WHAT IS WATER WORTH

Assessing the Economic Benefits and Costs of Nutrient Criteria Implementation

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Salt Lake County Watershed Symposium
September 27, 2012

Utah Department of Environmental Quality

CH2MHILL

WYSAC Wyoming Survey & Analysis Center

UtahStateUniversity

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- Water Quality Data and Analysis
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Study Objectives

1) Conduct comprehensive analysis of the statewide aggregate benefits and costs of implementing nutrient criteria
2) Estimate the economic benefits of reducing excess nutrients on recreational demand, quality of life and property value
3) Compile site-specific information on economic benefits and costs of reducing nutrients - decision support tool for implementation

Nutrient Enrichment

Wastewater
Stormwater

Excess Nitrogen and Phosphorus

Agriculture

Increased Algal Growth and Decomposition

Algal Toxins, Low Dissolved Oxygen, High pH

Aquatic life impacts: fish kills, reduced diversity, ecosystem function
Human health impacts: algal toxins
Aesthetic impacts: recreation and property value
Water treatment impacts: clogged intakes, taste and odor, disinfectant byproducts

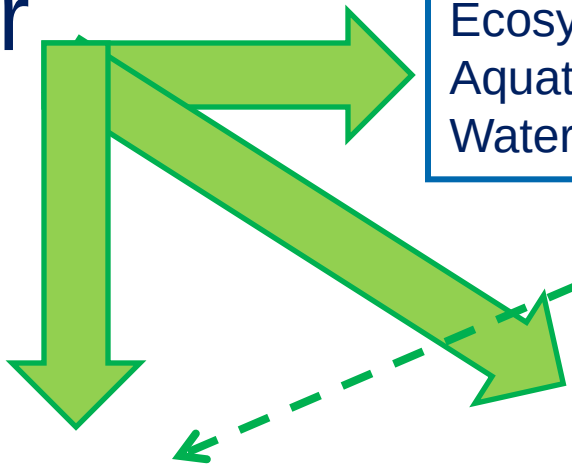
Farmington Bay

Matt Warner Reservoir

San Pitch River

Benefits Are Derived from Services

Water & Water Resources



Indirect Human Uses

Ecosystem Services
Aquatic Wildlife Habitat
Water Quality Enhancement

Passive Use

Quality of Life
Existence Value
Bequeathment Value
Diversity Preservation

Direct Human Uses

Recreation & Aesthetics
Drinking Water
Cooling & Processing
Irrigation & Stockwatering

"Benefits" are defined as amounts society is willing to pay rather than forego the good or service

What is Economic Benefit-Cost Analysis (BCA)?

- An accounting framework with rules, tools and analysis methods to evaluate economic efficiency
- BCA compares the economic value "with project" to the economic value "without project"
  - Includes goods and services exchanged in the market (capital, materials, labor) & non-market goods and services (e.g., recreation, aesthetics, ecosystem support services)
  - Sums the discounted stream of Bs and C's over time

Benefit Cost Analysis (BCA)

Benefit Categories

1) Recreational Value
2) Passive Value (Quality of Life)
3) Property Value
4) Water Treatment Cost Savings
   a) Drinking Water
   b) Industrial Users
   c) Agricultural Users

Cost Categories

1) Wastewater Treatment Upgrades
   a) Publicly Owned Treatment Works (POTW)
   b) Industial Dischargers
   c) Agricultural Dischargers
2) Stormwater Management
3) Nonpoint Source Pollution
4) Regulatory Administration
   a) TMDL
   b) Site Specific Criteria

Estimating Recreational and Quality of Life Benefits

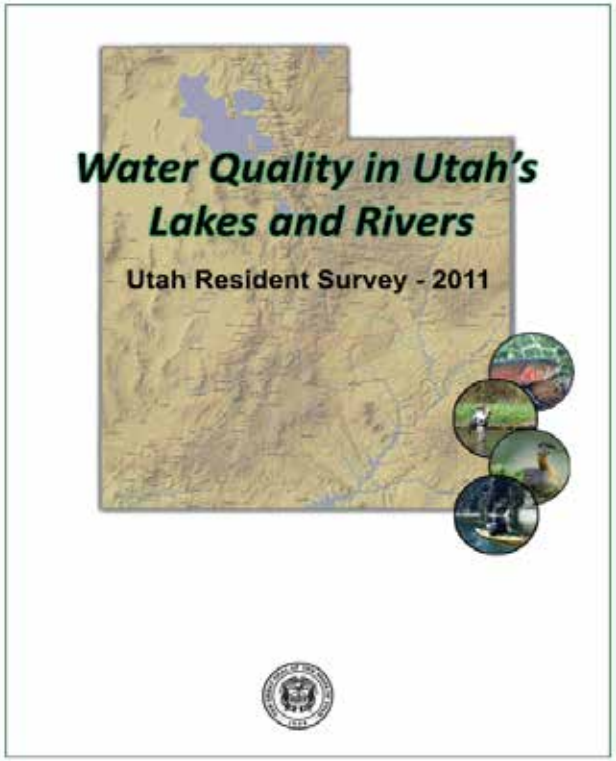
- Conducted three mail surveys of households in Utah
  - Total Economic Valuation Survey
  - Recreation Demand Survey
  - Waterfowl Hunters Survey
- Asked contingent questions on surveys, such as:
  - Would you be willing to pay $X for cleaner water?
  - What level of degradation to water quality would make you switch to another recreation site?
- Performed econometric modeling utilizing survey responses
  - Statistical regression to correlate responses to water quality and other characteristics

