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Participatory GIS Mapping Highlights Indirect Use and Existence Values of Coastal Resources and Marine Conservation Areas

Kaegan M. Scully-Engelmeyer
Portland State University

Elise F. Granek
Portland State University, graneke@pdx.edu

Max Nielsen-Pincus
Portland State University, maxnp@pdx.edu

Greg Brown
California Polytechnic State University, San Luis Obispo

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Participatory GIS mapping highlights indirect use and existence values of coastal resources and marine conservation areas

Kaegan M. Scully-Engelmeyer [a,*], Elise F. Granek [a], Max Nielsen-Pincus [a], Greg Brown [b]

[a] Portland State University, 1719 SW 10th Ave, Portland, OR 97201, USA
[b] Formerly California Polytechnic State University, San Luis Obispo, CA 93407, USA

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ABSTRACT

Consideration of social and cultural dimensions in coastal and marine planning has increased and ecosystem services provide important framing to investigate values and priorities associated with these systems. Research efforts in coastal communities offer insights on social dimensions of ocean and coastal management decisions, but questions remain about how demographics and geographic residence affect perceptions of marine resources and management. We conducted and analyzed a public participation geographic information system (PPGIS) mapping survey of Oregon residents to capture uses and perceived values of coastal and marine areas. We measured coastal values, explored regional differences in those values, and identified a suite of coastal and marine ecosystem services that Oregonians prioritize from the recently established marine reserve network. Examining respondent demographics, conservation values, and coastal geographic features, we discovered values varied by region in Oregon, with regions demonstrating distinct value orientations. Regional differences in value orientation highlight the importance of incorporating multiple interpretations of value into coastal resource communication strategies, and the consequence of coastal proximity on attitudes and values about coastal resources. Incorporating use (indirect and direct) and non-use (existence) values into a Total Economic Value framework revealed that participants prioritized indirect use (scenic, recreation) over direct use and existence values coastwide. Spatial variation of participant's use and value locations demonstrates the utility of participatory mapping in marine spatial planning efforts, both in documenting spatially explicit non-market values of coastal areas and identifying potential areas of conflict among coastal stakeholder groups. Within Oregon's marine reserve network, which was not delineated in the mapping exercise, value preferences diverged from coastwide averages, wherein existence values (biodiversity/wildlife, wilderness, etc.) were elevated above other categories.

1. Introduction

A challenge for assessing public benefits from natural resource management is the conceptualization of value. Ecosystem services provide an important tool for understanding human relationships with marine and coastal systems and have grown in prominence as a framework for organizing research on environmental values (Barbier, 2012; Peterson and Lubchenco, 1997), as a means to document non-market values associated with ecosystem processes and to quantify ecosystem services in the context of traditional economic measurements of value (Brown and Fagerholm, 2015; Schägner et al., 2013). Economic models present challenges since respondents may not conceive of nature in economic terms, and, where identified, values presented by respondents from differing socio-economic levels may not be comparable (Costanza and Folke, 1997). Efforts to expand ecosystem service applications outside of economics have argued for a metric based on relationships to the natural systems' function and performance, providing a shared basis to discuss and explore values (Granek et al., 2010), though no such metric is currently in use.

Ecosystem services research can be expanded by explicitly incorporating cultural and social metrics into the analysis. By engaging diverse communities in meaningful, 'placed-based' conservation research, social, ecological, cultural and economic values of natural systems can be better explored (Brown, 2004; Klain and Chan, 2012). Traditional

* Corresponding author.
E-mail addresses: kaegas2@pdx.edu (K.M. Scully-Engelmeyer), graneke@pdx.edu (E.F. Granek), nmax@pdx.edu (M. Nielsen-Pincus), ggbrown@calpoly.edu (G. Brown).

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approaches to ecosystem services often use expert-based models that rely on regional land and water inventories, often spatially referenced, and focused on regulating or provisional services (e.g., food, fiber, flood mitigation). Research on cultural ecosystem services (Daniel et al., 2012), suggests a need to expand expert-based systems to include stakeholder experiential values. The National Science Foundation's Advisory Committee for Environmental Research and Education asserts that "place-based science" is at the heart of understanding "complex environmental systems, particularly in the 21st century" (Pfirman, 2003). As such, value is expanded beyond purely economic metrics to include a social model or total economic value (TEV) model that incorporates lived experiences, community relationships, and the intersections with natural systems in a particular place (Plottu and Plottu, 2007). In the past decade researchers have incorporated ecosystem services into the TEV framework to help quantify non-market values in aggregated non-use and existence value categories (Mendes, 2012; Wattage, 2010).

Recent ecosystem services applications in coastal settings have utilized participatory mapping surveys to solicit spatially explicit responses (Dalton, 2006; Klain and Chan, 2012; Steinback et al., 2010). These and other approaches have targeted stakeholder groups or local communities to inform management about the quality and composition of marine natural capital (Burdon et al., 2019). Broader population surveys using these participatory mapping tools have been developed (Brown and Kyttä, 2014); however, broadly utilized participatory approaches have lagged in usage, in part due to the lack of agency resources to undertake mapping (Brown, 2012). Previous work on the Oregon coast (Freeman et al., 2013; Lafranchi and Daugherty, 2011) has utilized a stakeholder experiential values approach. Our project builds on this existing work by expanding the participant population and conducting a statewide survey of Oregonians using ecosystem services to frame values. This public participation geographic information system (PPGIS) survey collected spatial and traditional survey response data and respondents were asked to identify spatially explicit values they hold about Oregon's coastal and marine areas. Geographic (or spatial) discounting, the concept that an individual's relative level of concern with an area decreases as geographic distance increases, is frequently associated with place- and preference-based survey information and willingness to pay scenarios (Hannon, 1994), but may also be applicable to how individuals perceive and value local and regional resources (Brown, 2017; Pocewicz and Nielsen-Pincus, 2013). Documenting the diversity in local value expressions is critical in the development of functional 'place-based' ecosystem management programs (Norton and Hannon, 1997).

Since ecosystem services are an evolving area of social research, predicting expected outcomes of this research is challenging. Place-based research indicates that more distant populations tend to conceptualize place in larger geographic units, versus local residents who use smaller geographies (Cheng and Daniels, 2003), and multimodal travel thresholds have the potential to influence where and how people visit areas of interest (Laatikainen et al., 2017). In this case we don't investigate how participants conceptualize size of place-based values, but instead location and type of pins provide information about how and where different populations in Oregon interact with and value coastal resources. Our first question was whether respondent values along the coast are tied closely to travel cost and opportunity, with the most accessible areas being of highest value (most pinned in this case). Second, we asked whether values of perceived importance vary based on respondents' home region in Oregon. Finally, we explored how survey participants interact with and value marine resources within Oregon's recently designated Marine Reserve/Marine Protected Area (MR/MPA) network. An important outcome of this research is to provide a statewide assessment of the values associated with Oregon's coastal areas and a baseline dataset from which to evaluate the effects of coastal management strategies- like Oregon's Marine Reserve Program - or future policies. Characterizations of region-specific variation in spatial values and priorities, especially comparing coastal vs. non-coastal residents, demonstrates the utility of participatory mapping in informing coastal management and marine spatial planning efforts. More generally, spatial values data have the potential to identify diverse stakeholder perspectives and values across regions in a variety of applications (e.g., Brown and Kyttä, 2014), including coastal management, and inform communication and outreach efforts to increase engagement of stakeholders with natural resource management.

