



Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Measuring and quantifying the ecosystem service values of conservation investments on western rangelands

Angela Fletcher, Earth Economics

Aaron Lien, University of Arizona



Conservation Outcomes Webinar Series

FARM PRODUCTION AND CONSERVATION
FSA | NRCS | RMA | Business Center

Outline

- Project overview and goals
- Main results and outcomes
- Implications
- Detailed review of the project and results
- Questions and discussion

Project Overview

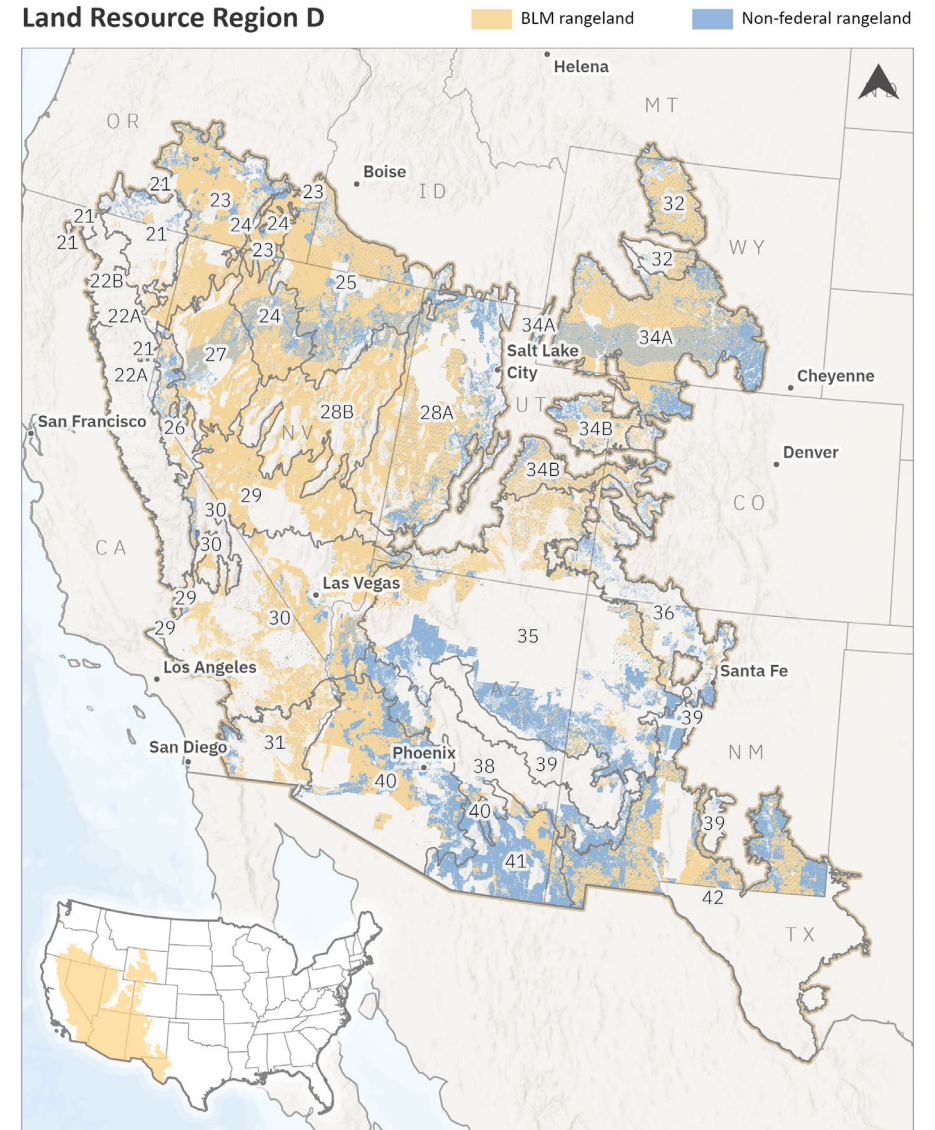
- What's missing:
 - an understanding of economic value of conservation investments
- Why this matters:
 - Supports informed decisions about resource allocation
 - Helps to balance agricultural productivity and ecosystem health
 - Accounts for unrecognized or intangible benefits of conservation
 - Supports outcomes-based decisionmaking

Project Goals

- Provide an estimate of the economic value of ecosystem services associated with rangeland conservation practices
 - Three practices considered
 - Prescribed Grazing
 - Brush Management
 - Herbaceous Weed Treatment
 - 13 ecosystem services considered

Study Area

- Land Resource Region D
- 351 million acres
- 11 states
- 23 MLRAs
- Non-federal rangeland and BLM





Rangeland Ecosystem Services



NATURAL CAPITAL

Healthy rangelands contain native grasses and shrubs.



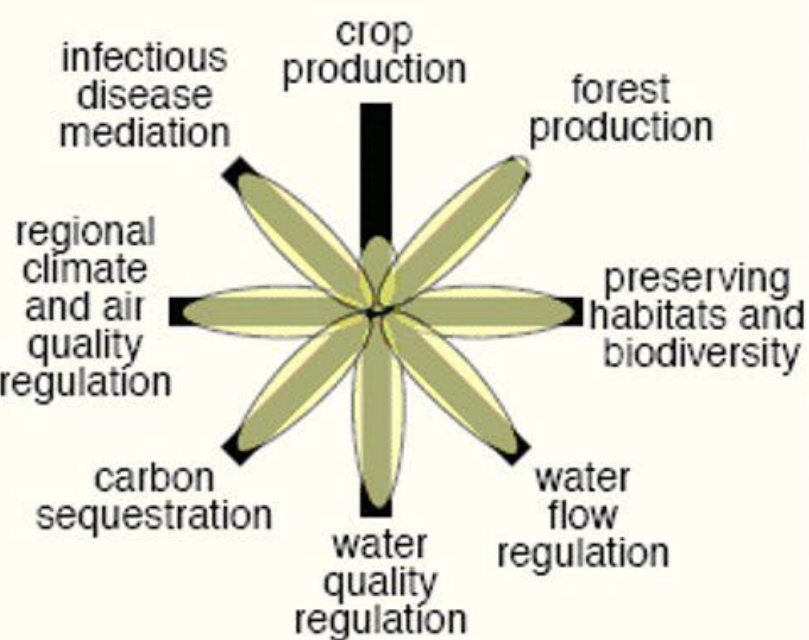
ECOSYSTEM FUNCTION

Plant roots can trap, slow, and filter rainwater and runoff, improving the water quality of nearby streams and rivers.

