VALUING ECOLOGICAL OUTCOMES FOR EVERGLADES RESTORATION DECISION- MAKING

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Coral Springs, Florida

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Why study the economic benefits of Everglades restoration?

- Enables benefit-cost analysis of restoration alternatives and/or specific projects
- Gives better understanding of how the benefits of restoration are distributed among different stakeholders
- Can be used with other social sciences to understand what motivates people to support Everglades restoration

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How can economists monetize the benefits of ecological restoration?

- Observe markets
  - What is the value commercial fish species dependent on Florida Bay?
  - *Easy and accurate but not possible with many benefits*

- How much do people spend to enjoy environmental amenities
  - How do the expenditures of recreational anglers respond to changes in Florida Bay?

- How does environmental quality impact goods in other related markets
  - How does improved water quality effect residential real estate values?

- Avoided costs associated with environmental improvement
  - How will Everglades restoration influence future desalinization costs in south Florida?

- **Survey people and ask how much they are willing to pay for the benefits of restoration**
  - **Focus of this survey work**

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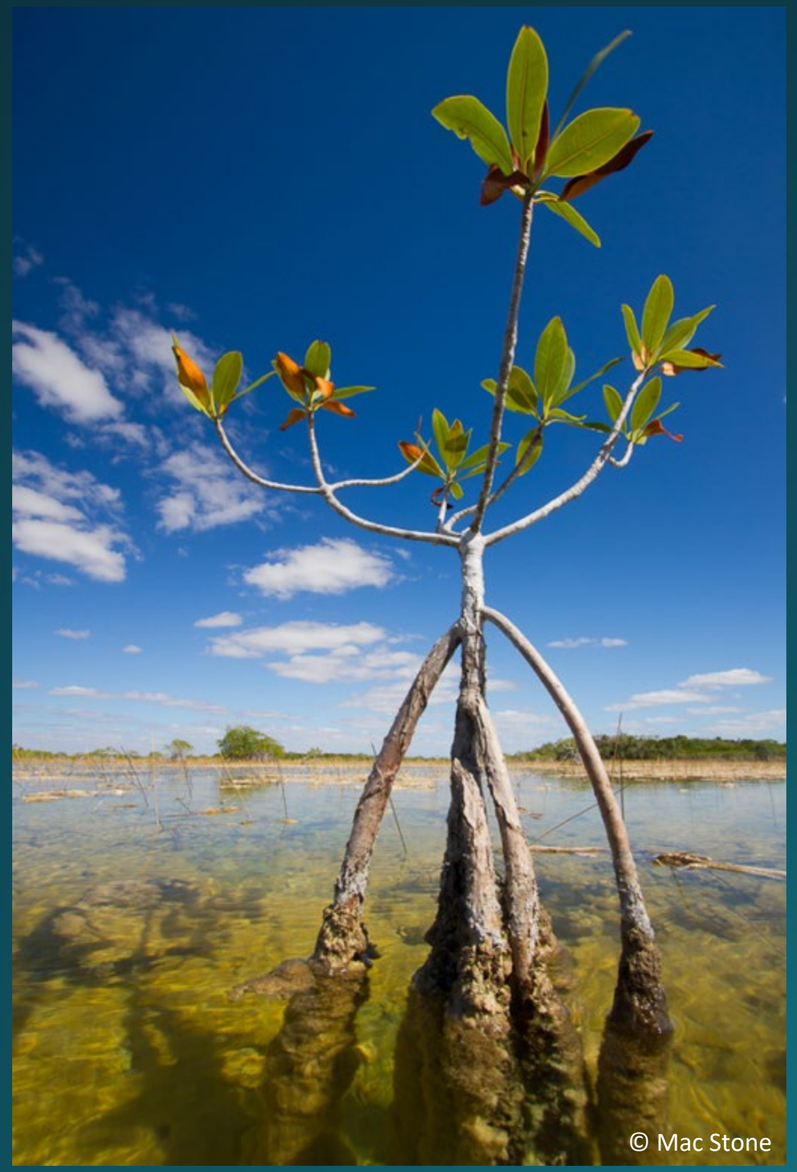
Context of Survey