2. Materials and methods

2.1. Study area, sample population, and area of analysis

We surveyed Oregonians about their coastal and marine values with respect to Oregon's near shore and adjacent land based coastal areas. Study participants were required to confirm they were over 18 years of age and had lived in Oregon for at least one year. An area of analysis was delineated in order to exclude response pins that did not contribute to our understanding of coastal and marine values. Marine pins that fell beyond the US Contiguous Zone[1] (24 nautical miles from shore) were excluded from analysis as well as coastal and land based pins that were outside of Oregon's Coastal Zone[2] (Fig. 1A).

In addition to coastal and marine values, we sought to understand values associated with Oregon's recently implemented Marine Reserves Program, which provides a variety of protections and management restrictions at five sites along the Oregon coast at Cape Falcon, Cascade Head, Otter Rock, Cape Perpetua, and Redfish Rocks. Each area comprises a marine reserve, which is defined as: "an area within Oregon's Territorial Sea or adjacent rocky intertidal area that is protected from all extractive activities, including the removal or disturbance of living and non-living marine resources…" (Oregon Ocean Policy Advisory Council, 2008). Additionally, a proportion of the sites also include marine protected areas and one seabird protection area, which carry modified use restrictions.

2.2. Survey methods and response categories

To conduct our coastal values survey we created a participatory mapping platform and invited Oregonians with an internet connection to engage in the mapping exercise. Recruitment for the online mapping exercise was conducted between February 9th and June 30th, 2016 by sending a link to the exercise to email lists associated with coastal interest groups, shared on social media, and posted on several public websites. This mapping exercise was implemented using a spatial survey tool that solicited surveyor and Oregon coast location information to record respondent coastal values. This approach builds upon previous spatial survey research on ecosystem services (Brown, 2012; Brown et al., 2002) and participatory Google Map-based survey data collection (Brown and Kyttä, 2014; Pocewicz et al., 2012; Pocewicz and Nielsen-Pincus, 2013; Bonzon et al., 2005; Merrifield et al., 2013; Steinback et al., 2010). The mapping exercise tool was based on the Google Maps API allowing for interactive participant digitization of spatial information employing a participatory GIS tool (Bearman and Appleton, 2012) and was hosted by the Landscape Values and PPGIS Institute.

To map values, respondents used "pins" to identify coastal and marine locations that provide various ecosystem services (Table 1). Respondents were provided a list of potential values for the coast and marine areas and instructed to place pins on locations that best represented those values to the respondent. The base map displayed to participants included a standard Google Map with basic topography, roads, and place names, but did not include locations of Marine Reserves or

[1] https://nauticalcharts.noaa.gov/data/us-maritime-limits-and-boundaries.html

[2] https://www.oregon.gov/LCD/OCMP/Pages/Coastal-Zone.aspx

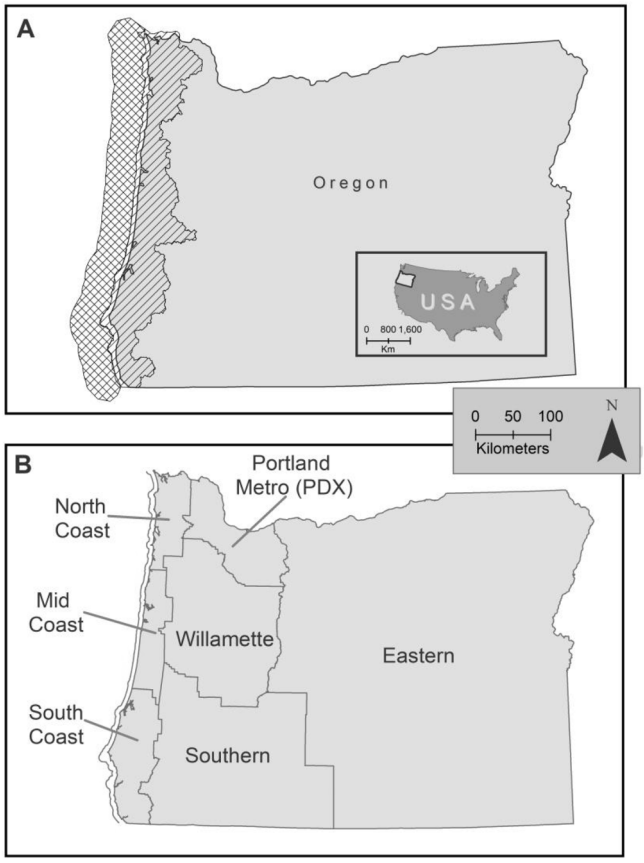

Fig. 1. A. The area of analysis was delineated to include the US Contiguous Zone (crosshatch) off of Oregon for marine pins and Oregon's Coastal Zone (simple hatch) for coastal and land-based pins; pins outside of these two zones were excluded from analysis. B. Survey participants were categorized to represent seven geographic regions of Oregon based on the zip code they supplied. Data sources: ESRI, Bureau of Land Management, OR/WA State Office, National Oceanic and Atmospheric Administration (NOAA), ORSO, US Census Bureau.

Marine Protected Areas. Marine conservation areas were not identified on the map interface in order to document respondent spatial data within management areas without the influence of personal opinions towards management designations. Participants were also asked a series of demographic questions in a pre-mapping Qualtrics survey including gender, education level, and home zip (postal) code. Additionally, there was a series of questions specifically about Oregon's Marine Reserves Program focused on gaining insight into respondents' awareness and support of current and future marine conservation efforts on the coast. Participants were asked whether they were aware of the MR/MPA program, how informed they felt about it, how much they supported the existing program, and whether they would support expansion of the network.

Adapting the Total Economic Value (TEV) and Ecosystem Services categorization methodologies suggested in (Mendes, 2012), we divided respondents' value pins into three categories to differentiate types of use and market and non-market services (Fig. 2). The only value that was not assimilated into this framework was the *special place* category due to the variable interpretations of this value by respondents. Future scenarios were not presented in value pin prompts, therefore "bequest "and "option" categories were not included in the analysis.

Table 1
Each respondent was prompted to place pins in locations representing a variety of place-based values.

