Valuation of Ecosystem Services: An Economic Perspective

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Natural infrastructure features generate multiple benefits

For example:

- Changes in flood risk
- Habitat/biodiversity
- Recreation
- Waste treatment/water quality
- Carbon sequestration/storage

Valuation of disparate benefits is an important tool for assessing tradeoffs and comparing outcomes

Identifying and quantifying **ALL** benefits

"BCA itself **does not impose a hierarchy between "economic", "ecological" or "social" costs and benefits,** but because economic effects are more easily monetizable than ecological or social effects, they typically play a more prominent role in project planning and decision making." (Blachly et al. 2022)

$$Net\ Present\ Value = \sum_{t=1}^{T} \frac{B_t - C_t}{(1+r)^t}$$

Identifying and quantifying **ALL** benefits

"[C]ategories of effects such as 'ancillary' or 'indirect' are not meaningfully different for analytical purposes from categories of effects that are 'primary' or 'direct'"

Preamble to proposed OMB circular No. A4 (2023)

Monetizing nonmarket benefits

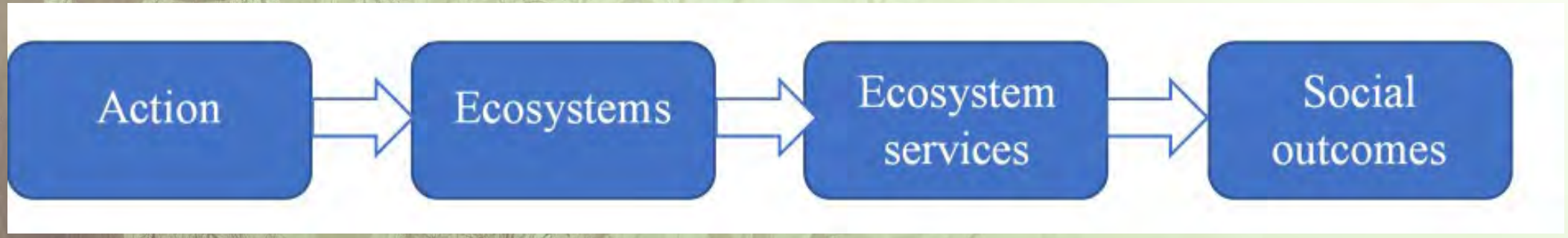
Identifying and quantifying **ALL** benefits

- Ecosystem-service approach

"both the tangible and intangible benefits humans obtain from ecosystems" (MEA 2005)

- Final goods and services/Benefit Relevant Indicators/Ecological endpoints

Monetizing nonmarket benefits



Planting native woody vegetation	Floodplain ecosystem	(Bird) habitat provision	Abundance for bird watchers (Δ expected sightings)

Additional benefits (e.g., water quality carbon sequestration, flood risk reduction) **should be modelled separately**

Chain-linking example of Benefit Relevant Indicators

Identifying and quantifying ALL benefits

- Ecosystem-service approach

”both the tangible and intangible benefits humans obtain from ecosystems” (MEA 2005)

- Final goods and services/Benefit Relevant Indicators/Ecological endpoints

Monetizing nonmarket benefits

Vast body of knowledge

- Primary study methods
- Benefit transfer

Valuing non-market ecosystem services

- "Economic value" is about tradeoffs
  - Willingness to pay (WTP) for an improvement
  - Willingness to accept (WTA) as compensation for loss

- Individual measures of economic value reflect
  - Preferences (represented by a utility function)
  - Values (moral and ethical considerations), attitudes and beliefs
  - Available information

Approaches for non-market valuation fall into two general categories

- Revealed preference
  - Based on observed (or reported) behavior in actual markets
  - Constrained by data availability
- Stated preference
  - Based on stated behavior in a hypothetical market
  - Can be tailored to value specific good or service * including non-use values

RP1: Travel cost model

- Appropriate for estimating recreational use value
  (e.g., hiking, swimming, bird watching)
- Typically relies on reported behavior
- Treats travel cost (actual expense plus opportunity cost of time) as the "price" of a trip

$$\#\,\boldsymbol{trips} = \boldsymbol{f(Travel\ Cost, environmental\ quality, individual\ charcacteristics)}$$

- Can infer value of increased trips induced by a change in environmental quality

RP2: Hedonic price models

Higher flood risk

What is the price differential?