- *Part of a larger study to understand the tradeoffs in different Everglades restoration options and projects*
- *Designed to understand the marginal value of ecological benefits (attributes) that are linked to specific performance indicators and existing hydrological/ecological models*
- *Also want to understand why people want to restore the Everglades*

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Survey Administration

- The Qualtrics platform was used to administer the survey to a sample (panel) of representative Florida residents
- Survey was informally tested on science team, colleagues, and some other EF staff
- More formal test was done on a sample of 100 Florida Residents
- After survey modifications the survey was administered to an additional 2,000 Florida residents

Attributes for WTP

- Wading Birds in Everglades National Park
- American Alligators in Everglades National Park
- Endangered Everglade Snail Kite in the Greater Everglades
- Spotted Seatrout in Florida Bay, Everglades National Park
- Reduced Discharges from Lake Okeechobee to the St. Lucie and Caloosahatchee Rivers
- *The cost of restoration was presented as a tax on utilities*

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Attribute Descriptions

American Alligators in Everglades National Park

By digging holes and other activities, alligators help retain water in the dry season and form important habitat for other species. Alligators are also important indicators of ecosystem health for the Everglades.

Alligators are very sensitive to water conditions that affect their food sources and ability to reproduce. By restoring the timing and extent of water flowing through the Everglades to more natural conditions, Everglades restoration is expected to increase the available habitat for alligators and increase their populations.

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Attributes	Attribute levels			
Wading Birds in Everglades National Park	0% increase above current populations	10% increase above current populations	50% increase above current populations	75% increase above current populations
American Alligators in Everglades National Park	0% increase above current population	10% increase above current population	50% increase above current population	75% increase above current population
Endangered Everglade Snail Kite in the Greater Everglades	0% increase above current population	10% increase above current population	50% increase above current population	75% increase above current population
Spotted Seatrout in Florida Bay, Everglades National Park	0% increase above current population	10% increase above current population	50% increase above current population	75% increase above current population
Reduction of polluted water discharges to St. Lucie and Caloosahatchee Rivers	0% reduction in frequency	10% reduction in frequency	50% reduction in frequency	75% reduction in frequency
Annual cost per household	$0 per year	$50 per year	$75 per year	$100 per year

Optimal Design of Choice Sets

- With six attributes and four levels each, there are 4,096 possible choice sets – *too many for typical survey sample sizes*
- D-optimal design was used to determine the experimental design of the choice sets
  - Minimizes the variance and bias of the parameter estimates
  - Generally produces better parameter estimates than traditional experimental designs (e.g. fractional factorial)
- Eight Blocks with six choice sets each were used

BLOCK	BIRDA	GATORA	SNAILA	TROUTA	WATERA	COSTA	BIRDB	GATORB	SNAILB	TROUTB	WATERB	COSTB
1	10% Increase above current populations	10% Increase above current populations	50% Increase above current populations	0% Increase above current populations	75% reduction in frequency	$100 per year	75% Increase above current populations	50% Increase above current populations	50% Increase above current populations	0% Increase above current populations	0% reduction in frequency	$50 per year
1	75% Increase above current populations	75% Increase above current populations	75% Increase above current populations	75% Increase above current populations	75% reduction in frequency	$75 per year	50% Increase above current populations	10% Increase above current populations	10% Increase above current populations	50% Increase above current populations	50% reduction in frequency	$50 per year
1	0% Increase above current populations	75% Increase above current populations	75% Increase above current populations	10% Increase above current populations	0% reduction in frequency	$100 per year	0% Increase above current populations	50% Increase above current populations	10% Increase above current populations	0% Increase above current populations	75% reduction in frequency	$50 per year
1	10% Increase above current populations	0% Increase above current populations	75% Increase above current populations	50% Increase above current populations	75% reduction in frequency	$75 per year	75% Increase above current populations	10% Increase above current populations	0% Increase above current populations	0% Increase above current populations	10% reduction in frequency	$100 per year
1	50% Increase above current populations	75% Increase above current populations	0% Increase above current populations	75% Increase above current populations	0% reduction in frequency	$50 per year	0% Increase above current populations	10% Increase above current populations	0% Increase above current populations	75% Increase above current populations	50% reduction in frequency	$100 per year
1	75% Increase above current populations	75% Increase above current populations	0% Increase above current populations	0% Increase above current populations	75% reduction in frequency	$75 per year	50% Increase above current populations	10% Increase above current populations	10% Increase above current populations	10% Increase above current populations	10% reduction in frequency	$75 per year