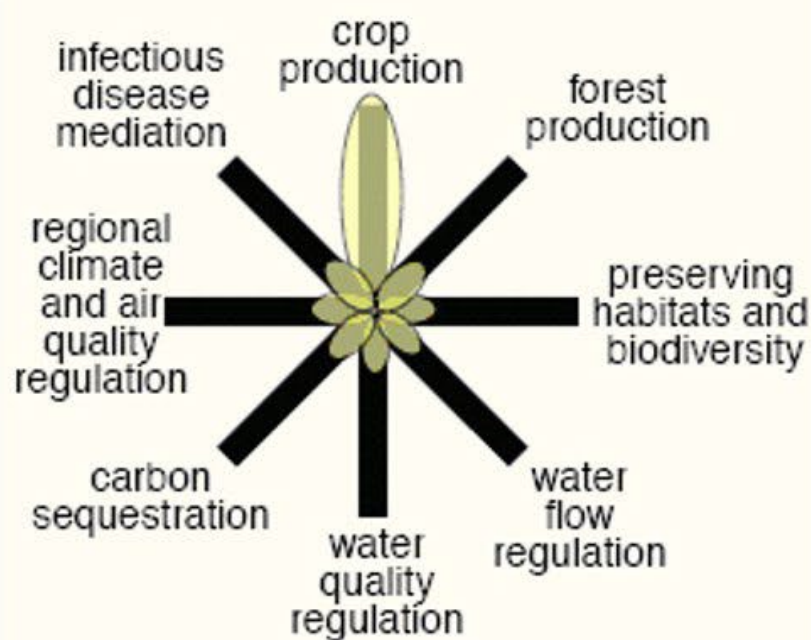


ECOSYSTEM GOODS + SERVICES

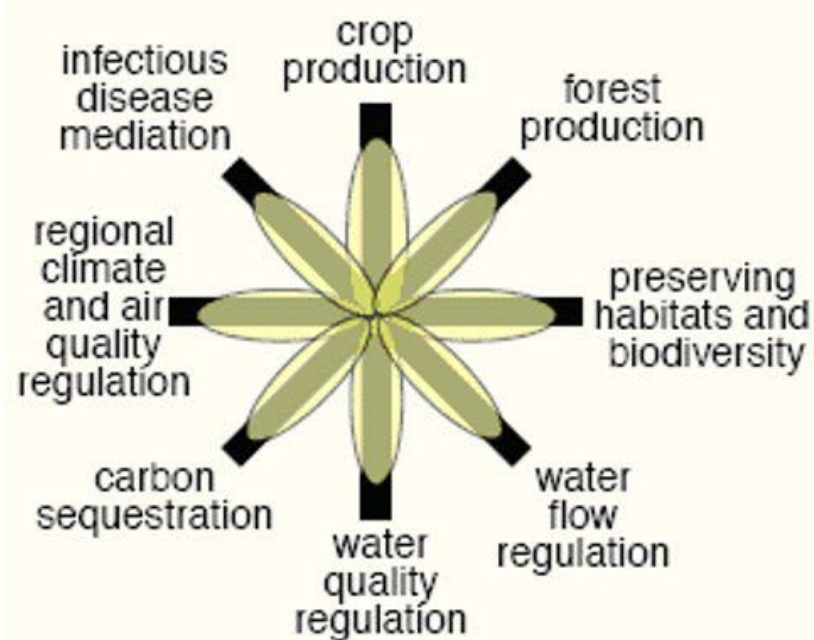
Cleaner water benefits people living downstream that may use it as a source for drinking water, irrigation, or industrial uses.



natural ecosystem



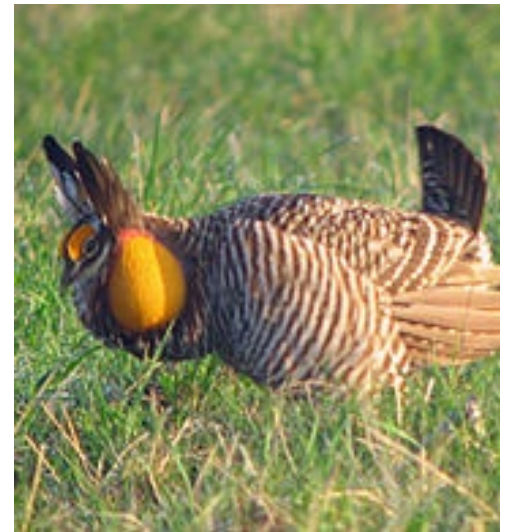
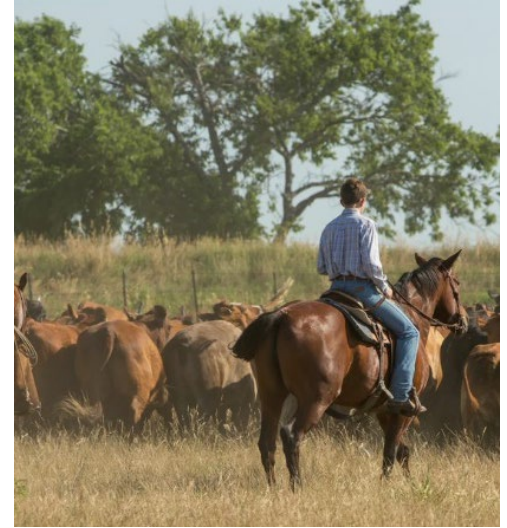
intensive cropland



cropland with restored ecosystem services

Valuing Ecosystem Services

- **Market Benefits**, like forage or cattle, can be sold or traded in traditional markets.
- **Non-Market Benefits** are not sold or traded in markets, but still provide benefit to people and must be valued by other means.



Rangeland Ecosystem Services Definitions

Ecosystem Service	Definition
Aesthetics	Appreciation of natural features
Air quality	Ability to create and maintain clean, breathable air
Biological control	Regulation of pests by natural ecosystems or organisms
Carbon sequestration	Ability to remove and store carbon from the atmosphere
Fire risk reduction	Reduction in the risk of wildfire impacts on humans and infrastructure
Forage production	Production of food used for domesticated and wild animals
Habitat	Protection of biodiversity and habitats for species
Recreation	Physical enjoyment of ecosystems through outdoor activities
Social	Ecosystems' role in the desire to preserve ecosystems or satisfaction derived from knowledge that an ecosystem exists
Soil fertility	Maintenance of soil structure and deposition of nutrients through nutrient cycling
Soil retention	Retaining arable land through erosion prevention
Waste treatment	Filtration of harmful pollutants and particles in water and soil
Water supply	Regulation of water flows by ecosystems used for drinking, irrigation, etc.

Valuing Ecosystem Services as Policy

Policies state that Agencies should consider ecosystem services in reporting.

- OMB guidance for valuing ecosystem services (2023)
- H.R. 2748, Safeguarding America's Future and Environment Act (2019)
- M-16-01, Incorporating Ecosystem Services into Federal Decision Making (2015)
- CEQ Final Interagency Guidelines (2014)
- Agency handbooks and guidance documents (e.g., NRCS National Economics Handbook)

Main Results

Estimates of total ecosystem service values **per acre, per year** resulting from the implementation of conservation practices

Annual Estimate	NRCS (2011-2020)	BLM (2016-2020)
Brush Management (314)	\$5—\$14	\$4—\$9
Herbaceous Weed Treatment (315)	\$10—\$26	\$12—\$21
Prescribed Grazing (528)	\$2—\$5	\$2—\$4

Implications

- Conservation investments matter!
 - Economic values is only one, limited way to consider “value”
 - NRCS programs result in meaningful change over time
- Actual impacts of NRCS programs are much greater
 - Only a three practices evaluated
 - Limited ecosystem service values available for even these three
- More data needed for better estimates of impacts
 - Monitoring of practice implementation and outcomes
 - Research to link practices to ecosystem service outcomes



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Project Goals

Vision:

- Build a framework federal agencies can use that adds ecosystem service values into rangeland decision-making processes.

Goals:

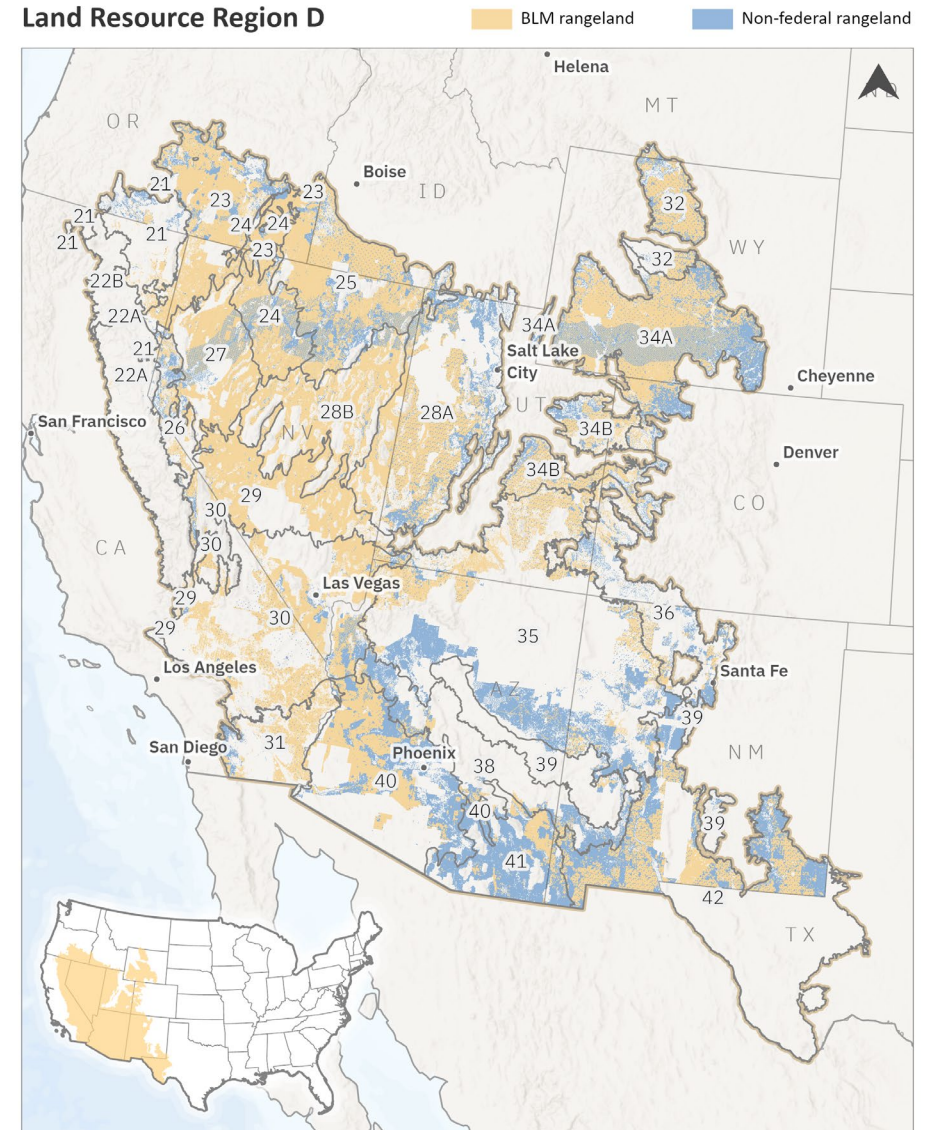
- Report conservation outcomes in ways the general public values at scale.
- Provide broad sense of non-market economic benefits from conservation investments.
- Identify existing science gaps and research priorities.

