WHAT IS WATER WORTH

Economic Benefits of Nutrient Removal from Utah's Waters

Jeff Ostermiller
Utah Division of Water Quality

American Water Resources Association
Annual Conference
November 7, 2013

Utah Department of
Environmental Quality

CH2MHILL

WYSAC
Wyoming Survey & Analysis Center

UtahStateUniversity

Economic Benefits Research Team

Economics and Survey Administration

- Mary Jo Kealy, Project Manager, CH2M Hill, Inc.
- Nanette Nelson, Wyoming Survey and Analysis Center
- Paul Jakus, Utah State University
- John Loomis, Colorado State University
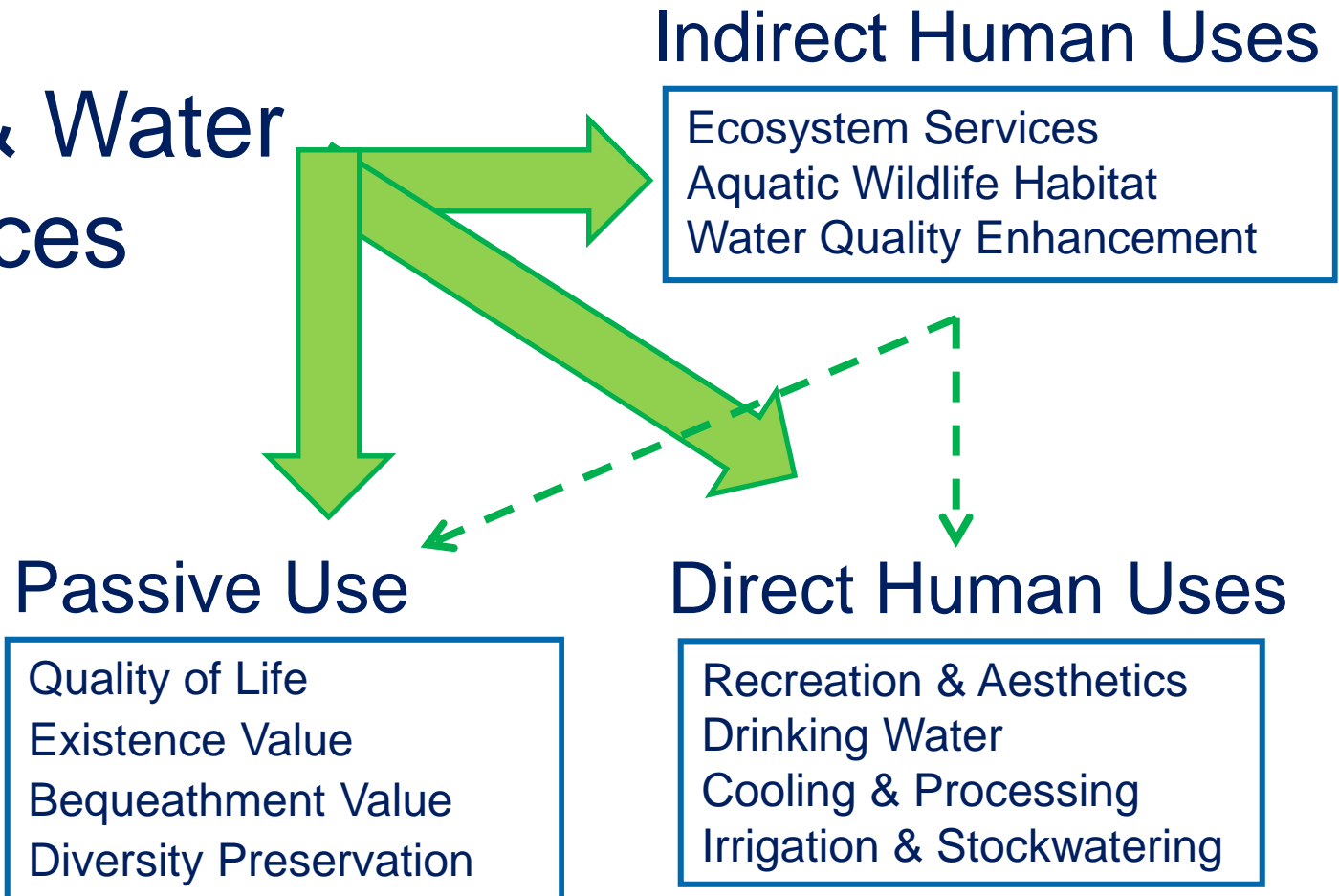- Cody Stanger, Site Specific Tool

Water Quality Data and Analysis

- Utah Division of Water Quality
  - Nicholas von Stackelberg
  - Ben Holcomb
  - Mark Stanger
  - John Mackey
  - Jeff Ostermiller