Example Restoration Choice

Impact of future restoration	Choice A	Choice B	Choice C
Wading Birds (in Everglades National Park)	**10% increase** (above current populations)	**0% increase** (above current populations)	**I would choose neither choice A or choice B**
American Alligators (in Everglades National Park)	**50% increase** (above current population)	**75% increase** (above current population)	
Endangered Everglade Snail Kite (in the Greater Everglades)	**75% increase** (above current population)	**0% increase** (above current population)	
Spotted Seatrout (in Florida Bay, Everglades National Park)	**50% increase** (above current population)	**10% increase** (above current population)	
Reduction of polluted water discharges (to St. Lucie and Caloosahatchee rivers)	**75% reduction** (in occurrence relative to current conditions)	**50% reduction** (in occurrence relative to current conditions)	
Annual cost per household	**$100 per year**	**$50 per year**	

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Random Utility Model

- Utility = economic term for satisfaction

$$U_{njt} = \beta x_{njt} + \varepsilon_{njt}$$

U_{njt} is the (indirect) utility of the n individual from choice j from choice set t

x_{njt} is a vector of attributes of choice set j and respondent characteristics

β is a vector of parameters

ε_{njt} is the unobservable component of utility

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Modeling Restoration Preferences

Mixed logit regression model was used to model respondent choices

$$p_{nit} = \frac{\exp(\beta_n \chi_{nit})}{\sum_{j=1}^{J} \exp(\beta_n \chi_{njt})}$$

p_{nit} is the probability that individual n chooses choice i over all other alternatives $j \neq i$ in choice situation t

χ=vector of variables representing ecological benefits and cost

β=vector of coefficients

exp=base of natural logarithm

Advantages of mixed logit model over standard logit model

- ***Assumes variation in preferences among respondents***
- Does not assume independence of irrelevant alternatives
- Allows for correlation of unobserved factors over time

