



Neskowin, OR © OregonLive.com



Yancheng National Nature Reserve, China



Shinan, South Korea - Sun-Kee Hong

Coastal ecosystem services in the Temperate Northern Pacific: An emphasis on beneficiaries

Chanda J. Littles, Chloe A. Jackson, Theodore H. DeWitt, Matthew C. Harwell
PICES Annual Meeting
Victoria, BC
October 19, 2019

Introduction

- Understanding how coastal habitats contribute to human well-being can facilitate better coastal planning and land management
- As a first step, we look to published literature to see how well beneficiaries are represented and identify knowledge gaps
- We then hone in on the literature evidence for coastal beneficiaries in the Pacific region

Why should we (people) care?

DEVELOPMENT

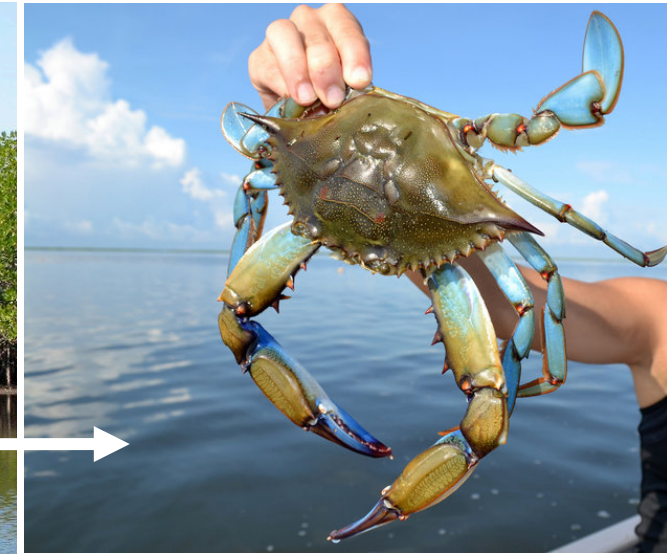
**HABITAT
RESTORATION**

RUNOFF MGMT

**AGRICULTURAL
PRACTICES**



HABITAT
(e.g., mangroves)



Baja Sur – Octavio Aburto, iLCP



**EGS
AVAILABILITY**

Indonesia – Steven Lutz, GRID Arendal

What are FEGS? (final ecosystem goods & services)

“components of nature, directly enjoyed, consumed, or used to yield human well-being” (Boyd & Banzhaf 2007)

Environmental
Attributes



Estuaries and Near
Shore Marine Habitats

+

Beneficiaries



Recreational
Clammers

→

FEGS



Fauna Consumed
(e.g., mussels, fish, crabs)

EGS & Habitat Linkages, *Example*

Table 7
ES availability by habitat.

Habitat	Provisioning (a_{Pi})	Range [0-1]	Regulating and maintenance (a_{RMI})	Range [0-1]	Cultural (a_{Ci})	Range [0-1]
A1	0	0.00	4	0.30	15	0.67
A2.22	0	0.00	1	0.00	4	0.14
A2.23	15	0.63	4	0.30	21	0.95
A2.24	12	0.50	4	0.30	22	1.00
A2.31	9	0.38	6	0.50	9	0.38
A2.5	7	0.29	11	1.00	21	0.95
A2.61	0	0.00	7	0.60	5	0.19
A2.71	0	0.00	3	0.20	17	0.76
A3.A4	7	0.29	3	0.20	19	0.86
A4.13	13	0.54	2	0.10	4	0.14
A4.21	8	0.33	2	0.10	4	0.14
A5.13	24	1.00	2	0.10	12	0.52
A5.23	2	0.08	5	0.40	1	0.00
A5.24	13	0.54	3	0.20	12	0.52
A5.43	19	0.79	3	0.20	12	0.52
A5.51	10	0.42	2	0.10	5	0.19
A5.53	7	0.29	5	0.40	11	0.48