Lower flood risk

$$\boldsymbol{Property\ price} = \boldsymbol{f(structural\ characteristics, neighborhood\ characteristics, flood\ risk)}$$

RP2: Hedonic price models… for mortality risk reductions

Low mortality risk

What is the wage differential?

Higher mortality risk

$$\boldsymbol{Wages} = \boldsymbol{f(job\ characteristics, worker\ characteristics, mortality\ risk)}$$

SP1: Contingent Valuation

Conceptually, CV involves describing a policy scenario and asking: what is your WTP for the scenario?

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Would you vote for this proposal if the proposal would cost you $\$B_1$ each month in a higher water bill?

_ I would vote Yes _I would vote No

$$\text{Probability (Yes)} = 1 - \{1 + \exp[B_0 - B_1(\$X)]\}^{-1} \quad (1)$$

Measuring the total economic value of restoring ecosystem services in an impaired river basin: results from a contingent valuation survey

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Abstract

...e restored along a 45-mile section of the Platte river were described to ...oach developed by an interdisciplinary team. These ecosystem services were ...ion of water, erosion control, habitat for fish and wildlife, and recreation. ... choice willingness to pay question regarding purchasing the increase in ...er bill. Results from nearly 100 in-person interviews indicate that households would pay an average of $21 per month or $252 annually for the additional ecosystem services. Generalizing this to the households living along the river yields a value of $19 million to $70 million depending on whether those refusing to be interviewed have a zero value or not. Even the lower bound benefit estimates exceed the high estimate of water leasing costs ($1.13 million) and conservation reserve program farmland easements costs ($12.3 million) necessary to produce the increase in ecosystem services.

SP2: Choice experiments

Wetland attributes	Alternative 1	Alternative 2	Alternative 3
Landscape vegetation	Forest	Forest	Meadow
Biodiversity	Low	Low	High
Sport fish	No	Yes	No
Fence	No	No	Yes
Crayfish	No	Yes	No
Walking trails	No	No	Yes
Cost	SEK 0	SEK 850	SEK 400
I would choose: (please check one box)	☐	☐	☐

Wetland restoration
(in Holmes, Adamowicz, and Carlsson (2017)

Methods and Effects of Protection	Result in 2020s with NO NEW ACTION	Result in 2020s with PROTECTION OPTION A	Result in 2020s with PROTECTION OPTION B
	No Change in Existing Defenses	More Emphasis on HARD Defenses	SIMILAR Emphasis on Hard and Soft Defenses
Homes Flooded	**51%** 2,585 of 5,034 homes expected to flood in a Category 3 storm	**51%** 2,585 of 5,034 homes expected to flood in a Category 3 storm	**36%** 1,812 of 5,034 homes expected to flood in a Category 3 storm
Wetlands Lost	**5%** 25 of 497 wetland acres expected to be lost	**10%** 50 of 497 wetland acres expected to be lost	**10%** 50 of 497 wetland acres expected to be lost
hes and Dunes Lost	**10%** 3 of 30 beach acres expected to be lost	**4%** 1 of 30 beach acres expected to be lost	**16%** 5 of 30 beach acres expected to be lost
walls and Coastal Armoring	**24%** 12 of 50 miles of coast armored	**24%** 12 of 50 miles of coast armored	**24%** 12 of 50 miles of coast armored
$ Your Household per Year	**$0** Increase in annual taxes or fees	**$35** Increase in annual taxes or fees	**$35** Increase in annual taxes or fees
WOULD YOU VOTE? (OOSE ONLY ONE) I vote for	☑ I vote for **NO NEW ACTION**	☑ I vote for **PROTECTION OPTION A**	☑ I vote for **PROTECTION OPTION B**
	If you prefer **No New Action** check here	If you prefer **Protection Option A** check here	If you prefer **Protection Option B** check here