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
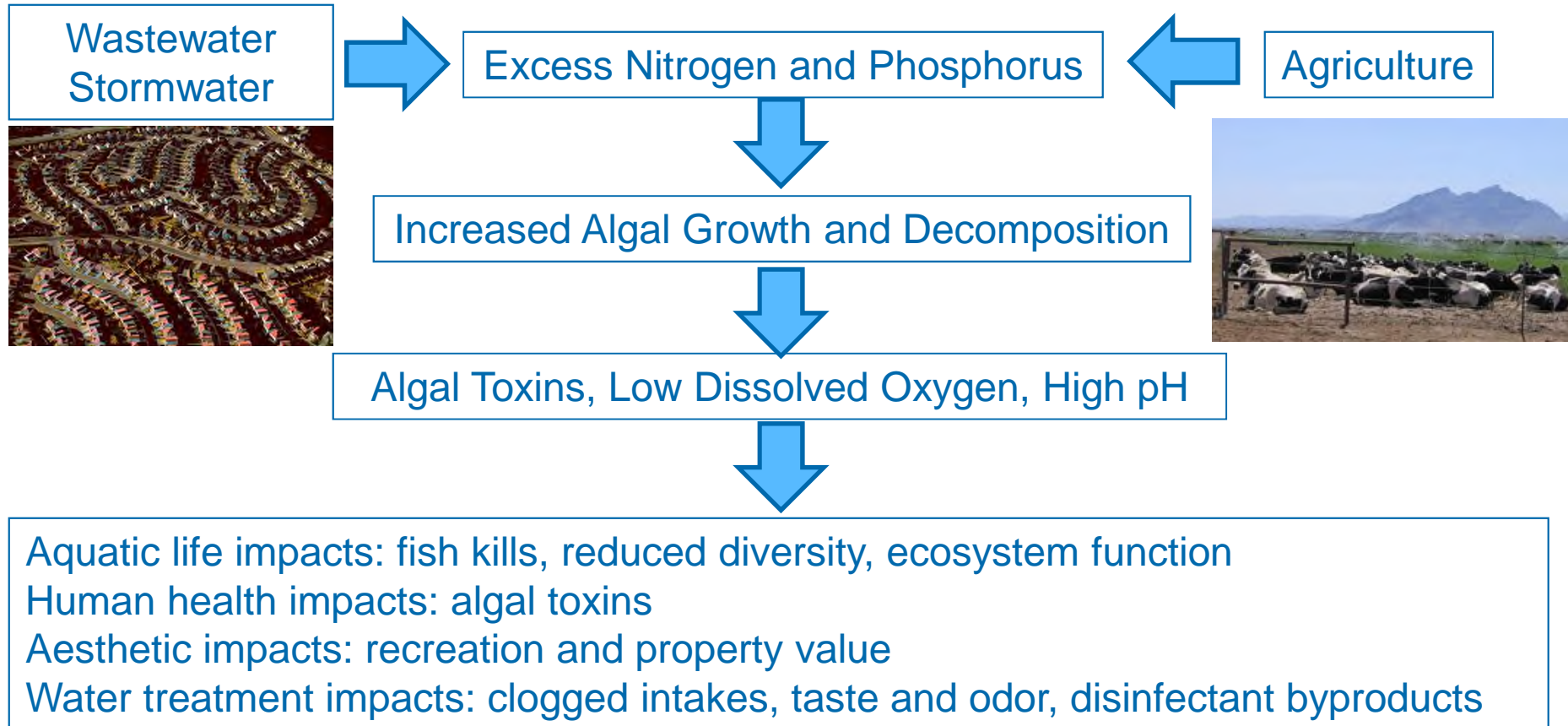
Study Conclusions

➢ Utahns' place most importance on bequeathment and fish & wildlife support for why they value water quality

➢ Utahns' willingness to pay for excess nutrient reduction is commensurate with the cost estimates for POTW upgrades

➢ Recreationists' tend to choose the sites that are consistent with their stated water quality preferences

➢ Recreation economic benefits are a fraction of total economic value

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

Utah Nutrient Reduction Program

➢ Currently under development through stakeholder process

➢ <u>Potential</u> elements of the Nutrient Reduction Plan:

- Instream: Numeric nutrient criteria for nitrogen (N), phosphorus (P) and response indicators
- Wastewater: Technology based limits for N & P
- Stormwater: Enhanced BMPs for nutrient sensitive waters
- Agriculture: Additional funding for N & P BMP implementation through sewer fee (other?)
- Prioritization: Recovery Potential
- TMDL alternatives, especially where heavily modified

Benefit Cost Analysis (BCA)