Survey Methods

- Mail response survey
- Dillman's Total Design Method employed to improve survey response
  - Cover letter (separate mailing)
  - Multiple survey mailings
  - Reminder postcards and/or telephone calls
- Methods employed to detect, minimize and correct for bias
  - Avidity bias
    - Random sampling
  - Representative sample frame
  - Non-response error
    - Detect and correct for
  - Measurement error
    - Multiple focus groups conducted for each survey

Total Economic Valuation Survey

- Objective is to estimate total willingness to pay (WTP) to protect rivers and lakes from excess nutrients
  - WTP = Recreation + Passive Use Benefits
- Random sample taken from all Utah households
- Survey administered summer 2011
- 2,700 surveys mailed
  25% response rate



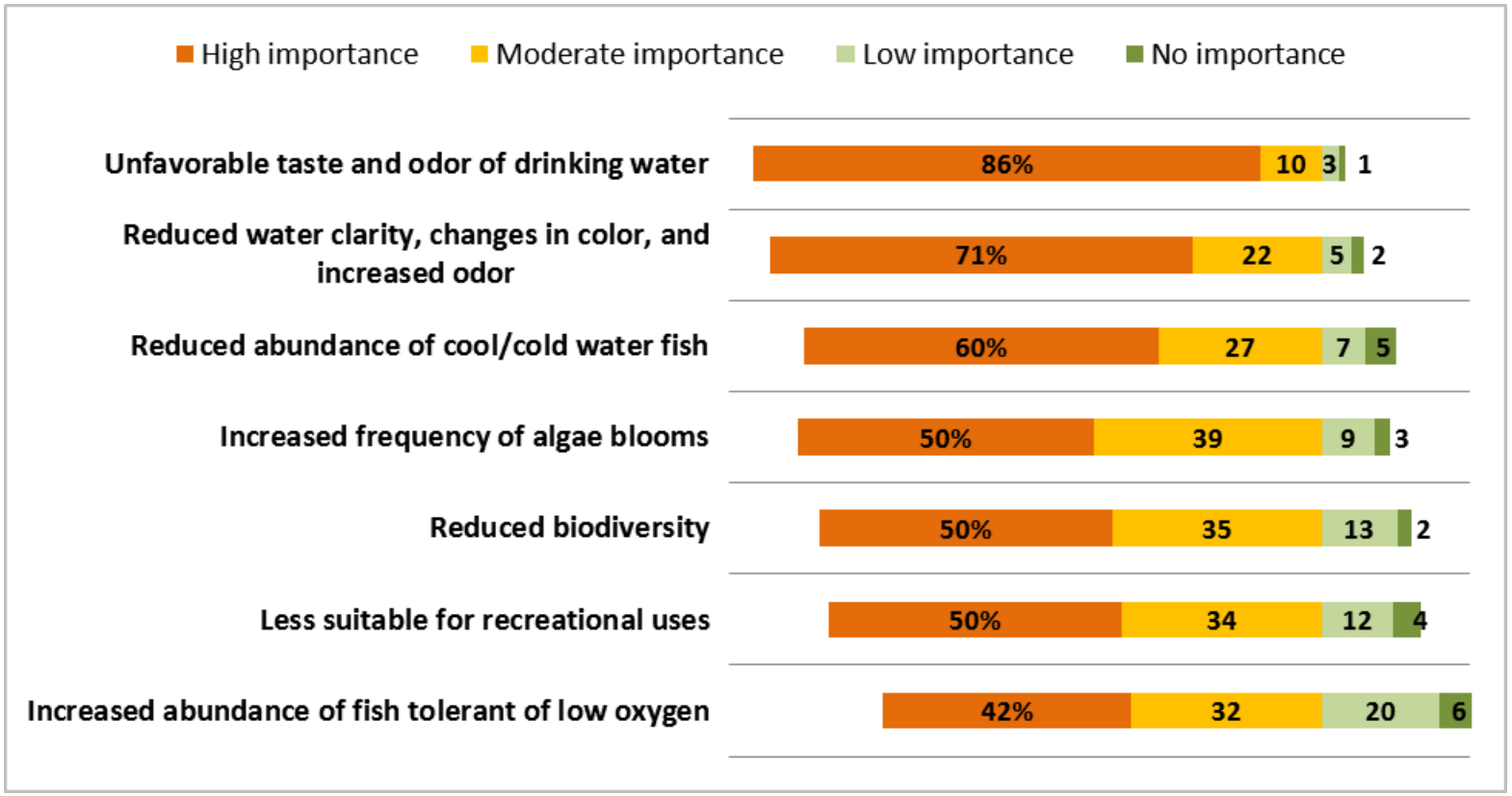
Demographics

Distribution of Utah Households by Water-based Recreation	
Nonuser	26.8%
User	73.2%
Both River and Lake	53.2%
River Only	7.5%
Lake Only	12.5%