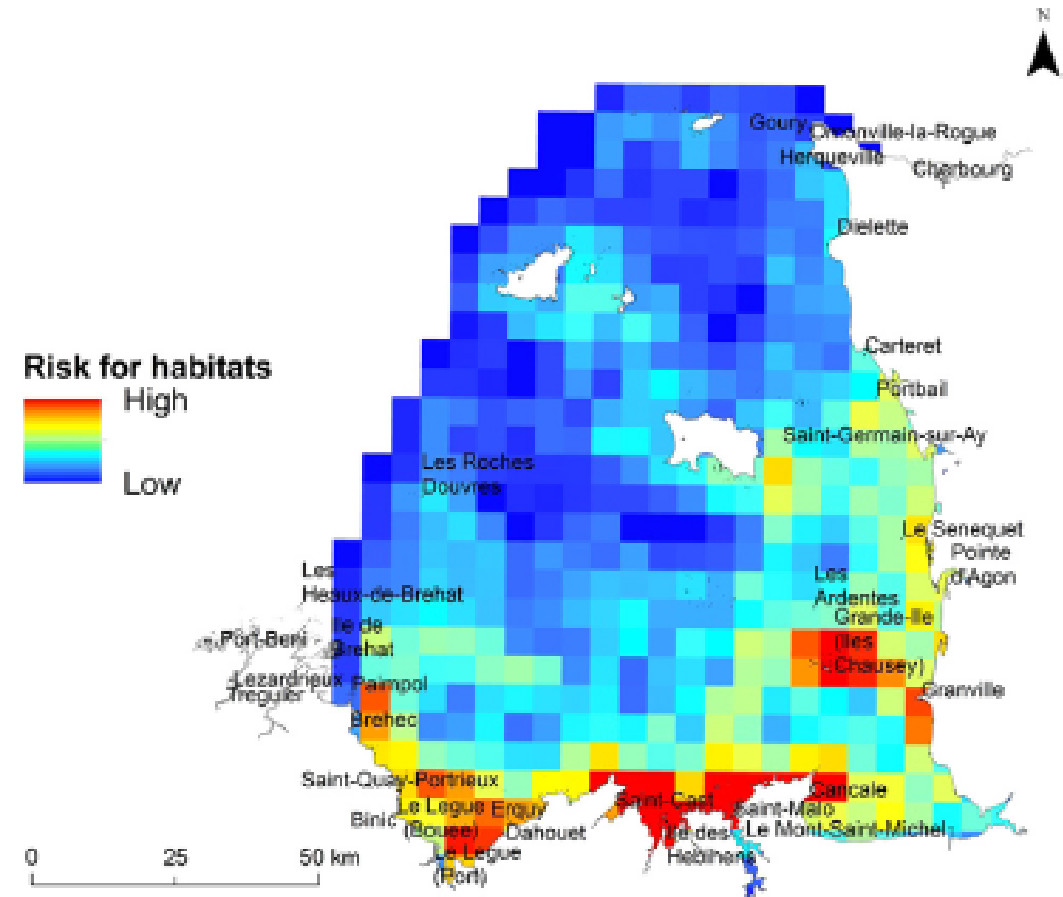


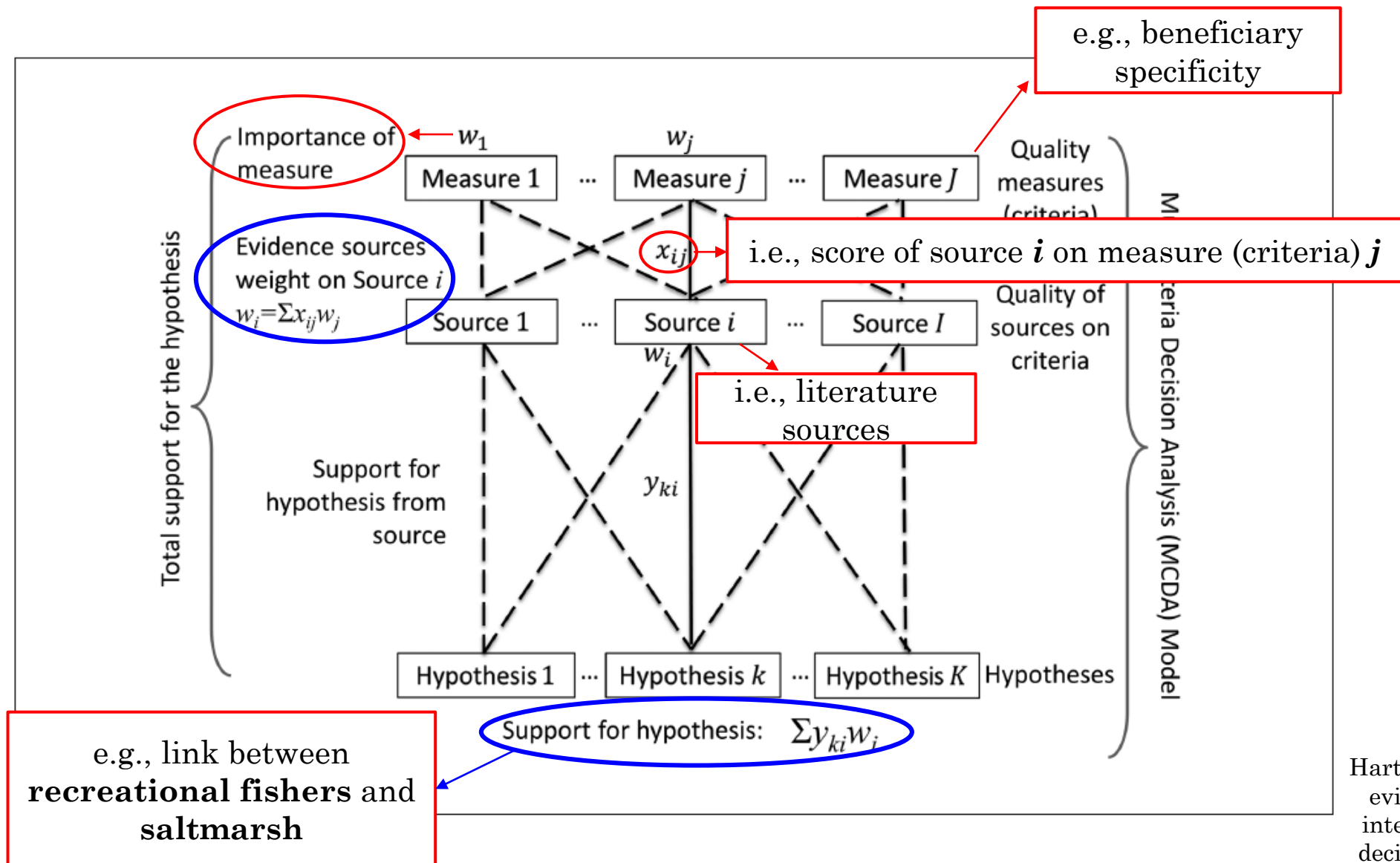
Fig. 5. Cumulative habitat risk for the GNB.

EUNIS Classification → **EGS**, with *INVEST* tool for risk assessment by habitat

Weight of Evidence (WOE) approach for assessing habitat:FEGS linkages

- Step 1: Identify coastal habitat classification system and beneficiary categories (CMECS; FEGS beneficiaries)
- Step 2: Develop scoring criteria for assessing relevance of literature sources linking FEGS to coastal habitats
- Step 3: Score each literature source, weighing criteria equally
- Step 4: Compile (weighted-sum) evidence for habitat:FEGS beneficiary linkages

WOE Framework



Adapted from:

Linkov, I., O. Massey, J. Keisler, I. Rusyn, and T. Hartung. 2015. From "weight of evidence" to quantitative data integration using multicriteria decision analysis and Bayesian methods. ALTEX 32(1): 3-8.

Literature Review

- Literature search identified 2839 potential sources
- Follow-up assessment of titles and abstracts – yielded 396 references for full review
- After reading each paper, there were 36 more omissions – thus, 360 sources in the final meta-analysis
- Review time per paper ~10 minutes, ranged between 5 and 40 mins¹

Search terms in ScienceDirect²

- “ecosystem service*” AND “coast*”
 - “ecosystem good*” AND “coast*”
 - “ecosystem service*” AND “nearshore*”
 - “ecosystem good*” AND “nearshore*”
 - “ecosystem service*” AND “habitat*”
 - “ecosystem good*” AND “habitat*”
-

¹Based on a subset of the last 42 papers reviewed

²Search engine with more than 14 million publications from over 3800 and 35,000 journals and books, respectively

Direct human uses (i.e., Final EGS)

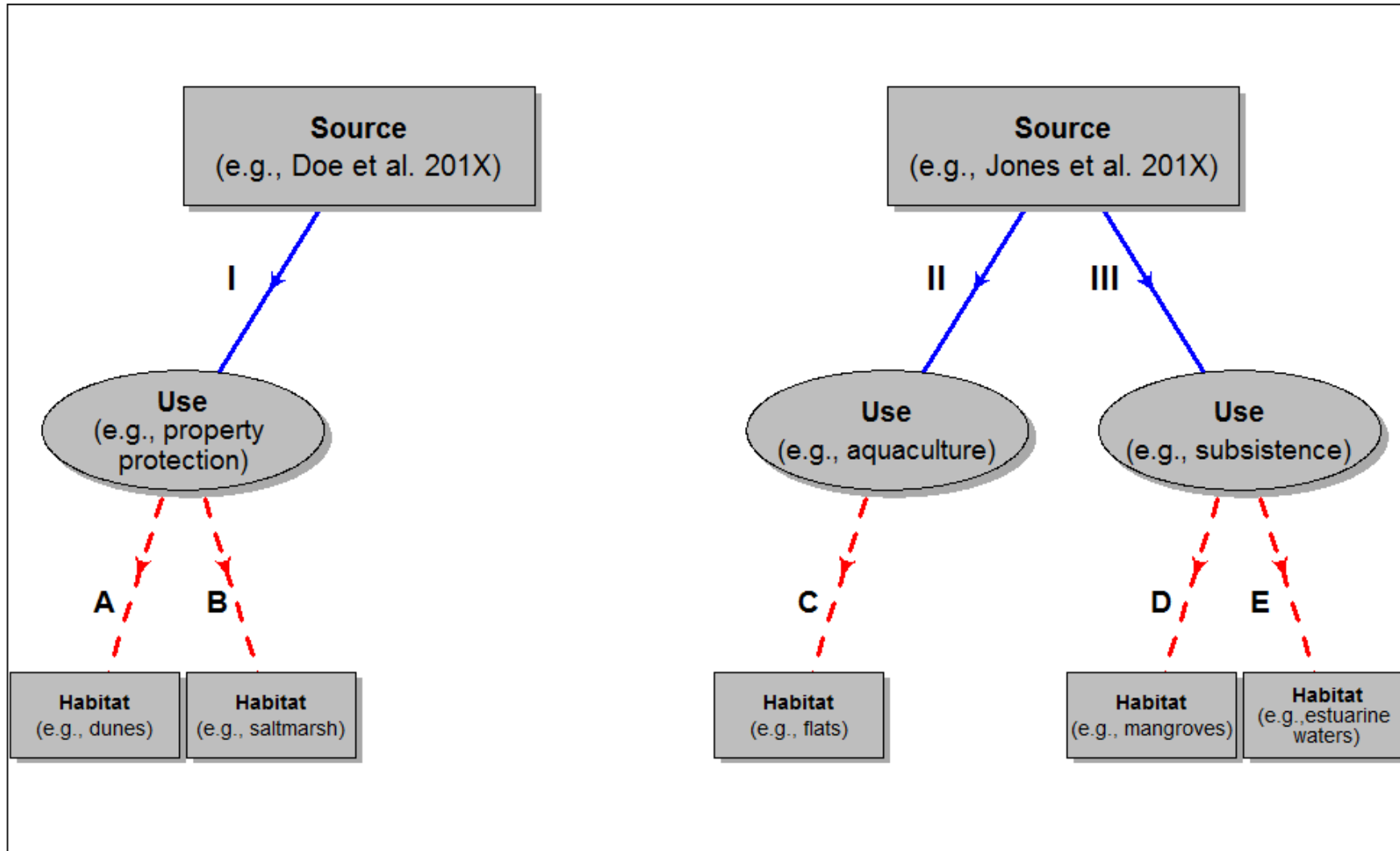
Academic
Agriculture
Customs
Industry
Municipal/Residential
Non-Use
Recreation
Subsistence
Transport

Indirect uses

Biodiversity
Climate regulation
Nursery habitat
Nutrient cycling
Carbon sequestration
etc.