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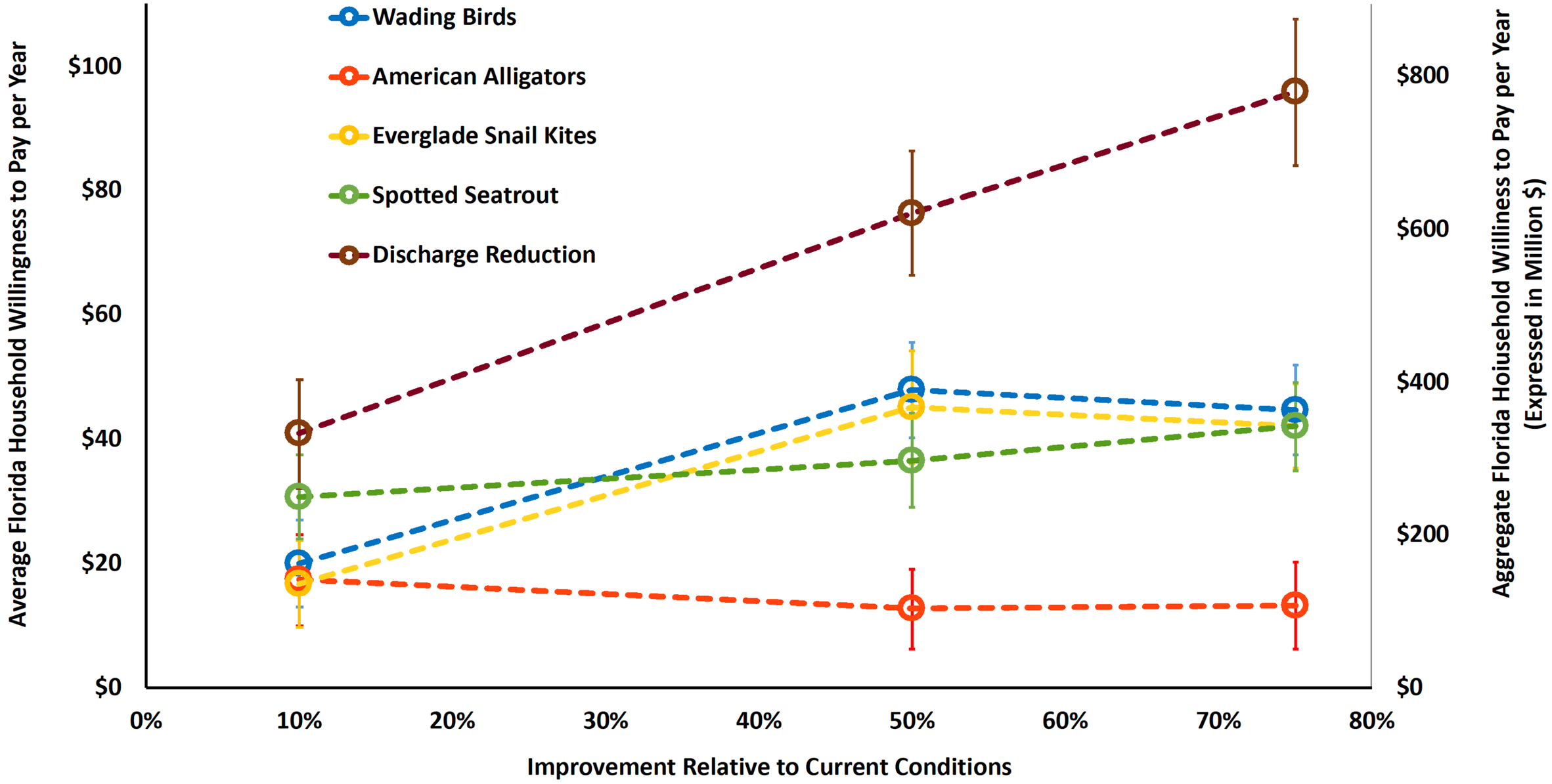
Mixed logit model in WTP space — Number of obs = 37,797

Wald chi2(17) = 3160.87

Log likelihood = -10758.264 — Prob > chi2 = 0.0000

choice	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Mean						
cdum	-270.4611	11.84613	-22.83	0.000	-293.6791	-247.2431
bird10e1	9.987129	1.798661	5.55	0.000	6.461818	13.51244
bird50e1	23.97137	1.955657	12.26	0.000	20.13835	27.80439
bird75e1	22.3749	1.843975	12.13	0.000	18.76077	25.98902
gator10e1	8.653226	1.854615	4.67	0.000	5.018248	12.2882
gator50e1	6.322579	1.649479	3.83	0.000	3.08966	9.555499
gator75e1	6.662263	1.782688	3.74	0.000	3.168259	10.15627
snail10e1	8.362252	1.793628	4.66	0.000	4.846805	11.8777
snail50e1	22.55166	2.297169	9.82	0.000	18.0493	27.05403
snail75e1	21.04403	1.695418	12.41	0.000	17.72107	24.36698
trout10e1	15.33191	1.723947	8.89	0.000	11.95304	18.71078
trout50e1	18.29932	1.914012	9.56	0.000	14.54793	22.05072
trout75e1	20.99302	1.811796	11.59	0.000	17.44196	24.54407
water10e1	20.42007	2.213306	9.23	0.000	16.08207	24.75807
water50e1	38.14248	2.540328	15.01	0.000	33.16353	43.12143
water75e1	47.8977	2.990213	16.02	0.000	42.03699	53.75841
mcost	-3.982718	.081381	-48.94	0.000	-4.142221	-3.823214
SD						
cdum	214.0815	12.77031	16.76	0.000	189.0521	239.1108
bird10e1	-9.11306	2.624145	-3.47	0.001	-14.25629	-3.969829
bird50e1	12.64118	2.863366	4.41	0.000	7.029086	18.25327
bird75e1	-2.070989	1.361855	-1.52	0.128	-4.740177	.5981982
gator10e1	15.47423	2.035433	7.60	0.000	11.48485	19.4636
gator50e1	3.894405	2.54299	1.53	0.126	-1.089763	8.878572
gator75e1	-16.91802	1.801875	-9.39	0.000	-20.44963	-13.38641
snail10e1	15.36204	2.409522	6.38	0.000	10.63947	20.08462
snail50e1	-.5941168	2.12677	-0.28	0.780	-4.76251	3.574276
snail75e1	11.29941	2.165882	5.22	0.000	7.054357	15.54446
trout10e1	16.38899	3.406899	4.81	0.000	9.711594	23.06639
trout50e1	30.23803	2.660753	11.36	0.000	25.02305	35.45301
trout75e1	-1.94816	1.91151	-1.02	0.308	-5.694651	1.798331
water10e1	1.179095	2.251676	0.52	0.601	-3.23411	5.5923
water50e1	-5.263725	4.337751	-1.21	0.225	-13.76556	3.23811
water75e1	30.84326	2.111841	14.60	0.000	26.70413	34.98239
mcost	-1.197319	.1068859	-11.20	0.000	-1.406812	-.9878266