Utah Households Primary Activity While Visiting Lakes and Rivers		
Activity	**Lakes**	**Rivers**
Near-shore activities	34.5%	52.9%
Fishing - cold water fishery	27.5%	31.3%
Boating	21.6%	4.4%
Swimming	13.4%	7.3%
Fishing - warm water fishery	1.7%	1.8%
Hunting	1.4%	2.3%

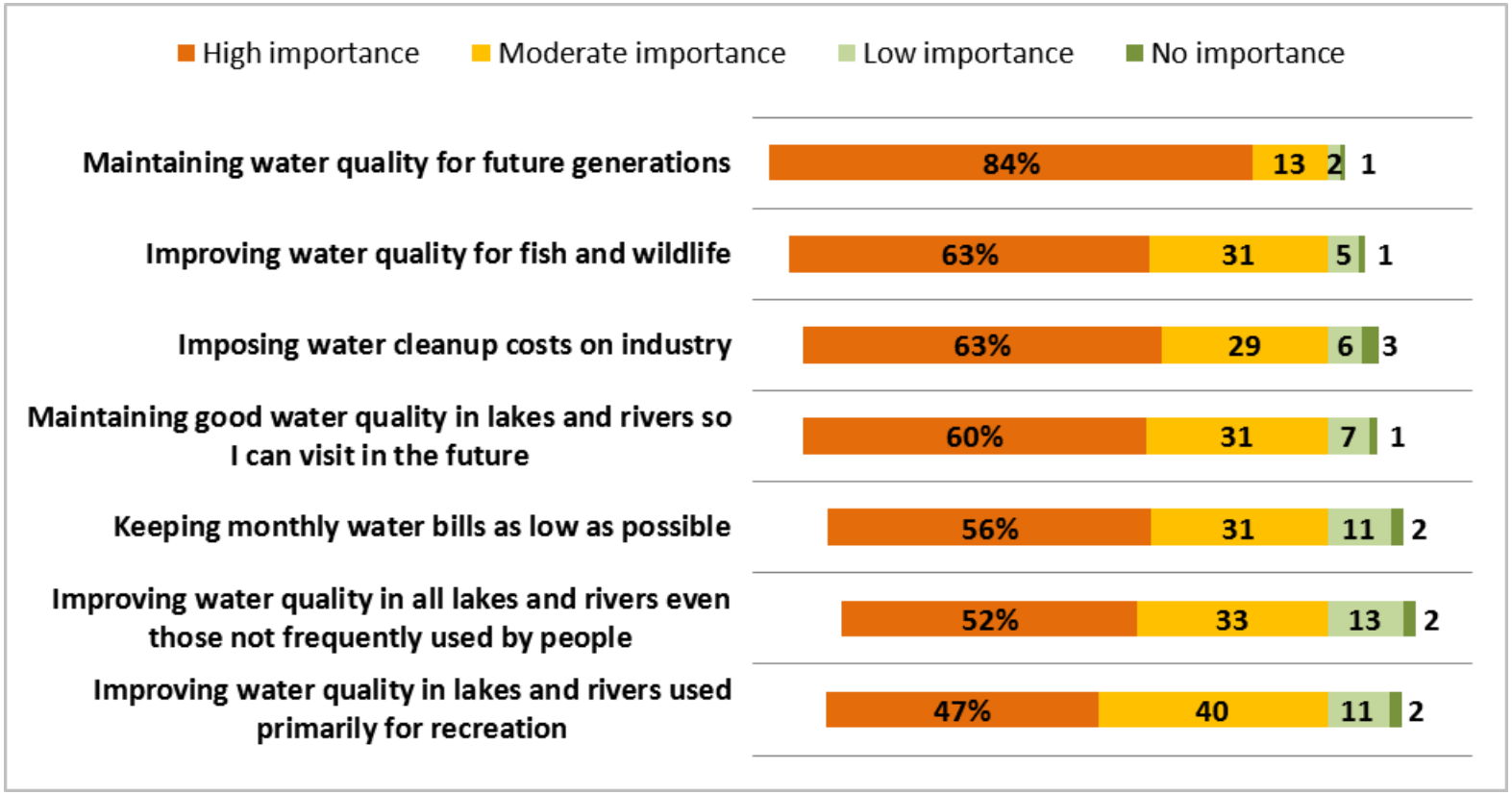
Public Opinion

Importance of preventing changes to water quality from excess nutrients



Public Opinion

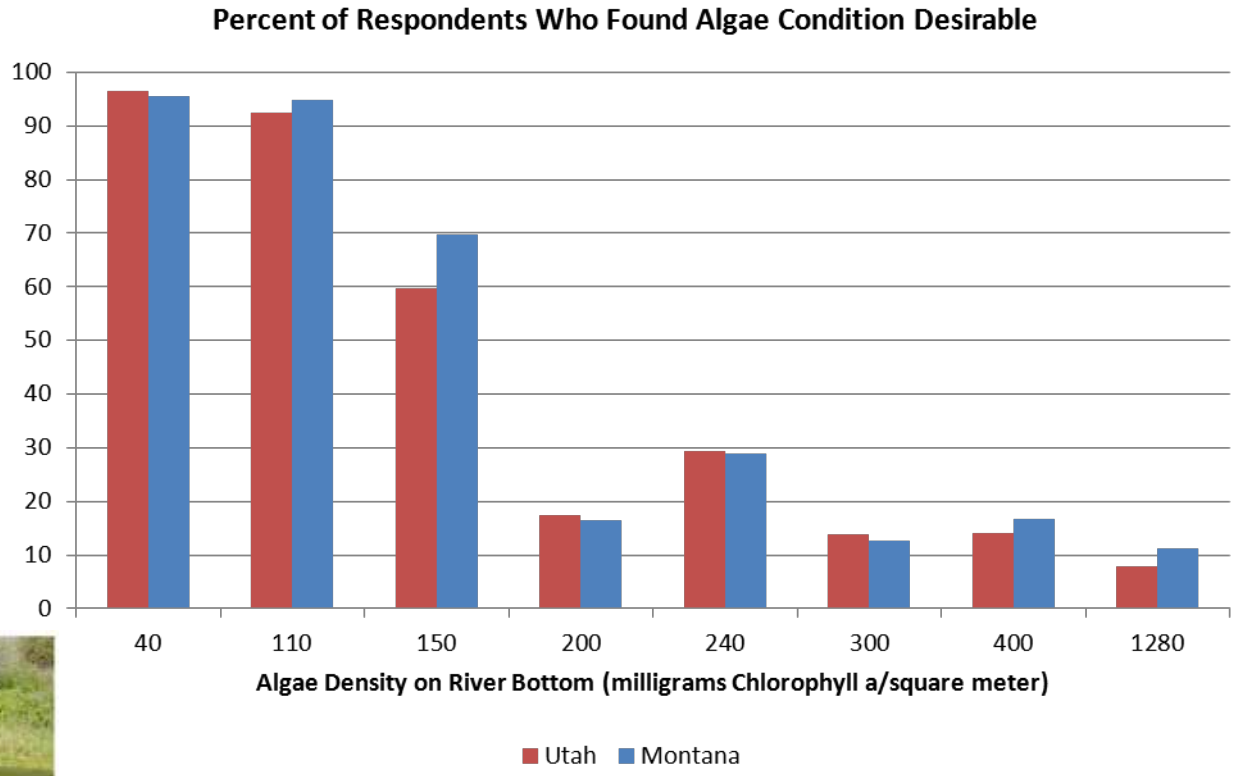
Importance of water quality-related issues in Utah