Example: Valuing coastal defense options (Johnston et al. 2018)

Averting behavior models

Household expenditures to reduce exposure to an environmental risk

Examples:

- Flood risk reduction – expenditures on raising a home, flood-proofing a basement, etc.
- Drinking water quality – expenditures on bottled water

A third method? Towards an **Experienced Preference** Approach

"[F]or many areas of public policy, measurements based on WTP make no sense because **little individual choice is involved**.

In these areas **we can get better measures of the benefits of a policy change through direct measures of SWB**. It is time to begin developing an alternative system of CBA where the units are SWB units" (Layard 2010).

How do we measure experienced utility?

- With a hedonimeter: "an ideally perfect instrument, a psychophysical machine, continually registering the height of pleasure experienced by an individual" (Edgeworth 1881)
- **Self-reported, Subjective Well-Being (SWB) scores**

In general, I consider myself:

1	2	3	4	5	6	7
Not a very happy person					A very happy person	

All things considered, how satisfied are you with your life as a whole nowadays?

1	2	3	4	5	6	7	8	9	10
Extremely dissatisfied									Extremely satisfied

$$SWB = f(individual\ characteristics, individual\ income, environmental\ quality)$$

Experienced Preference Approach

- Additional tool for non-market valuation
- Effects of environmental amenities on SWB interesting by themselves…

Experience sampling

G Model
JGEC-1103; No. of Pages 9
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Happiness is greater in natural environments

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ABSTRACT

Links between wellbeing and environmental factors are of growing interest in psychology, health, conservation, economics, and more widely. There is limited evidence that green or natural environments are positive for physical and mental health and wellbeing. We present a new and unique primary research study exploring the relationship between momentary subjective wellbeing (SWB) and individuals' immediate environment within the UK. We developed and applied an innovative data collection tool: a smartphone app that signals participants at random moments, presenting a brief questionnaire while using satellite positioning (GPS) to determine geographical coordinates. We used this to collect over one million responses from more than 20,000 participants. Associating GPS response locations with objective spatial data, we estimate a model relating land cover to SWB using only the within-individual variation, while controlling for weather, daylight, activity, companionship, location type, time, day, and any response trend. On average, study participants are significantly and substantially happier outdoors in all green or natural habitat types than they are in urban environments. These findings are robust to a number of alternative models and model specifications. This study provides a new line of evidence on links between nature and wellbeing, strengthening existing evidence of a positive relationship between SWB and exposure to green or natural environments in daily life. Our results have informed the UK National Ecosystem Assessment (NEA), and the novel geo-located experience sampling methodology we describe has great potential to provide new insights in a range of areas of interest to policymakers.


vodafone UK 14:48
Settings
Save
Beeps per day 3
Don't beep before 08:15
Don't beep after 22:45
These are UK times
Beep sound Doorbell


vodafone UK 14:46
Cancel
Feelings
Do you feel... ?
Not at all Happy Extremely
Not at all Relaxed Extremely
Not at all Awake Extremely
Next


vodafone UK 14:47
mappiness
My happiness
How has my happiness varied over time?
This chart plots your reported feelings in sequence.
Happy Relaxed Awake
0.84
0.66
0.48
0.3
0.12
19 Jul
24 Jul


vodafone UK 14:48
mappiness
My happiness
0
Home
Work
Elsewhere
Happy
0.68
0.51
0.34
0.17
0
Indoors
Outdoors
In a vehicle
With whom am I happiest?
This chart compares your average happiness in the company of different

SCIENTIFIC REPORTS

OPEN

Happiness is Greater in More Scenic Locations

Chanuki Illushka Seresinhe[1,2], Tobias Preis[1,2,3], George MacKerron[4] & Helen Susannah Moat[1,2,3]

