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The landscape of climate change adaptation aspirations in the US non-profit conservation sector

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Abstract

Despite extensive recommendations for adapting conservation to climate change, limited knowledge exists about how practitioners aim to respond. To address this gap, we analyzed proposals for on-the-ground climate adaptation projects submitted by US conservation non-profits, which play a central role in conserving biodiversity. We assessed 415 proposals submitted between 2011 and 2015 to the Wildlife Conservation Society's Climate Adaptation Fund, a US-based fund focused solely on adaptation for wildlife and ecosystems. We evaluated the distribution of proposed projects across conservation targets, strategies, and activities, and their geographic alignment with climate impacts. Proposals most often targeted river and riparian ecosystems, fish, and birds. Attention on amphibians and invertebrates was disproportionately low relative to their climate vulnerability. Proposals commonly included efforts to restore previous structures and functions, while relatively few described facilitating change (e.g., supporting future-adapted species). Proposal density was highest along the Atlantic and Pacific coasts, geographically aligned with non-profit density and public opinion on climate change. There was no geographic alignment between exposure and proposed responses to five of six climate threats (warming, aridity, wildfire, inland flooding, sea level rise). Our findings identify gaps in adaptation attention, and can enhance strategic resource allocation, targeted capacity building, and adaptation outcomes for conservation.

KEYWORDS

climate adaptation, climate change, funding and philanthropy, global warming, non-profit sector

1 | INTRODUCTION

Conservation research has increasingly focused on adapting conservation practice to inevitable threats posed by climate change (Stein et al., 2013). Hundreds of studies make recommendations for biodiversity and ecosystem management (reviewed in Heller & Zavaleta, 2009; Hagerman & Pelai, 2018; Prober et al., 2019). However, we know little about how practitioners themselves anticipate responding to climate change via tangible, on-the-ground adaptation activities.

In US natural resource management, a very limited number of studies synthesize developing on-the-ground adaptation efforts (Ontl et al., 2017; Peterson St. Laurent et al., 2021). Moreover, numerous studies have focused on adaptation in public agencies (e.g., Archie et al., 2012;

Jantarasami et al., 2010; Kemp et al., 2015), but we know of only one study focused on adaptation in the non-profit sector (Peterson St. Laurent et al., 2021). The scarcity of research on developing efforts in the non-profit sector is significant given the sector's central role in conserving biodiversity and compensating for insufficient government effort (Armsworth et al., 2012). For climate adaptation, the role of the non-profit sector may be especially important because public agencies are perceived to have low adaptive capacity (Armsworth et al., 2015) and face barriers that impede adaptation (e.g., Archie et al., 2012; Jantarasami et al., 2010; Kemp et al., 2015).

To address these gaps, we synthesized and evaluated the largest available pool of climate adaptation project proposals focused on wildlife and ecosystems proposed by US non-profits. The pool comprises a large sample size and geographic scope, including >400 proposals for projects in diverse ecosystems, submitted by >250 non-profit organizations from across the United States. Our overarching aim was to describe and quantify US non-profit aspirations for adaptation, identify potential gaps in proposed responses, and create a baseline for tracking future developments.

We address three specific questions:

First, what ecosystems and taxa do proposals target? Current and predicted impacts to biological systems are widespread and varied (Groffman et al., 2014), but we do not know which targets are of most concern to practitioners, nor whether this attention is proportional to climate vulnerability.

Second, what strategies and activities are proposed? Characterizing the strategies and activities practitioners propose allows us to determine their popularity, including efforts to facilitate change away from historic conditions. It also reveals how practitioners hope to translate a literature focused on general concepts and principles (Heller & Zavaleta, 2009; Lawler, 2009) into specific on-the-ground activities.

Third, what is the geographic distribution of proposed projects relative to specific threats? Identifying regional differences in proposed responses and their correspondence with a range of climate impacts predicted across the US could point to mismatches between climate exposure and attention to adaptation. In particular, adaptation aspirations are likely to geographically align with the distribution of conservation non-profits and public opinion on climate change, rather than exposure to climate threats.