Aesthetic/Scenic	I value these places for their views, unique landforms, unique waveforms, unique sounds, or other sensory experiences.
Biodiversity and Wildlife	I value these places for the unique or special animals, plants or other natural life/communities. These places might also be places to easily view wildlife or birds.
Cultural and Spiritual	I value these places because they allow me to share wisdom, traditions, my way of life, or because of their spiritual importance. Includes places of tribal importance.
Fishing: Sport/ Charter	I value these places for their fishing values, or as an access point for sport or charter fishing. Include crabbing, clamming, or other shellfish collection.
Heritage and Historic	I value these places because their history or use is important for me. May include historic structures such as lighthouses, or working waterfronts.
Intrinsic	These places have special value all for their own sake. Their value is not something that can be described by money or other measures.
Learning and Education	I value these places for their education role and ability to teach others about natural history, ecology, human history or other opportunities. May include formal places of learning such as camps or retreats.
Beach Recreation	I value these places for beach or shoreline activities including walking, kite flying, beachcombing, picnicking, tide-pooling or relaxing on the shore.
Recreation: Motorized	I value these places for recreation with motorized vehicles such as boats or personal watercraft, or on shore areas for beach or dune recreation with motorized vehicles.
Recreation: Non-Motorized	I value these places for outdoor recreation on or near the water. Includes surfing, kayaking, kite boarding, sailing, swimming, or other similar activities. Also includes hiking or biking near the coast. Include recreation areas as well as access points.
Social	I value these places for the role they play in my family or social life (e.g., location of marriage, location for social gatherings, etc.)
Tourism	I value these places for supporting tourism or the tourism industry. May include restaurants, viewpoints, lodging, or tour operators.
Economic (Non-tourism)	I value these places for their importance in the local or regional non-tourism economy. These places might be important to commercial fishing, timber, mining, or other industry or commercial activity.
Wilderness	I value these places for their uniquely wild or pristine character where human influence is not present or is minor.
Special/Other	Please note in the text window the reasons you value this place.

2.3. Analysis

2.3.1. Regional values and preferences

All pin locations and other survey response data were imported into ArcMap (version 10.7.1). Pins falling outside of the area of analysis were removed from the database. Points were created at the center of each survey respondent's zip code area polygon (downloaded from the Oregon Spatial Data Library[3]) for those who elected to enter their home zip code, and joined with coastal and marine pins placed by that respondent. Home zip code points were used to identify zip code-region associations and connect respondents to their regions within the state (Fig. 1B). Home zip codes and pin placement coordinates were then used to identify the connections between respondents' home region within Oregon and the coastal locations of their responses.

To explore whether value categories were associated with the various regions of the state, we used a balloon plot to examine the relationships among sets of categorical variables: regional groups and coastal values. Balloon plots display matrix information about two categorical variables in a graphical format, where size and color of circles

[3] https://spatialdata.oregonexplorer.info/geoportal/

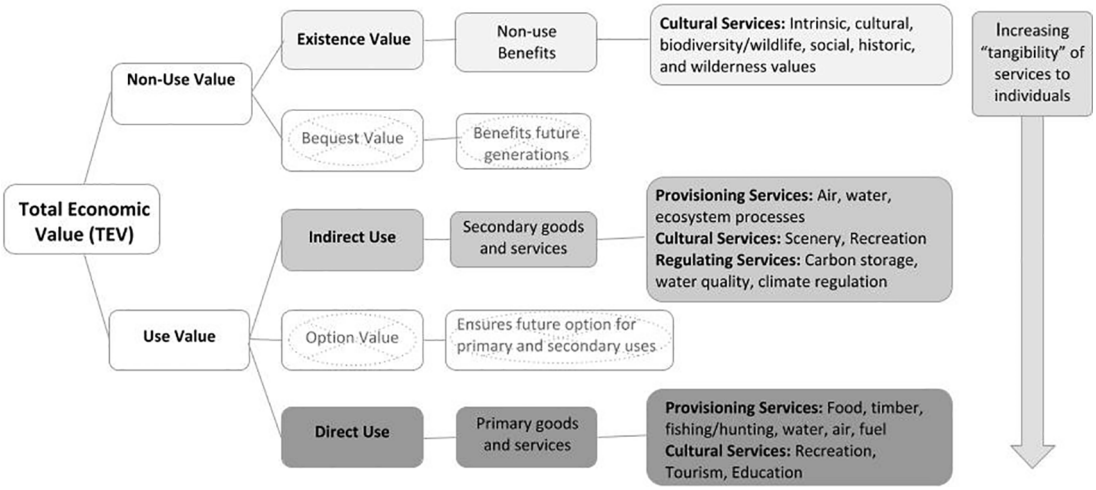

Fig. 2. Conceptual diagram incorporating ecosystem service values into Total Economic Valuation (TEV) framework. Survey value categories were placed into existence, indirect, and direct use categories based on ecosystem services representations as suggested by Mendes (2012). Option and Bequest categories are not included in this analysis.

communicate the relative point count. We then used correspondence analysis (CA) in R-studio (version 1.2.5033) to explore the relationships among values/priorities and respondents' home regions in a two-dimensional space to identify associations among values, priorities and regions. In this analysis, row and column weights are assigned to a contingency table of two sets of categorical variables, and resultant factor score for each row and column are plotted. In CA biplots, relationships between categorical variables can be understood by their position in the plot, wherein similarities within categories (values, priorities, or regions) are expressed by relative proximity and similarities between categories are expressed by their angle or vector from the origin (Brown et al., 2014).

2.3.2. *Marine Reserve/Marine Protected area analysis*

Boundaries of Oregon's five Marine Reserves/Marine Protected Areas were not displayed on the map during the survey. Pins that fell within MR/MPA sites were examined to understand whether values differ between areas inside and outside of marine reserves and/or protected areas. Values within each MR/MPA were tallied and compared with pin tallies within the territorial sea boundary to explore which value categories participants associated with MR/MPAs relative to coastwise averages. The territorial sea was chosen for this comparison because of its similar characteristic to most MR/MPA areas (0–4.83 kilometers from coastline) and it extends the length of the coast, offering a good sample of nearshore marine based pins. Awareness and support of current and future MR/MPA designations were investigated by comparing the amount of each value category placed by each respondent (direct and indirect use & existence) in and outside of designated MR/MPA areas to explore relationships between those opinions and priority value types.

Table 2

A. Demographics including gender, education, and rural/urban percentages varied across regions. The proportion of respondents from each Oregon region relative to the population for that region was overrepresented in coastal regions and under-represented inland. B. Pin placement such as total mapped values, average pins per respondent and proportional response within TEV categories also varied by region.

