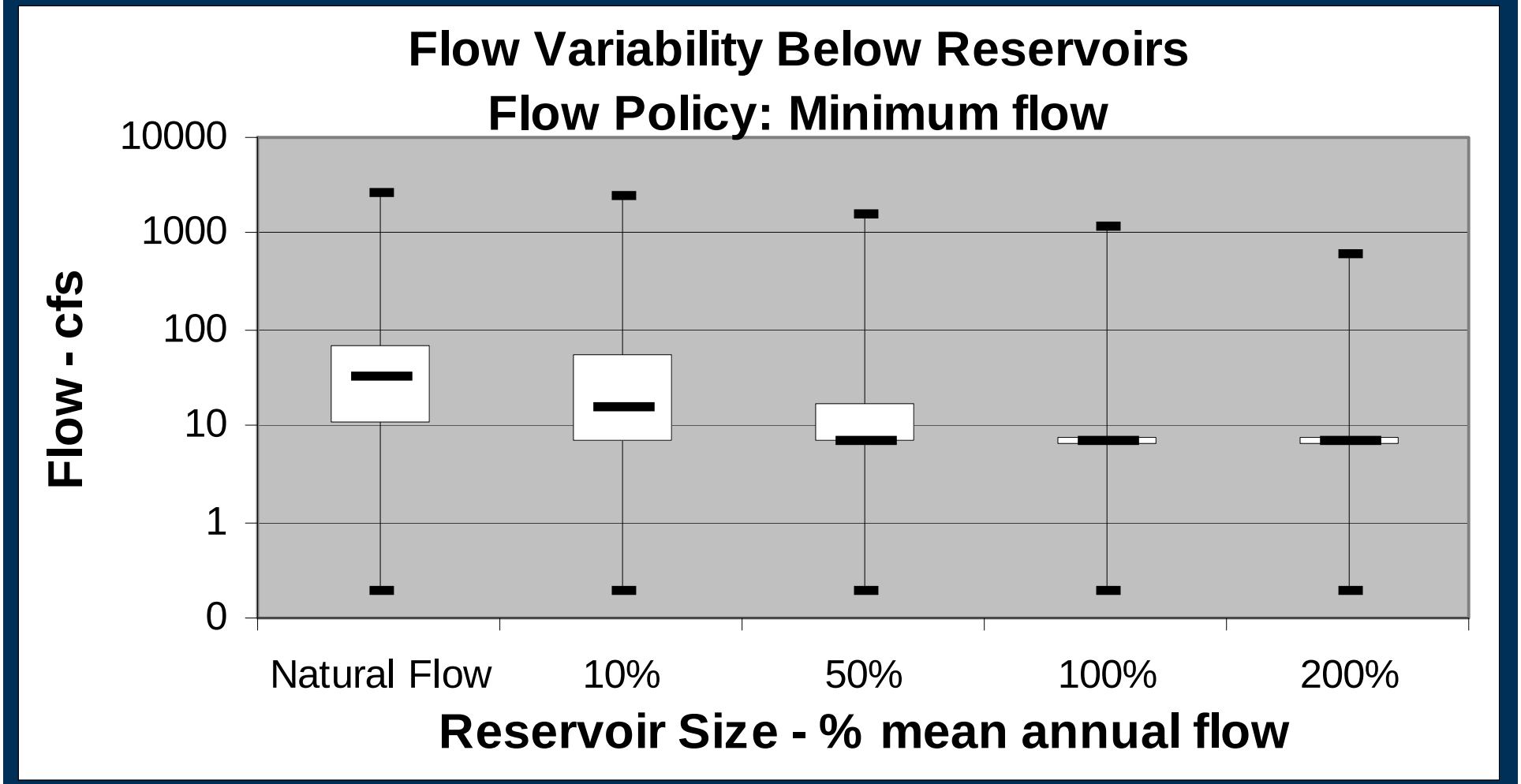
Reservoir Size



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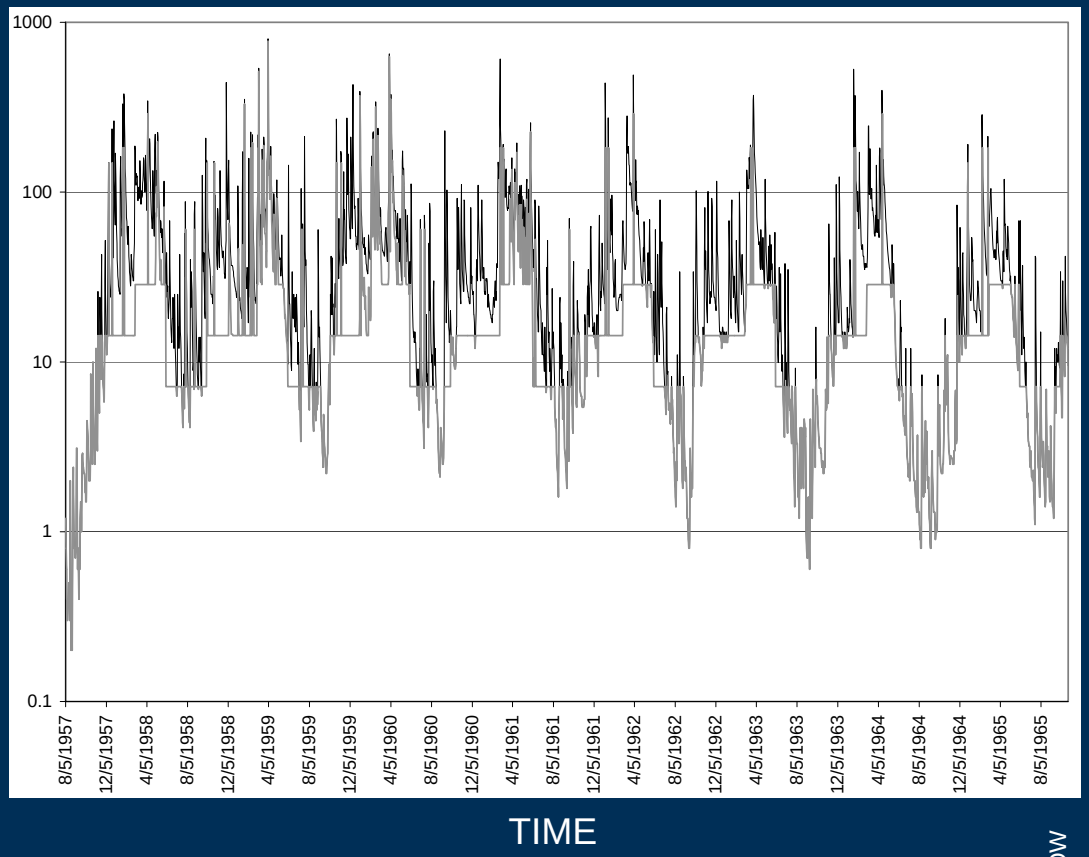
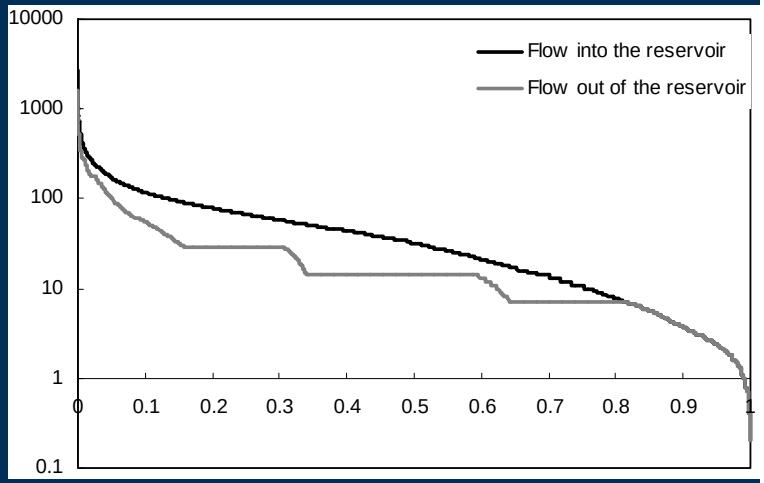
Flow Policy: Seasonal min with pulses