2 | METHODS

2.1 | Study sample

Our sample was the three-page preproposal applications ("proposals") submitted to the Wildlife Conservation Society (WCS) Climate Adaptation Fund (www.wcsclimateadaptationfund.org) between 2011 and 2015. Made possible by a grant from the Doris Duke Charitable Foundation, the fund was launched in 2011 to support tangible, "shovel-ready" US climate adaptation projects. The fund provides US 501(c)(3) non-profit conservation organizations with grants ranging from $50,000 to 250,000 for 1- to 2-year-long projects. We aimed to study the broader field of proposed responses rather than WCS's goals and funding preferences, thus we focused on proposals rather than funded projects (the latter is the focus of Peterson St. Laurent et al., 2021).

In their proposals, applicants were asked to describe project activities, outcomes and partners, and to include a project budget describing a minimum 1:1 match of their funding request from additional funding sources ("matching funds," Supporting Information Appendix S1). While program aims did not change substantively over the study period, outreach materials (e.g., application forms, RFP) did evolve. For example, a "Guidance Document" was added in 2012, and materials mentioned refugia strategies more often over time (analysis not shown); we therefore include outreach documents from both early and late years of the study period in Appendix S1. Of 490 proposals submitted from 2011 to 2015, we excluded those that did not describe on-the-ground activities and resubmissions of the same proposal over multiple years (in the latter case, we only included the most recent proposal). Our final sample included 415 proposals submitted by 259 organizations.

The unprecedented scale and scope of this sample offers a unique gauge of adaptation aspirations in the US non-profit conservation sector. While other funders invest in US-based efforts to advance adaptation (e.g., the Kresge Foundation, Climate Resilience Fund, public funding sources), the WCS Climate Adaptation Fund is the single largest US-based fund we know of focused solely on adaptation for wildlife and ecosystems. The pool of proposals comprise a consistent set of information (i.e., all applicants responded to the same application prompts, scale of funding, etc.), creating a quantifiable data source. Numerous non-profits with a wide range of organizational sizes and biodiversity targets are included, and their geographic foci are representative of conservation non-profits in the United States (see Section 3). Beyond the applicants themselves, the pool reflects an even larger sample of hundreds of project partners (see Section 3). Finally, while the 1:1 match requirement may limit our interpretation of some findings (see below and Section 4), overall we view this requirement as a strength. In addition to ~$11.5 million granted by WCS to these efforts during the study period, applicants collectively described >$84.1 million in committed matching funds from hundreds of additional public and private funders (see Section 3). Thus, the sample encapsulates funding pools beyond the WCS Climate Adaptation Fund, and tends to capture substantive plans rather than early-stage ideas.

Given the lack of any comparable datasets, this pool can provide valuable insights into practitioners' aims, but it nevertheless has some limitations. Like surveys collected via outreach to a network, our sample only includes proposals from non-profits that were aware of the funding program. Program parameters (Supporting Information Appendix S1) likely limit who can apply and what they propose. For example, activities not funded by the WCS Climate Adaptation Fund (e.g., assisted colonization) and efforts with budgets much larger than grant amounts are likely underrepresented. Smaller non-profits may find it difficult to obtain matching funds compared to larger organizations with more flexible funding. The match requirement and relatively small grant amounts means applicants likely combine multiple funding sources, including others that are less focused on adaptation. This, plus the focus on short-term, shovel-ready projects, means adaptation may be added as a secondary project feature rather than a project priority, and applicants may have limited ability to attempt riskier projects. Finally, applicants likely self-selected or framed their proposals to fit their associations with WCS and the Climate Adaptation Fund's stated priorities (Supporting Information Appendix S1). We therefore focus on features that should be robust to such effects, or otherwise describe the potential role of these factors in the discussion. Research should confirm the generality of our findings if and when comparable datasets can be assembled from other public and private funders and in geographies beyond the United States.

2.2 | Data extraction

We extracted data from proposals for a suite of variables (Table 1). We aimed to capture how applicants described their work, rather than making inferences. For a more detailed analysis, we extracted additional information from a random subsample of 100 proposals. Unless noted, we report sample sizes (N) for each variable in Table 1 instead of in-line in the results section.