The sign of the estimated standard deviations is irrelevant: interpret them as being positive



Based on Florida Household Estimate of 8,125,176. *Source: Rayer, S., Wang, Y., Doty, R., Roulson-Doty, S., & Smith, S. K. (2017). Florida Population Studies Revised Estimates of Households and Average Household Size for Florida and Its Counties , 2000 – 2016 , with Estimates for 2017, 51(December), 1–16.*

Impact of Sociodemographic Factors on Responses

- Sociodemographic and some viewpoint variables were interacted with the *restoration* dummy variable
  - Gender
  - Race
  - Age
  - Education
  - Income
  - Voted in state or local election in the last three years
  - Political Views (conservative v. liberal)
  - Should cost be a factor in restoration of the Everglades
  - Government competency
  - Should respondent have to pay
  - Difficulty in selecting preferred alternatives
  - Donations to environmental organizations
  - Has respondent visited Everglades National Park

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Impact of Sociodemographic Factors on Responses

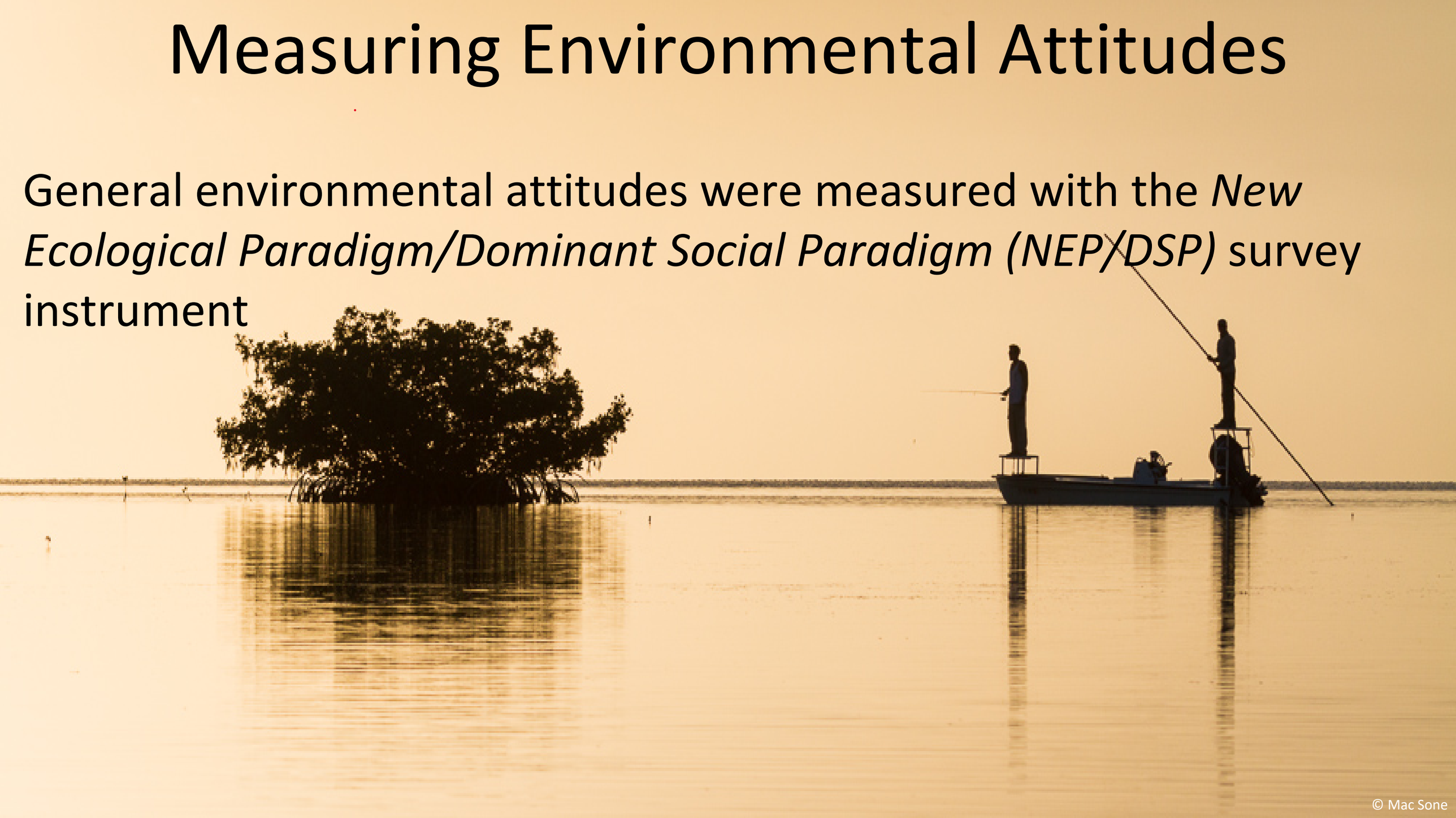
- Respondents that donated to environmental organizations or visited the Park were more likely to choose a restoration option