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Flow Alteration Metrics

Flow statistic	# Days Pre (avg/yr)	# Days Post (avg/yr)	Change (percent)	Impact Score range	Score
High Flows					
≥ 0.02	7.3	2.4	-66.6%	0 – 3	2
≥ 0.10	37.1	10.4	-72.1%	0 – 3	2
Mid Flows					
≤ 30% MAF	120.9	315.4	155.3%	0 – 3	3
Low Flows					
≤ 0.90	36.5	296.9	712%	0 – 3	3
≤ 0.98	7.3	295.4	3903%	0 – 3	3
			Total	0 - 15	13

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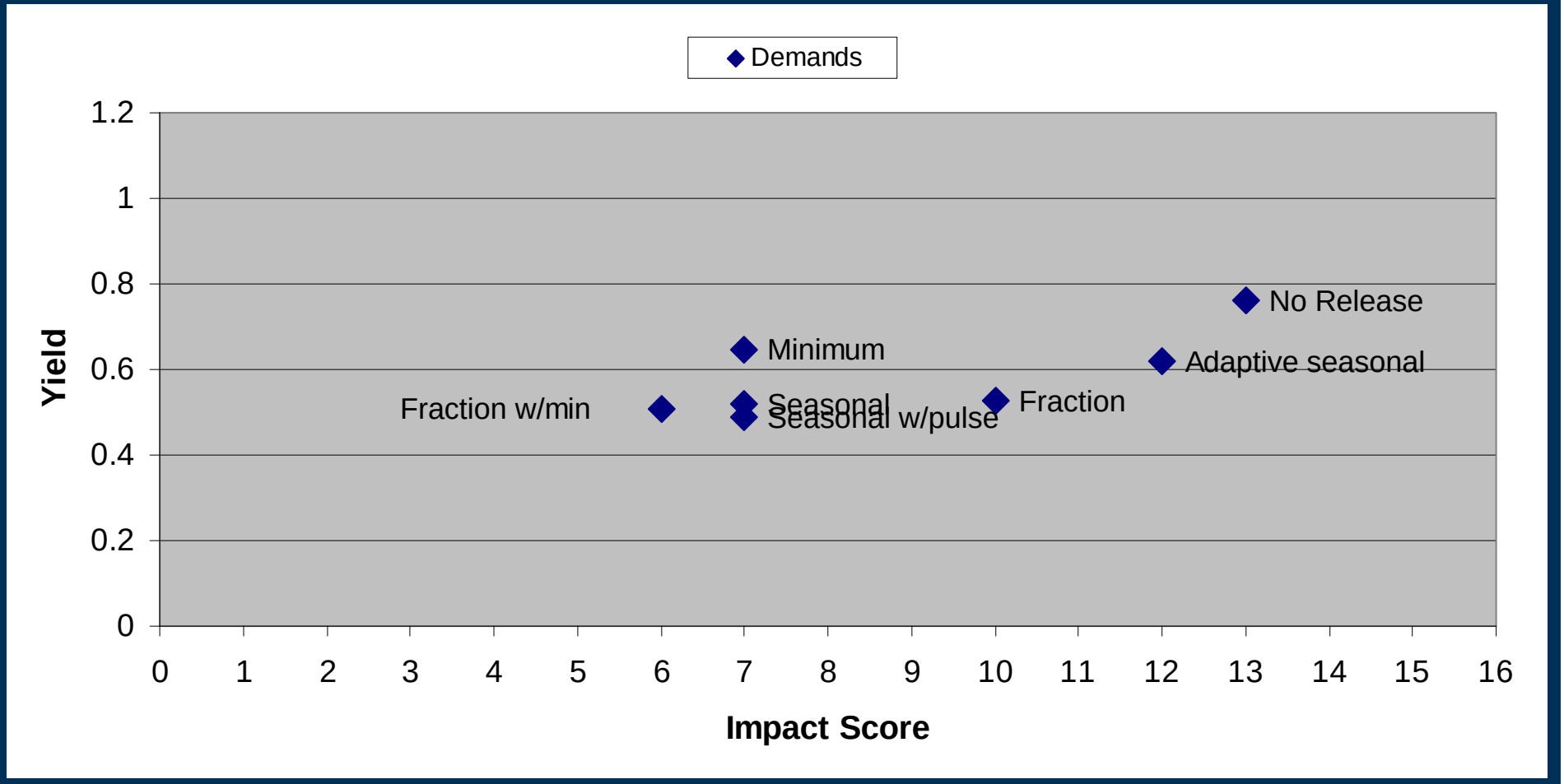
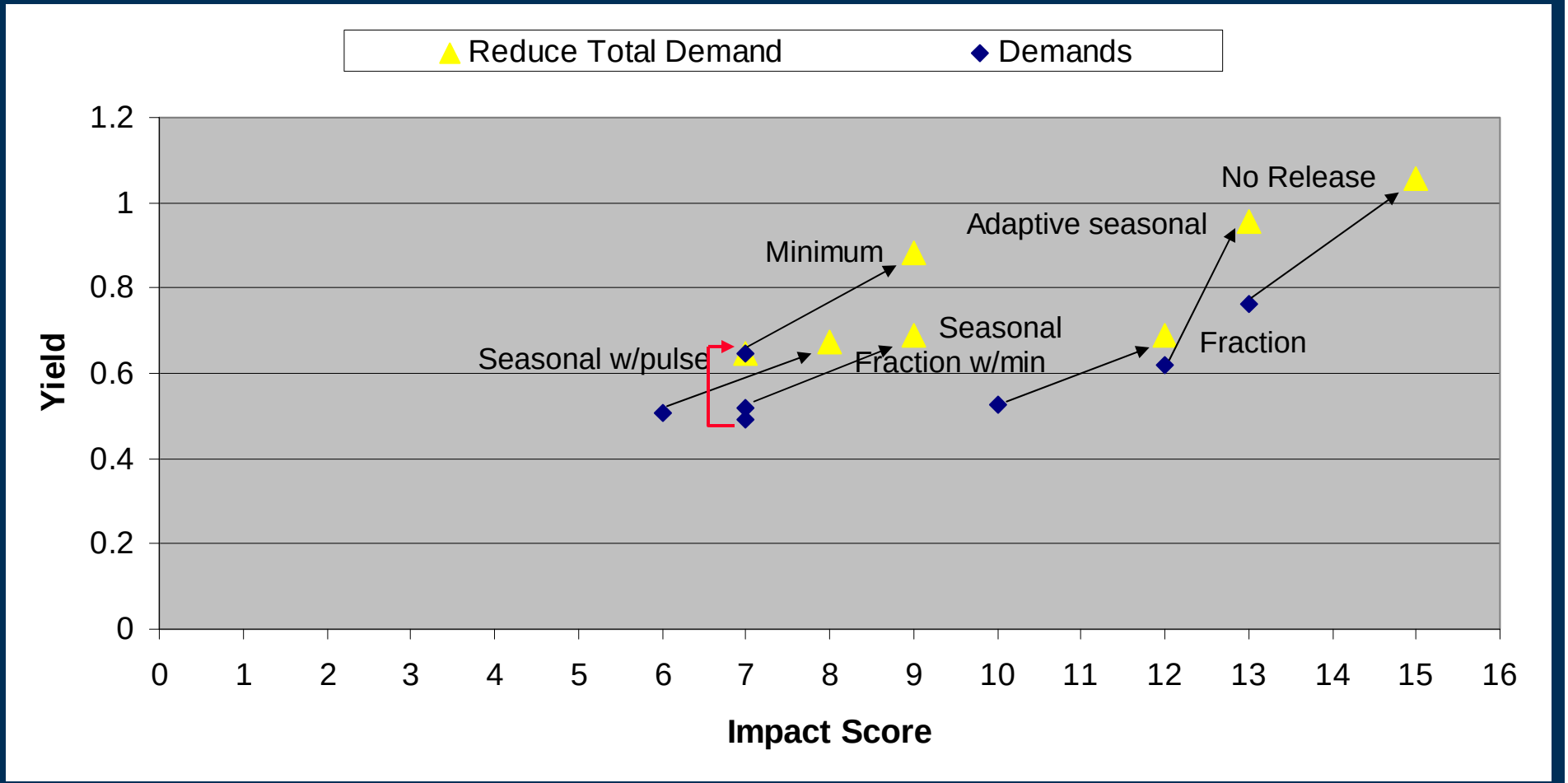
Yield and Impacts