Benefit Categories

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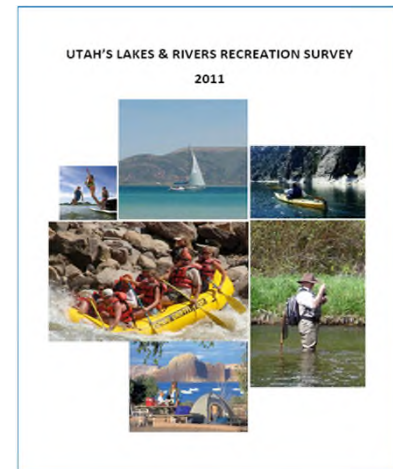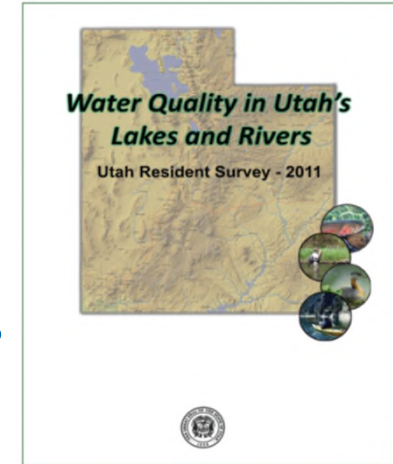   b) Industrial Users
   c) Agricultural Users

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
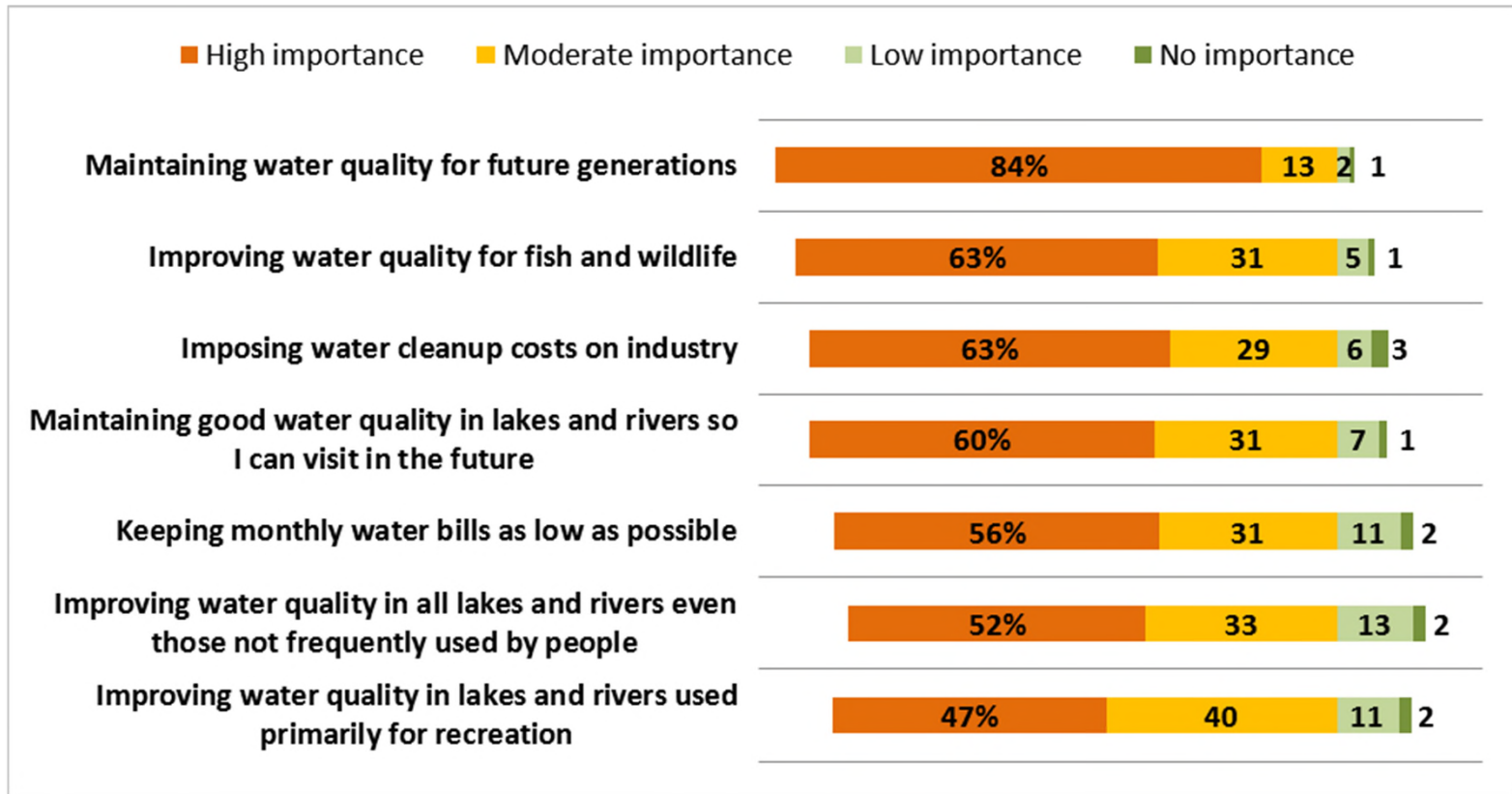   a) TMDL
   b) Site Specific Criteria