“Indirect
EGS”

Lines of Evidence: Beneficiary-Habitat Linkages



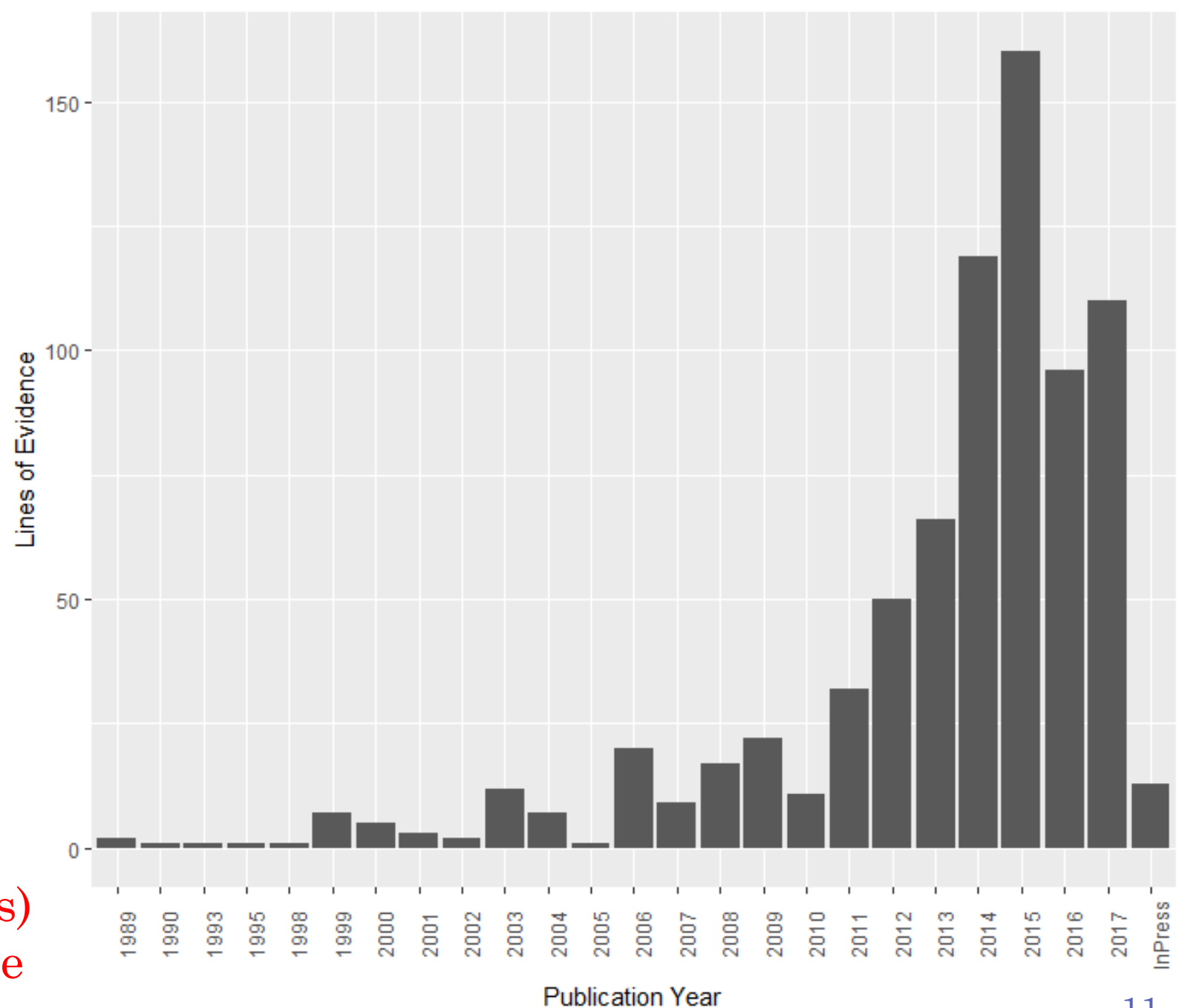
Lines of Evidence by Publication Year

2839 potential sources

396 references reviewed

360 references used

Reflects period since
“ecosystem services” (or goods)
entered the scientific parlance



Statistical Methods

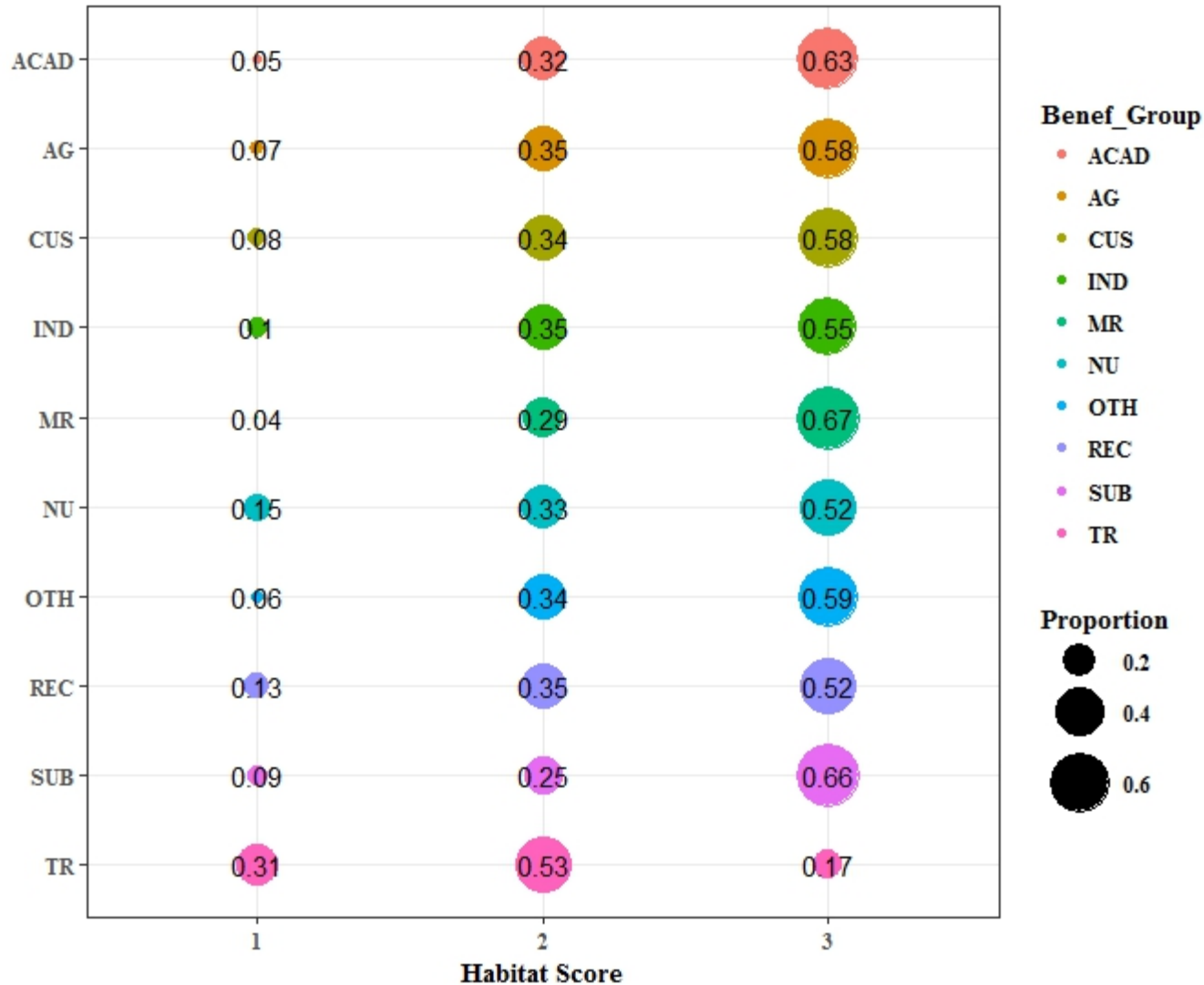
Scoring Criteria

- Nonparametric Kruskal-Wallis test for significant differences in scores
- Post-hoc Dunn's Test to determine which groups differed

Weight of Evidence (\approx evidence count)

- $Count \sim Hab_Category + Beneficiary$
- GLMs assumed Poisson count processes
- Also tested zero-inflated models
- Tukey post-hoc comparisons to determine which habitat and beneficiary groups differed