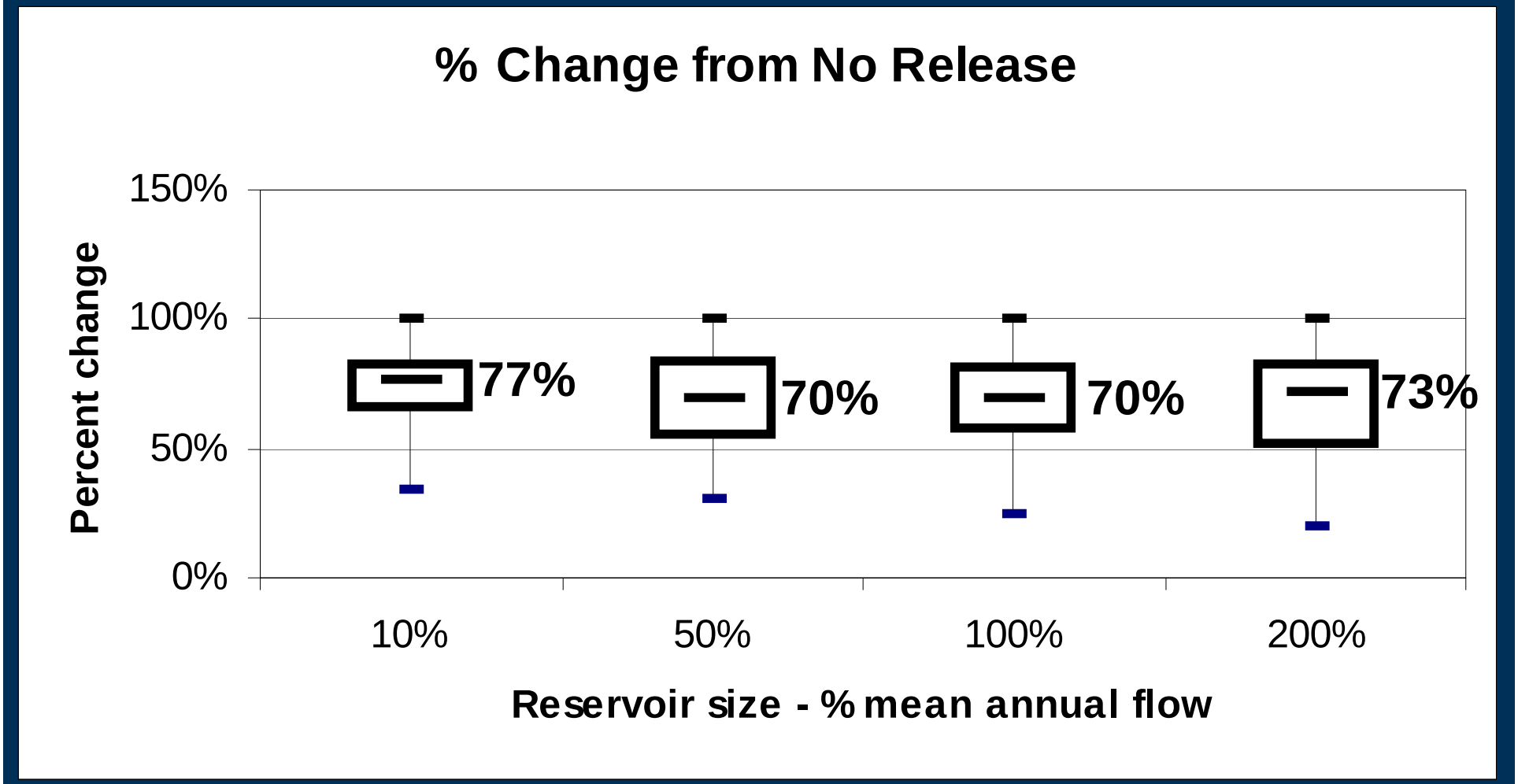
Drought Management Policies

Reservoir Level (% full)	Demand Reduction
60-100%	0
40-59%	20%
0-39%	40%

Yield and Impacts
Drought Management



Release rules can reduce reservoir yields by 24-30%



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