Economic Value of Reengineering WI Great Lakes beaches

Matthew Winden
Fiscal & Economic Research Center
Institute for Water Business

UNIVERSITY OF WISCONSIN WHITEWATER
COLLEGE OF BUSINESS AND ECONOMICS
A DEGREE ABOVE

Introduction

- Sources of impaired water quality include:
  - Litter and food waste
  - Algae accumulation and decay
  - Storm water runoff
  - High levels of Fecal Indicator Bacteria (FIB)

- Poor water quality reduces the appeal & use of beaches
  - Can even result in health advisories and beach closures

Introduction

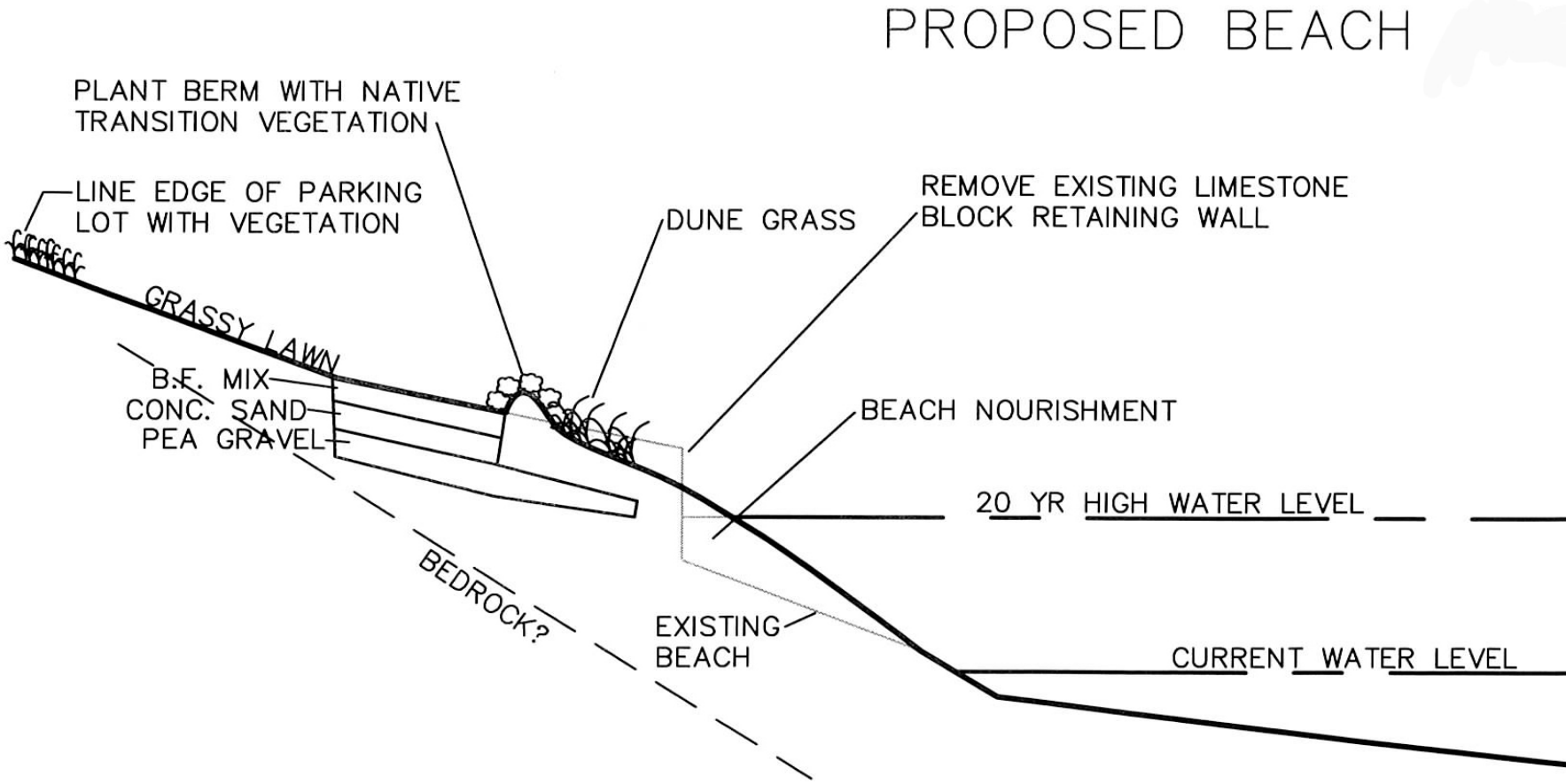
Problem

- Declines in appeal/use reduce the value of the beach
  - Loss in consumer value from foregone beach use
  - Health risks/costs associated with unsafe use
  - Reduction in related regional economic activity and tourism