We classified proposals' adaptation strategies—the general approach to achieving conservation objectives in the face of climate change (e.g., ensure connectivity, protect refugia)—using categories modified from Stein

TABLE 1 Variables extracted and sample size

Variable	N
Project scale, context, and funding	
Total project budget (request to WCS plus matching funds)	415
Applicant's annual organizational budget[b]	415
Matching fund amount and source type (federal, state, other public, private)[c,d]	415
Partnership types (federal, state, other public, private, university)[c,e]	263
What ecosystems and taxa do proposed projects target?	
Ecosystems[c]	415
Taxa[c]	100
What strategies and activities are proposed?	
Strategies[c]	100
On-the-ground activities[c]	100
What is the distribution of proposed projects relative to geography and specific threats?	
US state[c]	415
Climate impacts[c]	415

[a]Not all proposals provided enough information to extract these variables; we report the number successfully extracted in results.
[b]See Supporting Information Appendix S2 for detailed methods.
[c]Proposals could be coded for >1 nonexclusive category.
[d]Applicants were asked to list components of their matching funds as either "committed" or "received" (combined as "funding" here), or otherwise "pending" (which we did not analyze).
[e]Only extracted for 2011–2013 proposals due to a change in the wording of the application question in subsequent years.

et al. (2014) (Tables 2 and S2.1). We chose this categorization because it is clearly defined and applicable across ecosystem types. We added one category ("facilitate change," i.e., transitioning a site to a future-adapted state) given the need for changing goals and letting go of past states (Heller & Zavaleta, 2009; Millar et al., 2007; Peterson St. Laurent et al., 2021; Schuurman et al., 2020; Stein et al., 2013, 2014), as well as several substrategies (Table 2). We attempted to categorize proposals as aiming for resistance, resilience or transformation, or other similar categorizations (Peterson St. Laurent et al., 2021; Schuurman et al., 2020), but found it was often not possible to determine applicants' intents from such brief documents.

We categorized proposed on-the-ground activities, which we define as actions undertaken to implement strategies (e.g., prescribed fire, in-stream engineering). To determine how particular strategies were associated with activities, we used a contingency table approach (see Supporting Information Appendix S2 for detailed methods).

TABLE 2 Adaptation strategies described in US climate adaptation project proposals ($N = 100$)

Adaptation strategy	Definition (modified from Stein et al., 2014)[a]	% Category	% Subcategory	Rank
Restore previous structure and function	Rebuild, modify or transform ecosystems that have been lost or compromised, in order to restore previous structures (e.g., habitat complexity) and functions (e.g., nutrient cycling).	72		1
Ensure connectivity	Protect, restore, and create landscape features that facilitate movement among patches.	62		2
Movement of organisms	Target connectivity that facilitates the movement of organisms.		55	
Movement of abiotic elements	Target connectivity that facilitates the movement of abiotic elements, e.g., water, nutrients.		18	
Movement of habitat	Target connectivity that facilitates the movement of habitat.		4	
Protect refugia	Protect, restore, manage or create areas less affected by climate change, as sources of "seed" for recovery in the present, or as destinations for climate-sensitive migrants in the future.	40		3
Long-term *in situ* refugia	Target areas in the species' current range with long-term stable climates; i.e., "evolutionary refugia" (Keppel et al., 2012).		19	
Short-term *in situ* refuges	Target areas in the species' current range that provide temporary relief from climate impacts on ecological timescales (Keppel et al., 2012).		14	
Ex situ refugia	Target habitat outside the species' current range, but likely to be within the future climate space of the species.		10	
Reduce non-climate stressors	Minimize localized human stressors (e.g., pollution) that hinder the ability of species or ecosystems to withstand or adjust to climatic events.	23		4
Protect key ecosystem features	Focus management on structural characteristics, organisms, or areas that represent important "underpinnings" or "keystones" of the current or future system of interest.	21		5
Keystone organisms or ecosystem engineers	Target organisms with outsize, critical roles in creating and/or maintaining ecosystems, communities or habitats.		11	
Sites with key functions	Target sites with key functions, especially those that cannot readily shift, e.g., arid springs, spawning sites.		6	
Geophysical heterogeneity and "nature's stage"	Target climatic diversity or enduring geologic features (Anderson & Ferree, 2010).		5	
Facilitate change	Actively or passively facilitate community or ecosystem transition away from the current state and toward a new, future, and more suitable or desired state as climate changes within a site. Target species, community types, genotypes, or phenotypes adapted to future conditions.	20		6
Relocate organisms[b]	Actively transplant organisms from one location to another.	13		7
Support evolutionary potential	Protect a variety of species, populations, and ecosystems in multiple places to bet-hedge against losses from climate disturbances.	9		8

[a]For differences from Stein et al. (2014) and categorization rules of note, see Table S2.1.
[b]The Climate Adaptation Fund did not fund assisted colonization from 2011 to 2015, so this strategy is likely underrepresented here.