A		Total	Eastern	Mid Coast	North Coast	PDX	South coast	Southern	Willamette	Unknown
Respondents	Count	244	10	48	29	68	40	5	38	6
	Percentage	100.00%	4.10%	19.70%	11.90%	27.90%	16.40%	2.00%	15.60%	0.00%
Oregon Population		100.00%	11.60%	1.60%	1.60%	44.80%	2.10%	11.50%	26.90%	0.00%
Gender	Female	56.10%	60.00%	50.00%	65.50%	50.00%	62.50%	40.00%	57.90%	83.30%
	Male	40.20%	30.00%	47.90%	31.00%	45.60%	35.00%	60.00%	39.50%	0.00%
	Prefer not to answer	2.50%	10.00%	2.10%	3.40%	4.40%	2.50%	0.00%	2.60%	16.70%
Education	Advanced Degree	88.90%	80.00%	85.40%	89.70%	92.40%	92.50%	100.00%	89.50%	63.60%
	High school	9.80%	10.00%	14.60%	10.30%	7.60%	7.50%	0.00%	10.50%	9.10%
Zip code designation	Rural	55.70%	70.00%	100.00%	100.00%	5.90%	100.00%	100.00%	7.90%	0.00%
	Urban	41.80%	30.00%	0.00%	0.00%	94.10%	0.00%	0.00%	92.10%	0.00%
	Unknown	2.50%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	100.00%
Aware of MR/MPA program?	No	18.44%	50.00%	4.17%	10.34%	25.00%	15.00%	40.00%	33.33%	21.05%
	Yes	80.74%	40.00%	95.83%	86.21%	75.00%	85.00%	60.00%	66.67%	78.95%
	Unknown	0.82%	10.00%	0.00%	3.45%	0.00%	0.00%	0.00%	0.00%	0.00%

B		Total	Eastern	Mid Coast	North Coast	PDX	South coast	Southern	Willamette	Unknown
Total Mapped Values		8005	317	1434	1635	1539	1428	99	1306	247
Average pins per person		33	32	30	56	23	36	20	34	41
TEV value categories	Direct Use	20.30%	24.90%	17.30%	17.60%	22.70%	28.20%	29.30%	15.10%	13.80%
	Indirect Use	46.50%	40.40%	49.20%	38.20%	48.70%	45.80%	45.50%	52.00%	55.90%
	Existence	30.10%	21.10%	30.60%	41.50%	25.80%	23.80%	24.20%	29.70%	30.00%
	Special Place	3.10%	13.60%	2.90%	2.60%	2.70%	2.20%	1.00%	3.20%	0.40%

3. Results

3.1. Coastal value response

In total, 244 respondents provided viable results for analysis. The number of pins each respondent placed along the coast ranged from 1-484, with an average response rate of 33 pins (median response rate of 20). Of the 244 respondents, 238 (98%) provided their home zip code. Responses were received from all regions of Oregon (Table 2A), and were disproportionately non-metropolitan as residents from rural and frontier (</= 6 people/mi^2) zip codes accounted for 56% of the survey respondents, 21% higher than the state's population proportion from those designations[4]. Respondents skewed towards higher levels of education, with 89% of participants holding a degree beyond a high school diploma, including associates, vocational, bachelor, and graduate degrees (Table 2A).

Participants placed 8,005 pins across the 15 value categories (Fig. 3), 7,758 (97%) of which included corresponding zip codes that we grouped into regions; the remaining 247 (3%) were marked as unknown. *Aesthetic/scenic* and *biodiversity/wildlife* values received the most pins, followed by *beach recreation* and *non-motorized recreation*. Across all coastal and marine areas, TEV categories representing indirect use values received 46.5% of pins (3724), followed by 30.1% non-use existence values (2408), 20.3% direct use values (1627), and 3.1% special place pins (246) (Fig. 3).

3.2. Regional responses

Regional responses varied with the lowest number of responses from the Southern Oregon region (99 pins) and the largest number from the North Coast Region (1,635 pins), which is largely a product of the response rate in each region (Table 2). Values also differed by region, though some values, such as *aesthetic/scenic* - and to a lesser extent *non-motorized recreation*, *biodiversity*, and *beach recreation* - were consistently high across regions (Fig. 4). Relationships between value responses and regions reveal associations with various categories, providing information about how cultural/identity differences between Oregon geographies may influence how people value and perceive coastal and marine resources (Figs. 4 and 5). Grouping of categories in the CA biplot (Fig. 5) indicate similarities between close categories, and distance between categories indicate differences. In terms of the relationship between categories and regions, the similarities and differences are expressed by their direction from the plot origin point (the center), where similar vectors indicate closer relationships between categories and regions. The more acute angle between region and category signifies a stronger relationship such that the South Coast region (and Southern OR to a lesser extent) shows strong positive associations with the *sportfish*, *economic*, and *motorized recreation* categories, and weaker positive relationships with *non-motorized recreation* (Fig. 5). The North Coast exhibits strong associations with heritage, cultural, and wilderness value pins while Portland metro area positively associates with tourism, learning, and social value pins. Eastern Oregon respondents display associations with special place pins. Willamette and Mid-coast regions show a weak positive relationship with beach recreation pins.

Density analysis of regional responses and associated latitudes show that survey participants in coastal regions placed the most pins within their home regions, and inland respondents prioritized coastal areas with similar latitudes (Fig. 6). Mid coast and South coast respondents displayed the highest densities of pins within their own region, but all regions display preferences for placing pins in similar latitudes to some degree.

[4] https://www.ohsu.edu/oregon-office-of-rural-health/about-rural-and-frontier-data

3.3. Marine reserves and marine protected area responses

Of the 8005 total pins mapped, 791 (9.9% of total pins and 20.3% of marine based pins within the Territorial Sea placed during the survey) were placed within the boundaries of the Marine Reserves and Marine Protected Areas network. Although the boundaries of Oregon's current MR/MPA areas were not outlined for participants to see during the mapping exercise, the pins placed in these locations are distinct from each other and from the pattern of pins placed across Oregon's Territorial Sea. Value categories, number, and specific locations of pins varied by MR/MPA area (Fig. 7), as did the top values (Table 3) associated with each area. Additionally, each MR/MPA area contained pins for at least one value that occurred in greater than expected proportions given coastwide tallies within the Territorial Sea, with some sites displaying large deviations from the coastwide proportions such as *biodiversity/wildlife* in Redfish Rocks (+30.8%) and *aesthetic/scenic* in Cape Perpetua (+9.3%). TEV category representation varied across the individual areas but overall "existence" values were more represented (+7.1%) within the boundaries of the MR/MPA network compared to the average across the Territorial Sea (Table 3). Except for the smallest of the MR/MPAs (Otter Rock), all reserves showed an increased proportion of "existence" pins, with some areas such as Redfish Rocks and Cascade Head deviating widely (+24.4% and + 20.4% respectively).

Participant knowledge about the MR/MPA program did not appear to influence TEV choice ratios (Fig. 8A), but attitudes and opinions about the program did. Participants who were strongly opposed to the MR/MPA program chose predominately "Direct use" value pins; as support for the program increased, we observed a decrease in "direct use" pins and increases in all other categories (Fig. 8C). When asked whether participants would support an expansion of the MR/MPA program, those who were not in favor tended to place proportionately higher "direct use" pins and those who were unsure opted for more "indirect use" values. How informed respondents felt about the MR/MPA program had little influence on TEV choice ratios (Fig. 8B). Nor did socio-demographic factors, explored in a similar fashion, appear to affect TEV choice ratios (Supplementary Material, Fig. S1).