Study Location



Study Area

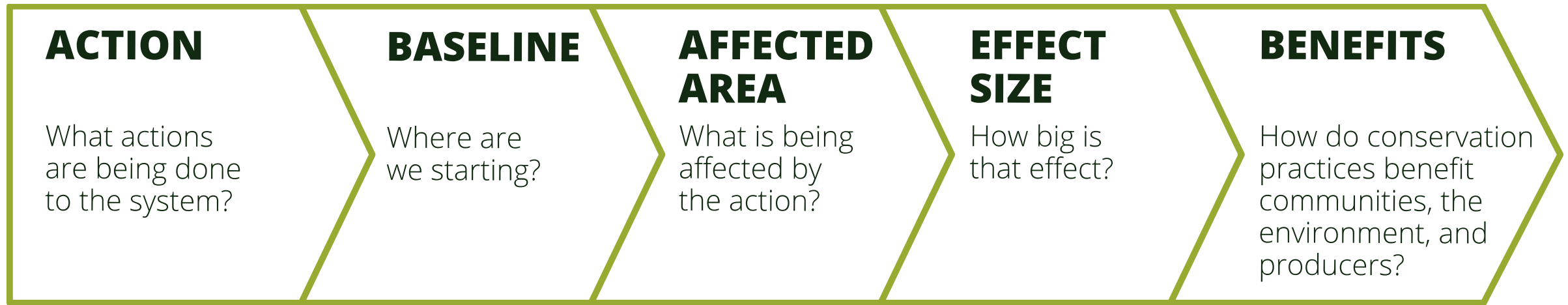
- Land Resource Region D
- 351 million acres
- 11 states
- 23 MLRAs
- Non-federal rangeland and BLM



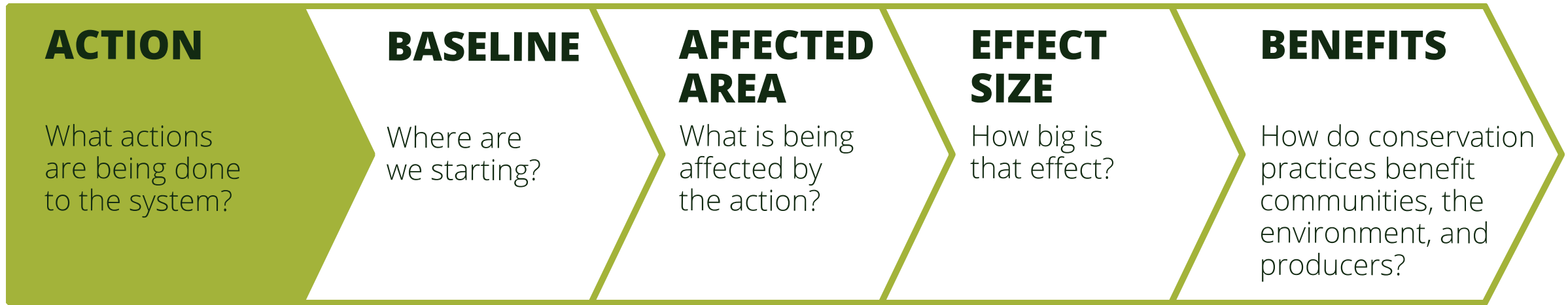
Project Constraints

- Limited data on practice applications
- Some data suppressed for confidentiality
- Results should be timely
- Produce consistent and repeatable analysis

Framework Outline

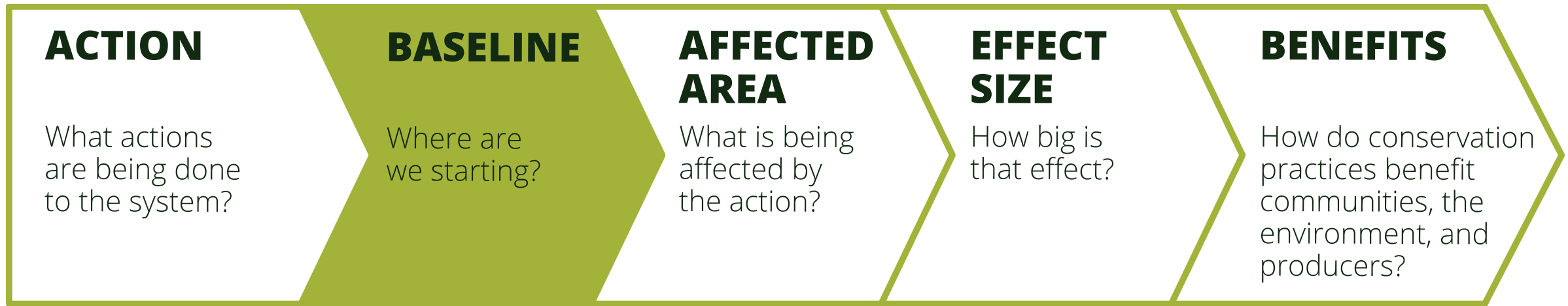


Framework: Conservation Actions



- NRCS contracts certified from 2011-2020
- BLM treatments from 2016-2020
- Practices: Brush Management, Prescribed Grazing, Herbaceous Weed Treatment

Framework: Establishing a Baseline



Baseline components:

- Rangeland types
- Rangeland health attributes
- Unit values of ecosystem services

Baseline: Land Cover Types

Acres (millions)

Landcover	Total Rangeland	Non-Federal Rangeland	BLM Rangeland
Forest	4.5 (2%)	3.2 (4%)	1.3 (1%)
Grassland	27.9 (15%)	13.7 (15%)	14.1 (14%)
Shrubland	160.5 (83%)	72.7 (81%)	87.9 (85%)
Total	192.9 (100%)	89.6 (100%)	103.4 (100%)