Methods for Estimating Benefits

- Conducted two surveys of Utah households via mail
  - Total Economic Valuation Survey
    (general - 2,700 surveys – 25% response)
  - Recreation Demand Survey
    (targeted - 3,600 surveys – 39% response)
- Asked contingent questions on surveys
  - 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?
- Developed future water quality scenarios
  - Current program – degrade conditions
  - Proposed program – maintain current conditions
  - Proposed program – improve conditions
- Performed econometric modeling
  - Statistical regression to correlate responses to water quality, respondent and site characteristics
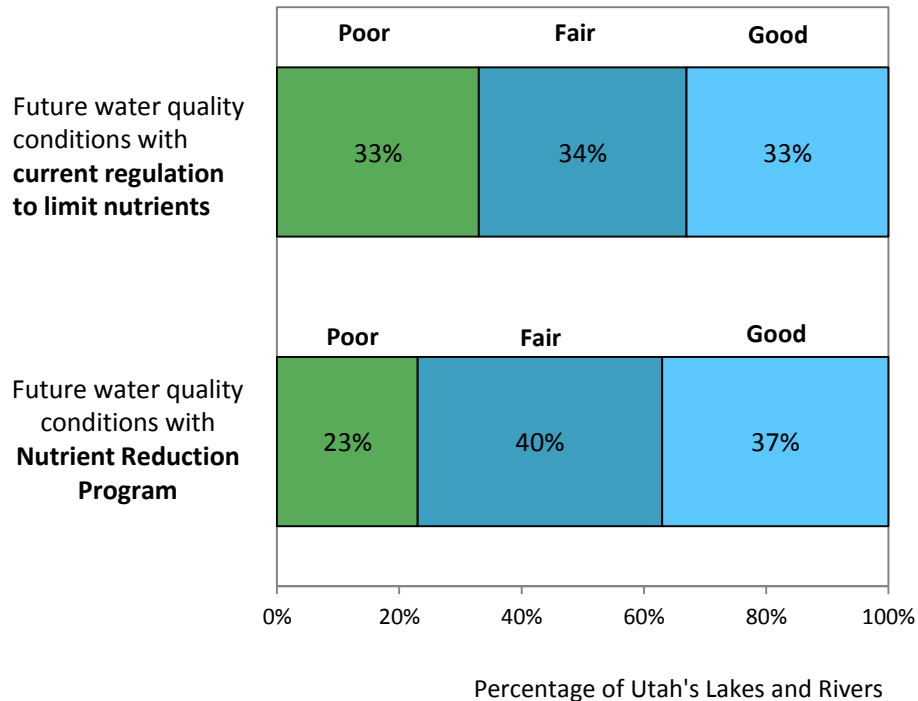

Water Quality in Utah's Lakes and Rivers
Utah Resident Survey - 2011

UTAH'S LAKES & RIVERS RECREATION SURVEY
2011

Utah Public Opinion Results

Importance of factors related to preventing impacts from excess nutrients (%)

Legend: High importance · Moderate importance · Low importance · No importance

Factor	High importance	Moderate importance	Low importance	No importance
Maintaining water quality for future generations	84%	13	2	1
Improving water quality for fish and wildlife	63%	31	5	1
Imposing water cleanup costs on industry	63%	29	6	3
Maintaining good water quality in lakes and rivers so I can visit in the future	60%	31	7	1
Keeping monthly water bills as low as possible	56%	31	11	2
Improving water quality in all lakes and rivers even those not frequently used by people	52%	33	13	2
Improving water quality in lakes and rivers used primarily for recreation	47%	40	11	2

Nutrient Reduction Program Scenarios

Maintain

Future water quality conditions with **current regulation to limit nutrients**

Poor	Fair	Good
33%	34%	33%

Future water quality conditions with **Nutrient Reduction Program**

Poor	Fair	Good
23%	40%	37%

Percentage of Utah's Lakes and Rivers

Improve

Future water quality conditions with **current regulation to limit nutrients**

Poor	Fair	Good
33%	34%	33%

Future water quality conditions with **Nutrient Reduction Program**

Poor	Fair	Good
5%	50%	45%

Percentage of Utah's Lakes and Rivers

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.

	Poor	Fair	Good
Future water quality conditions with current regulation to limit nutrients	33%	34%	33%
Future water quality conditions with the Nutrient Reduction Program	23%	40%	37%