4. Discussion

Participatory mapping has become an important tool for understanding attitudes about protected area management in coastal areas, not only to quantify associated social resources and cultural ecosystem services, but also to inform managers of effective communication strategies (Engen et al., 2018). Attitudes about and priorities for coastal resources and their management vary based on geographic differences, and group level observations about cultural ecosystem services in a particular area can provide valuable information about specific natural resource use issues (Johnson et al., 2019). Even on a smaller scale, demographic and regional differences present themselves in ecosystem service and value mapping exercises, and individuals' value orientation and propensity to participate can influence the interpretability of PPGIS results (Brown et al., 2016; Muñoz et al., 2019). In this study we observed similar phenomenon, where participation in our opt-in survey over-represented coastal residents and regions within the state displayed unique value orientations.

4.1. Coastal value patterns

Aesthetic/scenic was the most pinned value category, followed by *biodiversity/wildlife*, *beach recreation*, and *non-motorized recreation* (surfing, kayaking, etc.). High numbers of pins in these categories align with previous research findings concerning Oregon's coastal and marine resources. A 2011 study about non-consumptive uses along Oregon's coast found that beach going and scenic enjoyment were the two most popular categories, and a 2016 assessment of Willamette Valley residents' use marine areas found that sightseeing and exploring tidepools were the

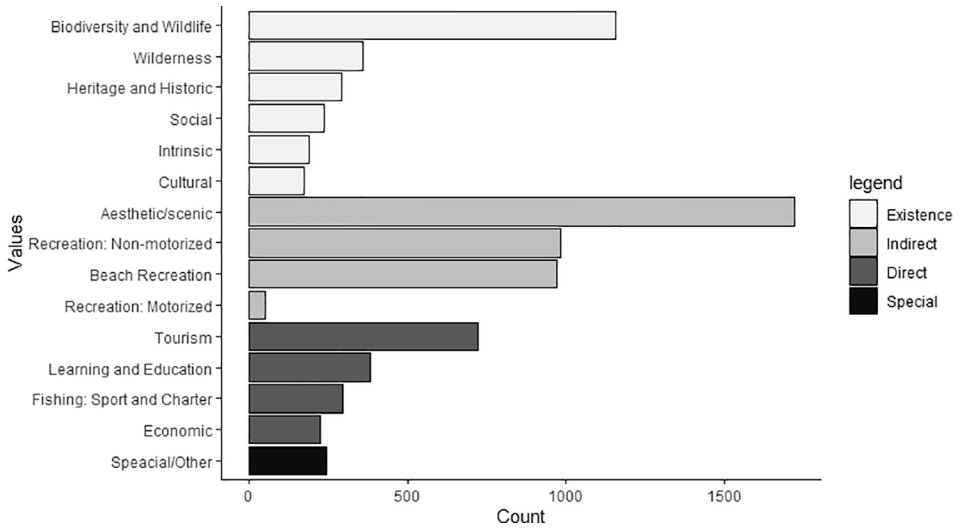

Fig. 3. Indirect use values were pinned most frequently (3724), followed by non-use existence (2408), direct use (1627) and special/other values (246). Value types are color coded in greyscale to indicate to which TEV category they belong.

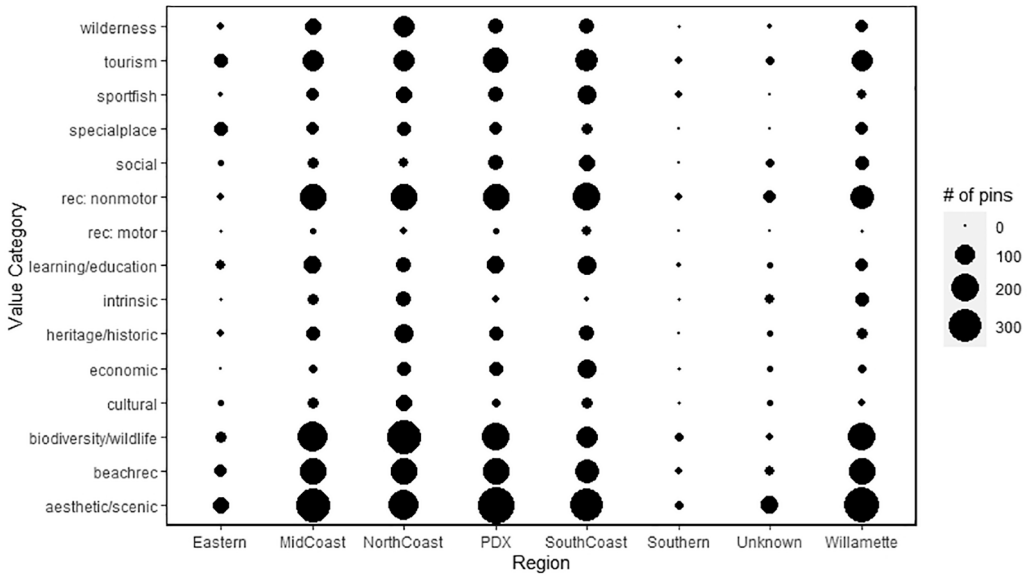

Fig. 4. Values varied by region though aesthetic values were consistently high statewide. Balloons display the actual count of responses in each response category in relation to the region of origin with circle size and color representing the count.

most popular activities (Lafranchi and Daugherty, 2011; Needham et al., 2016). It has been suggested that the fine scale data about coastal resources collected via public participation in marine and coastal resource inventories can contribute valuable data about hotspots of good and bad environmental conditions as well as change over time (Jarvis et al., 2015). Our findings highlighting the diverse and spatially explicit values Oregonians associate with coastal and marine resources suggest that future marine spatial planning projects would benefit from PPGIS survey efforts specifically tailored to project characteristics.

4.2. Regional participant observations

Connections between pins and respondent's home zip code reveal that values appear to be tied to travel and opportunity cost, wherein more accessible/closer areas received more value pins. These patterns may also point to a form of geographic discounting by way of value pin placement, wherein emphasis was given to areas closer to participants' homes and distant coastal areas were understated as a result. For example, higher densities of response pins placed by coastal residents were observed within respondents' home region compared to other parts of the coast (Fig. 6). Additionally, the Portland, Willamette, and Southern Oregon regions showed more pin density in coastal areas at similar latitudes, indicating residents of those regions are more connected with coastal resources closer to their homes. These types of patterns have been observed in previous research exploring, for example, accessibility to recreation areas, whereby multimodal travel thresholds predict popular areas (Laatikainen et al., 2017). The COVID-19 pandemic over the last year has impacted the overall outdoor recreation trip behavior in the United States (Landry et al., 2021), affecting rural and urban populations differently (Rice et al., 2020). The resultant effects of restricted mobility and changes in perception of place-based values for coastal and inland residents present interesting questions for future research.