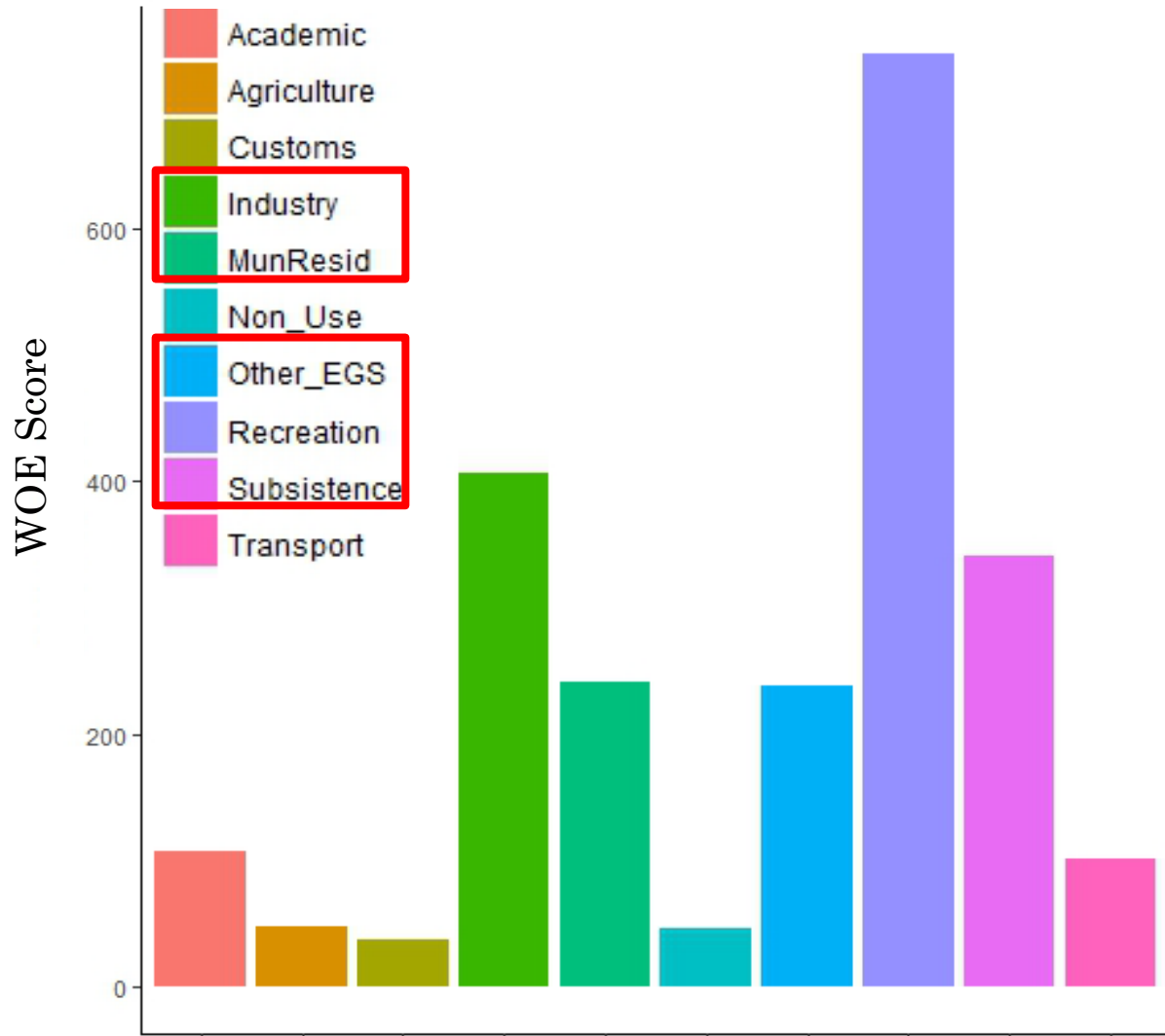
Differences in Scores (e.g., habitat specificity)



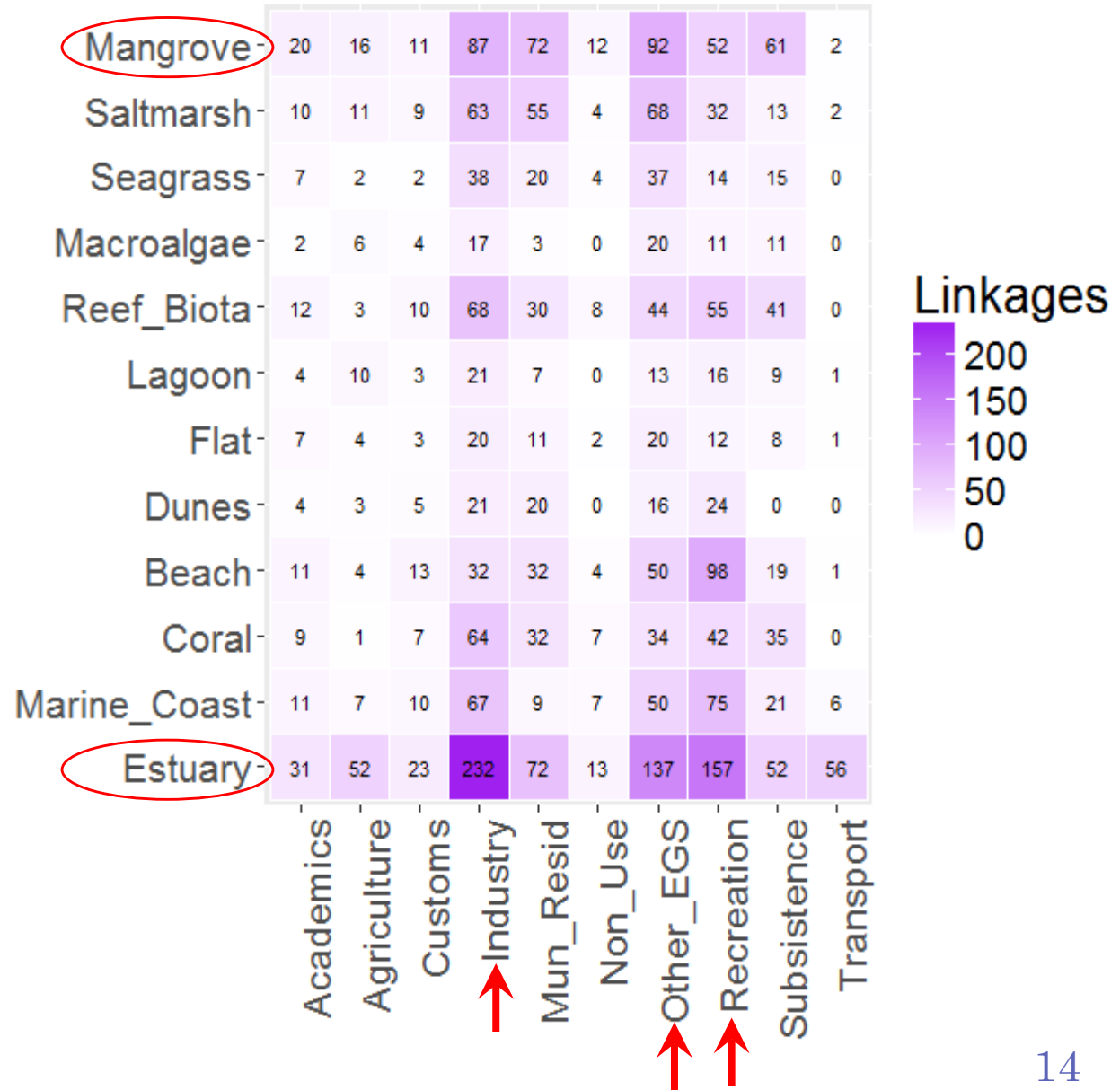
Beneficiary Group	Post-Hoc Differences*			
Academic (ACAD)	a	b		
Agriculture (AG)	a	b	c	
Customs (CUS)	a	b	c	
Industry (IND)	a		c	
Municipal/Residential (MR)		b		
Non-Use (NU)	a	b	c	
Other EGS (OTH)	a	b		
Recreation (REC)			c	
Subsistence (SUB)		b		
Transport (TR)				d

*Groups with different letters denote significant score differences, based on the Kruskal-Wallis Chi-Square and post-hoc Dunn Test