Stream Aesthetics

150 mg Chla/m^2

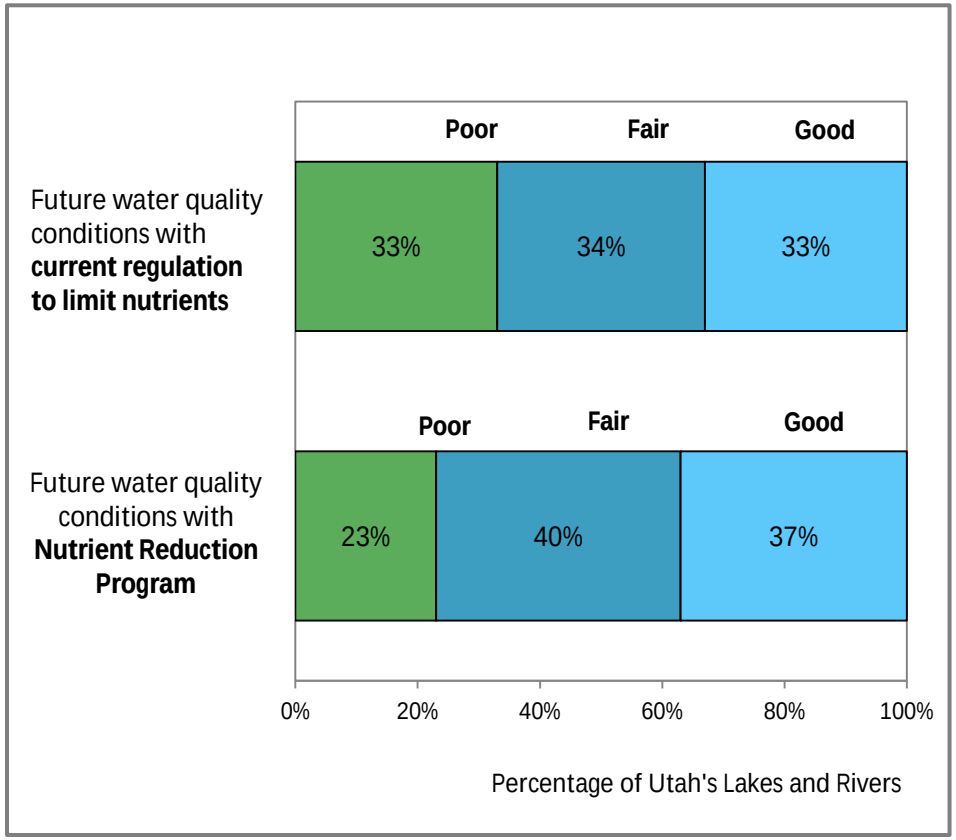
200 mg Chla/m^2



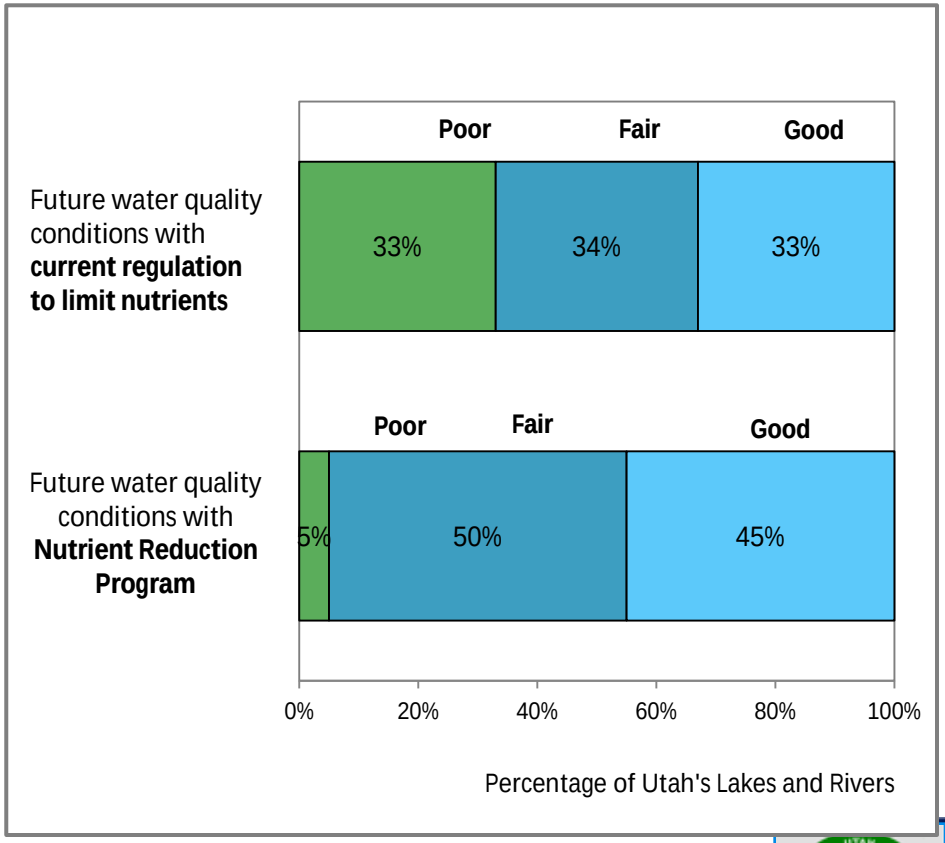
Proposed Recreation Beneficial Use Criteria for Benthic Algae of 150 mg Chla/m^2

Nutrient Reduction Program Scenarios

Maintain

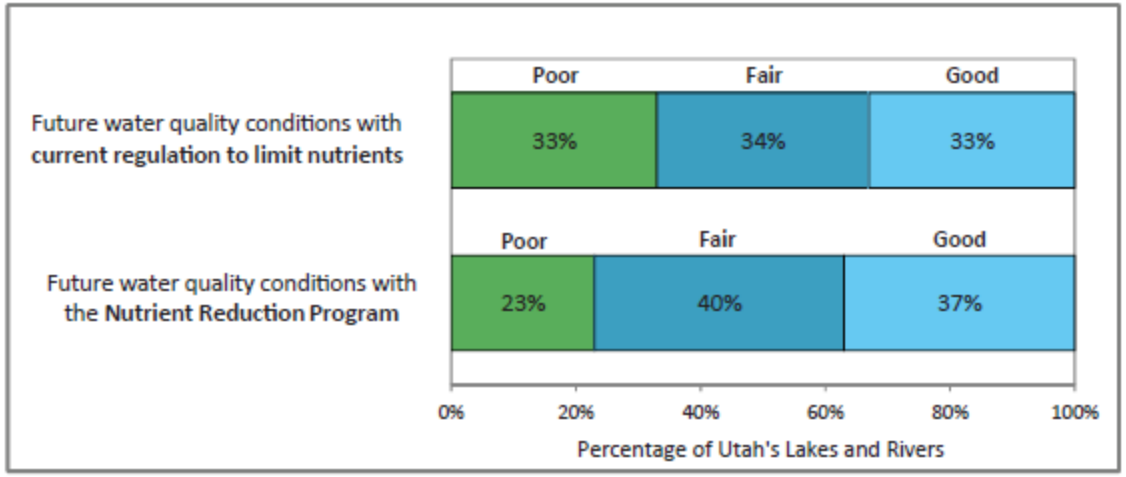


Improve



Total Economic Value Survey Design

The **Nutrient Reduction Program** will reduce the percent of waters in the **Poor** category from 33% down to 23% and increase the percent of waters in **Good** condition from 33% to 37%. Implementation of the program would start next year and be phased in over 20 years. In some cases, complete clean up may take longer than 20 years.



The costs of the program will be shared between households, businesses, and industry in proportion to their share of total nutrient discharges. Based on these proportions, the share of the cost for each Utah household will be an additional $2 per month.

3. Which one of the following two options regarding your household's monthly water and sewer bill would you choose? Please do NOT consider what other people could or could not afford.