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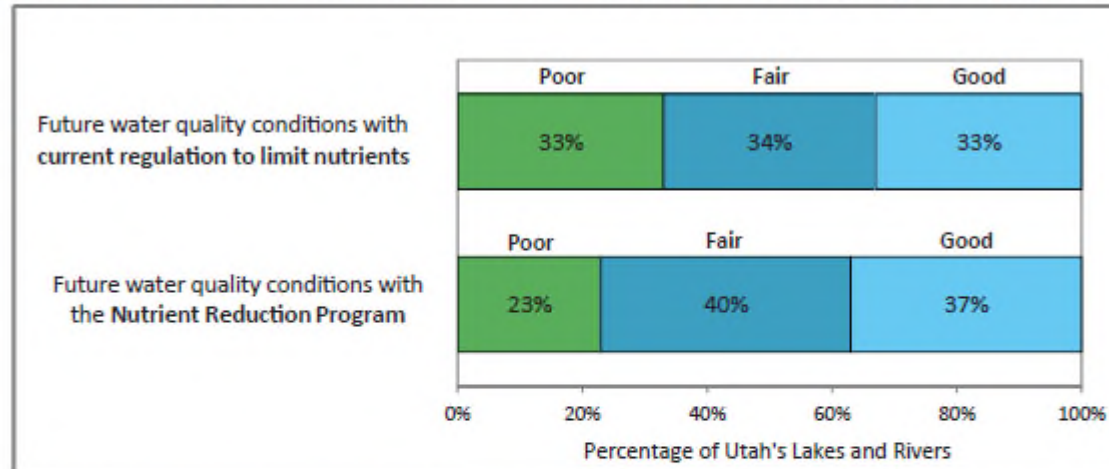
The costs of the program will be shared between households, businesses, and industry in proportion to their share of total nutrient discharges. Based on these proportions, the share of the cost for each Utah household will be an additional $2 per month.

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

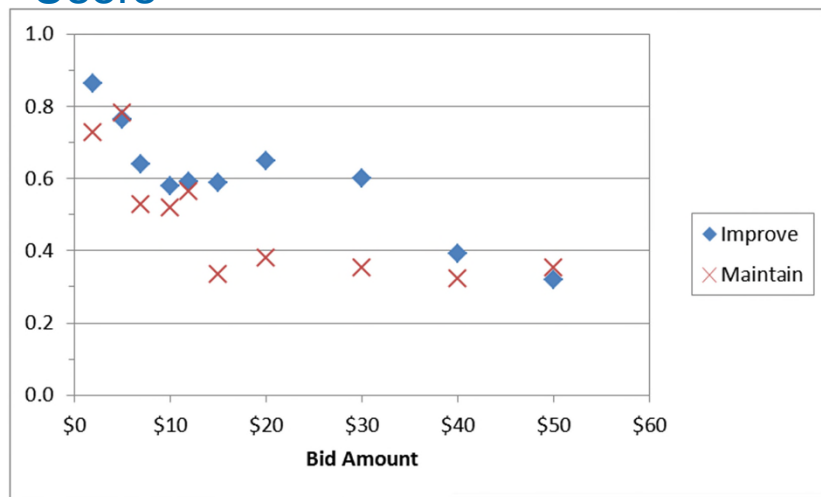➢ Bid vectors per month: $2, $5, $7, $12, $15, $20, $30, $40, $50

Bid Response

Nonusers

Users

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%

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

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 monthly sewer rates:
    Median $18.97
    ERU-Normalized Average $15.82

Recreation Demand Modeling

70 Northern Lakes

61 Southern Lakes

153 Rivers

284 total sites
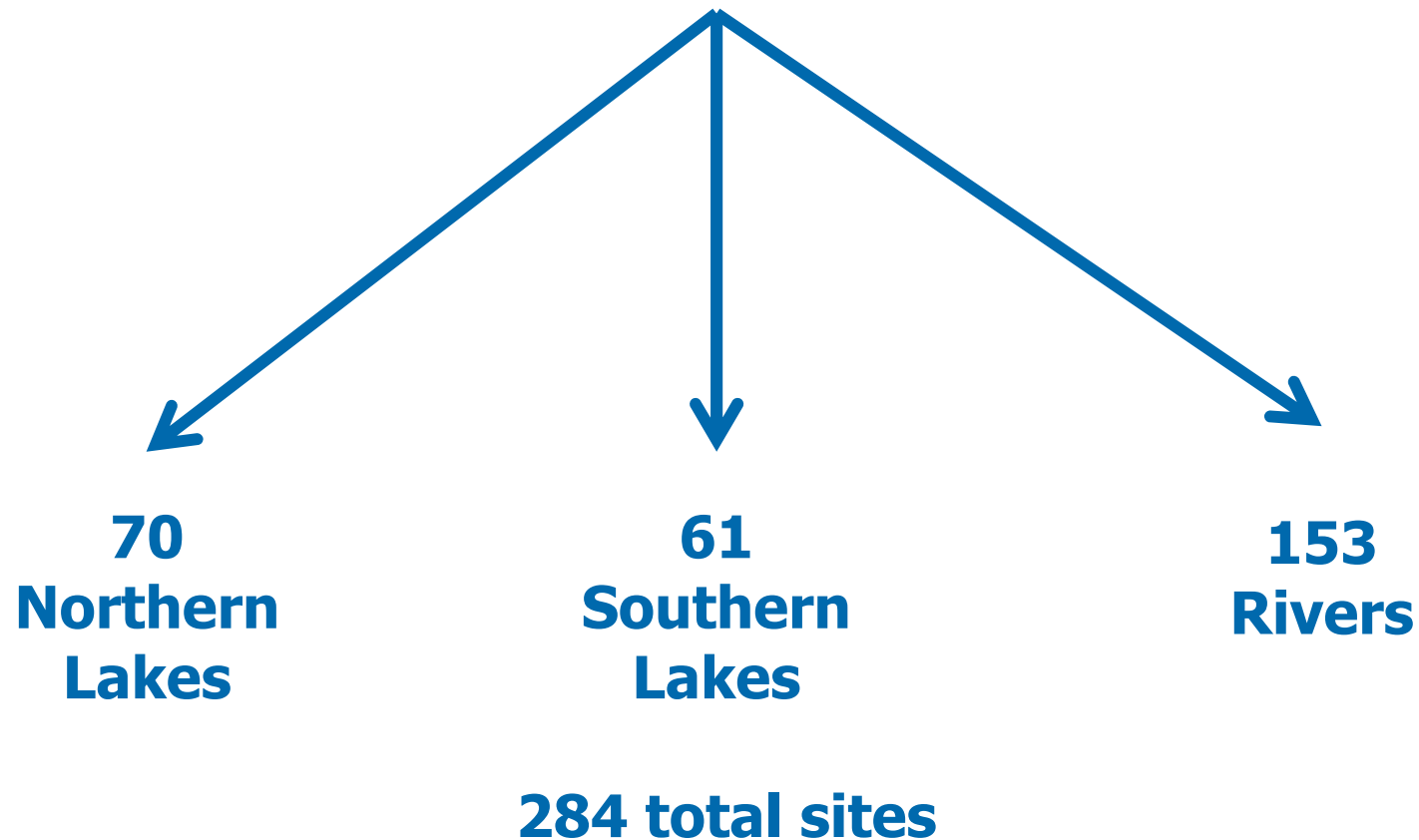
Recreationists Opinion Results