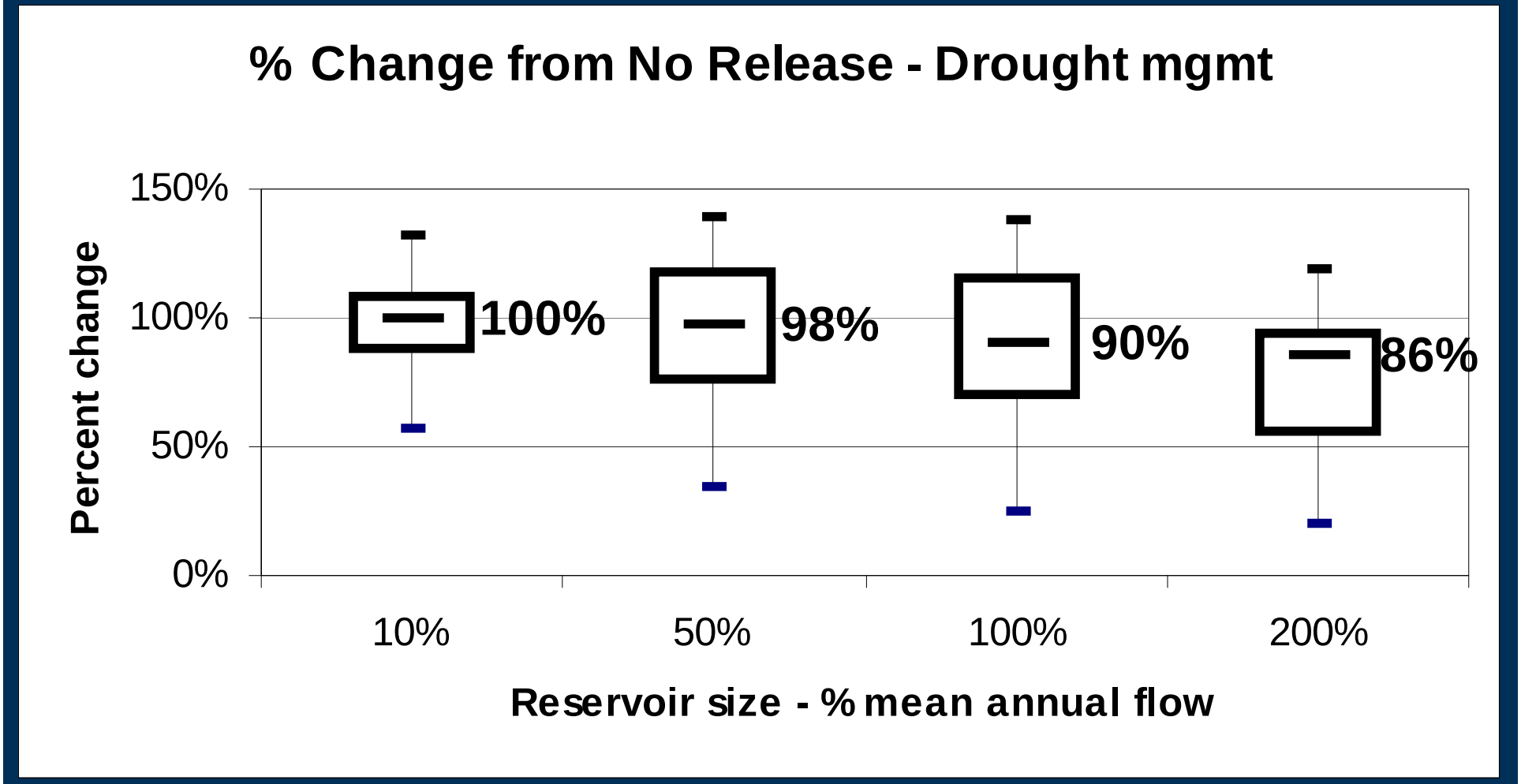
Drought management can allow for comparable yields to no releases



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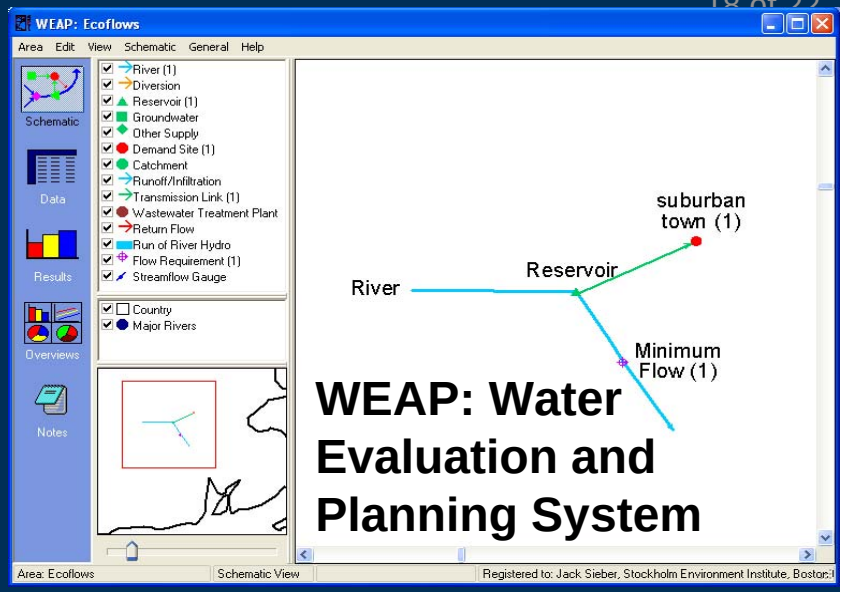
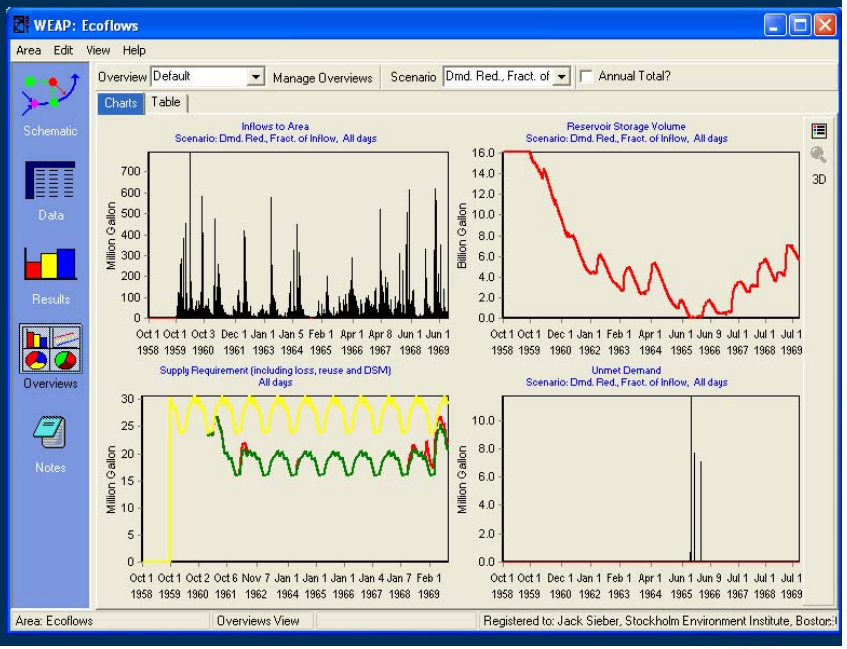
Results and Lessons Learned