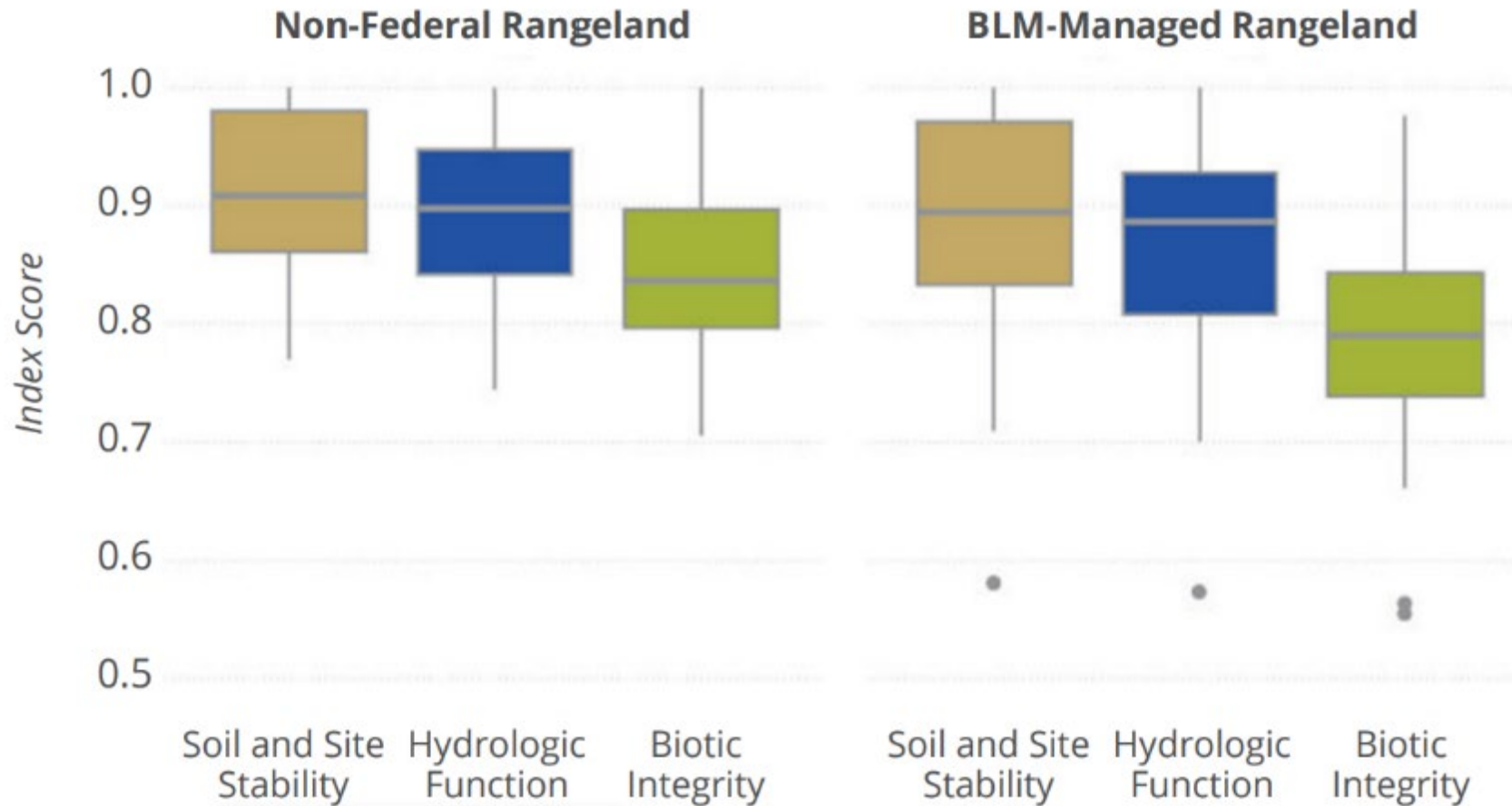


Baseline: Rangeland Health Attributes

- National Resources Inventory (NRI)
- Assessment, Inventory, and Monitoring (AIM)

Indicator #	Rangeland Health Indicator	Rangeland Health Attribute		
		SOIL/SITE STABILITY	HYDROLOGIC FUNCTION	BIOTIC INTEGRITY
1	RILLS	X	X	
2	WATER FLOW PATTERNS	X	X	
3	PEDESTALS or TERRACETTES	X	X	
4	BARE GROUND	X	X	
5	GULLIES	X	X	
6	WIND SCoured AREAS	X		
7	LITTER MOVEMENT	X		
8	SOIL SURFACE RESISTANCE TO EROSION	X	X	X
9	SOIL SURFACE LOSS/DEGRADATION	X	X	X
10	INFILTRATION and RUNOFF		X	
11	COMPACTION LAYER	X	X	X
12	PLANT FUNCTIONAL/STRUCTURAL GROUPS			X
13	PLANT MORTALITY and DECADENCE			X
14	LITTER AMOUNT		X	X
15	ANNUAL PRODUCTION			X
16	INVASIVE PLANTS			X
17	REPRODUCTIVE CAPABILITY of PERENNIALS			X

Baseline: Rangeland Health Attributes



Baseline: Ecosystem Services Valuation

- Benefit transfer methods (BTM): applies values estimated for one site to a different site
 - Provides rapid analysis when primary site data doesn't exist
 - Literature review of relevant studies
 - Point and function transfer estimates

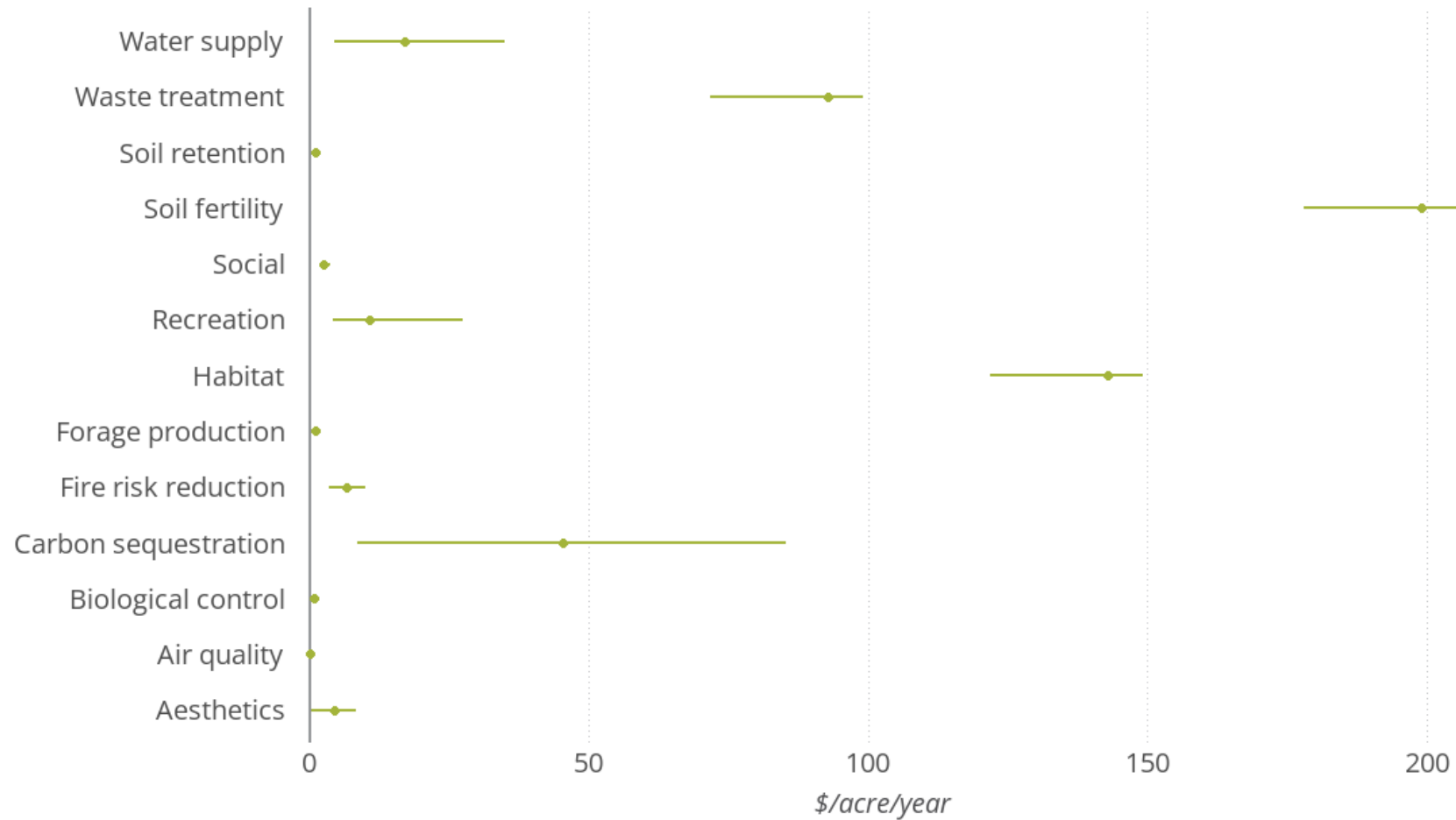
Ecosystem Services Valuation Dataset

- Valued 13 services on 3 rangeland types
- Dataset includes 34 value estimates from 16 studies

ECOSYSTEM SERVICES VALUED IN THIS STUDY	FOREST	GRASSLAND	SHRUBLAND
Aesthetics	•	•	•
Air quality	•	•	•
Biological control	•	•	•
Carbon sequestration	•	•	•
Fire risk reduction		•	•
Forage production		•	•
Habitat		•	
Recreation	•	•	•
Social		•	•
Soil fertility		•	
Soil retention		•	•
Waste treatment		•	
Water supply	•	•	