2.3 | Geographic analyses

We calculated the density of proposed projects in each state per square kilometer. To assess whether the high density of proposals in coastal states was driven by sea level rise, which is only relevant in coastal states, we also calculated densities after removing proposals responding to sea level rise. Because it only takes a few projects to result in high proposal densities in small Northeastern states, we also ran this analysis by region instead of state.

We used linear regression to test whether proposal density per state aligned with (1) the density of conservation non-profit organizations (i.e., potential applicants, see Supporting Information Appendix S2 for detailed methods) and (2) state-level public opinion on climate change. As a metric of public opinion, we used data on the percentage of people who thought "global warming will harm plants and animal species a moderate amount/a great deal" in 2016 (Ballew et al., 2019; YPCCC & Mason 4C, 2020). Our preliminary assessment showed that non-profit density and public opinion were correlated ($p < 1e\text{-}05$, $r = .62$); we therefore did not include both in the same model and were unable to tease apart their individual contributions to proposal density. To assess the alignment between exposure to climate impacts ("threats") and the geographic distribution of proposals ("response"), we compared state-level metrics of six threats to the geographic distribution of proposals responding to those threats (Table S2.2, see Supporting Information Appendix S2 for detailed methods). For each threat, we used linear regression to assess the correlation between threat and response metrics.

2.4 | Post hoc analyses

To assess how the distribution of foci across taxa compared to their relative vulnerability to climate change, we compiled Nature Serve's Climate Change Vulnerability Indices (Young et al., 2015) for 1,333 species, converted these to numeric scores, and calculated the mean for each taxon (see Supporting Information Appendix S2 for detailed methods). While the Climate Change Vulnerability Index may be biased for some taxa, it is widely used and applicable across taxa (Young et al., 2015), providing the best available metric we know of for comparing taxa's relative vulnerability to climate change. Given the high number of proposals focusing on salmonids, we also tested whether salmonids' mean Climate Change Vulnerability Index score was higher than that of other fish using a one-sided Wilcoxon rank sum test, which we considered significant when $p < .05$ and marginally significant when $p < .1$.

To determine the extent to which WCS's outreach materials might have inadvertently encouraged certain types of projects, we quantified how often these materials mentioned each animal taxa, ecosystem type, and strategy (see Supporting Information Appendix S2 for detailed methods).

All analysis and plotting was done in R (version 3.6.1, R Core Team, 2017), with the reshape2 (Wickham, 2007), ggplot2 (Wickham, 2009), fiftystater (Murphy, 2016), and cowplot (Wilke, 2016) packages.

3 | RESULTS

3.1 | Project scale, context, and funding

The median proposed project had a total budget of \$400,000 and was ~200 ha in extent ($N = 415$ and 293, respectively). The 259 applicant organizations had a median annual organizational budget of \$1.2 million, ranging from ~\$13,500 to >\$500 million (see Figure S2.1 for full distribution). Altogether, applicants listed ~470 partner organizations, ~650 matching funders, and >\$84.1 million in matching funds ($N = 413$). Eighty-nine percent of proposals had some amount of matching funds and 21% had their entire 1:1 match committed ($N = 400$).

3.2 | Ecosystems and taxa

Most proposed projects (54%) were in river and riparian ecosystems (Figure 1(a)). Less than 2% of proposed projects were in each of lakes/ponds, deserts, tundra/alpine/subalpine, and urban/suburban ecosystems.

The most common taxonomic foci were plants (60%), fish (41%), especially salmonids (25%), and birds (40%). The least common taxonomic foci were amphibians, invertebrates (both 18%), and reptiles (9%, Figure 1(b)). Based on mean Climate Change Vulnerability Index scores, the most vulnerable taxon to climate change was amphibians, followed, in order, by invertebrates, plants, fish, reptiles, mammals, and birds (Figure S2.2). Salmonids had marginally higher mean Climate Change Vulnerability Index score than other fish (3.4 vs. 2.9, $N = 14$ and 134 species, respectively, $W = 713$, $p = .06$).