Solution

- Beach remediation and re-engineering
  - Redesign of the beach
  - Treatment of (some) sources of water quality impairment
  - Promotion of natural sand retention and wave action

Redesign Example



Goals and Purpose

- Determine beach users' value for reengineering benefits
  - Reduce number of beach advisories/closures
  - Improve water quality
  - Assess changes in beach usage pre/post redesign

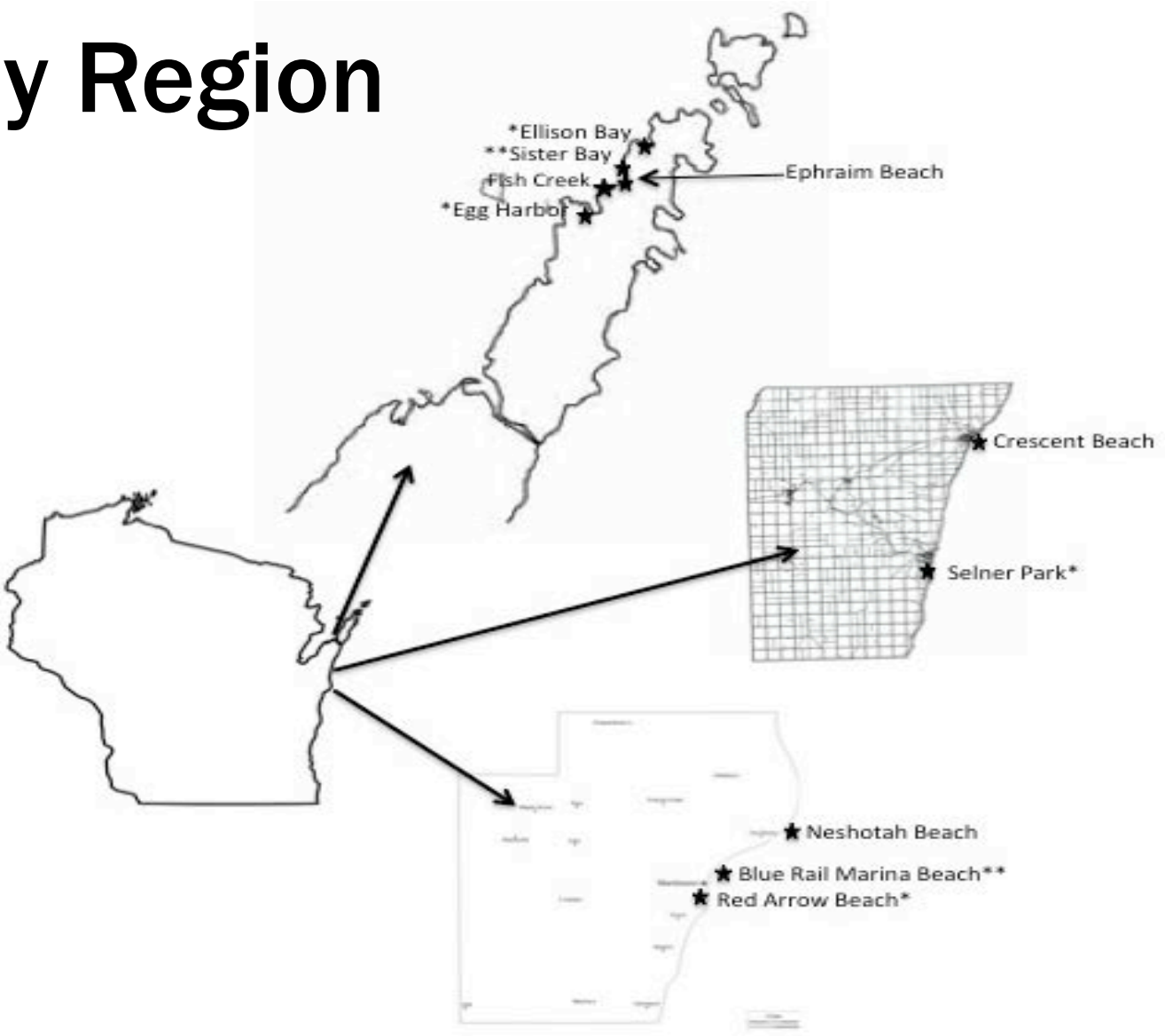
- Conduct reengineering public benefit-cost analysis (BCA)
  - Determine economic benefit/cost to communities