Literature Evidence Results

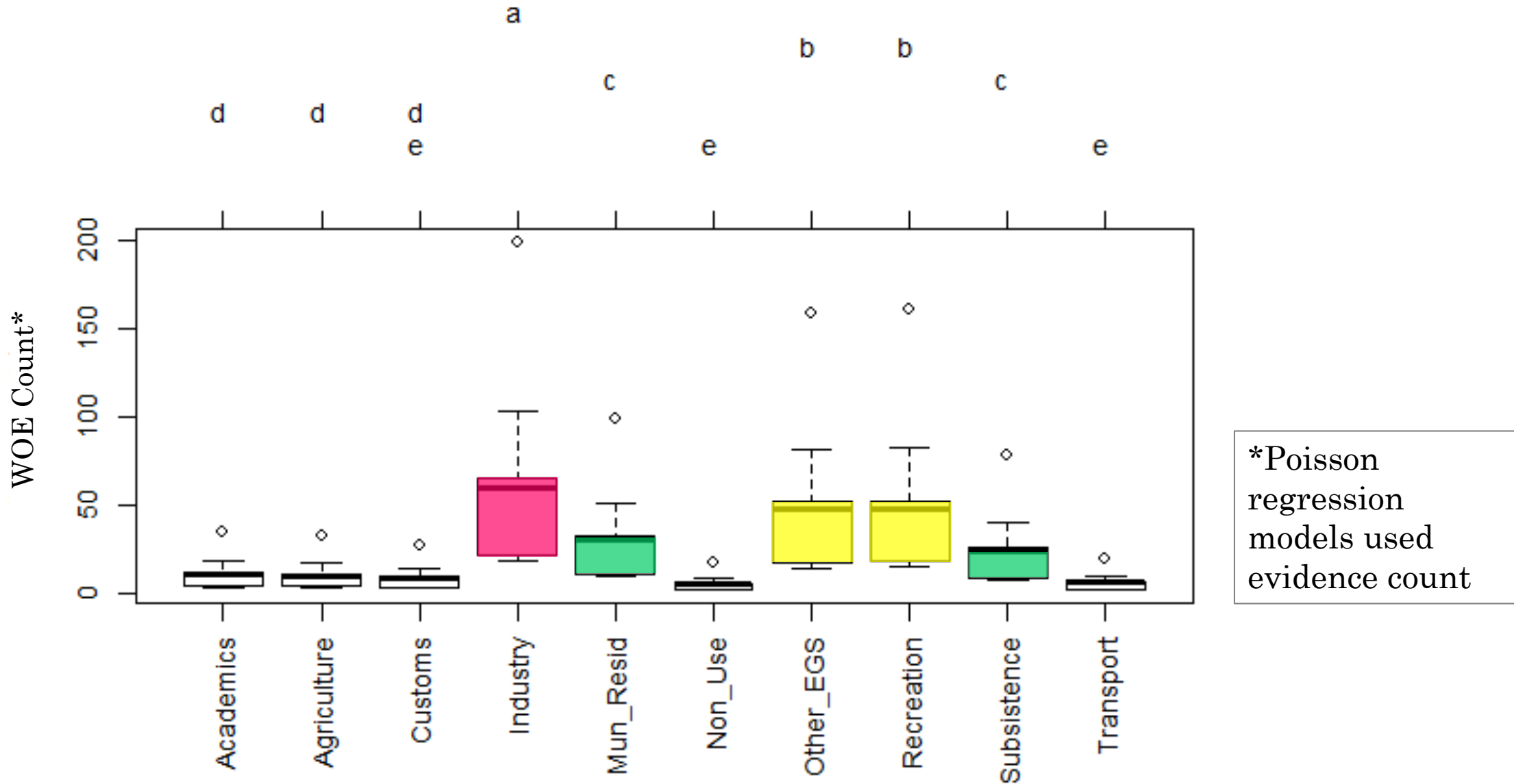


Habitats with broad uses

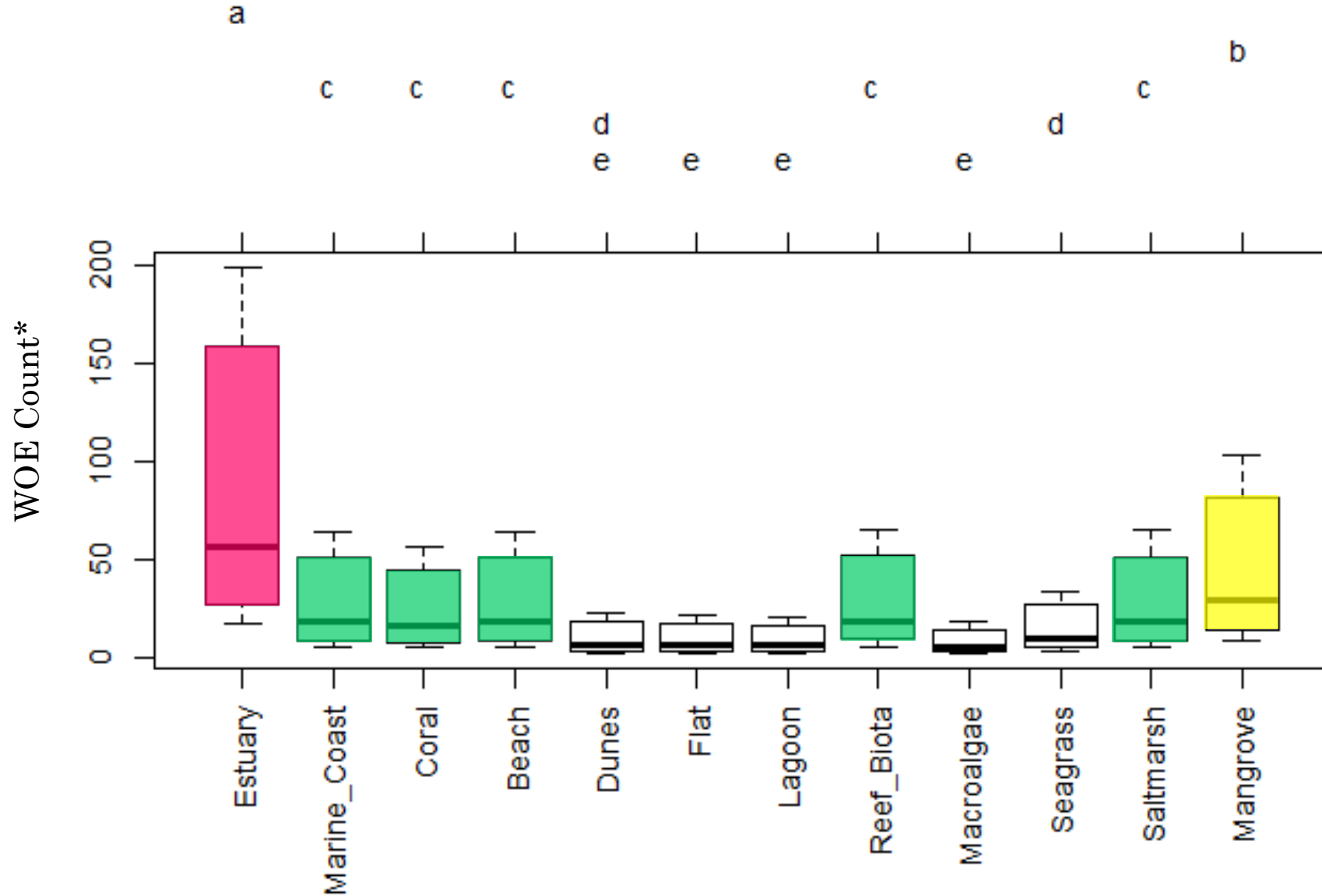


Uses with most/least literature evidence

WOE for Beneficiary Groups



WOE for Habitats

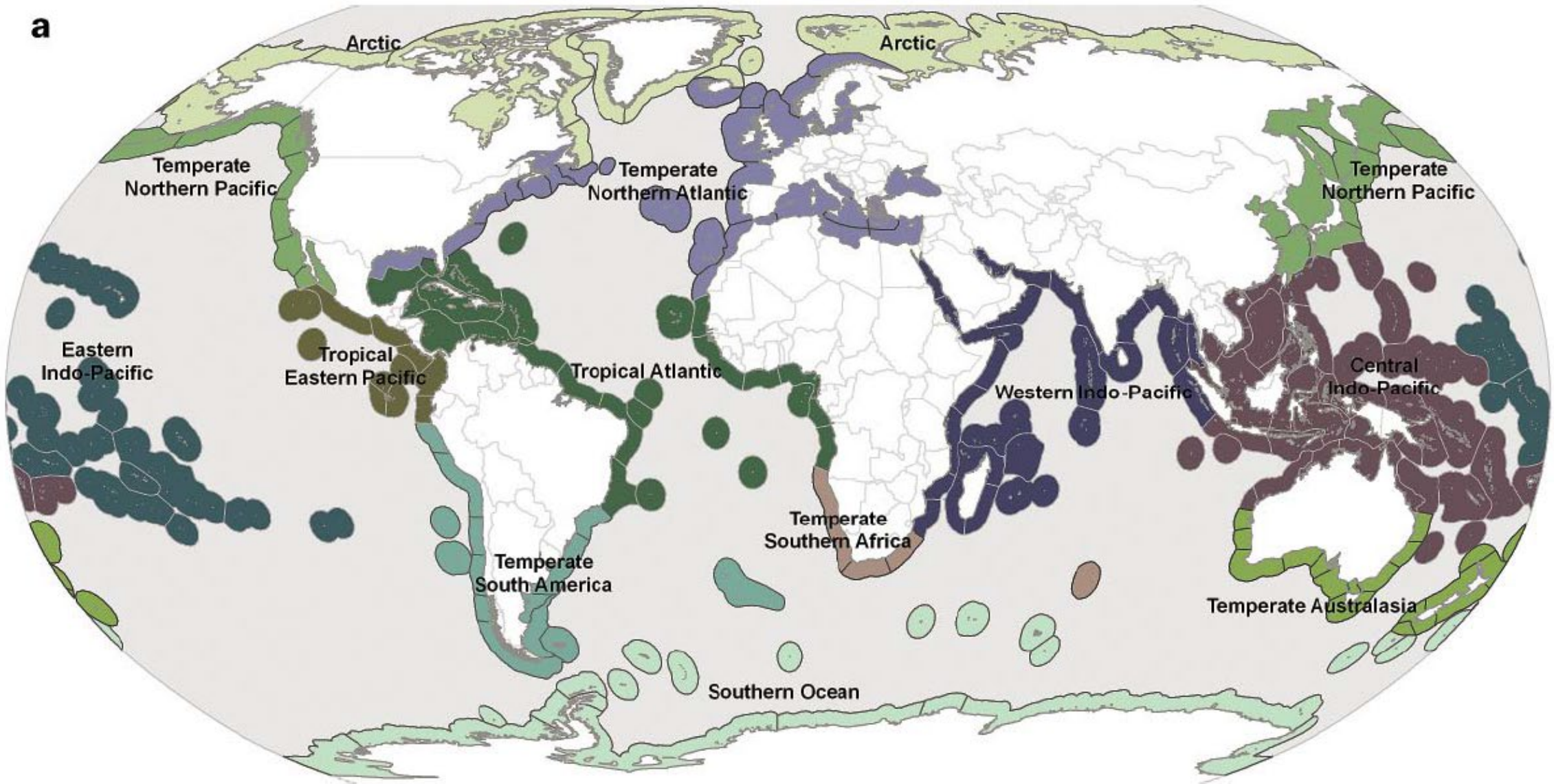


*Poisson regression models used evidence count

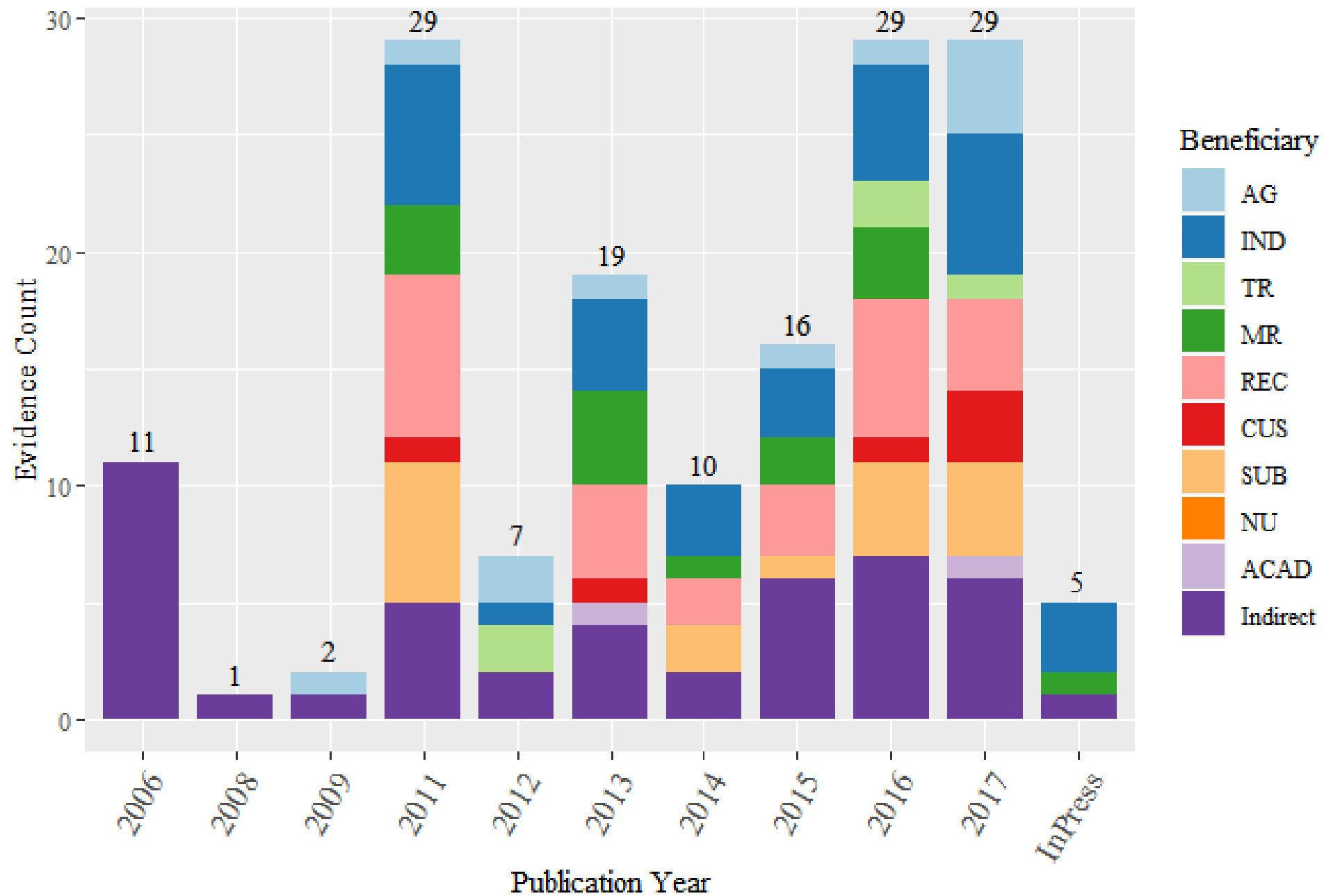
Summary