Mapping perceived environmental conditions, Pocewicz and Nielsen-Pincus (2013) observed geographic discounting, wherein local residents perceived positive environmental conditions closer to their

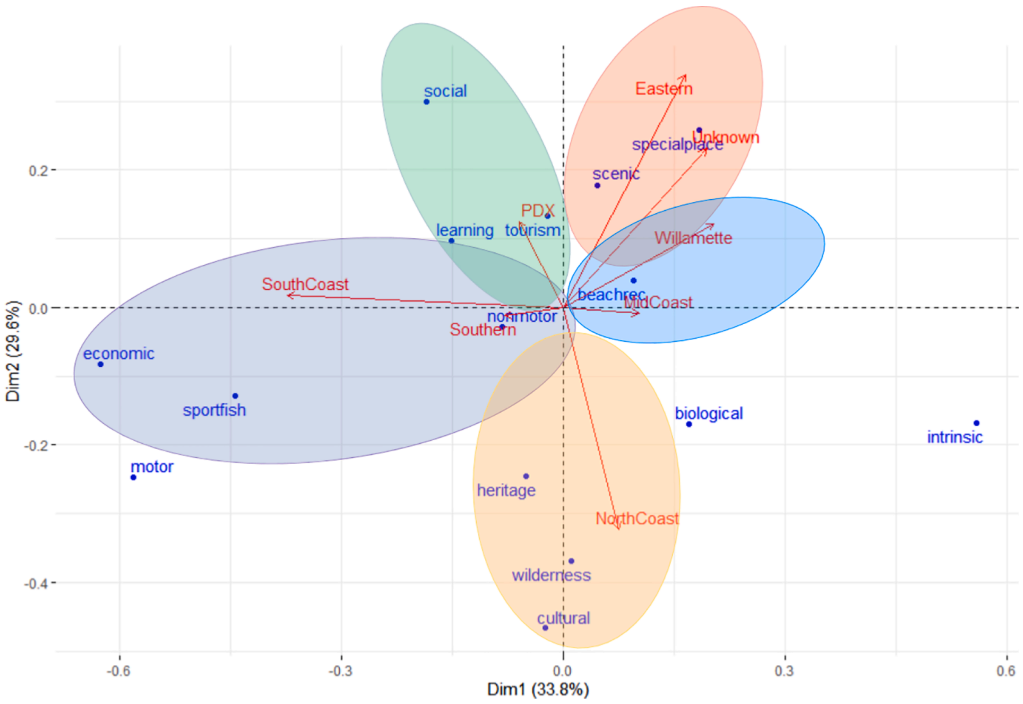

Fig. 5. Regions of Oregon represented different value types. PDX represents to Portland Metro area. Ellipses were drawn post facto to highlight grouping of values by region. The two dimensions displayed account for 63.4% of the variance in the dataset.

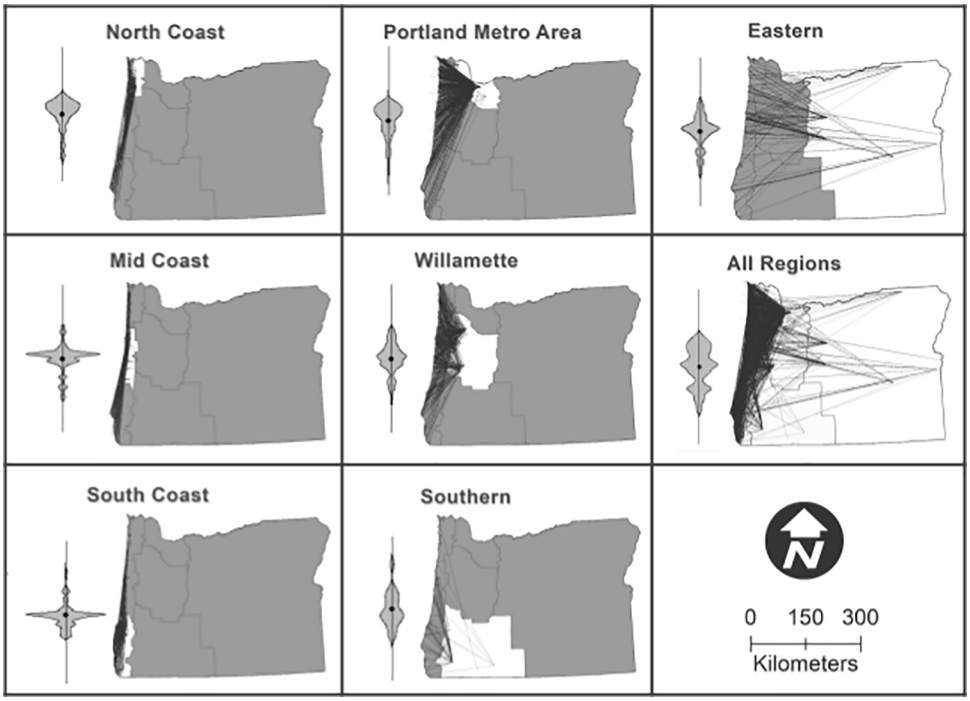

Fig. 6. Density of points along coastal latitudes shows the relationship between home region and coastal and marine areas where respondents prioritized in pin placement. Lines illustrate home postal code and where value pins were placed separated by home region. Adjacent violin plots illustrate densities of pins placed for each region across coastal latitudes.

homes and negative conditions further away. The familiarity and preference for adjacent coastal and marine resources that we observed highlights the importance of sampling geographically disparate populations to account for effects of geographic discounting in preferences for natural resource management. In our sample, coastal residents were over-represented compared to inland regions; we recommend future place-based environmental resource research incorporate sampling methodologies to ensure respondent rates are more proportional to population distribution to support more representative decision making.

Beyond regional differences in pin distribution, our analyses reveal strong relationships between individual value categories and Oregon regions. For example, the North Coast region was associated with