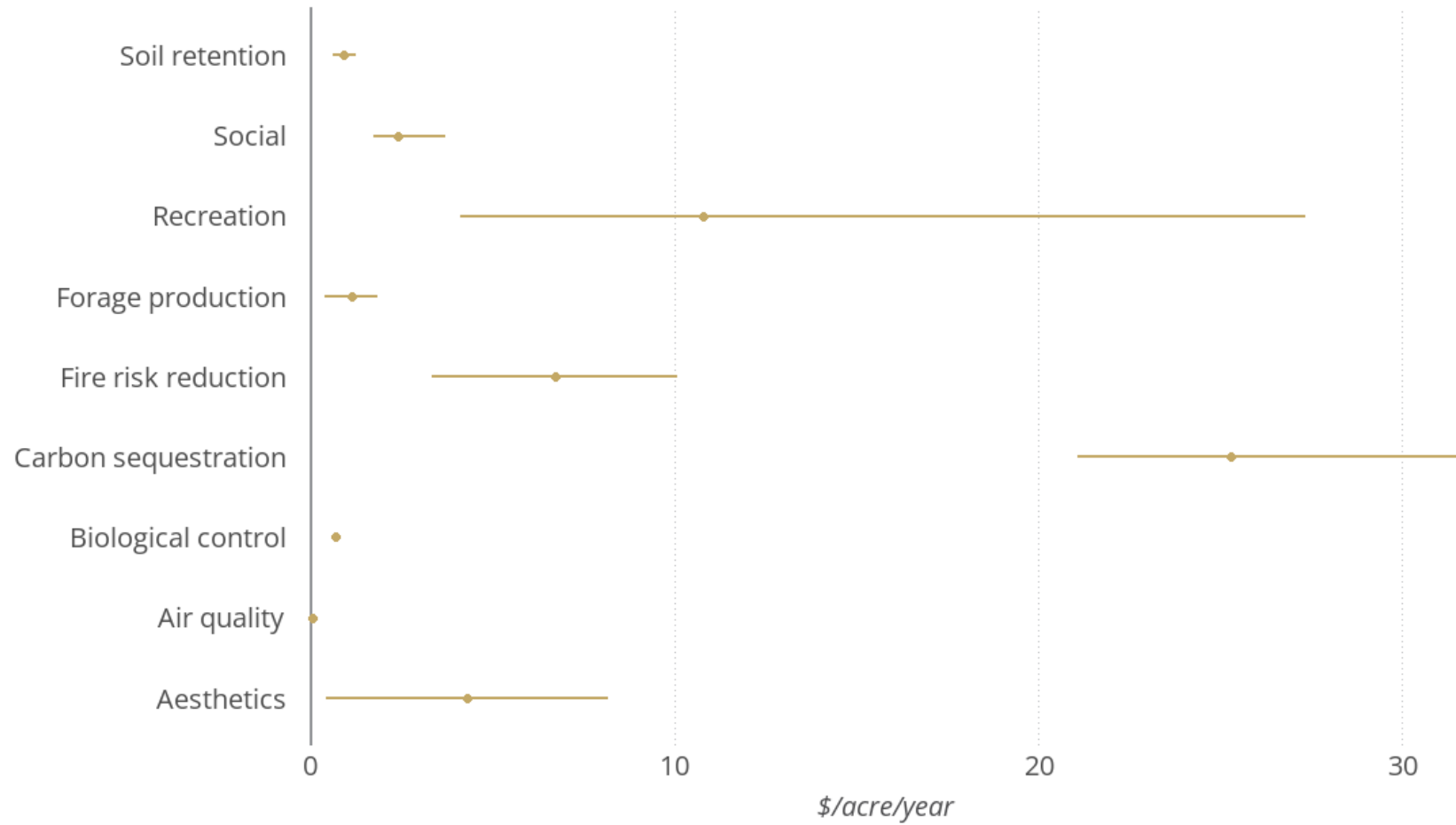
• Indicates landcover-ecosystem service combination included in the ESV dataset.