- Study reengineering as an option for beach management
  - Is it cost-effective from a public investment standpoint?
  - If yes, communicate and provide evidence to municipalities

Limited Previous Work

- Estimates exist for Lake Erie and coastal Michigan
  - Value of single-day trips range from $23-$55
  - Per-trip expenditures range from $26-$50
  - *Murray et al. 2001, Sohngen et al. 1999, Song et al. 2010*
- Users of Chicago's beaches spend $35/day
  - This represents a $14,000 expenditure per day
  - Over $1.5 million in beach season (~107 days)
  - *Shaikh & Tolley (2006)*
- Users of Milwaukee's beaches spend $6.64-$44.67/day
  - Urban beaches have significantly lower spending than destination
  - $55.90 average WTP for water quality improvements (CV method)
  - Aggregated over current users valued at $33.4 million annually
  - *Harrison et al. (2019)*

Study Region



Study Design

- Survey beach users during beach season (May-August)
- Intercept survey methodology
  - Randomly select beach users
  - Vary across beaches, days of week, times of day

- Result:
  - 398 completes

Beach Visit: Survey Distribution

Beach	Responses (#)	Percent
Sister Bay	86	21.6
Neshotah	74	18.6
Egg Harbor	63	15.8
Fish Creek	34	8.5
Murphy	20	5.0
Sunset	20	5.0
Ephraim	16	4.0
Bailey's Harbor	16	4.0
Nicolet	15	3.8
Haines	9	2.3
Rock Island	8	2.0
Clark Lake	6	1.5
Otumba	6	1.5
Red Arrow	6	1.5
Crescent	5	1.3
Anclam	4	1.0
Portage	4	1.0
Ellison Bay	2	0.5
School House	3	0.8
Sand Dime	1	0.3
Total (30)	398=n	100%

Beach Visit: Frequency

Total Visits Reported:	1,520
Average Visits Per Person:	3.8
Average Group Size:	2.7

Rank By Popularity

Sister Bay:	24%
Egg Harbor:	18%
Fish Creek:	16%
Ephraim:	13%
Neshotah:	13%
Ellison Bay:	7%
Red Arrow:	3%
Crescent:	3%
Blue Rail:	1%
Selner:	1%

Beach Visit: Sociodemographics

- **Gender:**
  - 32.7% Male
  - 67.3% Female
- **Average Age:**
  - 45.5 years
- **Average Household Income:**
  - $80,000-99,999
- **Education:**
  - 3.6% <H.S. Diploma
  - 8.9% H.S. Diploma
  - 12% Some College
  - 9.7% Associate's Degree
  - 38.5% Bachelor's Degree
  - 27.3% Graduate Degree
- **Ethnicity:**
  - 96% White/Caucasian
  - 1.3% Asian-American
  - 0.5% African-American
  - 1.3% Hispanic/Latino
  - 1% Other
- **Political Affiliation:**
  - 38.4% Democrat
  - 26% Republican
  - 19.6% Independent
  - 1% Green
  - 1% Libertarian
  - 2.2% Other
  - 11.8% No Response

Beach Visit: Expenditures

Expenditure Information (Average/Per Capita)	
Food:	$10.32
Transportation:	$15.78
Licenses:	$0.86
Fees:	$0.19
Fishing Gear:	$0.32
Beach Gear:	$5.16
Souvenirs:	$5.51
Lodging:	$55.62
Other:	$12.03
Total:	$105.83 (per person/per visit)

Expenditure Impact

- Egg Harbor beach in Door County
  - average daily usage of 20-30 beach users prior to redesign
  - increased to over 400 daily beach users per day after