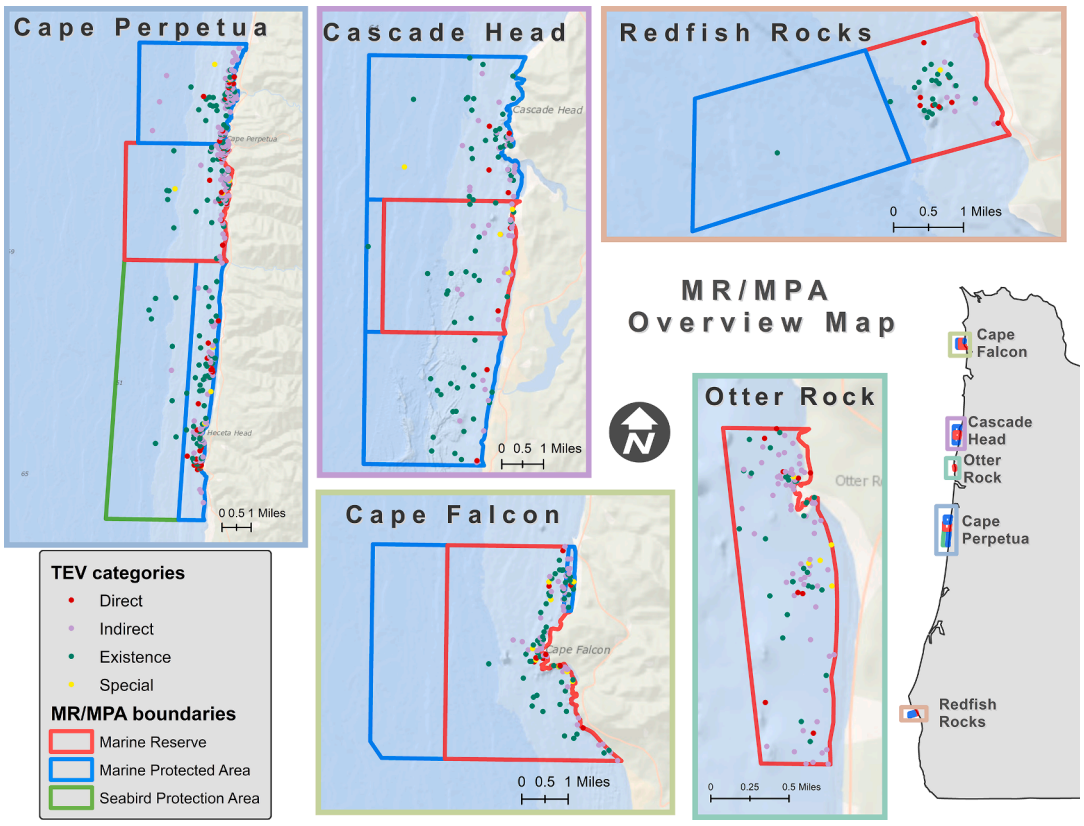

Fig. 7. The distribution and number of pins varied by Marine Reserve/Marine Protected Area location. Outlined areas represent type of spatial management and pin color represents value category.

Table 3
Counts of total pins and top value categories varied among the reserves. TEV categories also differed between reserves and coastwide averages within the Territorial Sea.

MR/MPA	Count of pins	Most pinned category	Largest deviation from average pins within Territorial Sea (%)	**TEV categories:** percentage (residual)			
				Direct-Use	Indirect-Use	Existence	Special
Cape Falcon	118	Biodiversity/Wildlife	Wilderness (+9.4)	8.5 (−4.2)	39.8 (−12.8)	44.9 (12.9)	6.8 (4.1)
Cascade Head	124	Biodiversity/Wildlife	Biodiversity/Wildlife (+8.7)	6.5 (−6.2)	37.9 (−14.7)	52.4 (20.4)	3.2 (0.5)
Otter Rock	113	Aesthetic/Scenic	Aesthetic/ Scenic (+5.5)	8.0 (−4.7)	61.1 (8.5)	26.5 (−5.5)	4.4 (1.7)
Cape Perpetua	397	Aesthetic/Scenic	Aesthetic/ Scenic (+9.3)	14.1 (1.4)	48.6 (−4)	35.0 (3)	2.3 (−0.4)
Redfish Rocks	39	Biodiversity/Wildlife	Biodiversity/Wildlife (+30.8)	20.5 (7.8)	20.5 (–32.1)	56.4 (24.4)	2.6 (−0.1)
MR/MPAs Overall	791	Aesthetic/Scenic	Biodiversity/Wildlife (+5.6)	11.5 (−1.2)	46.0 (−6.6)	39.1 (7.1)	3.4 (0.7)
TS Overall	3811	Aesthetic/Scenic	N/A	12.7	52.6	32.0	2.7

heritage, *wilderness*, and *cultural* values (Fig. 5, green ellipse) and the South Coast region with *motorized recreation*, *economic*, and *sportfish* values, with weaker associations to *learning* and *non-motorized recreation* values (Fig. 5, blue ellipse). These patterns emphasize different value priorities and uses for the north versus south coast respondents, indicating there may be a sociocultural aspect to observed regional differences. As suggested by van Riper et al. (2017) regional differences in ideals and attitudes about ecosystem services highlight the importance of incorporating critical pluralism when articulating natural resource management topics to coastal residents.

Overall, close to half of all pins that respondents chose to place were in the indirect use category (46.5%), 30.1% in the existence value category, and 20.3% in the direct use category. Regionally, differences are notable: Southern Oregon and South Coast respondents placed ~ 5% more pins in direct use categories and 5% less in existence value categories. Midcoast and North coast respondents placed ~ 5% more pins in existence categories and 5% less in direct use (Table 2). These patterns confirm observations made from the CA biplot of individual categories whereby North Coast respondents showed stronger associations with *wilderness, cultural,* and *heritage/historic* values. Differences in value orientations based on participant residence have been observed in other place-based environmental resource research, particularly related to instances of spatial discounting (Brown et al., 2002; Hannon, 1994), highlighting the importance of broad-reaching sampling efforts to gain a more complete understanding of social/cultural values and how regional differences contribute to value types and uses. Together the

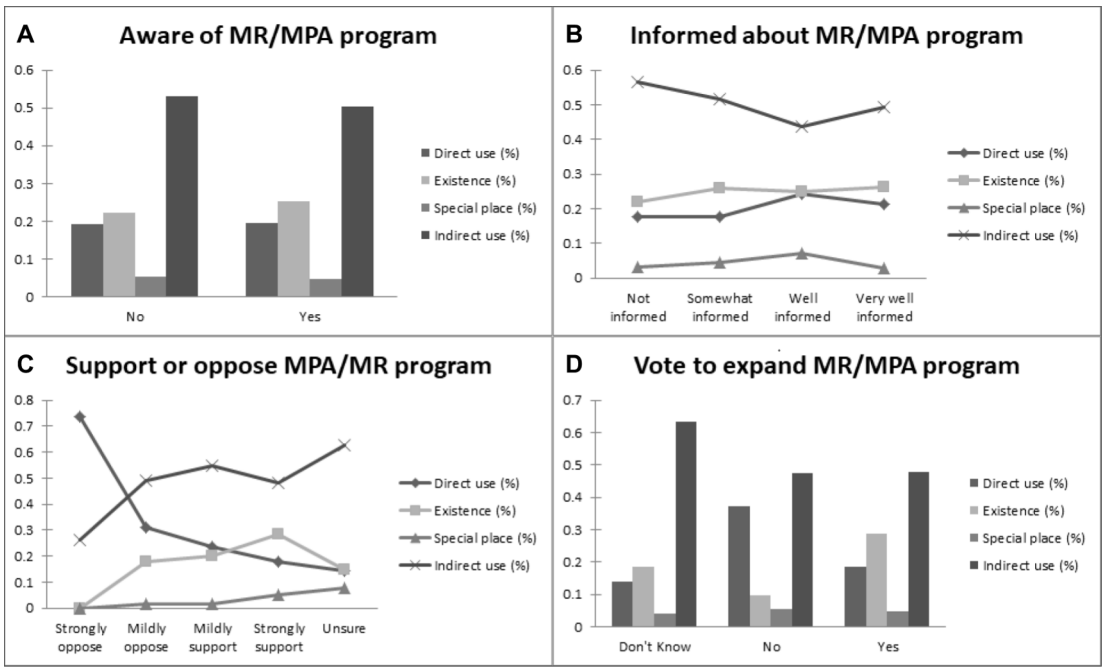

Fig. 8. Respondents' ratios of TEV categories in relation to how they responded to survey questions about their awareness of the existing MR/MPA program (A), how informed they felt about the current program (B), their support of the current program (C), and how they would vote in a proposal to increase the number and size of MR/MPAs (D).

regional differences we observed offer insights for coastal managers to effectively target and tailor communications about coastal and marine resources addressing region-specific priorities and concerns.