ESV Dataset: Grassland



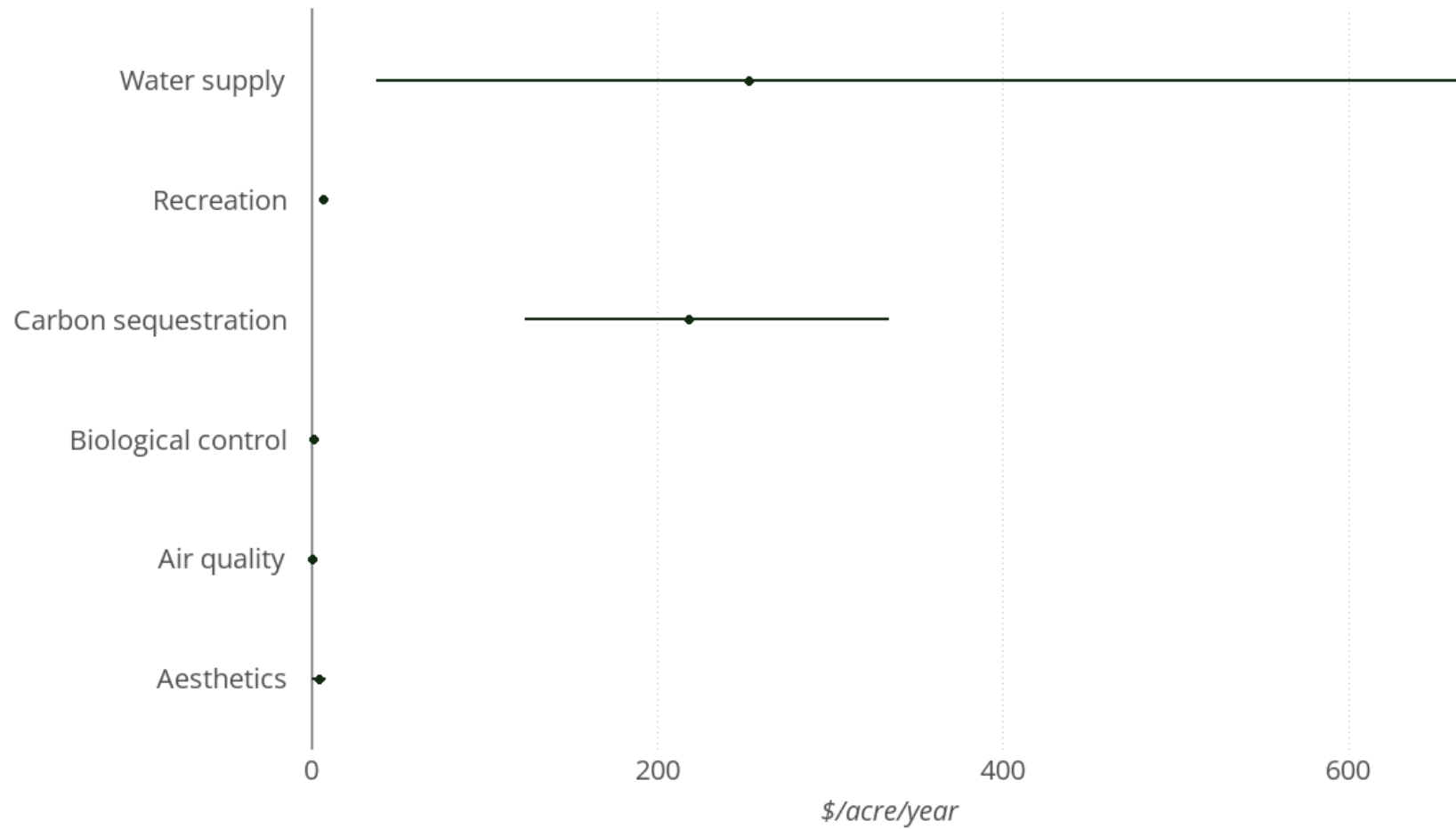


ESV Dataset: Shrubland



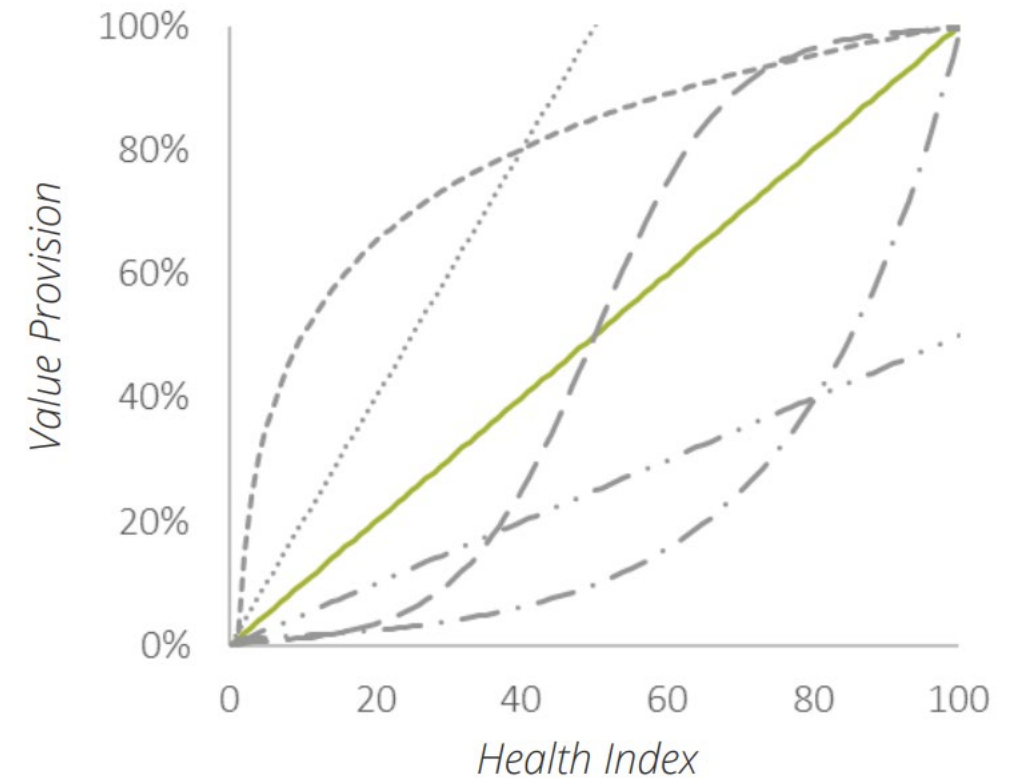


ESV Dataset: Forest

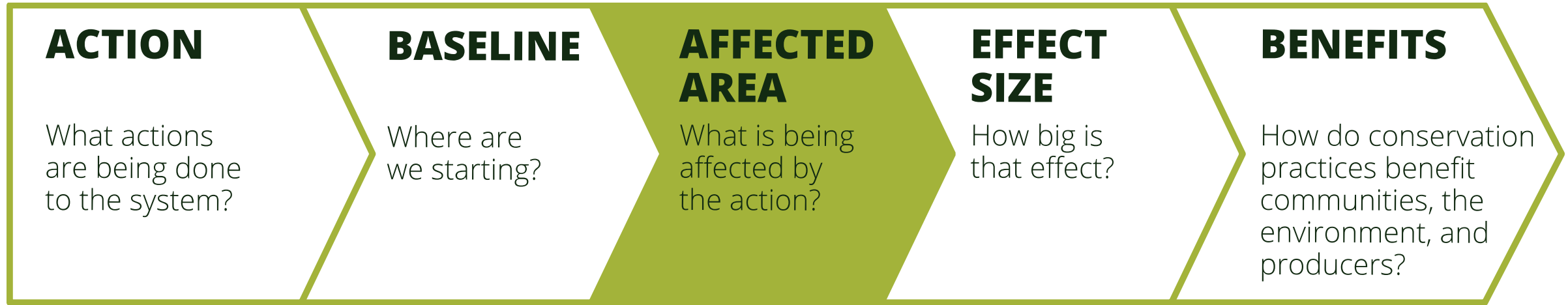


Tying Ecosystem Services to Health

- Expect a ability of rangelands to provide ES to decline with health
- Discount ecosystem service values by range health index (Aplet et al., 2000; Esposito et al., 2011; Phillips & McGee, 2014)
- Assumes \$ values are for "healthy" locations
- Assumed linear response of health and valuation effects from practices