- Environmental sustainability of water supplies can be improved through the use of integrated reservoir release policies and drought policies
- Reduced yields as a result of reservoir release policies can be largely offset by drought management measures:
  - Release rules can reduce reservoir yields by 24-30%
  - Drought management can allow for yields comparable to no-release yields and pre-reservoir flow conditions
- Increased supplies from drought management can be used to support environmental flows
- Release policies that are effective for small reservoirs may not be effective for large reservoirs

Project Collaboration

- **Case study in support of Connecticut Department of Environmental Protection's effort to develop a streamflow-protection regulation**
  - Tool will be used to: a) evaluate draft reservoir release and direct withdrawals policies (standards), and b) be compared to a similar but less robust model being developed by CT Institute for Water Resources





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Response to feedback

- We are starting to apply our results to case studies; therefore, we have just begun to receive feedback from partners in a specific way

- We also have received strong interest in this tool from state-agency personnel in the New England states

Ways in which CNS funding has helped

- CNS funding has enabled our research team to communicate results through publication and at conferences and workshops around the world:
  - American Society of Civil Engineers, World Environmental and Water Resources Congress (Anchorage, AK)
  - National Center for Environmental Research Subcommittee on Water Availability and Quality (Arlington, VA)
  - International River*Symposium* and Environmental Flows Conference (Brisbane, Australia)
  - EPA Region I Science Day (Boston, MA)
    - Presentation was direct result of being posted on the website
  - American Water Resources Association, Baltimore, MD
  - Article in American Water Works Association journal (October, 2007)

Future Work

- Apply results to case studies
- Continue evaluation of tradeoffs between reservoir-release policies, reservoir yield and drought management
- Formulate optimization by determining a set of streamflow statistics most representative of change in the natural-flow regime due to reservoir operation
- Develop decision-support tool to optimize reservoir operations that maximize both human and ecological water needs

Research Team

- The Nature Conservancy: Mark P. Smith and Colin A. Apse
- Stockholm Environment Institute: Brian Joyce and Jack Sieber
- Tufts University: Richard M. Vogel, Stacey A. Archfield, and Yongxuan Gao

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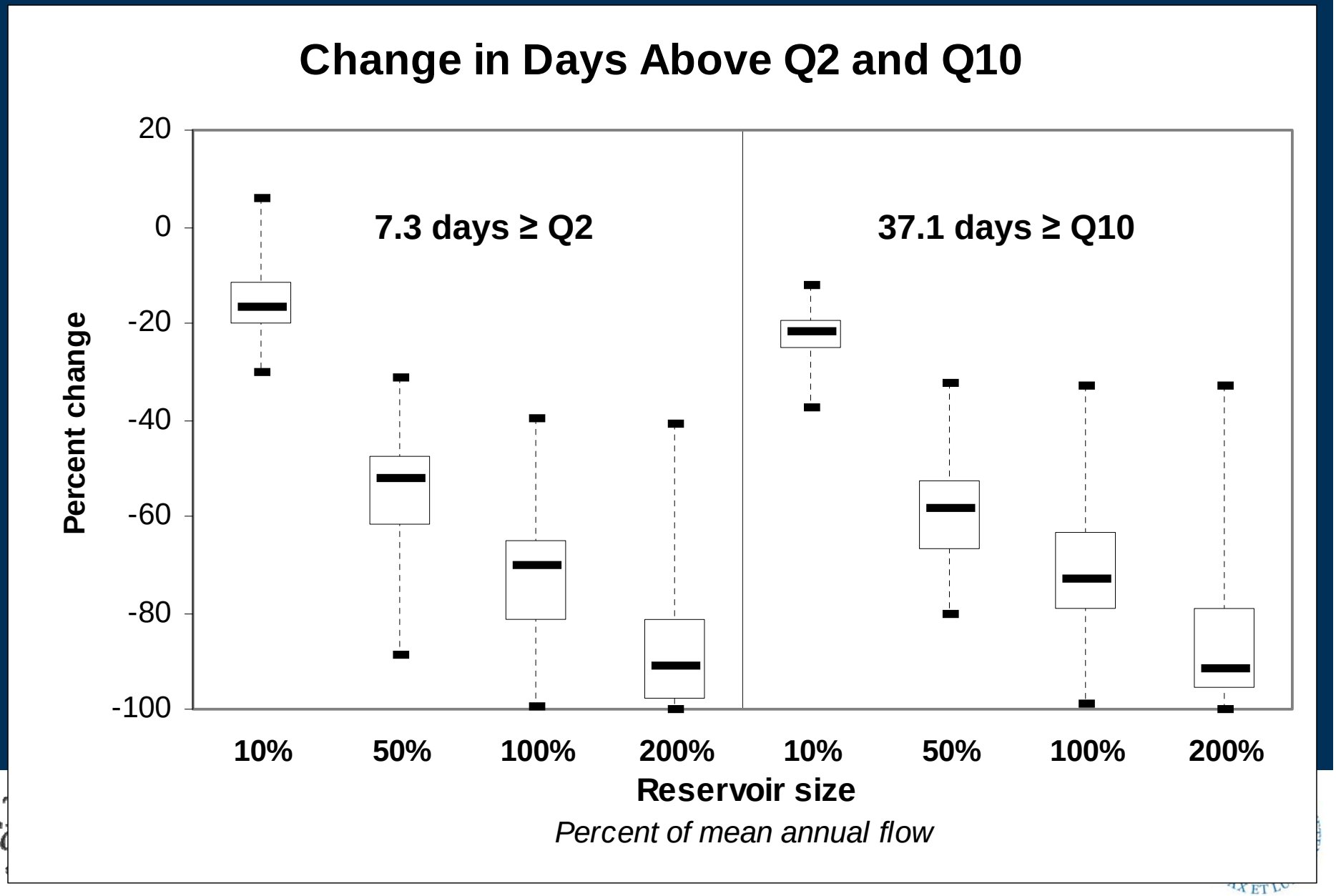
Meeting the needs of environmental-decision making for sustainability: Project goals

- Quantify trade-offs between competing water management objectives;
- Integrate a more precise definition of ecosystem flow needs into water supply management;
- Provide a tool for optimizing timing and use of drought management and water conservation techniques;
- Promote consensus-based decision-making to management of water resources.