4.3. MR/MPA observations

PPGIS researchers in Australia's Kimberly coast region found that MPA accessibility altered mapping densities as well as value orientations, where more remote areas were dominated by conservation oriented pins and accessible sites were dominated by recreation values (Strickland-Munro et al., 2016). Among the MR/MPA locations in our study, Cape Perpetua on the central coast received the most pins (397) and Redfish Rocks on the south coast received the least (39). This difference may be related to the relative size of each area or a reflection of popularity of visitation and accessibility of the central coast site relative to the southern coast site.

Marine protections research in Oregon has highlighted that though concerns about ecological integrity and overuse of the ocean are major drivers of support for marine conservation, awareness about the MR/MPA program is relatively low, emphasizing the importance of engaging those who are unaware of or undecided about these issues (Manson et al., 2021). In our study, participants who were unsure about their support of the current and future program placed proportionally more pins in "indirect use" categories (Fig. 8: C&D). This provides valuable information about how respondents undecided about MR/MPA issues engage with coastal resources and can inform communication and education efforts around future issues to increase involvement. Undecided coastal visitors appeared to enjoy *aesthetic/scenic*, *beach* and *non-motorized recreation* over other value types, suggesting the utility of interpretive information at beach access points and waysides in outreach efforts. Research in Norway and Europe has found that use-based framing of conservation is more engaging than preservation-based communication strategies (Engen et al., 2018), accentuating the importance of understanding how undecided citizens value and use coastal resources.

Values with positive deviations from coastwide averages (Table 3) combined with site specific features at each location offer insights and interpretations of densities of value types inside individual MR/MPA areas (Fig. 9).

Although we observed regional differences in how respondents chose and associated coastal values, we saw an overall pattern of "indirect use" values such as *scenic/aesthetic* and *beach recreation* highlighted above "existence" and "direct use" values within the area of analysis. Moreover, the MR/MPA network, hidden from respondents during the survey, had elevated levels of "existence" values such as *biodiversity/wildlife* and *wilderness* compared to Territorial Sea coastwide averages (Table 3). Elevated levels of *wilderness* pins observed within the MR/MPA network are particularly relevant because labeling of marine areas as wilderness has been explored recently as a potential marine designation (Johnston et al., 2019); these observations confirm that the term is salient to the public for marine environments. Our findings indicate that efforts of the marine reserves designation process to identify and protect locations that enhance biodiversity and habitat protection were largely reflected in the eyes of Oregonians sampled in this survey.

5. Conclusions

In this public participation GIS (PPGIS) project we explored how citizens statewide relate to and value coastal and marine resources and ecosystem services by examining their spatially explicit values and priorities for specific coastal and marine areas, as well as in relation to a newly established MR/MPA network. This type of social data is critical in documenting and understanding the full range of resources provided by conservation areas as well as marine areas more broadly (Strickland-Munro et al., 2016). Study participation was state-wide, but coastal residents were over-represented. This discrepancy of willingness/interest in survey participation highlights the salience of these issues/topics to coastal residents and their daily lived experiences. Value types were grouped based on their association with "direct-use", "indirect-use", and "existence" value types. Overall, "indirect-use" values were the most commonly pinned across all participants (46.5% of all pins) followed by "existence", "direct-use", and "special places". This offers insight into statewide perceptions and values of coastal and marine areas and confirms previous research about the importance of non-market values of

Marine Reserve/Protected Area Management Highlights

- **Cape Falcon –** This area registered its highest deviation from coastwide averages in the *wilderness* category (+9.4%) and "existence" value type (+12.9). This deviation may be in reference to Oswald West State Park (the coastal area adjacent to the MR), a nearly 2,500 acre temperate rainforest that stretches the entirety of the MR coastal boundary.
- **Cascade Head** - Most frequently placed pins in the entire survey with *biodiversity/wildlife* value elevated 8.7% above the coastal average suggesting high perceived *biodiversity/wildlife* characteristics of this location. Not surprisingly, the largest clustering of pins was just off of Cascade Head, a UNESCO Biosphere Reserve, of which the MPA is a part.
- **Otter Rock** - The most densely pinned MR/MPA location, the *aesthetic/scenic* (+5.5% above average) values may be associated with Devil's Punchbowl, a natural sandstone formation that is a tourist attraction, and the tidepooling opportunities on the north side of Otter Rock.
- **Cape Perpetua** - This reserve, with elevated densities of the most commonly pinned value across the coast, *aesthetic/scenic* (+9.3%), encompasses Heceta Head Lighthouse and Cape Perpetua Scenic Area, two iconic viewsheds and important ecological resources on the Oregon Coast.
- **Redfish Rocks –** Despite receiving the fewest pins of all MR/MPAs, this location had the largest deviation from coastwide averages in the *biodiversity/wildlife* (+30.8%) category, possibly a reflection of the abundant habitat diversity in this area or an artifact of the limited responses to draw from in calculating these percentages. Both subtidal habitats and the Redfish Rocks themselves are part of Oregon's Island National Wildlife Refuge.

Fig. 9. Pins placed within each MR/MPA deviated from coastwide value averages, which may be partially explained by geographic or physical characteristics within or adjacent to the sites.

Oregon's coastal and marine resources to state residents (Lafranchi and Daugherty, 2011; Needham et al., 2016).

Response pins falling within Oregon's current Marine Reserve and Marine Protected Area network were placed there without explicit demarcation of its boundaries on the map provided to respondents, allowing us to see how Oregonians value and prioritize activities in those areas of their own accord. Within the MR/MPA network, "existence" values were consistently higher than coastwide averages, indicating Oregonians' sampled in this mapping exercise recognize the conservation values of the areas these designations protect.

Our regional analysis indicated that pin placement was related to proximity to coastal areas, potentially tied to travel and opportunity costs, wherein coastal residents placed the majority of their pins in their home region and valley residents focused primarily on proximal coastal areas at similar latitudes. By identifying differences in local value orientations, these patterns further illustrate the role of geographic discounting in place-based research and suggest an opportunity to engage more diverse user groups and geographies in marine and coastal issues. Additionally, relative abundance of individual value pins varied based on respondents' home geographic region, suggesting that regional differences at the state level, similar to those at a national level, play a role in which attitudes citizens hold toward coastal resources, providing important use-based value data to inform future communication strategies and identify potential areas of conflict. On a fundamental level, values captured demonstrate that priority locations vary spatially along the coast and these differences offer insights into how and where individuals recreate, value, and hold opinions about coastal resources and uses. Region-specific applications of spatially explicit value assessments are useful for local coastal managers, but also highlight the utility of participatory mapping in marine spatial planning efforts more broadly, especially to increase inclusion of more diverse geographies and perspectives about coastal resources.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ecoser.2021.101301.

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