3.3 | Strategies and activities

The most common strategies described were "restore previous structure and function" and "ensure connectivity" (72 and 62%, respectively, Table 2). The most commonly

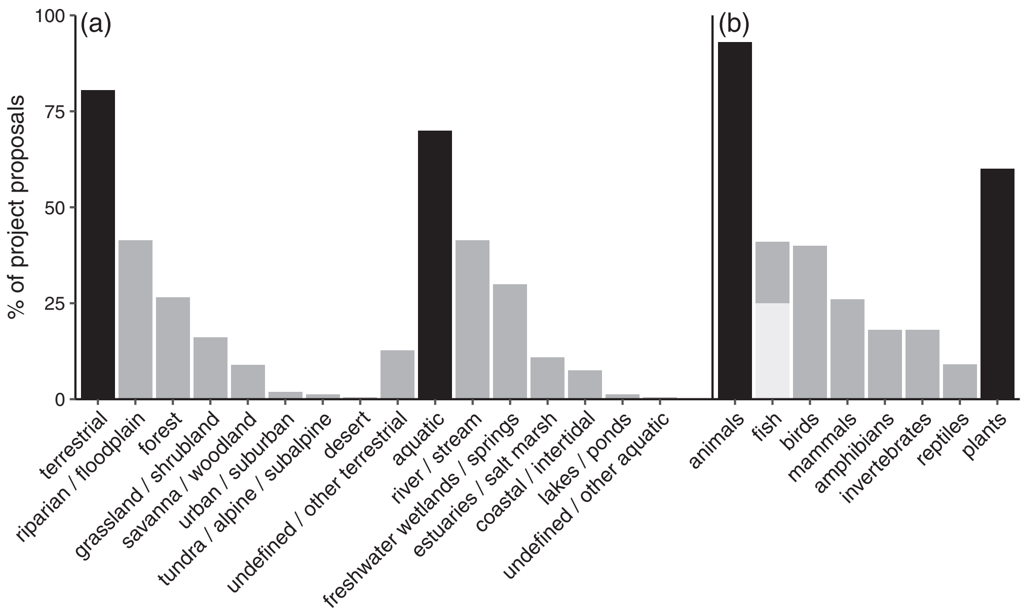

FIGURE 1 (a) Proposed US climate adaptation project ecosystems, grouped by terrestrial and aquatic ecosystems (black) and specific ecosystem types (gray). $N = 415$. (b) Taxonomic foci of proposed projects, grouped by animals and plants (black) and specific animal taxa (gray). Light gray indicates proposals that included a focus on salmonids. $N = 100$