Under current regulations to limit nutrients	Under the Nutrient Reduction Program
$0 increase	$2 increase
○	○

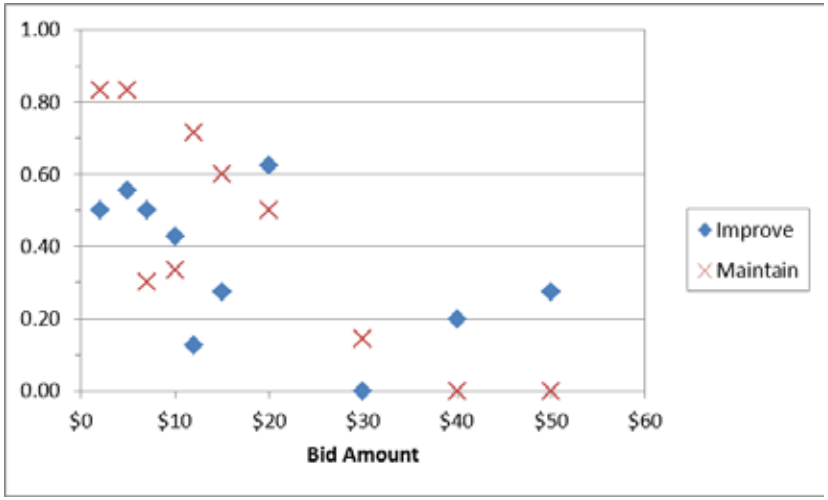
- Two scenarios with Nutrient Reduction Program: Maintain and Improve
- Bid vectors per month: $2, $5, $7, $12, $15, $20, $30, $40, $50

Bid Response

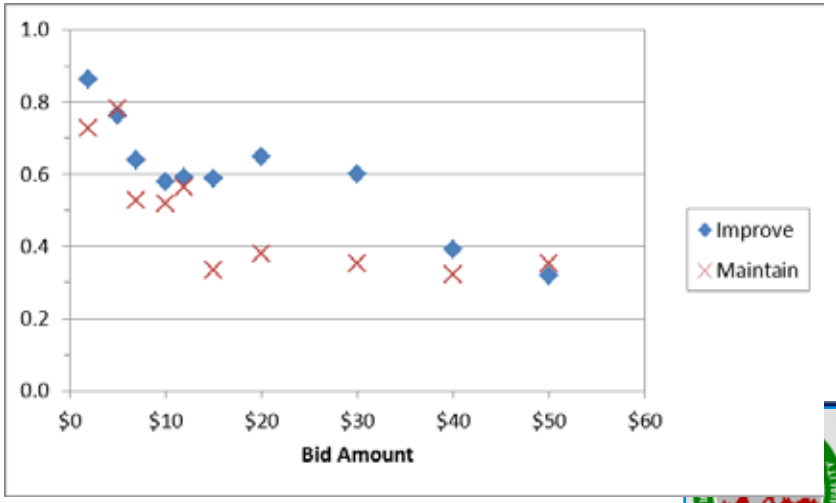
All Respondents

Bid	Maintain (% Yes)	Improve (% Yes)
$2	76%	75%
$5	77%	68%
$7	42%	62%
$10	44%	54%
$12	63%	50%
$15	41%	47%
$20	40%	62%
$30	31%	51%
$40	29%	32%
$50	26%	31%

Nonusers



Users



Statistical Model of Willingness To Pay

Logit Regression Model for Users

$$\Pr(NutRedux = 1) = F\left(\beta_0 + \beta_1 \ln(Bid) + \beta_2 Improve + \beta_3 Passive + X_i'\beta + \varepsilon_i\right)$$

Variable Definitions and Descriptive Statistics

Variable	Definition	Type	N
NutRedux	Voted 'yes' for the Nutrient Reduction Program	D	615
lnBid	Natural log of bid amount randomly chosen from the set {$2, $5, $7, $10, $12, $15, $20, $30, $40, $50}	C	625
Improve	Nutrient Reduction Program (coded 1 for Improve; 0 for Maintain)	D	625
Passive	Passive use value	D	618
Female	Gender (coded 1 for female; 0 for male)	D	614
Age	Age of respondent	C	609
College	Undergraduate degree or higher	D	615
Adult	Number of adults in the household	C	617
Child	Number of children (age ≤ 17) in the household	C	613
White	White	D	610
Income	Household income in the last 12 months	C	596

NOTES:
C = Continuous variable
D = Dummy variable. Sample sizes less than N=615 indicate missing data.

Utah Household Willingness to Pay
Maintain or Improve Water Quality Due to Nutrient Enrichment

DRAFT

Recreation Group	Future Water Quality Scenario	Monthly		Annual	
		Lower Bound	Upper Bound	Lower Bound	Upper Bound
User	Maintain	$3.13	$13.61	$37.56	$163.36
	Improve	$8.11	$31.97	$97.37	$383.64
Non-User	Both	$2.19	$7.05	$26.33	$84.64

Utah Total Annual Willingness to Pay

DRAFT

Scenario	Bound	Annual Household WTP		Total Utah Annual WTP[1]	Net Present Value[2]
		Users	Non-Users		
Maintain	Lower	$37.56	$26.28	$30.3M	$463.7M
	Upper	$163.32	$84.60	$124.8M	$1,909.7M
Improve	Lower	$97.32	$26.28	$68.7M	$1,051.1M
	Upper	$383.64	$84.60	$266.4M	$4,896.1M

1: Based on 642,470 Users and 235,221 Non-Users
2: 20 years; 2011 dollars; constant population

Selected Benefit to Cost Comparison

DRAFT

Benefits – Total Willingness to Pay

Scenario	Bound	Net Present Value (20 Years)
Maintain	Lower	$464M
	Upper	$1,910M
Improve	Lower	$1,051M
	Upper	$4,896M