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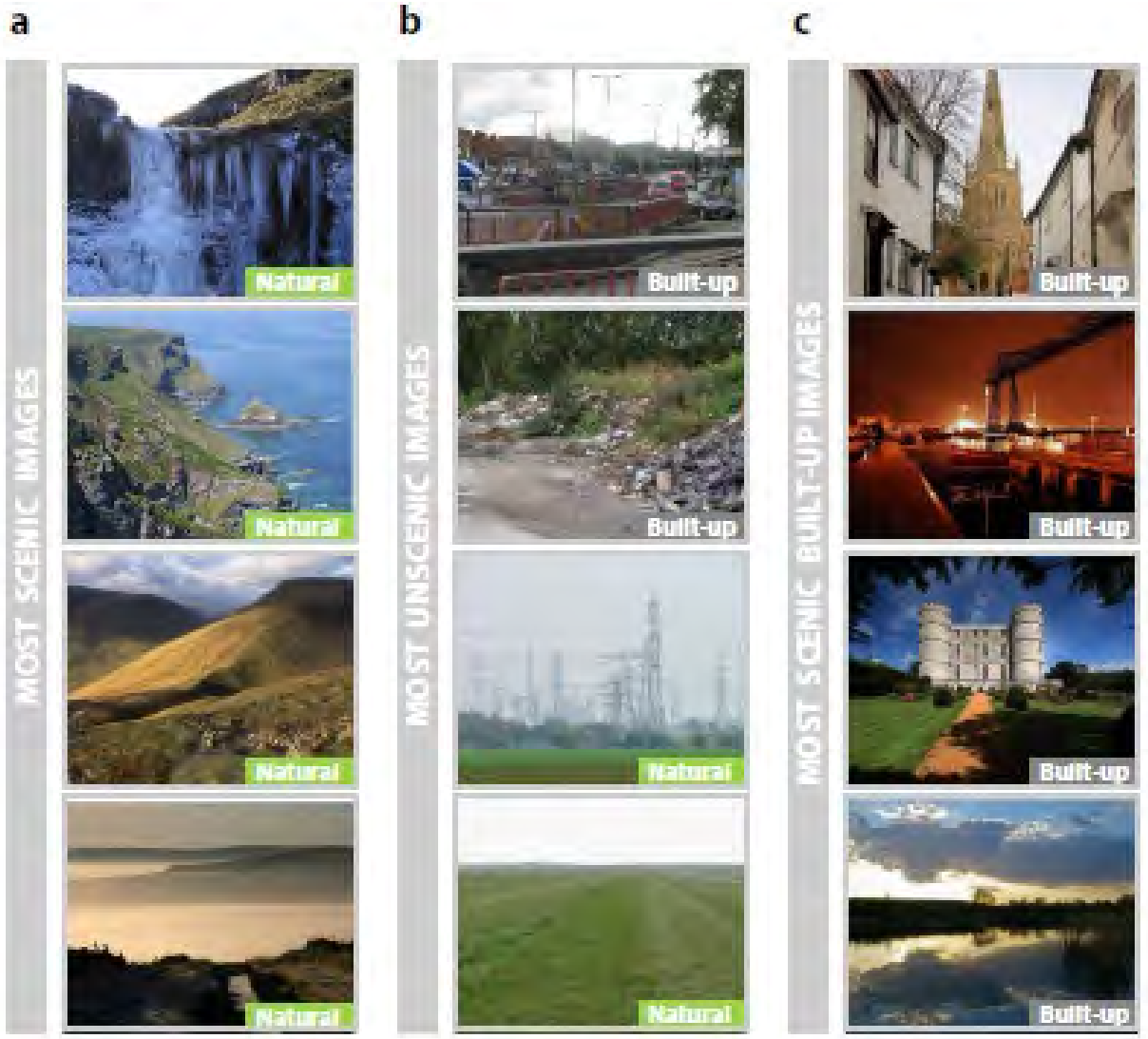
: 30 January 2019
d online: 14 March 2019