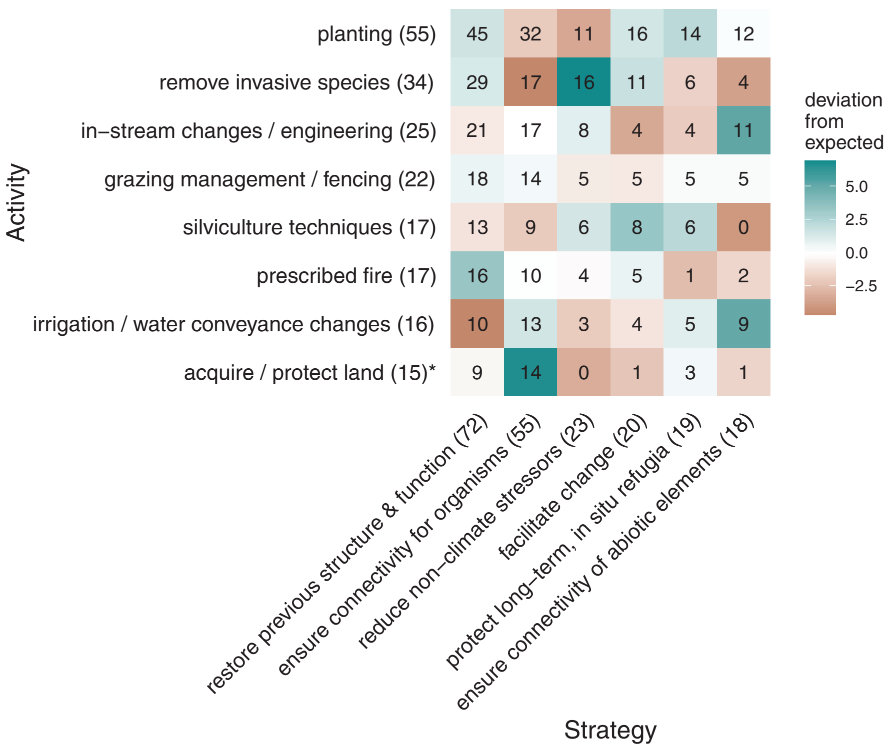

FIGURE 2 Project proposals with each combination of strategy and activity ($N = 100$). Numbers in cells indicate the number of proposals that included that combination of strategy and activity. Cells are colored by their deviation from expected (expected = sum (row) × sum (column)/overall sum), which indicates the extra (or lacking) proposals with that combination of strategy and activity compared to the null hypothesis that the two variables are independent. Numbers in row and column labels indicate the number of proposals that described that category overall. For strategies and activities listed in <15% of proposals, see Tables 2 and S2.3.
*The Wildlife Conservation Society (WCS) Climate Adaptation Fund only funded easements and land acquisition in 2011–2012; although applicants could list these activities as part of a larger project in subsequent years, they are likely underrepresented in this dataset

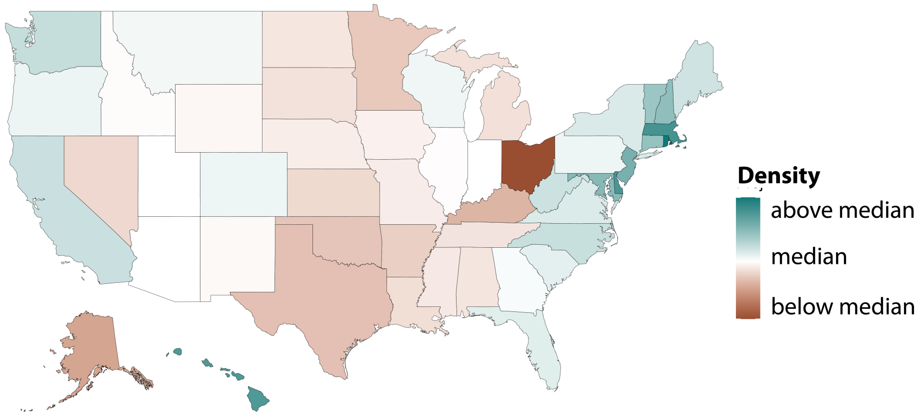

FIGURE 3 Climate adaptation proposal density by state (number/km^2)

proposed activities were planting and removal of invasive species (55 and 34%, respectively, Table S2.3). The strongest associations between strategies and activities were "ensure connectivity for organisms" with "acquire/protect land," and "reduce non-climate stressors" with "remove invasive species" (Figure 2).

3.4 | Geographic distribution of projects and threats

Almost all (19 of 20) states along the Atlantic or Pacific Ocean had above median proposal densities, and 24 of 30 inland and Gulf coast states had below median proposal densities (Figure 3). By region, the Pacific and Northeast regions had the highest and almost identical proposal densities (Figure S2.3(a)). These qualitative patterns remained after we removed proposals responding to sea level rise (Figure S2.3(b)). State-level proposal densities increased with both non-profit density ($p <$ 1e-04, $R^2 = .32$, $N = 50$) and public opinion on climate change ($p <$ 1e-05, $R^2 = .33$, $N = 50$).

There were no significant relationships between threat and responses to five of the six impacts we tested (warming $N = 247$, aridity/drought $N = 157$, wildfire $N = 67$, inland flooding $N = 75$, and sea level rise $N = 64$ proposals, Figure S2.4). The density of proposed projects addressing snow loss increased with increasing snow loss projections ($p = .01$, $R^2 = .28$, $N = 57$ proposals in 18 states, Figure S2.4(b)). In some states and regions with relatively large predicted threats, practitioners submitted relatively few proposals. For example, few proposals were submitted in response to warming in the Midwest (Figure S2.4(a)), increasing aridity in Nevada and Texas (Figure S2.4(c)), wildfire in several Southern states (Figure S2.4(d)), and sea level rise in Louisiana (Figure S2.4(f)).