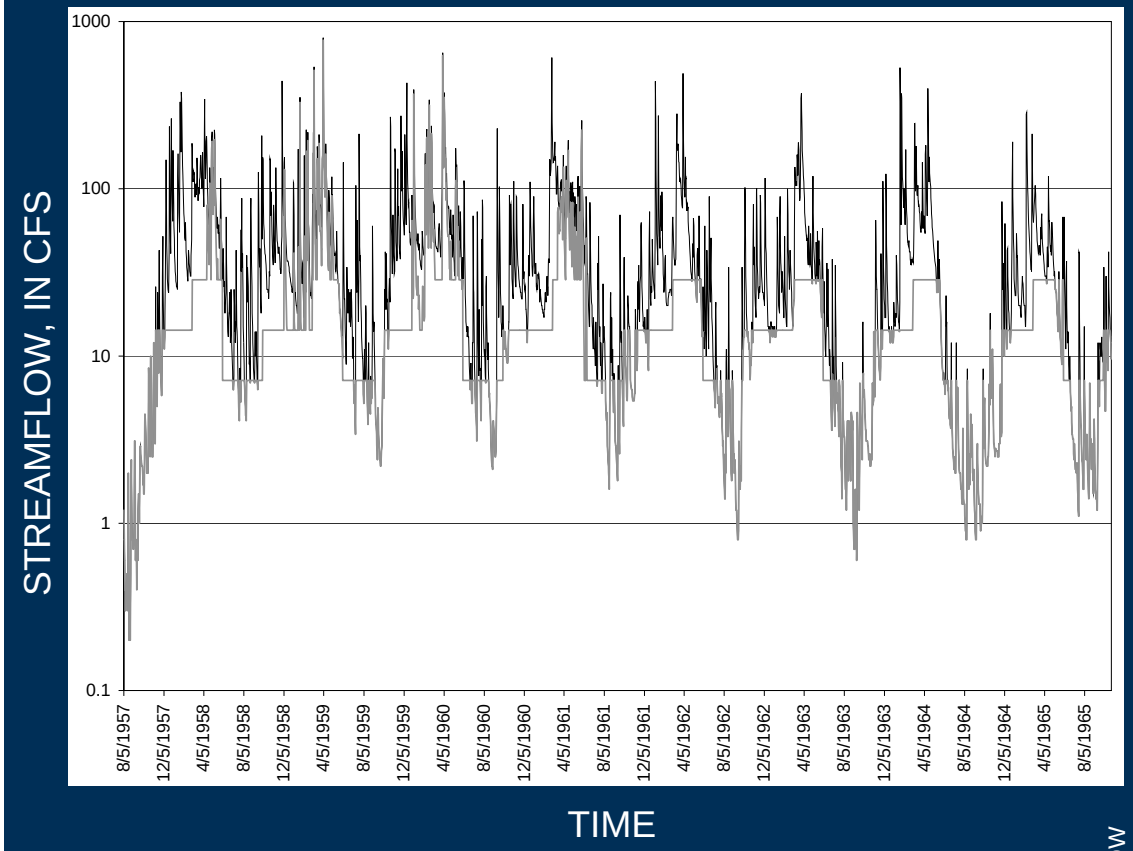
Changes in High Flow Events

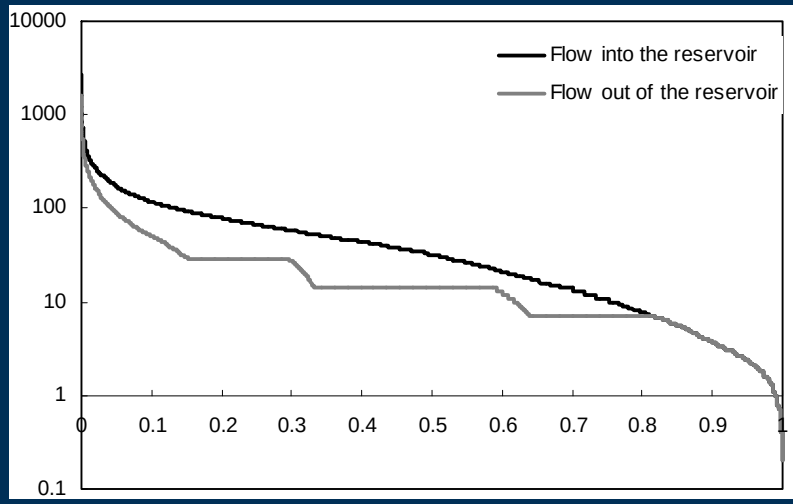


Reservoir Yields

Policy	Yield Fraction	mgd
No Release	0.76	26.5
Minimum	0.65	22.4
Adaptive seasonal	0.62	21.7
Fraction	0.53	18.7
Seasonal	0.52	17.7
Fraction w/min	0.51	17.0
Seasonal w/pulse	0.49	16.4

Flow Policy: Seasonal minimum flows





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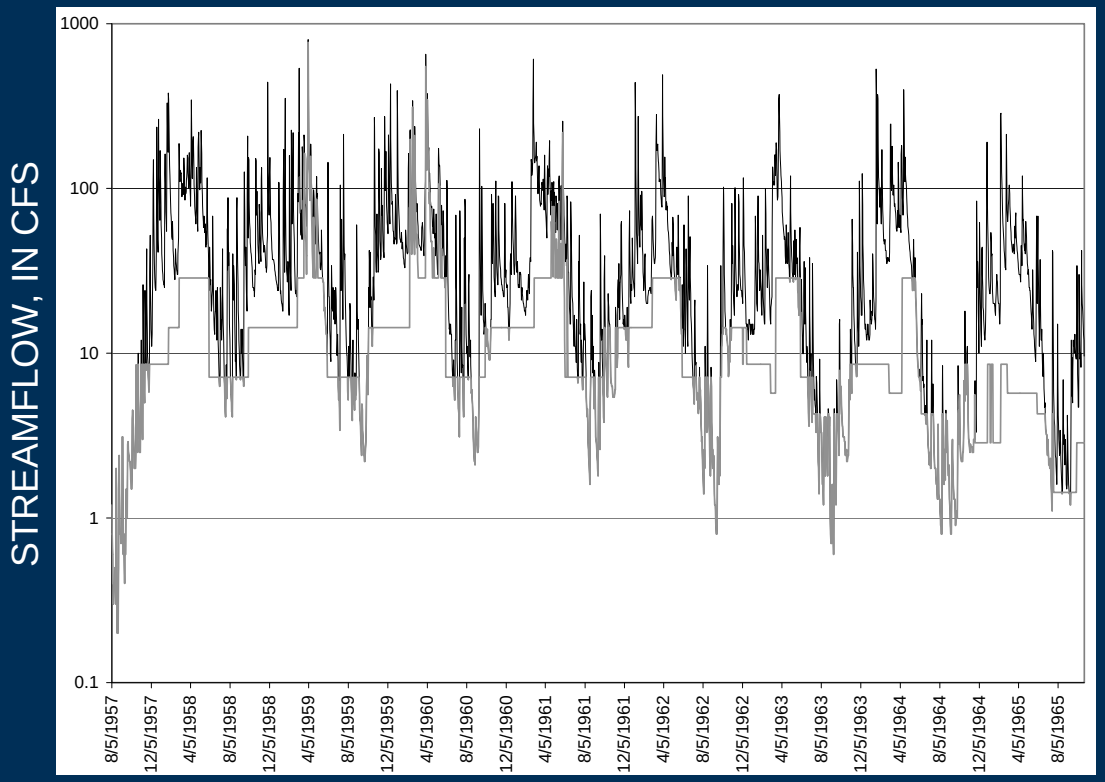
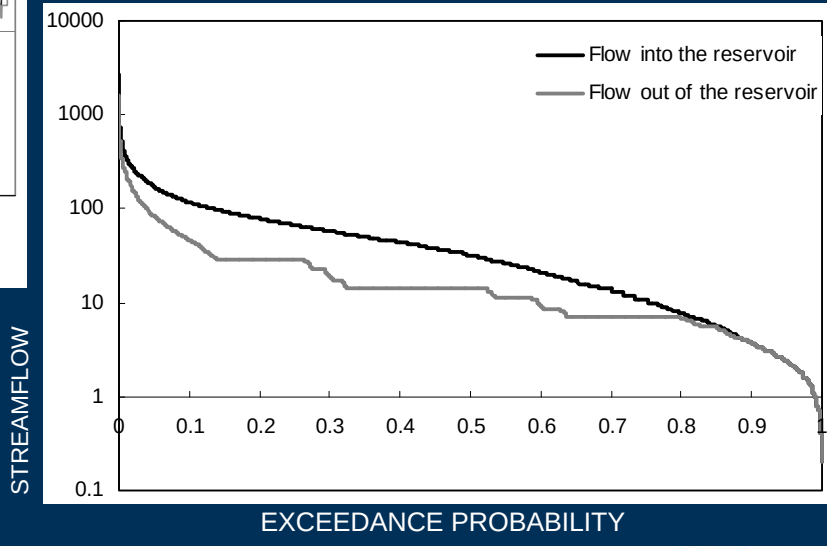
Flow Policy: Seasonal release based on reservoir level