Importance of water quality attributes when choosing a site to visit (%)

LAKE they visited most often

■ High importance ■ Moderate importance ■ Low importance ■ No importance

Attribute	High	Moderate	Low	No
No unpleasant odor	44%	33	17	6
Proximity to your home	38%	39	16	7
Water clarity	28%	43	22	7
No algae blooms	27%	40	22	11
Cold water fish species are present	35%	18	21	26
Warm water fish species are present	16%	20	26	39

RIVER they visited most often
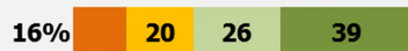
■ High importance ■ Moderate importance ■ Low importance ■ No importance

Attribute	High	Moderate	Low	No
Proximity to your home	43%	35	15	7
No unpleasant odor	30%	43	17	11
Long threads of dark green algae are not present	15%	38	31	15
Cold water fish species are present	30%	20	19	32
Warm water fish species are present	6%	15	30	49
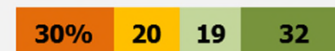
Recreation Demand Modeling Site Characteristics

Proximity: Travel Cost

Lakes

  Water Clarity: TSI(Secchi Depth)

  Algae vs. Sediment: TSI(Chl-a) – TSI(Secchi Depth)

Rivers

  Algae: Avg summer Dissolved Oxygen Saturation

  Nutrients:

  - Avg summer Total Inorganic Nitrogen (mg/l)
  - Avg summer Total Phosphorous (mg/l)

Recreation Demand Modeling Statistically Significant Results

Proximity: People prefer sites that are closer

Water Clarity:

- People prefer lakes with better water clarity

Algae:

- People have preference for lake water which is a little more green than brown
- People prefer rivers with ecologically optimum levels of dissolved oxygen saturation (90% to 110%)

Nutrients:

- People prefer lower levels of nitrogen in rivers
- Phosphorous results were inconclusive

Future Scenarios

➢ Intended to conform with TEV survey scenarios
➢ Predicted water quality parameters for each scenario for each survey segment
➢ Scenarios
- No change to watersheds with < 5% urban + agricultural land
- Approved TMDL waters improve
1) Status Quo (Current Policy)
   - Waterbodies degrade water quality
   - Baseline: current conditions
2) Maintain (Nutrient Reduction Program)
   - Waterbodies maintain water quality
   - Baseline: status quo
3) Improve (Nutrient Reduction Program)
   - Waterbodies maintain water quality
   - Baseline: status quo

Recreation Value vs. Total Economic Value

	Maintain WQ	**Improve WQ**
Annual Net Recreation Benefits	$19M	$50M
Annual Aggregate Total Value (Lower Bound – Users Only)	$ 30M	$ 69M
Annual Aggregate Total Value (Upper Bound – Users Only)	$125M	$266M

All dollar values in millions.

Aggregate Benefits of Alternative Water Quality Policies

	Status Quo	Maintain WQ	Improve WQ
Annual Net Benefits	($6.9M)	$19.3M	$49.7M
Aggregate*, Over 20 yrs	($50.8M)	$142.0M	$365.7M
Average Annual Benefit (discounted)	($3.9M)	$11.0M	$28.2M

All dollar values in millions.
*Assumes linear change in water quality over 20 years at 2.7% discount rate.

