An Index Reservoir for Use in Assessing Drinking Water Exposure

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Index Reservoir Discussion Points

- Purpose
- Brief Description of Index Reservoir Scenario
- Suitability for Assessing Drinking Water Exposure
- Selected Parameter Development Issues
- Comparison of Index Watershed to Monitoring Data
- Continuing Improvement/Path Forward

Purpose

- ★ Develop a scenario more appropriate for drinking water assessment.
- ★ Rapid implementation: compatible with current modeling tools.
- ★ To build confidence, use location that had monitoring data for comparison.

Index Reservoir Scenario

- ★ Based on Shipman City Lake near Shipman, Illinois.
- ★ Drinking water source for 675 people.
- ★ Known to be a vulnerable watershed; frequent exceedances of MCL for atrazine.
- ★ Reservoir is 13 acres and 9 feet deep; watershed is 427 acres.
- ★ About 50% of watershed is in agriculture; about half of that is used to grow corn.
- ★ For different crops, use local weather and soils, water quality (if data available), reservoir geometry and flow are constant.

Suitability for Assessing Drinking Water Exposure

- OPP uses models for screening assessments.
- Scenarios represent the most vulnerable sites in the range of possible sites:
  - EEC's greater than 90% of potential sites.
  - not worst case.
- Surface water monitoring data from the Midwest indicates that small reservoirs in agricultural watersheds are the most vulnerable to contamination with pesticides.

Factors Affecting Vulnerability

- ★ Runoff potential dominated by Hydrologic Groups C and D.
- ★ Crop Area Factor (CAF) and percent crop treated.
- ★ Ratio of Drainage Area to Reservoir Normal Capacity (DA / NC).
- ★ Location of pesticide application in watershed relative to the reservoir.

Runoff Potential

- Vulnerable watersheds have high proportion of high runoff potential soils.
- Shipman watershed is 50% B, 25% C, and 25% B/D soils.
- Soil in watershed will be adjusted for local conditions, generally a Hydrologic Group C soil will be used.

Crop Area Factor and Percent Crop Treated

- ★ Only land area treated with the pesticide can contribute pesticide loading. Untreated land contributes water but not pesticide.
- ★ *Assuming that the treated and untreated land are similar*, the concentration should be proportional to the treated area.
- ★ Treated area is the percent of area in basin growing the crop (CAF) times the percent cropped treated.
- ★ CAF for corn in Shipman is 25%.
- ★ OPP is currently developing basin scale CAF. It is expected that they will be available later this year.
- ★ Watershed scale estimates of percent cropped treated are not available: we assume 100% crop treated.

Drainage Area to Normal Capacity Ratio (DA/NC)

- ★ Larger watershed area relative to reservoir volume contributes greater more pesticide.
- ★ Larger DA / NC = higher potential pesticide loading per unit reservoir volume.
- ★ DA / NC for standard pond is 5 m^{-1} (100, 000 m^2 / 20,000 m^3).
- ★ DA / NC for index reservoir is 12 m^{-1}.

Summary Statistics for Water Supply Reservoir Assessment

n = 578	Drainage Area (m^2 x 1000)	Normal Capacity (m^3 x 1000)	DA / NC Ratio (m^{-1})
Minimum	5180.00	956.35	0.55
Maximum	5.54 E+8	3.49 E+7	5,270
Median	2.90 E+5	4.00 E+4	5.95
Mean	8.36 E+6	3.19 E+5	47.45
Rows do not reflect a single reservoir. Source: Ruddy and Hitt, 1990.			