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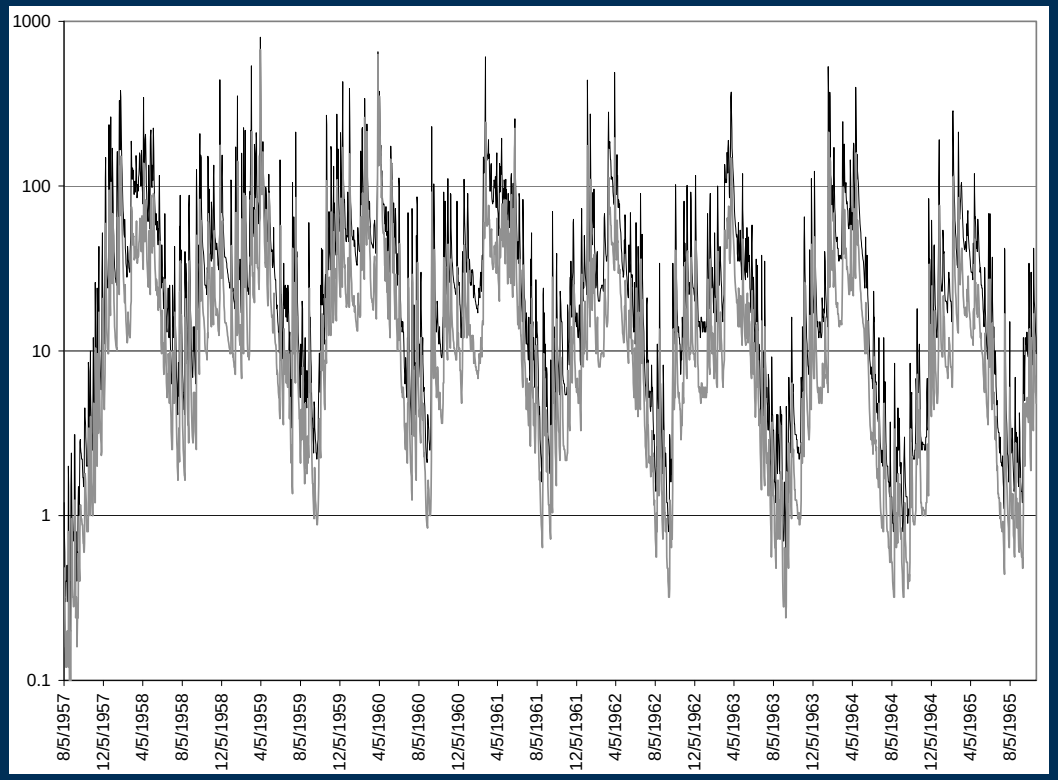
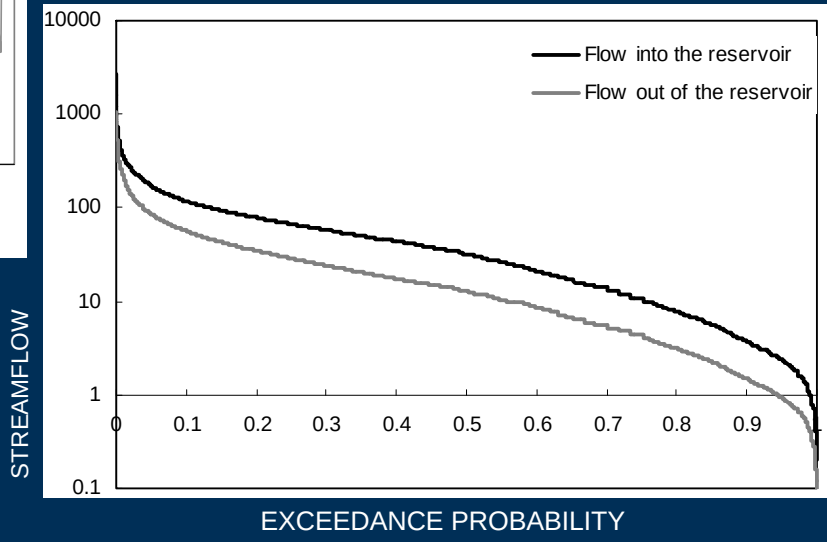
Flow Policy: Fraction of inflow