- Women were less likely to choose a restoration option

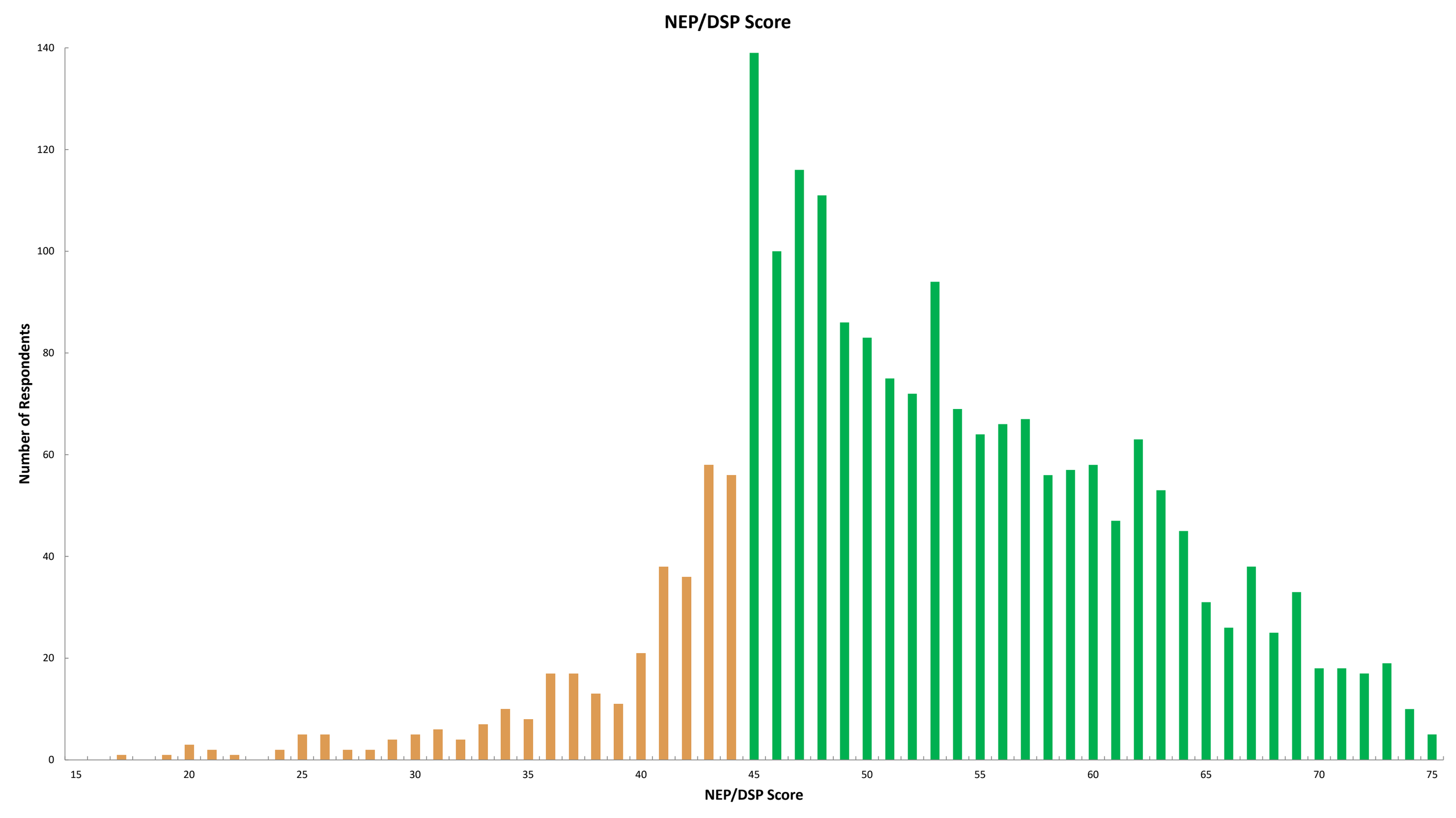
- People with more conservative views were *more* likely to choose a restoration option