Does spending time in beautiful settings boost people's happiness? The answer to this question has long remained elusive due to a paucity of large-scale data on environmental aesthetics and individual happiness. Here, we draw on two novel datasets: first, individual happiness data from the smartphone app, *Mappiness*, and second, crowdsourced ratings of the "scenicness" of photographs taken across England from the online game *Scenic-Or-Not*. We find that individuals are happier in more scenic locations, even when we account for a range of factors such as the activity the individual was engaged in at the time, weather conditions and the income of local inhabitants. Crucially, this relationship holds not only in natural environments, but in built-up areas too, even after controlling for the presence of green space. Our results provide evidence that the aesthetics of the environments that policymakers choose to build or demolish may have consequences for our everyday wellbeing.



Have more aesthetically pleasing landscapes more ecological value?

PROCEEDINGS B

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Review

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Integrating the aesthetic value of landscapes and biological diversity

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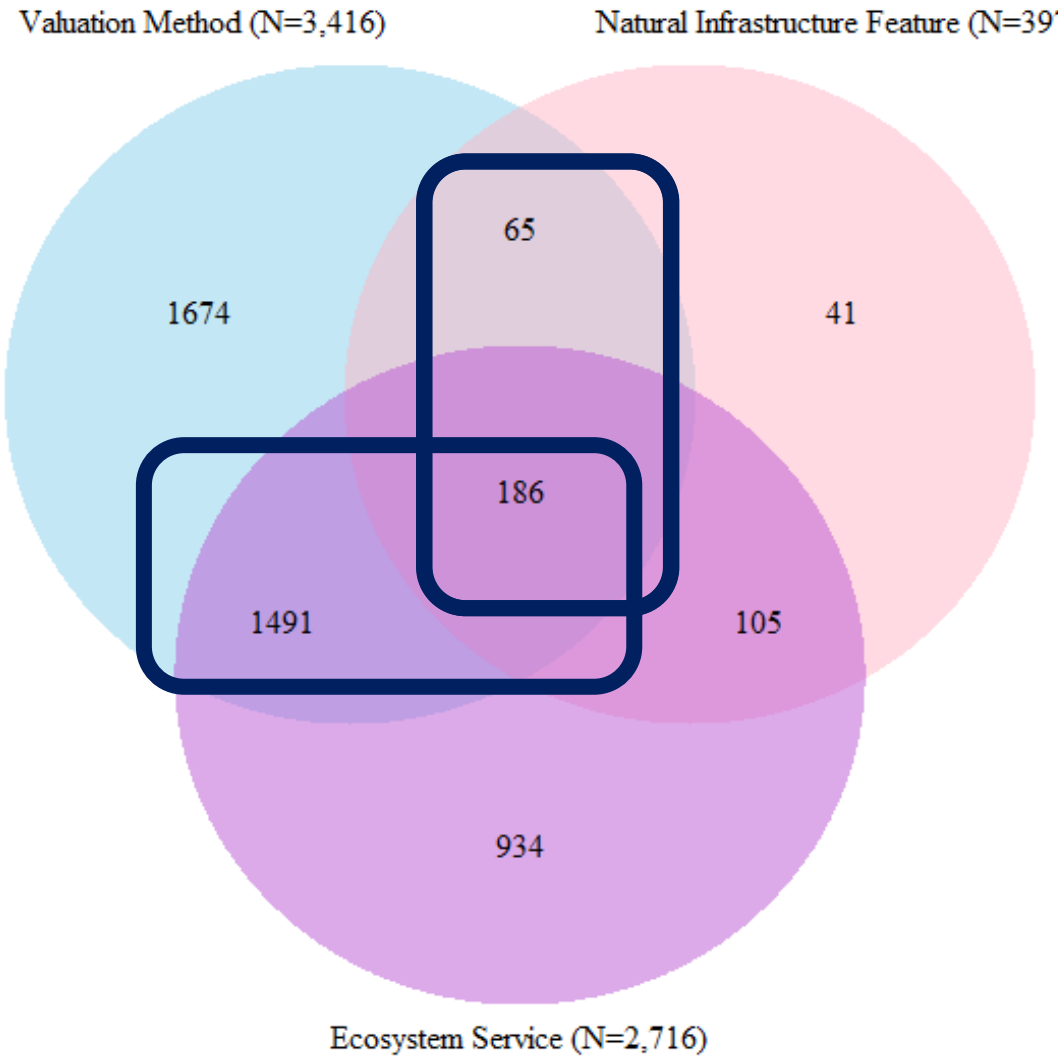
As a cultural ecosystem service, the aesthetic value of landscapes contributes to human well-being, but studies linking biodiversity and ecosystem services generally do not account for this particular service. Therefore, congruence between the aesthetic perception of landscapes, ecological value and biodiversity remains poorly understood. Here, we describe the conceptual background, current methodologies and future challenges of assessing landscape aesthetics and its relationship with biodiversity. We highlight the methodological gaps between the assessment of landscape aesthetics, ecological diversity and functioning. We discuss the challenges associated with connecting landscape aesthetics with ecological value, and the scaling issues in the assessment of human aesthetics perception. To better integrate aesthetic value and ecological components of biodiversity, we propose to combine the study of aesthetics and the understanding of ecological function at both the species and landscape levels. Given the urgent need to engage society in conservation efforts, this approach, based on the combination of the aesthetic experience and the recognition of ecological functioning by the general public, will help change our culture of nature and promote ecologically oriented conservation policies.