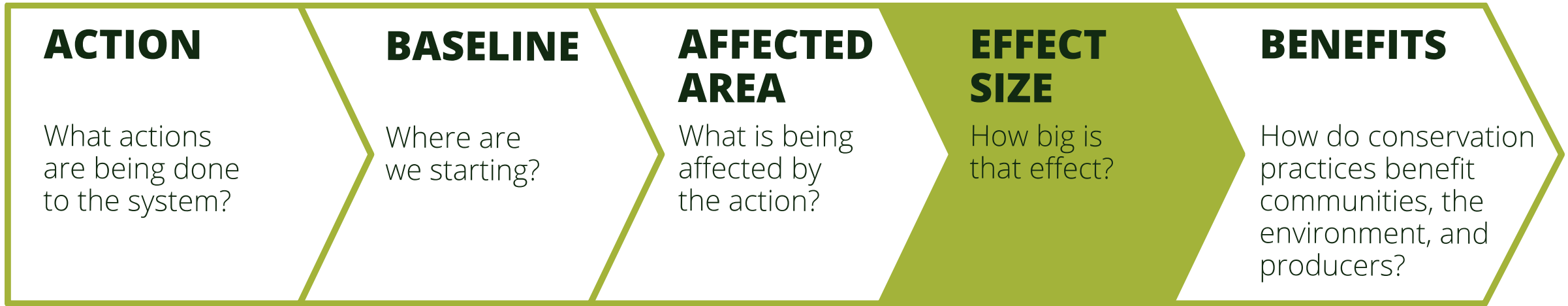


Framework: Affected Area

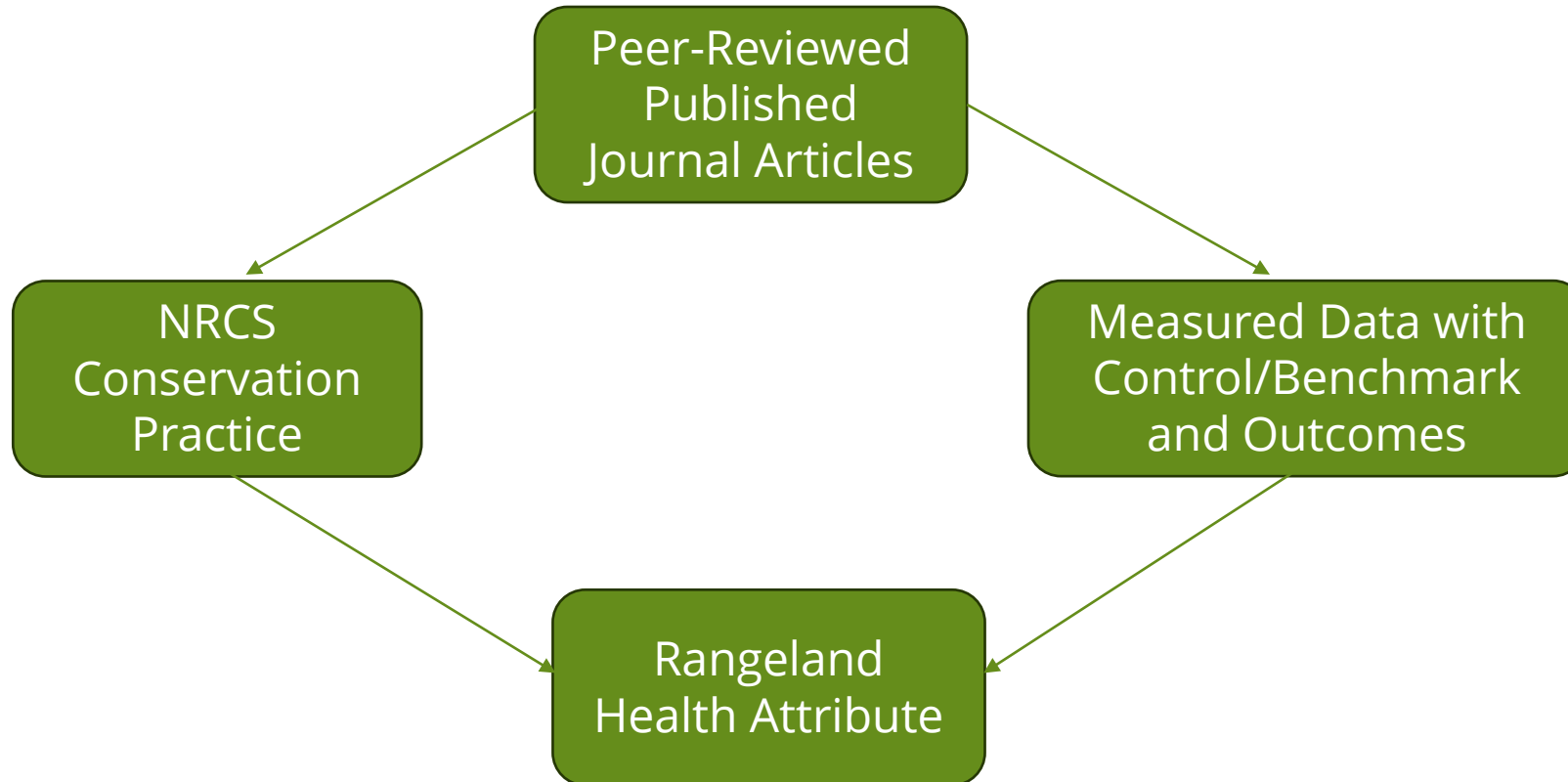


- NRCS contract data contains MLRA and acres affected
- BLM LTDL data has locations and shapefiles of areas treated

Framework: Effect Size

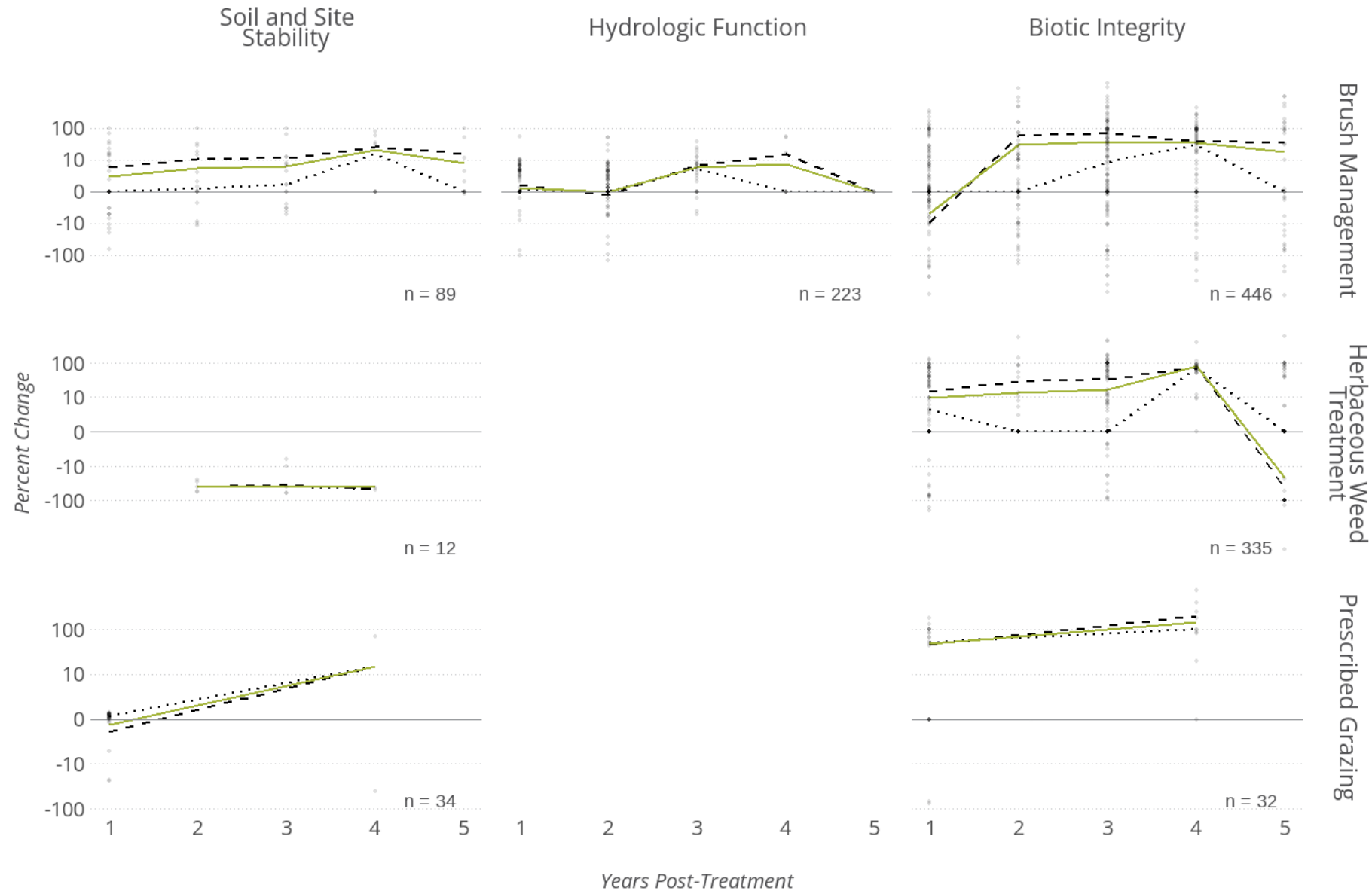


Conservation Outcomes Research Explorer (CORE)