- Additional $39,157/day in direct economic impact
  - ~370 additional users * $105.83/user
  - $27,409/day in indirect/induced economic impacts (m~1.7)
  - Total impact: $66,567/day
- With 107 day beach season,
  - Direct impact valued at $4.2 million annually
  - Total economic impact valued at $7.1 million annually

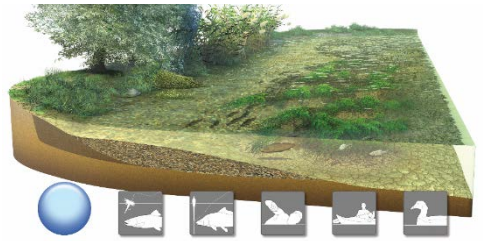
Valuation: Conjoint Choice

- Conjoint Choice Analysis/Experiment
  - Used to estimate willingness-to-pay (WTP)
  - Can estimate WTP for an object
  - Can estimate WTP for attributes which make up an object
  - *Technical note:*
    - *C-Optimal Design with 8 blocks, 5 questions per block, and 6 attributes*

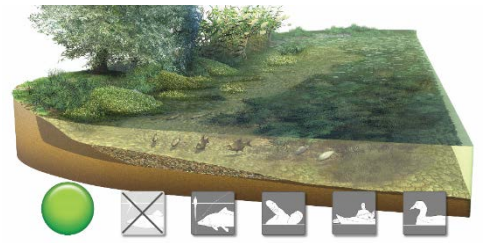
- Structure:
  - Describe important attributes of a beach visit (object)
  - Each attribute (e.g. water quality) takes on different levels
  - Combine attributes at different levels to describe a potential beach

Valuation: Attributes & Levels

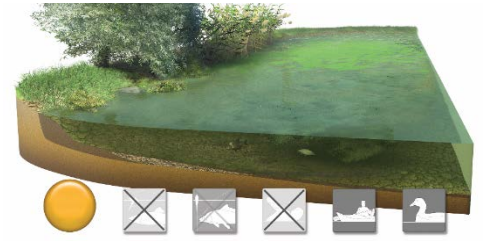
- Aesthetics (2 levels):
  - Native Grasses Present
  - Native Grasses Not Present
- Distance (4 levels):
  - 0-2 miles away
  - 3-9 miles away
  - 10-30 miles away
  - 30+ miles away
- Temperature (4 levels):
  - 70°F ave. ambient air temp
  - 80°F ave. ambient air temp
  - 90°F ave. ambient air temp
  - 100°F ave. ambient air temp
- Density (4 levels):
  - No (0) people
  - Few (<10) people
  - Some (10-20) people
  - Many (20<) people
- Water Quality (4 levels):
  - Red Water Quality
  - Yellow Water Quality
  - Green Water Quality
  - Blue Water Quality
- Payment (8 levels):
  - 5, 10, 15, 25, 35, 55, 75 or 105 $/year



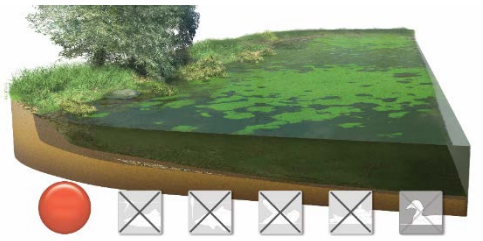
Blue: Highest Quality
Water is clear with healthy plants and no algae
Game fish (like trout) are present
Few coarse fish (not suitable for eating) are present
Provides a habitat for common, local birds
Water is safe for boating, fishing, swimming and pets



Green: Higher Quality
Water is less clear, but no algae is present
Few game fish (like trout) are present
Coarse fish are abundant
Provides a habitat for common, local birds
Water is safe for boating, fishing, swimming and pets