- Framework synthesizes existing knowledge on how FEGS beneficiaries utilize coastal habitat in a transparent and robust manner
- Demonstrates the varying degrees to which coastal habitats contribute to human well-being
- Results may inform...
 - Land-use decisions?
 - Restoration planning/prioritization?
 - Stakeholder engagement?

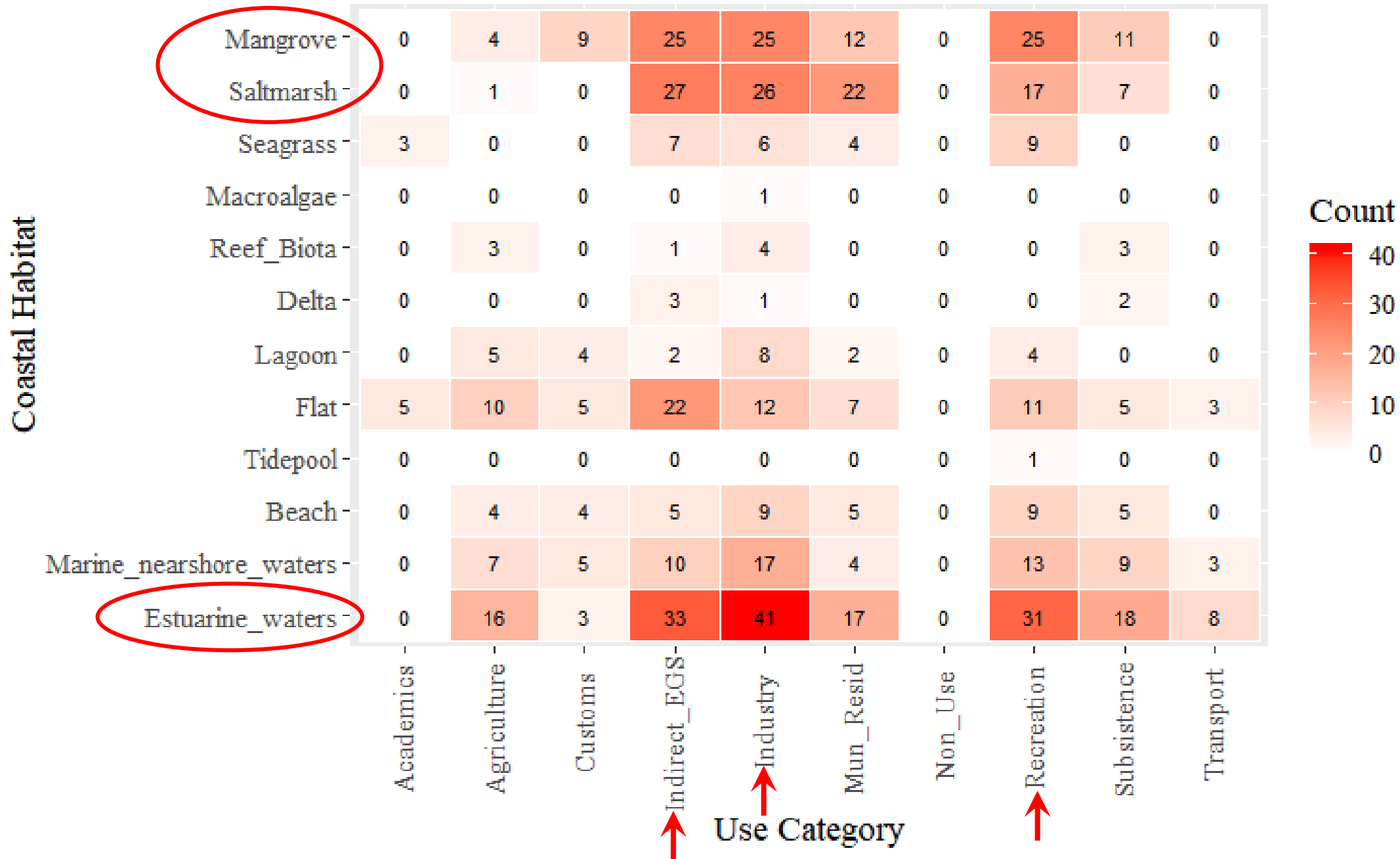
FEGS Beneficiaries in the Temperate Northern Pacific