Selected Benefit to Cost Comparison

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

Costs – Wastewater Treatment

Treat-ment Level	Phos-phorus Limit (mg/L)	Nitrogen Limit (mg/L)	Net Present Value (20 Yrs)
Tier 2	1.0	20	$114M
Tier 2N	**1.0**	**10**	**$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

Site Specific Tool

➢ Anticipate implementation of nutrient criteria will often require site specific evaluation

➢ Screening level tool to match benefits to costs on specific waterbodies

➢ Report results locally

➢ Incorporate into Recovery Potential

Utah Perennial Streams
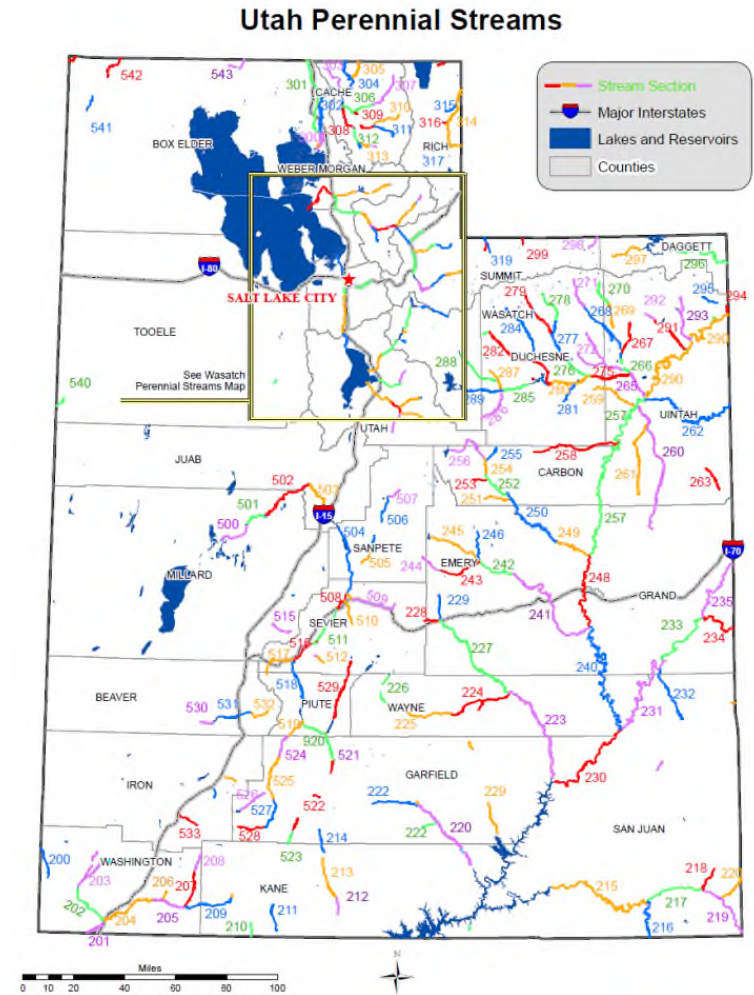
Additional Information
http://nutrients.utah.gov
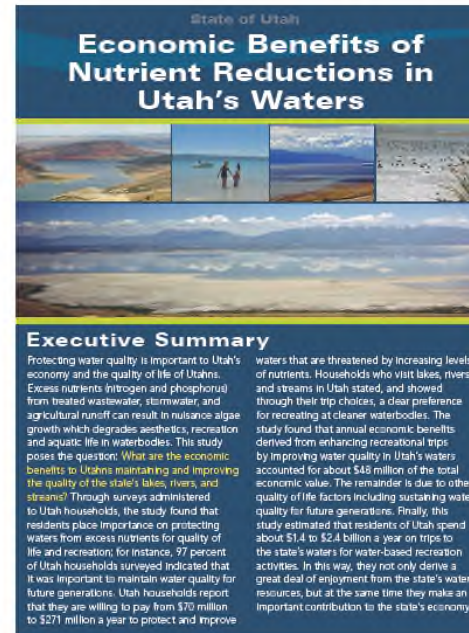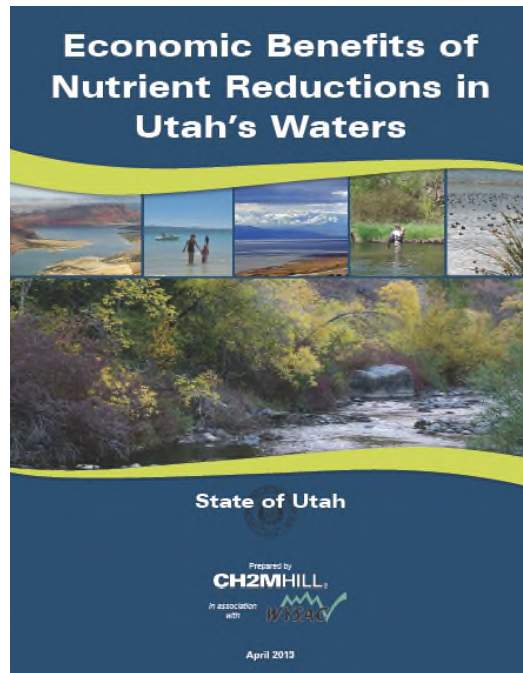
Jeff Ostermiller
Utah Division of Water Quality
jostermiller@utah.gov
(801) 258-1611