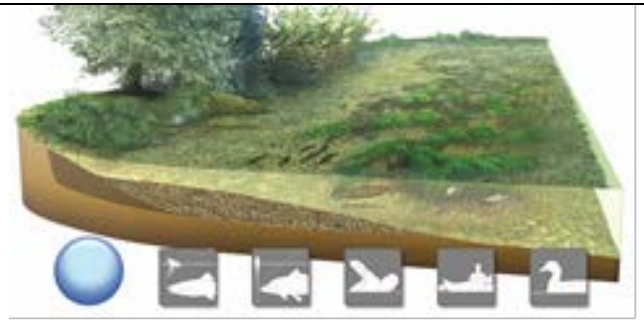
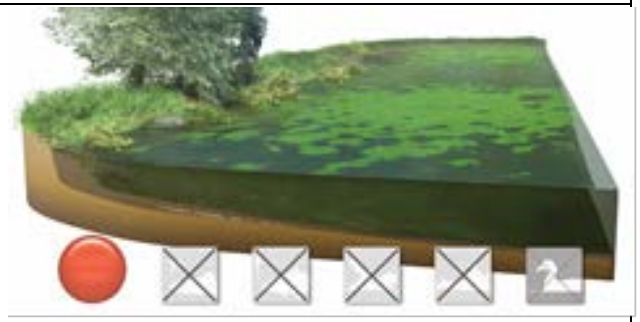
Yellow: Lower Quality
Water is murky and slightly green, with some algae
No game fish are present
Few coarse fish are present
Provides a habitat for common, local birds
Water is not safe for swimming
Water is safe for fishing, boating and pets



Red: Lowest Quality
Water is very murky and algae have spread
No fish are present or can survive
Few birds live in this habitat
Water isn't safe for swimming, fishing, boating or pets
Water contact can be hazardous to human and animal health

DIRECTIONS

In the scenario below, you are asked to consider different beaches. Your task is to decide whether you prefer Beach A, Beach B, or neither, and to place an "X" in the box for your preferred option.

Beach Features	**Beach A**	**Beach B**
Level of **Water Quality**		
	Highest Quality	Lowest Quality
Aesthetics	Abundant Native Vegetation	No Native Vegetation Present
Beach **Size**	Length 100 Feet, Width 12 Feet	Length 400 Feet, Width 32 Feet
Level of **Congestion**	No People Present	Some People Present (10-20)
Distance to the Beach	0 to 2 miles	Greater than 30 miles
Payment	$35	$75
I would choose	Beach A: ☐	Beach B: ☐
I would **not** choose to visit either beach: ☐		

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Empirical Approach

Random Utility Model (McFadden, 1974)

$$U_{ij} = \beta_0 + \beta_l{}' X_{ij} + \beta_M{}' (M_i - p_{ij}) + \varepsilon_{ij}$$

- i indexes individual, j indexes alternative, l indexes attribute
- X denotes attribute level
- M denotes individual respondent income
- p denotes payment/cost
- Betas are preference parameters to be estimated

Satisfaction (Utility) associated with a beach visit is determined by beach attribute levels. Beach users will choose the beach that provides them the greatest satisfaction within their constraints (time, income, etc.)

Empirical Approach

- First estimate conditional logit (CL) models (stata: clogit)
- Then estimate mixed logit (ML) models (stata: mixlogit)
  - Normal distribution for density
  - Water Quality Dummies across levels
- Most attributes have well-defined expectations for sign
  - Aesthetics?
    - + “Nice Remediation.” “Tremendously improved aesthetics of shoreline”
    - - “I hate that the grass takes up the beach now” “nicer before remediation”
  - Water Quality: Positive (prefer better)
  - Temperature: Positive (prefer warmer), diminishing (?)
  - Density?
  - Distance: Negative (prefer closer)
  - Payment: Negative (prefer less)

Mixed Logit (ML) Results

Mixed logit model

Log likelihood = -1398.5032

Number of obs	= 5,916
LR chi2(1)	= 0.01
Prob > chi2	= 0.9273

choice	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Mean						
asc	.9098893	.3814483	2.39	0.017	.1622644	1.657514
aesthetics	.0590015	.0798272	0.74	0.460	-.0974569	.2154599
yellow	.731305	.1755101	4.17	0.000	.3873116	1.075298
green	2.754474	.1713913	16.07	0.000	2.418554	3.090395
blue	2.745076	.2100531	13.07	0.000	2.333379	3.156772
temp	.1358898	.0396077	3.43	0.001	.0582602	.2135195
distance	-.0381126	.0520795	-0.73	0.464	-.1401866	.0639614
payment	-.0088458	.0023996	-3.69	0.000	-.013549	-.0041427
density	-.08162	.0362301	-2.25	0.024	-.1526297	-.0106102