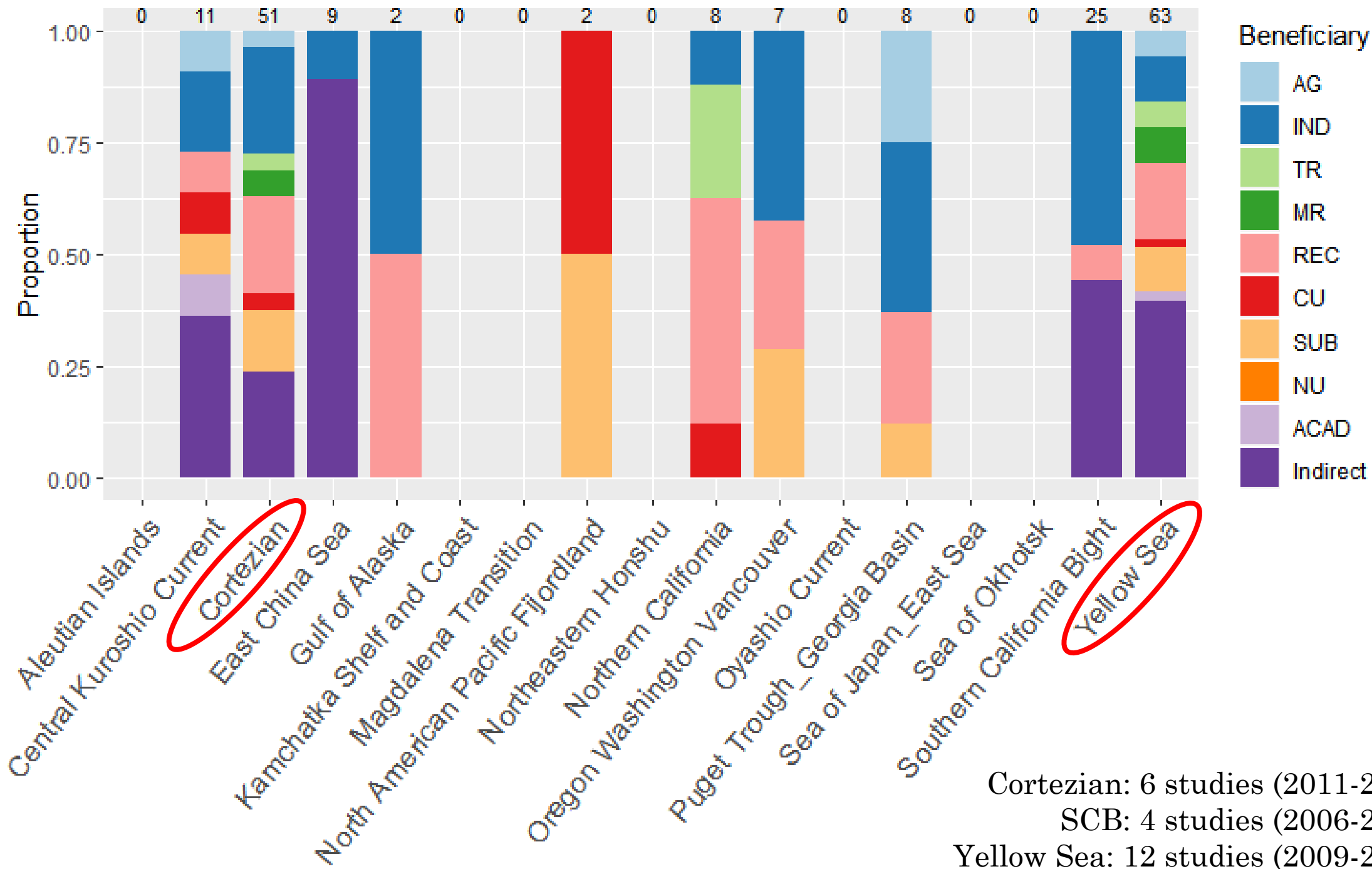


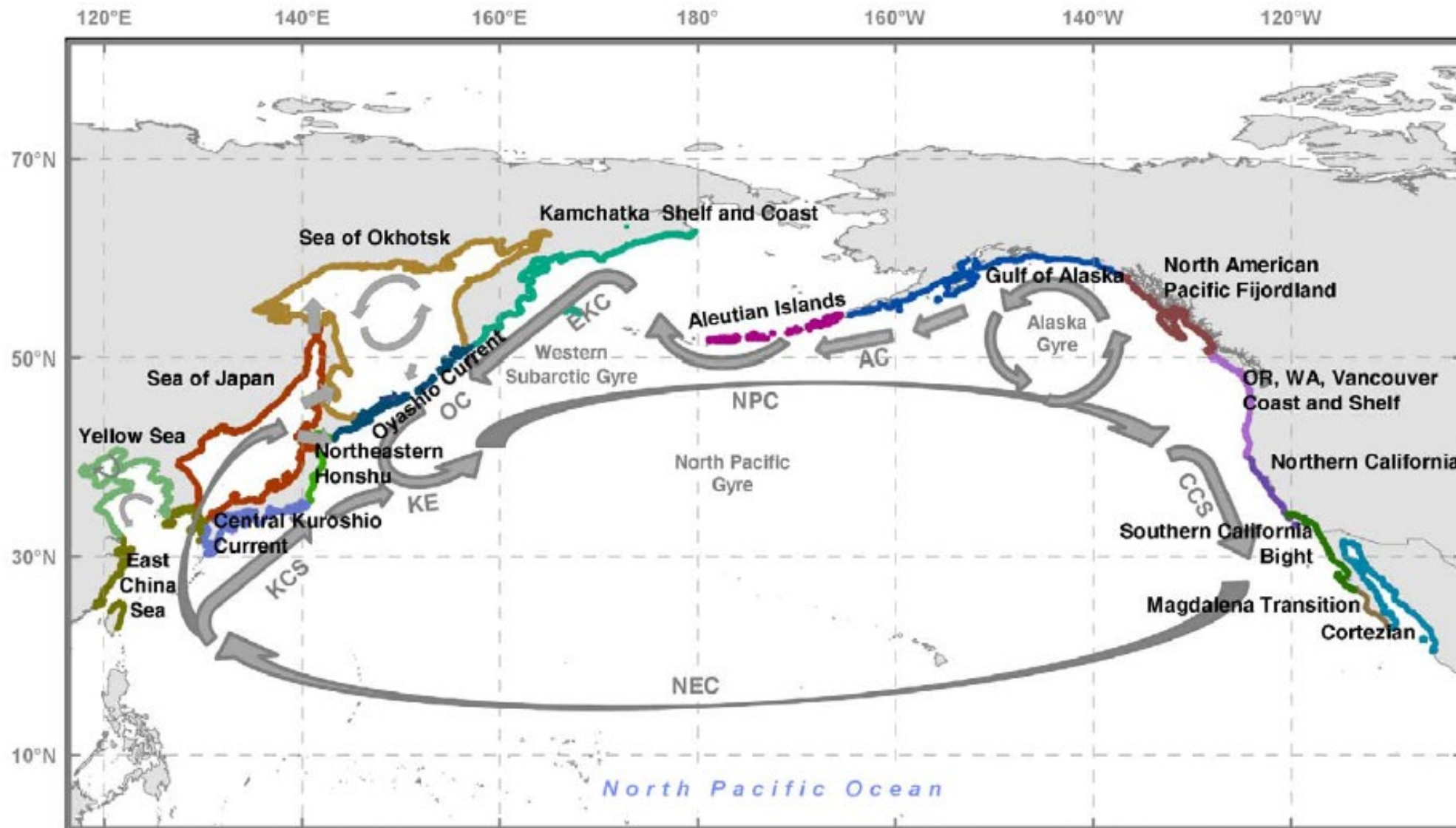
from Spalding et al. 2007, MEOW



Evidence for Coastal FEGS Use:Habitat Linkages





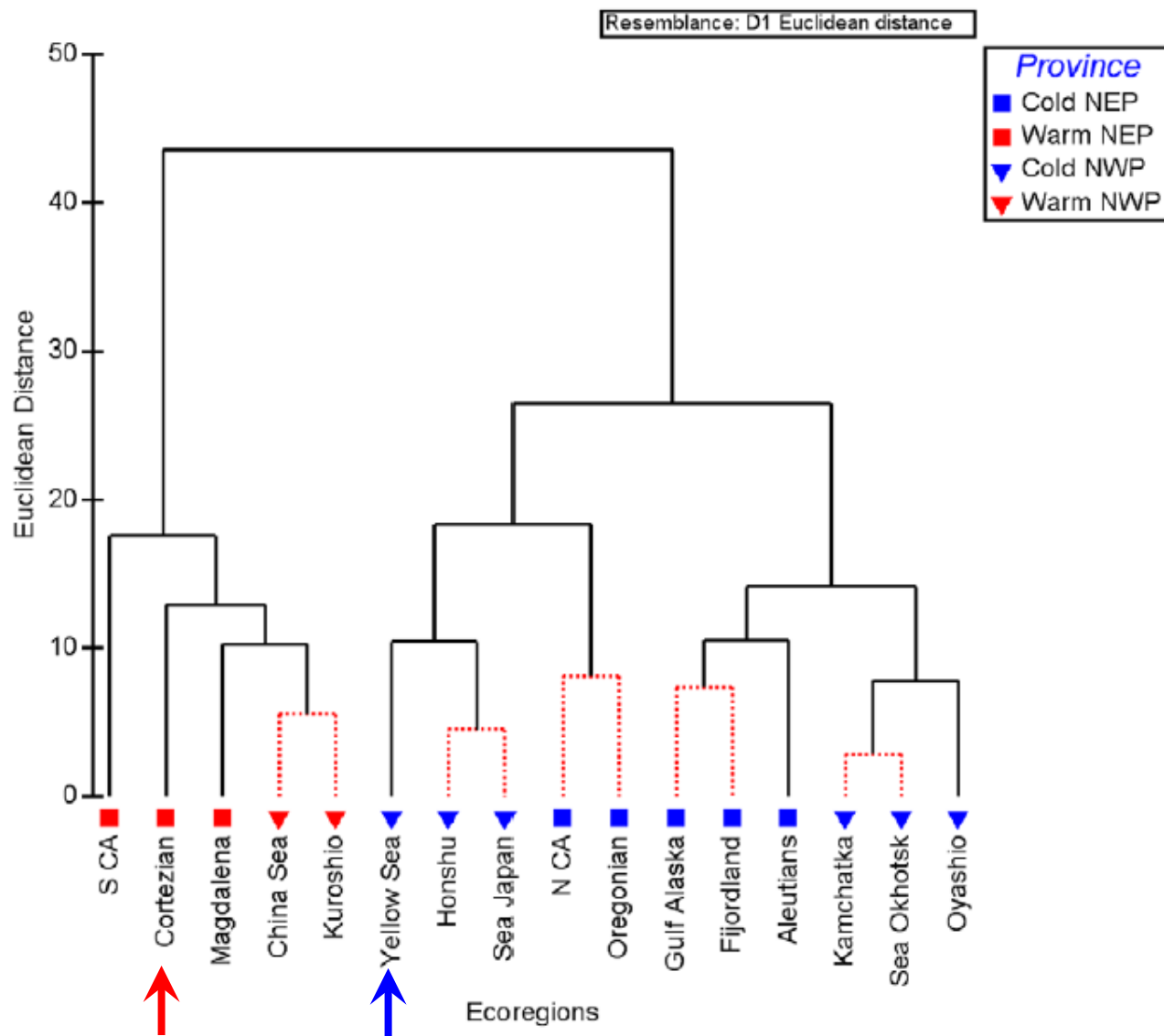
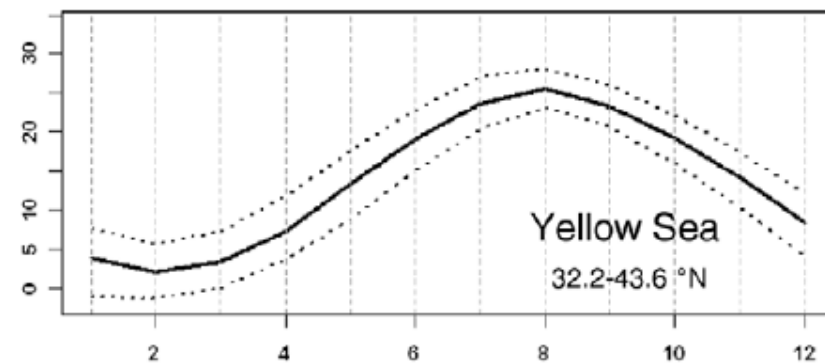
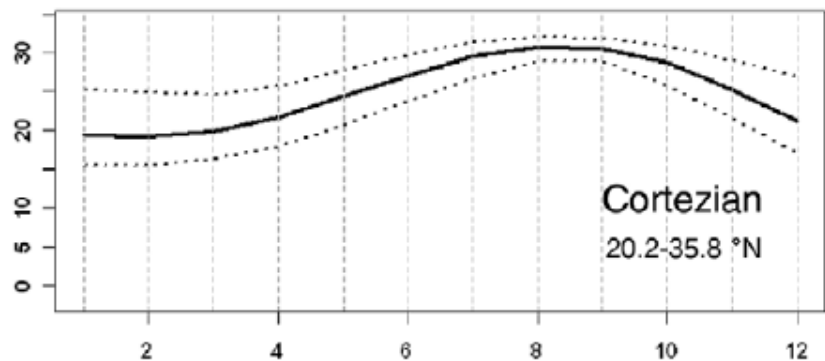


Temperate Northwestern Pacific Ecoregions

- East China Sea
- Yellow Sea
- Central Kuroshio Current
- Sea of Japan
- Northeastern Honshu
- Sea of Okhotsk
- Oyashio Current
- Kamchatka Shelf & Coast

Temperate Northeastern Pacific Ecoregions

- Aleutian Islands
- Gulf of Alaska
- North American Pacific Fjordland
- OR, WA, Vancouver Coast & Shelf
- Northern California
- Southern California Bight
- Magdalena Transition
- Cortezian



Conclusions

- Most published evidence for FEGS beneficiaries in the Pacific (through 2017) was for the Cortezian and Yellow Sea ecoregions
- Those ecoregions also had most diverse beneficiary portfolios
- Relatively few studies contributed to body of evidence
- As with the broader coastal literature, estuarine waters and mangroves were most commonly linked to FEGS users
- Industry, recreation, and indirect services were top three EGS

Why should we (people) care?

DEVELOPMENT

HABITAT
RESTORATION

RUNOFF MGMT

AGRICULTURAL
PRACTICES



HABITAT
(e.g., mangroves)



Baja Sur – Octavio Aburto, iLCP



EGS
AVAILABILITY

Indonesia – Steven Lutz, GRID Arendal

Questions & Future Applications

- An evaluation of coastal beneficiaries in different geographic settings
 - Are linkages between beneficiaries and land cover (habitat) classes consistent across scales?
 - How might an incorporation of “grey” literature refine results?
- How might evidence be incorporated into existing or emerging tools to assist decision-makers in coastal planning efforts?
- Other suggestions?

Acknowledgements

EPA/WED/Pacific Coast Ecology Branch

EPA FECS Workgroup

Pat Clinton, Tony Olsen, Karen Blocksom



<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6541417/>

Little et al. 2018