Measuring Environmental Attitudes

General environmental attitudes were measured with the *New Ecological Paradigm/Dominant Social Paradigm (NEP/DSP)* survey instrument



	Strongly Agree	Mildly Agree	Unsure	Mildly Disagree	Strongly Disagree
We are approaching the limit of the number of people the earth can support.	○	○	○	○	○
Humans have the right to modify the natural environment to suit their needs.	○	○	○	○	○
When humans interfere with nature it often produces disastrous consequences.	○	○	○	○	○
Human ingenuity will ensure that we do NOT make the earth unlivable.	○	○	○	○	○
Humans are severely abusing the environment.	○	○	○	○	○
The earth has plenty of natural resources if we just learn how to develop them.	○	○	○	○	○
Plants and animals have as much right as humans to exist.	○	○	○	○	○
The balance of nature is strong enough to cope with the impacts of modern industrial nations.	○	○	○	○	○
Despite our special abilities, humans are still subject to the laws of nature.	○	○	○	○	○
The so-called "ecological crisis" facing humankind has been greatly exaggerated.	○	○	○	○	○
The earth is like a spaceship with very limited room and resources.	○	○	○	○	○
Humans were meant to rule over the rest of nature.	○	○	○	○	○
The balance of nature is very delicate and easily upset.	○	○	○	○	○
Humans will eventually learn enough about how nature works to be able to control it.	○	○	○	○	○
If things continue on their present course we will soon experience a major ecological catastrophe.	○	○	○	○	○


NEP/DSP Score
Number of Respondents
0
20
40
60
80
100
120
140
15
20
25
30
35
40
45
50
55
60
65
70
75
NEP/DSP Score

Sociodemographic Factors and NEP/DSP Scores

- More liberal respondents scored higher on NEP questions and lower on DSP questions
- Women scored higher on NEP questions and lower on the DSP than men
- Older respondents scored higher on NEP questions
    - *Interesting result that is unusual with regard to other studies*
- Self reported knowledge of alligators and water pollution corresponded with higher NEP scores
    - *The opposite was true for snail kites?*

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Ongoing Work

- Monetize other benefits of restoration – e.g. water supply, climate change mitigation, other ecological benefits
- Combine marginal WTP estimates with ecological and hydrological models predicting how the attributes will change with different restoration alternatives
- Use Latent Class model to explore how environmental attitudes and sociodemographic factors impact WTP
- Use Multiple Criteria Analysis and other techniques to better understand tradeoffs

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