Snapshot of valuation literature

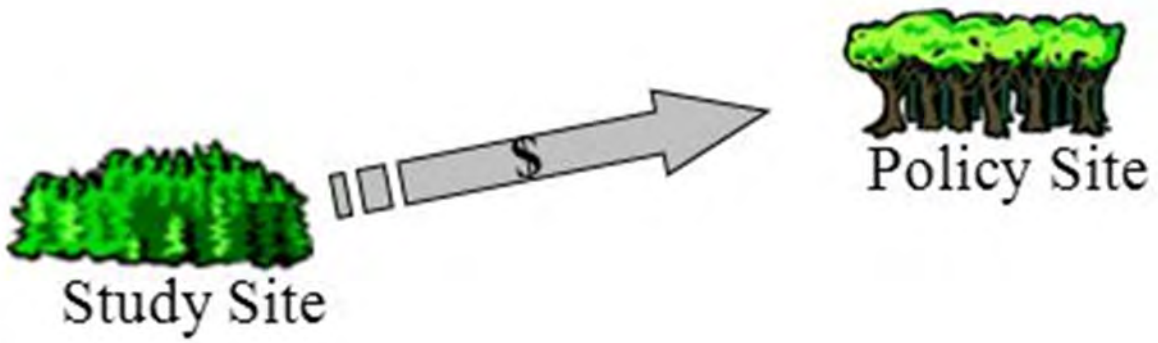
- 1,677 studies valuing an ES
- 251 studies valuing a NI feature
- 186 valuation studies linking ES to NI



Benefit transfer

When a primary study is infeasible

- Benefit transfer applies results from existing primary studies to estimate value at the policy site
- Several “toolkits” exist
- “Transfer errors” arise from site and population differences



Benefit transfer

- Some ecosystem services are amenable to BT
  - Carbon sequestration, VSL
- Other services are highly sensitive to site and population characteristics
  - Recreation, waste treatment, moderation of extreme events, etc.

- Considerable research has been dedicated to reducing transfer errors
- Current best practice is to employ a meta-regression model (e.g., Johnston 2019)

Take home

- Economic valuation of disparate benefits is an important tool for assessing tradeoffs and comparing outcomes.
- BCA does not impose a hierarchy between “economic”, “ecological” or “social” costs and benefits.
- Economic effects are more easily monetizable than ecological or social effects, and typically play a more prominent role in decision making.
- Vast body of knowledge (and growing) on valuation of ecosystem services for which there are no markets.

Thank you!

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