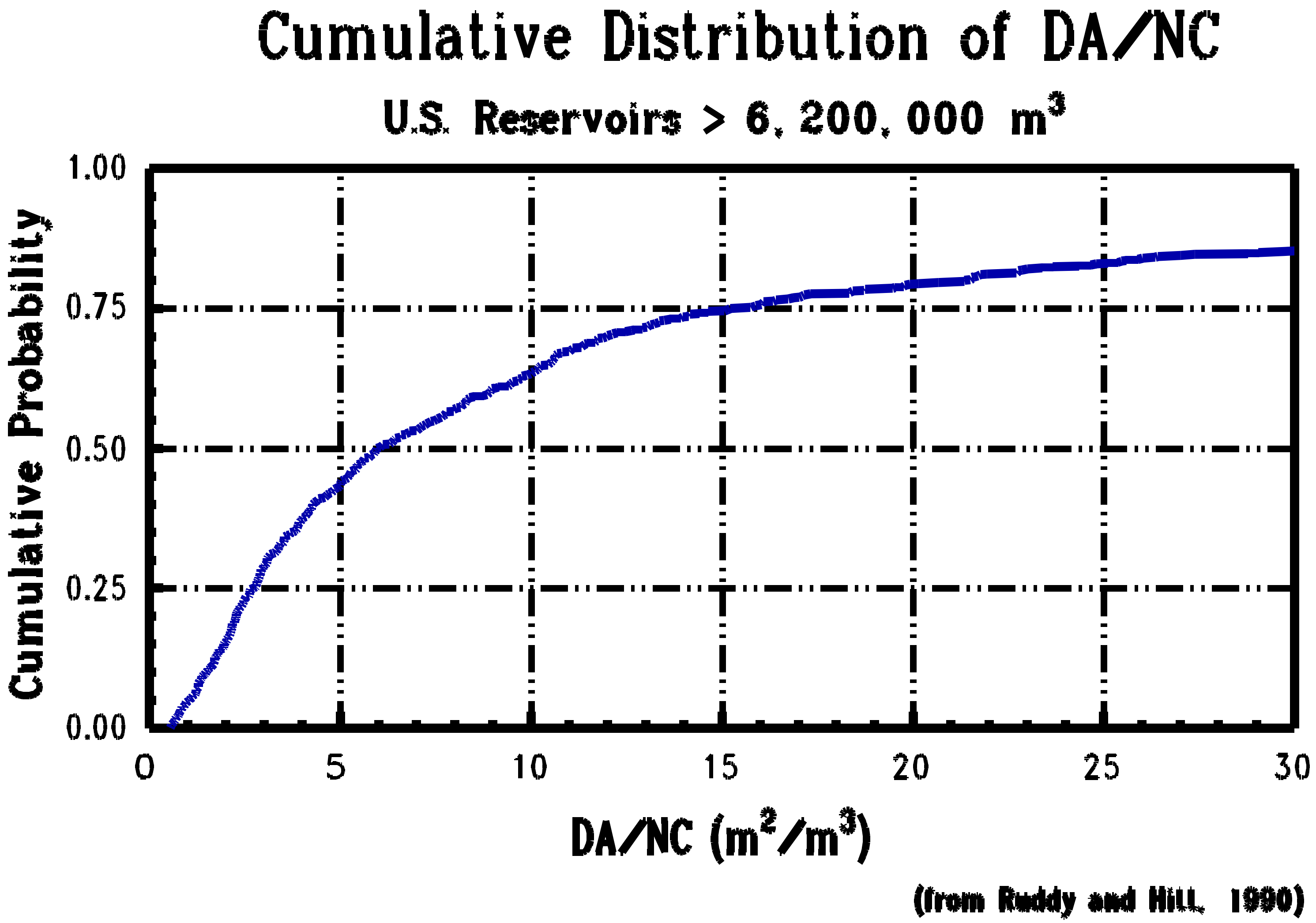
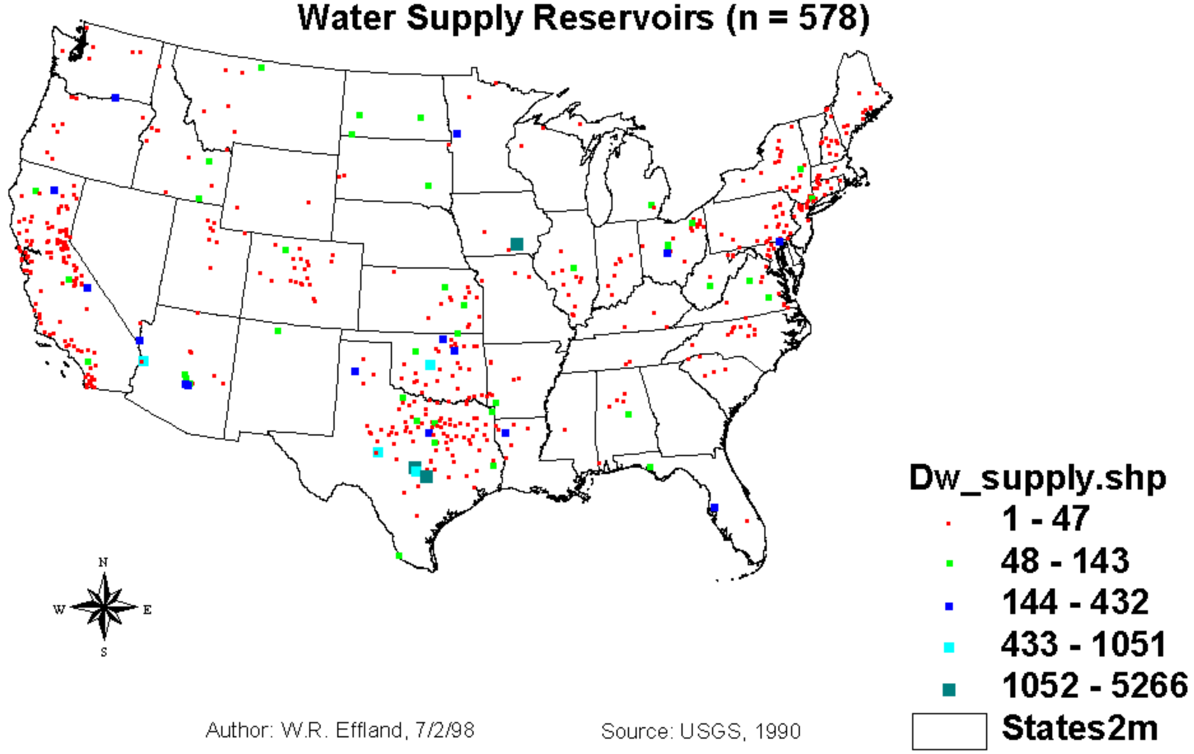