Additional Slides not in Presentation

Study Objectives

1) Conduct comprehensive statewide benefit-cost analysis (BCA) of implementing Nutrient Reduction Program

2) Estimate economic benefits of reducing excess nutrients on recreation and quality of life

3) Develop site-specific decision support tool for implementation and prioritization

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 was to estimate total willingness to pay (WTP) to protect rivers and lakes from excess nutrients

WTP = Recreation + Quality of Life

➢ Random sample taken from all Utah households

➢ 2,700 surveys - 25% response

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%

Water Quality in Utah's Lakes and Rivers

Utah Resident Survey - 2011
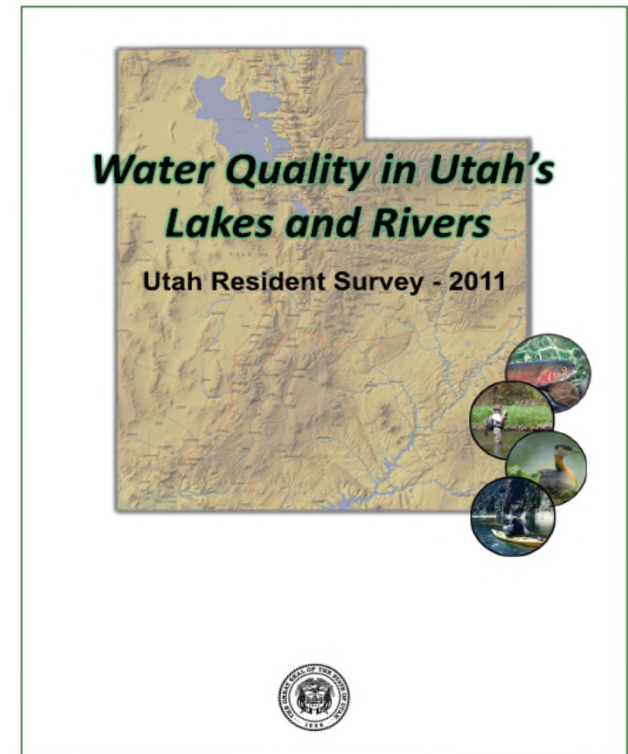
Statistical Model of Willingness To Pay

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.

Recreation Demand Survey

➤ Objective: 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%)

➤ 3,600 surveys
1,405 responses

UTAH'S LAKES & RIVERS RECREATION SURVEY
2011
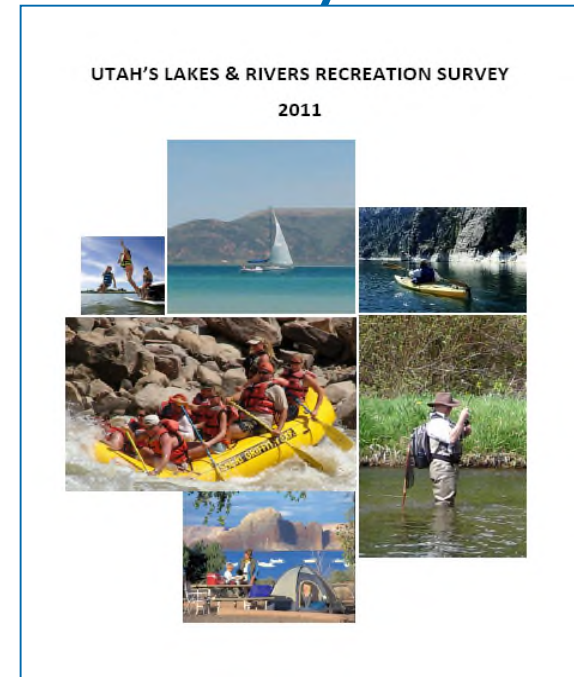
	Lakes	Rivers
Visited in Last Year	96%	56%
Average Trips per Year	14.3	6.5
Primary Activity		
Fishing	39%	29%
Boating	28%	5%
Near-shore	21%	55%

Utah Total Annual Willingness to Pay

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

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

Property Value Impacts
from Changes in Water Clarity
in Lakes and Reservoirs

	Maintain WQ	**Improve WQ**
Meters/Lakes	-0.27	0.94
Dollars/Lake	$ 433,000	$ 1.2 million
Total Dollars	$7.4 million	$20.2 million

N=17 Lakes; 549 lots and 819 developed parcels

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