FINAL

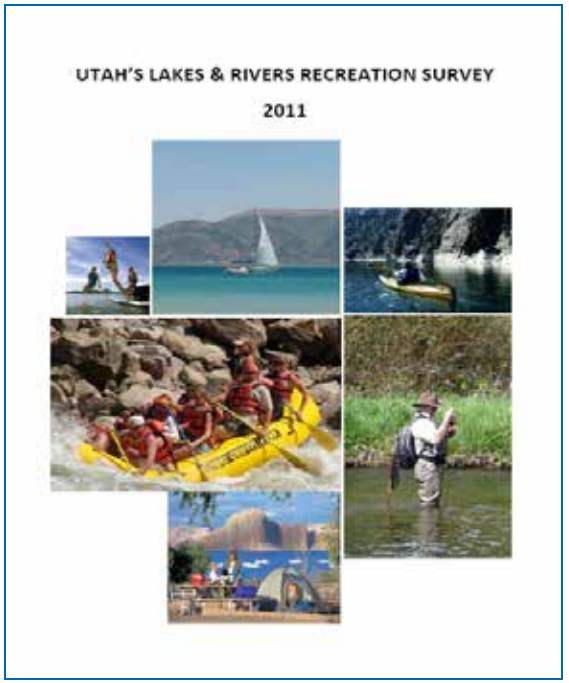
Costs – Wastewater Treatment

Treat-ment Level	Phos-phorus Limit (mg/L)	Nitrogen Limit (mg/L)	Net Present Value (20 Yrs)
Tier 2	0.1	10	$114M
Tier 2N	1.0	20	$232M
Tier 1	0.1	No limit	$1,090M
Tier 1N	0.1	10	$1,352M

Source: *POTW Nutrient Removal Cost Impact Study*, CH2M Hill, 2010

Recreation Demand Survey

- Objective is to estimate the recreation demand of water-based users and recreation value of reducing excess nutrients in rivers and lakes
- Hybrid Sample
  - Address Based Sample - randomly selected households (30%)
  - Targeted - households more likely to engage in water-based recreation, not random (70%)
- Administered fall 2011
- 3,600 surveys mailed
  1,411 surveys completed



Recreation Survey Results

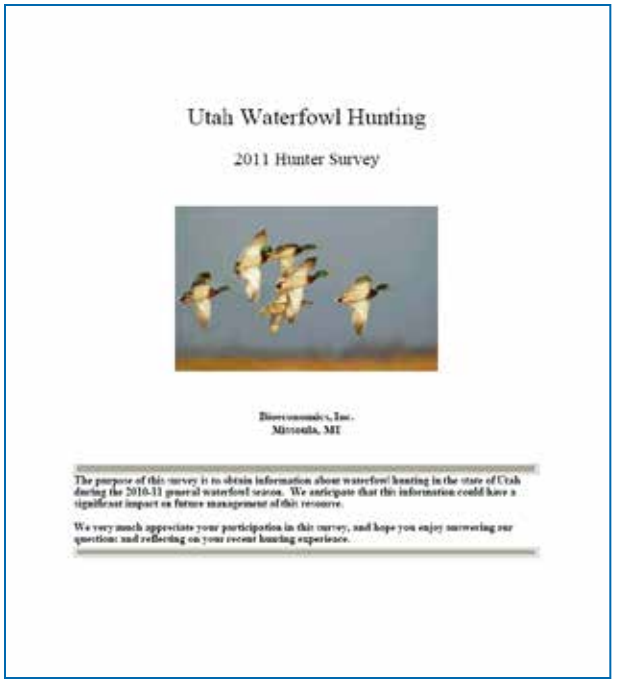
Variable	Mean or Percent
Visited a Lake in last 12 months	95.5%
Visited a River in last 12 months	56.4%
Female	49.9%
White	93.9%
Latino	6.0%
Four year degree or higher	31.2%
Age	42.4 years

Most Popular Waterbodies

Lakes		Rivers	
Day Trips	**Overnight**	**Day Trips**	**Overnight**
Utah Lake	Utah Lake	Logan River-1	Green River-4
Strawberry Reservoir	Starvation Reservoir	Provo River-1	Deer Creek (Provo River)
Pineview Reservoir	Bear Lake	Provo River-2	Bear River-4
Starvation River	Flaming Gorge Reservoir	Weber River-3	Ninemile Creek
Deer Creek Reservoir	Strawberry Reservoir	Jordan River-8	Huntington Creek-1

Waterfowl Hunters Survey

- Objective was to estimate the recreation demand of waterfowl hunters and non-market value of reducing excess nutrients in lakes and wetlands
- Focus of survey was Great Salt Lake and associated impoundments and wetlands
- Sample taken from list of Utah waterfowl hunters and hunting advocates
- Administered spring 2011
- 940 surveys mailed
  61.5% response rate


Utah Waterfowl Hunting

2011 Hunter Survey

Missoula, MT

The purpose of this survey is to obtain information about waterfowl hunting in the state of Utah during the 2010-11 general waterfowl season. We anticipate that this information could have a significant impact on future management of this resource.

We very much appreciate your participation in this survey, and hope you enjoy answering our questions and reflecting on your recent hunting experience.