Cumulative Distribution of DA/NC
U.S. Reservoirs > 6, 200, 000 m³
Cumulative Probability
1.00
0.75
0.50
0.25
0.00
0
5
10
15
20
25
30
DA/NC (m²/m³)
(from Ruddy and Hill, 1990)

Figure 2

Drainage Area to Normal Capacity Ratio

Water Supply Reservoirs (n = 578)



Reservoir Flow In/Out (1)

- No discharge from standard pond.
- Minimal data on the discharge from Shipman City Reservoir.
- 16.4 $m^3 \bullet h^{-1}$ results in an exchange of reservoir volume per year.
- Shipman Water Supply uses 246,000 L $\bullet day^{-1}$, accounts for 62% of capacity in a year.
- Nearest flow estimate downstream is on Macoupin Creek - Shipman City Lake is on a tributary; flow is 3000 $m^3 \bullet h^{-1}$

Reservoir Flow In/Out (2)

- ★ Estimate using Clinton soil (Hydrologic Group B) with PRZM for whole watershed. This is value currently used in scenario. (Conservative as other soils in watershed produce more runoff).
- ★ Assume precipitation equal evaporation (conservative in most years)
- ★ Assume that there is little seepage into or out of reservoir
- ★ Discharge equals input; constant reservoir volume.
- ★ Discharge equals 25 $m^3 \bullet h^{-1}$, includes flow through drinking water facility.

Turnover

- EXAMS (and most other hydrologic models) cannot easily handle turnover, the loss of stratification that occurs in the spring and fall in most larger lakes and reservoirs in the United States.
- The Index Reservoir is not stratified.
- Based on a very limited data set, there is evidence that Shipman City Lake stratifies in the deepest portion of the lake.
- Stratification reduces mixing between layers; pesticide loadings are some what restricted to one layer of the lake until turnover in the fall.

PRZM-EXAMS modeling, Shipman Watershed, 1948-1983						
Scenario	Peak ($\mu g \bullet L^{-1}$)		Annual Mean ($\mu g \bullet L^{-1}$)		Overall Mean ($\mu g \bullet L^{-1}$)	
	Median	90%	Median	90%	Mean	UB 90*
Standard Pond	8.9	56.0	3.5	12.5	5.5	7.2
Index Reservoir	14.7	132.0	5.4	32.9	11.0	15.3
Index Reservoir with CAF**	3.7	33.0	1.4	8.2	2.8	3.8
* upper 90% confidence bound ** CAF = 0.25						

Atrazine in Shipman City Lake, 1995-1996, Acetochlor Surface Water Monitoring Study.

Year	Annual Peak (µg • L^{-1})		Annual Mean (µg • L^{-1})	
1995	2.8		1.5	
1996	34.6		12.3	
Index Reservoir with CAF	median	90%	median	90%
	3.7	33	1.4	8.2

Safe Drinking Water Act Compliance Data for Atrazine in the Shipman Reservoir .			
Date	Contaminant Level ($\mu g \bullet L^{-1}$)	Date	Contaminant Level ($\mu g \bullet L^{-1}$)
Jan- March, 1993	6	July - Sept, 1995	< 3
April - June, 1993	6	Oct - Dec, 1995	< 3
July - Sept, 1993	8	Jan - March, 1996	< 3
Oct - Dec, 1993	5	April - June, 1996	< 3
Jan - March, 1994	< 3	July - Sept, 1996	< 3
April - June, 1994	< 3	Oct - Dec, 1996	6
July - Sept, 1994	<3	Jan - March, 1997	< 3
Oct - Dec, 1994	5	April - June, 1997	7
Jan - March, 1995	4	July - Sept, 1997	6
April - June, 1995	4	Oct - Dec, 1997	6

Refinements to Index Reservoir

- Reconsider index reservoir scenario./Replace Shipman.
- Better estimate flows.
- Evaluate other pesticides monitoring data in Shipman City Lake and other candidate reservoirs.
- Reevaluate using more accurate soils data.
- Develop better water quality parameters.

General Refinements

- ★ Implement use of CAF
- ★ Update Tier 1 meta-model (GENEEC)to include reservoir scenario
- ★ Use multiple soils to represent watershed.
- ★ Use of basin scale models.

Questions

- Is the Index Reservoir a suitable interim replacement for the standard pond for screening-level drinking water assessments?
- Give that the Index Reservoir has a drainage area to normal capacity ratio that is greater than 70% of reservoir-based drinking water supplies, does the SAP believe that the Index Reservoir represents a conservative but reasonable scenario for screening level assessments for drinking water exposure?
- Do the process and criteria used to select the Index Reservoir represent a reasonable approach? Are there other criteria we should consider when we reassess the reservoir scenario in the future?
- OPP has discussed a number of possible refinements to the reservoir approach and its screening approach in general? Which of these refinements does the SAP believe should have the highest priority?