3.5 | Outreach materials

WCS's outreach materials mentioned river and riparian systems more than other ecosystems. The most commonly mentioned animal taxa were mammals. The three most mentioned strategies were "restore previous structure and function," "protect key ecosystem features," and "facilitate change" (Table S2.4).

4 | DISCUSSION

Our synthesis of 415 adaptation project proposals from across the US non-profit conservation sector describes a previously uncharacterized landscape of aspirations. The large sample size, diversity of non-profits represented, and hundreds of public and private partners and matching funders involved in these projects provide a unique gauge of the sector's proposed response to climate change. Understanding non-profits' aims is valuable since they will ultimately be the ones putting much climate adaptation into practice in the United States. Moreover, this knowledge can point to gaps between practitioners' hopes and what is most needed for effective adaptation. Although our sample is inherently shaped by the WCS Climate Adaptation Fund's program parameters, it is the most comprehensive dataset of its kind available. Moreover, examining this dataset is valuable in its own right given the program's scale and potential to drive practice.

Proposed projects focused most often on river and riparian ecosystems, fish, and birds, and less on some taxa with relatively high climate vulnerability (i.e., amphibians, invertebrates). Relatively few proposals described forward-looking approaches to "facilitate change." Practitioners proposed well-established, conventional activities to deploy strategies on-the-ground. Finally, there was little alignment between the geographic distribution of proposed projects and exposure to the threats they address, and practitioners in some areas with high exposure to climate threats submitted relatively few proposals.

4.1 | What ecosystems and taxa do proposed projects target?

Practitioner attention was disproportionate to relative climate vulnerability for some taxa: birds were commonly targetted in proposed projects, but have a relatively low mean Climate Change Vulnerability Index, while amphibians and invertebrates received less attention despite their high mean Climate Change Vulnerability Indices (Figures 1 and S2.2). In some cases, practitioners may be focusing on species with high vulnerability to climate change relative to their taxonomic group. There are also legitimate distributions of effort besides vulnerability, such as focusing on endangered species or using a triage approach (Bottrill et al., 2008). However, we suspect the distribution of attention is not intentional, but rather due to gaps in conservation resources and attention. Invertebrates and amphibians already receive relatively little attention and conservation investment (Davies et al., 2018; Evans et al., 2016; Small, 2011), and we worry that practitioners' adaptation efforts may worsen this disparity. Similarly, lakes/ponds, deserts, tundra/alpine/subalpine, and urban/suburban systems were rarely targeted in proposals. Given the vulnerability of some of these systems to climate change (e.g., Butcher et al., 2015; Hayhoe et al., 2004), further research should determine whether this lack of attention is intentional and appropriate.

The focus on fish, river and riparian ecosystems (Figure 1) was exemplified by the one-quarter of proposals targeting salmonids, which is vastly disproportionate to the number of salmonid species in the United States. The attention parallels the higher mean Climate Change Vulnerability Index of salmonids compared to other fish (although this difference was only marginally significant), and is somewhat proportional to the relatively high mean Climate Change Vulnerability Index of fish overall (Figure S2.1). Similarly, the focus on river and riparian systems may reflect these ecosystems' high climate vulnerability, adaptive potential, and functional roles (Capon et al., 2013; Seavy et al., 2009). Given WCS's matching fund requirement, this focus might also be due to disproportionate federal spending on endangered and threatened fish (Evans et al., 2016) and the fundraising capacity of river and riparian interest groups. Studies of other adaptation efforts should try to isolate whether this is a broader trend, or a result of WCS's matching fund requirement or inadvertent prompting in their outreach materials (Table S2.4).

4.2 | What strategies and activities are proposed?

The most commonly proposed strategy was "restoring previous structure and function" (Table 2). Further assessment should ensure that such proposals are truly adaptive rather than adaptation in name only. While restoring historic conditions can help align ecosystems with directional changes in some cases (Ontl et al., 2017), in others, reaching historic targets may be challenging (Harris et al., 2006; Millar et al., 2007; Schuurman et al., 2020). This suggests a need for analysis of structures and functions that might sustain themselves into the future. For example, efforts to maintain historic stream flows might be difficult to achieve in areas with long-term drying.