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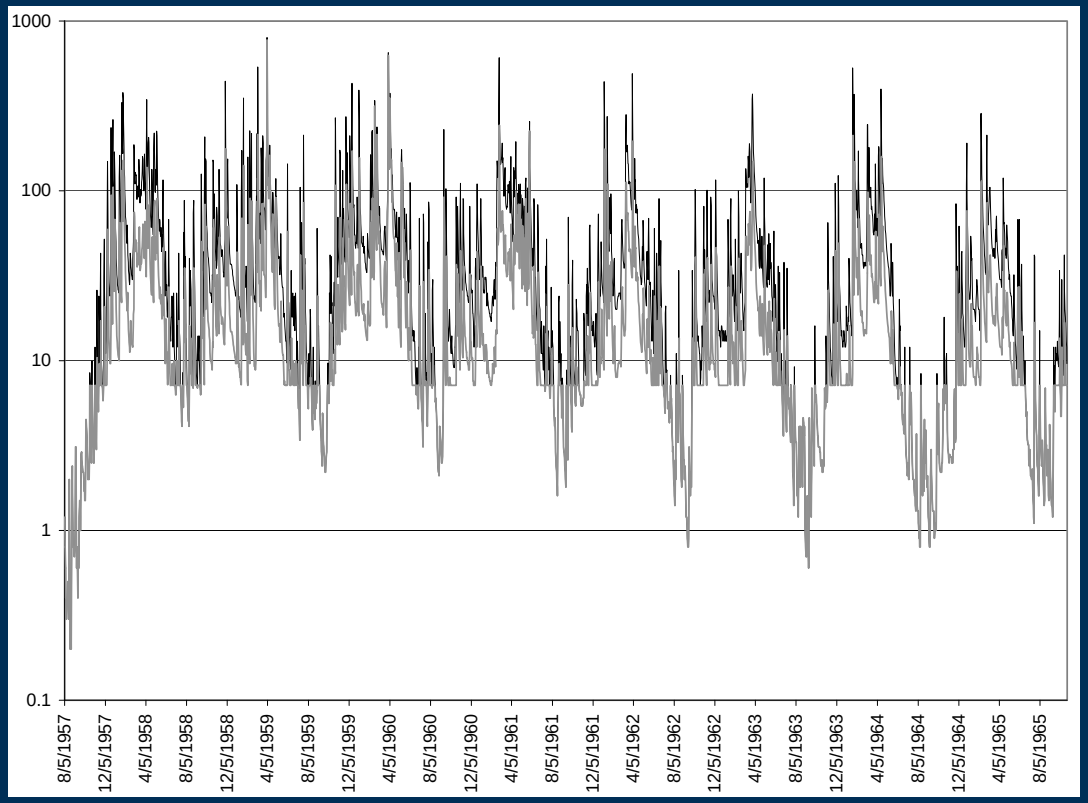
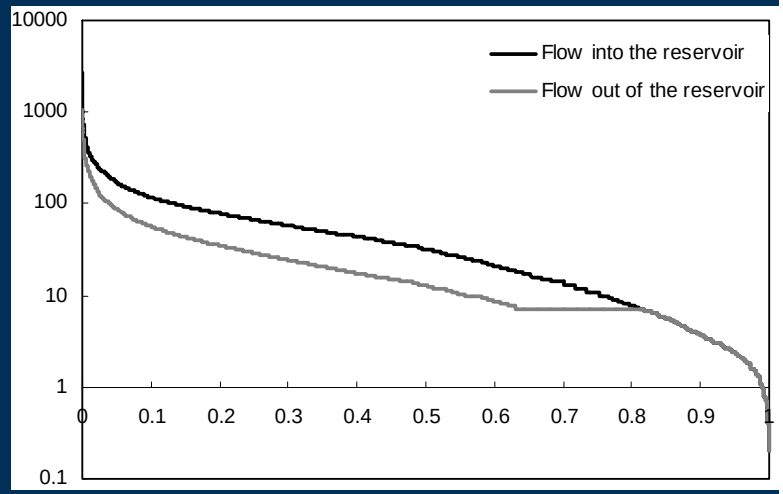
Flow Policy: Fraction with minimum





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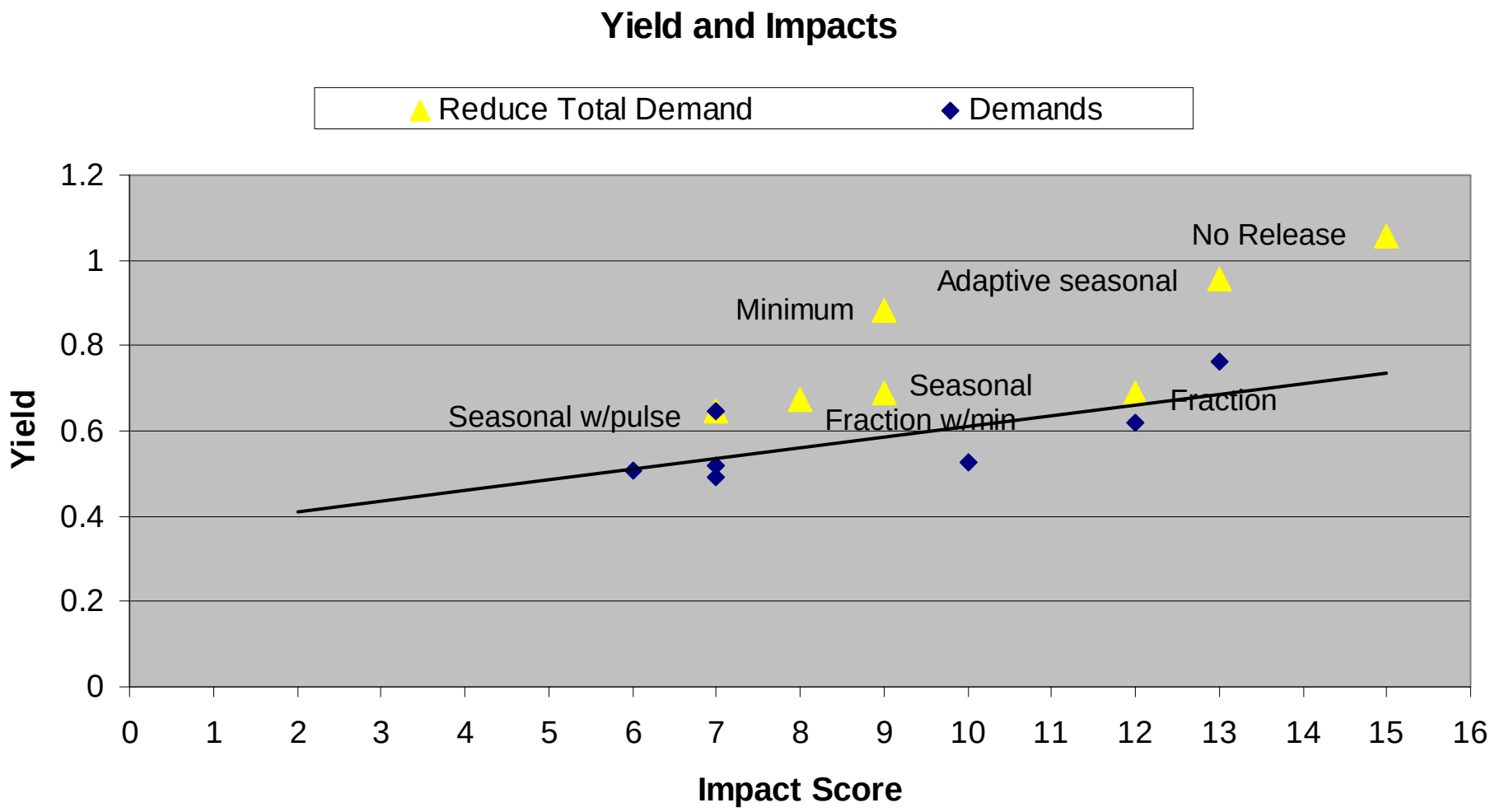
Yield and Impacts



Yield and Impacts

Effects of Drought Management