Property Value

- Objective:

  Estimate the impacts of nutrient enrichment on the value of properties adjacent to lakes and reservoirs

- Approach:

  Combine literature valuation studies with Utah property and water quality data

Water Treatment Cost Savings

- Problem: Excess nutrients cause increased algal growth
  - Intake clogging
  - Taste and odor issues
  - Disinfectant byproducts with potential human health effects
  - Nitrate – blue baby syndrome
- Objective:

  Estimate the water treatment costs associated with excess nutrients
- Approach:

  Survey of Utah water purveyors

Benefit Cost Analysis (BCA)

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3) Nonpoint Source Pollution
4) Regulatory Administration
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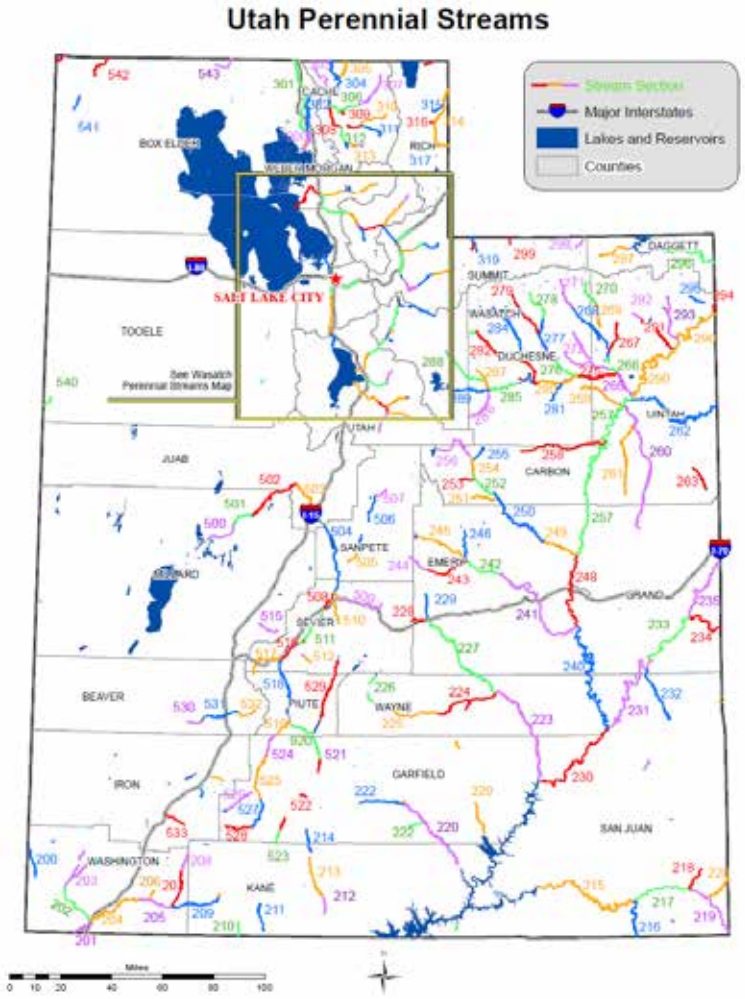
Site Specific Tool

- Anticipate implementation of nutrient criteria will often require site specific evaluation
- Develop screening level tool to assist with site specific economic considerations



Additional Information

http://nutrients.utah.gov

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Survey Comments

I appreciate the quality of water in the state, you do a great job. My bigger concern is with water waste; too many businesses and government entities do not control their sprinkler systems and have wrong landscapes for our area. Thanks.

I don't know why you want my opinion when it comes to city or state problems; they usually do what they want regardless of how we feel. But I gave mine anyway. Have a good day and God bless you in your efforts to help us and the life in our lakes and rivers.

I believe US citizens do not pay enough for water OR gasoline (another story). Water should be protected and conserved but I am SKEPTICAL of the governments or Universities' bureaucratic attempts at doing this, particularly with unlimited TAX funds. Perhaps partnering with or subcontracting Sierra Club, Nature Conservancy, National Wildlife Defense, or a similar organization with a track record of results would be comforting/reassuring to tax payers.

I feel that this is an important program. Keep up the good work. We cannot improve unless everyone helps out; but that will take time, money, and a more environmentally conscious generation. We MUST start somewhere!

I get sick when I see how dark, murky, and dirty our rivers and lakes are. However, my husband has been laid off and we are on a limited budget. It's about time cities, counties, and state and federal governments limit their budgets.

I believe water quality in Utah will continue to deteriorate no matter what we do. Millions more people plus increased industry (oil, gas, coal, other minerals, and factory farms) will doom us to a decreased quality of life in the future.

I live by the Jordan river in Rose Park, if this program could clean up THAT river, I would be mighty happy.

I think this is an excuse for more taxes. Government agencies need to use what they have; get rid of all unnecessary upper management. Less government. Use what you have; revisit your priorities. How much did this survey cost us? Can't you figure out the algae problem?? That is your job.

Because my landlord pays for water/sewer, I'm not concerned about the increase but I ultimately believe the party(s) responsible for destroying the water quality should be the party(s) responsible for cleaning it up; but then they would end up raising their prices ultimately affecting the consumer, so better $7 increase than possibly more.

I was surprised to learn that fertilizing lawns contributes to poor water quality.