ML Results (*ceteris paribus*)

- **ASC:** Not Statistically Significant
  - No “Status Quo” bias detected
- **Aesthetics:** Not Statistically Significant
  - Respondents’ don’t have a beach vegetation preference
- **Water Quality:** Positive, Statistically Significant
  - Respondents’ strongly prefer better water quality levels
- **Temperature:** Positive, Statistically Significant
  - Respondents’ have a preference for warmer temperatures
- **Congestion/Density:** Negative, Statistically Significant
  - Respondents’ strongly prefer less congested beaches
- **Distance:** Negative, Not Statistically Significant
  - Respondents’ don’t indicate a preference for closer beaches
- **Payment:** Negative, Statistically Significant
  - Respondents’ strongly prefer to pay less to visit a beach

Willingness-to-Pay

- **Water Quality Improvement**
  - $82.67/year to improve water quality to yellow level
  - $310.88/year to improve water quality to blue or green level
- These are the values the average individual would be willing to pay annually to visit a beach with the specified water quality level relative to a red-level of water quality

- Average number of beach visits per year (3.8)
  - $21.75/visit to improve water quality to yellow level on average
  - $81.81/visit to improve water quality to blue/green level on average
  - Value of avoided FIB exceedance/beach closure (12/year average)
  - Preventing all exceedances/closures: $261-$981/user/year

Willingness-to-Pay (ML)

- **Density/ Congestion Reduction**
  - $9.23/year to improve congestion by 1 level
  - This is approximately $1 per person reduction on average. The value the average individual would be willing to pay annually to decrease congestion by 1 person on their beach visit days.

- **Temperature Increase**
  - $15.36/year to increase ave. temperature by 1 level (10 degrees)
  - This is approximately $1.54 per degree increase on average. The value the average individual would be willing to pay annually to increase average ambient air temperature by 1 degree Fahrenheit on their beach visit days. (As a note – obviously this cannot be controlled, but it does give indications about what may happen with beach visits over time in this region of climate change impacts average ambient air temperatures over time)

Summary

- Doing the “right” thing (in terms of water quality improvement) is also economically beneficial
- Increased beach appeal and use leads to:
  - Increased beach visits (increasing consumer value)
  - Increased direct local/regional expenditure
  - Increased indirect/induced local regional expenditure
  - Reductions in health costs associated with closures

Directions/Extensions

- Full Study Underway 2019 and 2020
- Additional models of interest
- Regional economic impacts (jobs/taxes)
- Public benefit-cost analysis

AACSB ACCREDITED

Questions, comments, concerns appreciated: windenm@uww.edu

Special Thanks To:

UWO Student Researchers

Generous Funding Provided By:

Great Lakes Restoration Initiative

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Conditional Logit (CL) Results

Conditional (fixed-effects) logistic regression

Number of obs	= 5,916
LR chi2(6)	= 1393.77
Prob > chi2	= 0.0000
Log likelihood = -1469.5794	Pseudo R2 = 0.3217

choice	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
aesthetics	.0041053	.0351858	0.12	0.907	-.0648576	.0730682
water	.7896412	.0311021	25.39	0.000	.7286821	.8506003
temp	-.00688	.0271614	-0.25	0.800	-.0601152	.0463553
density	-.1273118	.0282602	-4.50	0.000	-.1827008	-.0719229
distance	-.1962842	.0354529	-5.54	0.000	-.2657706	-.1267978
payment	-.0172436	.0017016	-10.13	0.000	-.0205786	-.0139085

CL Results (*ceteris paribus*)

- **Aesthetics:** Not Statistically Significant
  - Respondents' don't have a beach vegetation preference
- **Water Quality:** Positive, Statistically Significant
  - Respondents' strongly prefer better water quality levels
- **Temperature:** Not Statistically Significant
  - Respondents' don't have a temperature preference in these ranges
- **Congestion/Density:** Negative, Statistically Significant
  - Respondents' strongly prefer less congested beaches
- **Distance:** Negative, Statistically Significant
  - Respondents' strongly prefer closer beaches
- **Payment:** Negative, Statistically Significant
  - Respondents' strongly prefer to pay less to visit a beach