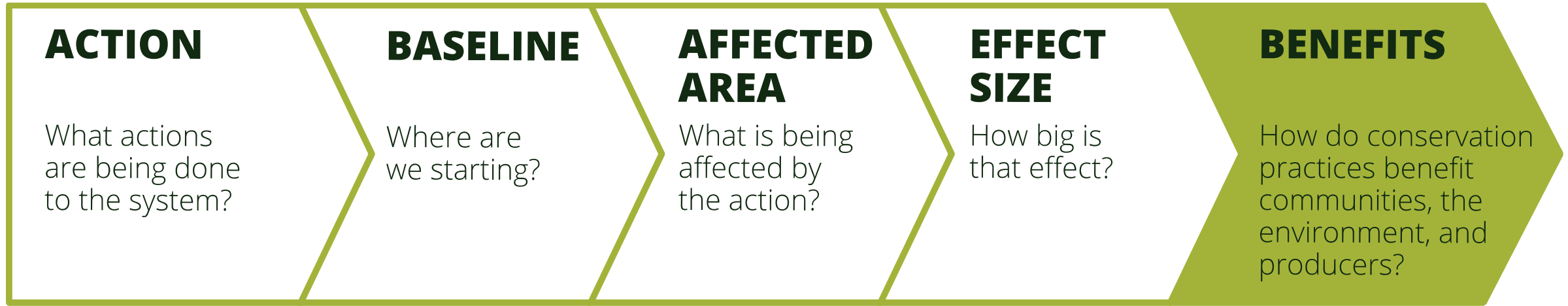


CORE Data

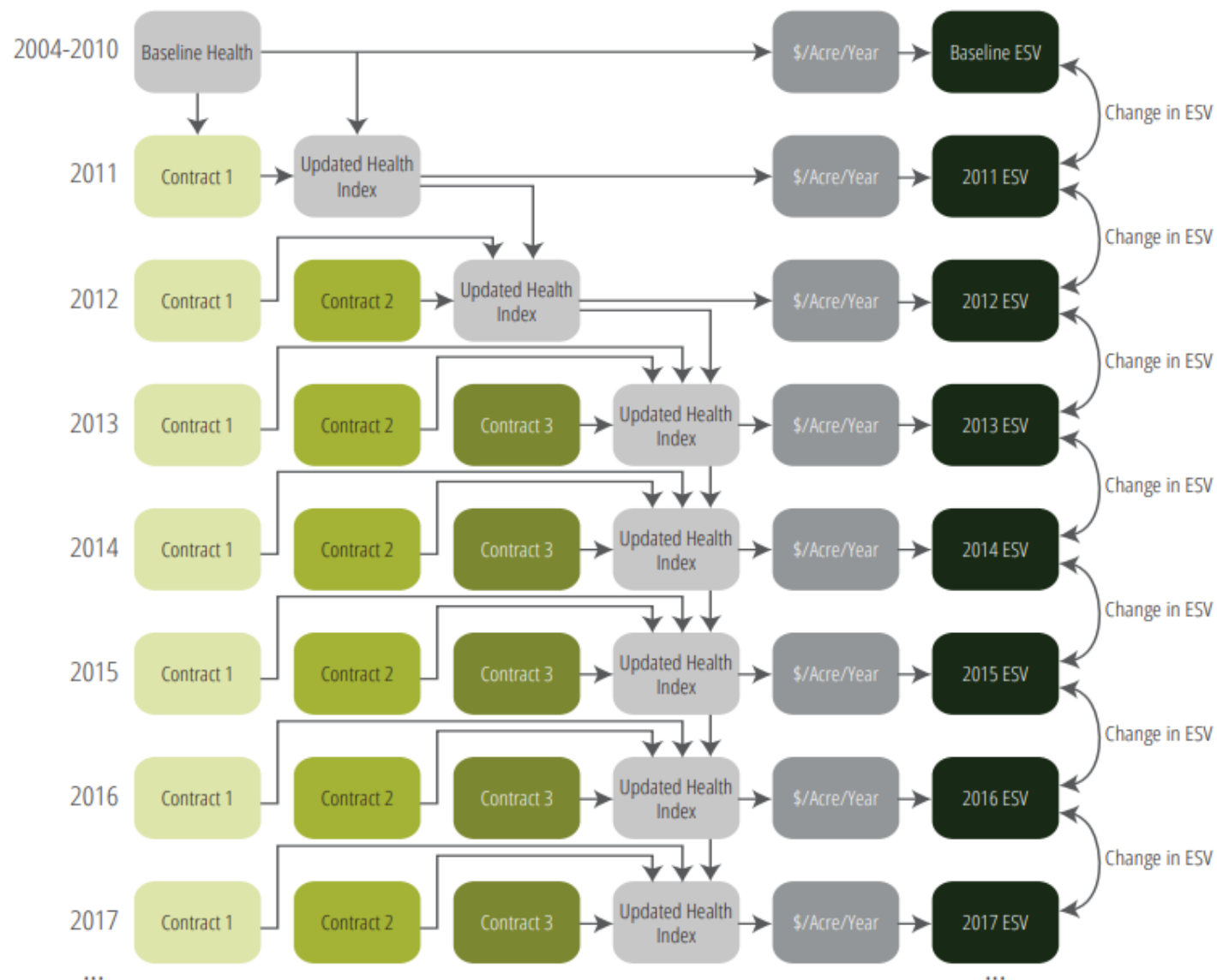
- Dashed line = mean
- Dotted line = median
- Green line = values used in report



Framework: Change in ESV



Workflow



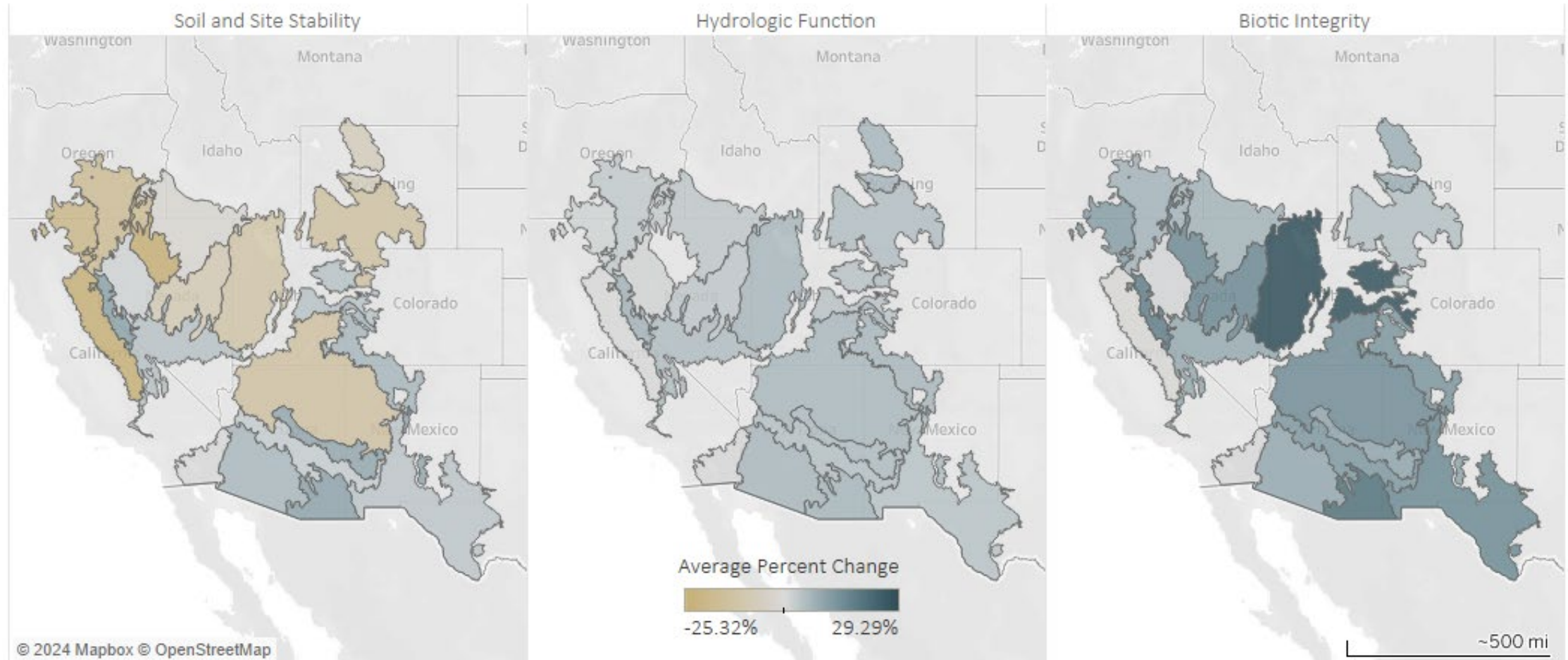
Project Outputs

- Report released January 2024
<https://www.nrcs.usda.gov/ceap/grazing-lands>
- Manuscript submitted to Journal of Soil and Water Conservation, awaiting review
- Interactive summary:
www.eartheconomics.org/conservation-and-communities
- ESV Dataset available:
<https://zenodo.org/records/10425543>

Results: Acres Treated Per Year

Annual Estimate	NRCS (2011-2020)	BLM (2016-2020)
Number of Contracts/Treatments	795	105
Total Rangeland Acres	89.6 M	103.4 M
Acres Treated/Year	1.7 M	83,000
% of Rangeland Acres Treated/Year	1.8%	0.07%

Results: Ecosystem Health



Results: Annual Ecosystem Service Values

Annual Estimate	NRCS (2011-2020)	BLM (2016-2020)
Financial Assistance/Year	\$13.1 M	N/A
Baseline ESV/Year	\$6.8 B—\$13.4 B	\$7.1 B—\$14.6 B
Change in ESV/Year	\$8 M—\$21 M	\$6 M—\$9 M
% Change in ESV/Year	0.1%—0.2 %	0.06 %—0.08 %

Results: ESV Returns per Acre Treated

- Average annual improvement in ESV by practice, per acre treated

Practice	NRCS	BLM
Brush Management (314)	\$5—\$14	\$4—\$9
Herbaceous Weed Treatment (315)	\$10—\$26	\$12—\$21
Prescribed Grazing (528)	\$2—\$5	\$2—\$4

Sensitivity Analysis

- Proportion of baseline total ecosystem service value

ECOSYSTEM SERVICES VALUED	FOREST	GRASSLAND	SHRUBLAND
Aesthetics	<0.5%	<0.5%	3%
Air quality	<0.5%	<0.5%	<0.5%
Biological control	<0.5%	<0.5%	<0.5%
Carbon sequestration	4%	5%	17%
Fire risk reduction		1%	5%
Forage production		<0.5%	1%
Habitat		16%	
Recreation	<0.5%	1%	4%
Social		<0.5%	2%
Soil fertility		23%	
Soil retention		<0.5%	1%
Waste treatment		11%	
Water supply	5%	2%	

Take-Aways

- Estimated scale of **non-market** benefits of rangeland conservation: at least as much as NRCS spends in Financial Assistance—tens of millions annually
- These are conservative estimates, many ecosystem service values couldn't be estimated
- Rangeland ecosystem services also provide market benefits, which was not the focus of this report



Thank you!

Interactive summary & PDF:

www.eartheconomics.org/conservation-and-communities

<https://www.nrcs.usda.gov/ceap/grazing-lands>

ESV Dataset available:

<https://zenodo.org/records/10425543>

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