Unlike approaches that pursue historic reference conditions, proposals to meet new, future targets using the "facilitating change" strategy were relatively rare (Table 2), despite this strategy's relative prominence in WCS's outreach material (Table S2.4). Most proposals of this type (18 of 20) included the promotion of species or community types predicted to do better in the future—or withholding support from those predicted to decline. "Facilitating change" proposals also included planting future-adapted seeds from warmer and drier geographies, and actively converting coastal uplands to salt marsh to replace lower-lying marsh inundated by rising seas. Such efforts may run counter to long-standing practices (Kates et al., 2012) and be considered high risk, since predictions may be incorrect and novel approaches may have unanticipated consequences (Heller & Zavaleta, 2009). This novelty and potential risk may partly explain the relatively low number of proposals with this strategy, especially for applicants that added adaptation as a secondary feature, or relied on more conservative funding sources for their match.

Our analysis connects general strategies to the tangible activities that managers hope to use to actualize them in specific contexts (Figure 2). Adaptation is often the application of conventional conservation activities in new places and for new reasons (Lawler, 2009; Mawdsley et al., 2009). As such, practitioners planned to use mostly well-established management activities to achieve proposed strategies (Table S2.3). Most associations between strategies and activities were unsurprising—for example, ensuring connectivity for organisms (strategy) by acquiring or protecting land (activity) to form wildlife corridors. More unexpected was the association between proposals to facilitate change with silviculture activities (Figure 2). This aligns with reports of such approaches in the forestry sector (Ontl et al., 2017). Clear economic stakes in managed forests might encourage experimental, novel strategies. Moreover, long-lived trees may delay natural responses in forests, necessitating more hands-on, forward-looking approaches.

4.3 | What is the distribution of proposed projects relative to geography and specific threats?

The higher density of proposed projects in states along the Atlantic or Pacific Ocean compared to Gulf coast and inland states (Figure 3) aligns with the distribution of conservation non-profits and public opinion on climate change in the United States. We did not find evidence that sea level rise was a major driver of this pattern (Figure S2.3(b)). The geographic alignment with non-profits and public opinion is expected, given our sample: non-profit applicants with secured or plans for matching funds, both of which we expect to be more common in places with supportive public opinion. It is also unsurprising given the lack of national coordination of adaptation efforts (Bierbaum et al., 2013), leaving practitioners to respond independently.

Of the six climate change threats we analyzed, five (all but snow loss) showed a lack of correspondence between exposure and interest in responding (Figure S2.4). It may be that local-scale impacts drive practitioner interest but are obscured by our coarse, state-scale analysis, especially in large states with spatially variable climate exposure. Alternatively, other facets of vulnerability (e.g., the sensitivity of species and ecosystems to climate threats) and differing conservation needs (e.g., the distribution of endangered species) might justify the observed distribution of practitioner interest. Finally, some aspirations may be undetected by our sample, if practitioners are less likely to apply to the WCS Climate Adaptation Fund in places where "climate adaptation" is not named as such due to political polarization (Ballew et al., 2019), or in geographies with limited exposure to WCS's outreach. WCS's outreach was distributed widely via their networks and partners, but did not systematically target each state.

Overall, the lack of geographic alignment between adaptation interest and exposure to climate threats is problematic. If we assume that proposed responses prefigure real world efforts, and that those efforts need to be proportional to climate threats in order to be effective, then the lack of proposals in areas projected to experience large climate threats indicates a concerning lack of preparation (e.g., relatively few proposals to address increasing aridity in Nevada and Texas). Even if aspirations in some geographies are undetected by our sample, practitioners in vulnerable geographies are missing out on a major source of potential funding. This disparity deserves further investigation, as the causes are likely to be unique to each place (Lonsdale et al., 2017).

4.4 | Conclusions and recommendations

In many cases, the landscape of proposed responses we have characterized reflects existing conservation priorities and know-how, rather than necessarily addressing the most critical needs given the impacts of a changing climate. It is not surprising to see a focus on charismatic taxa like birds, but effective adaptation across biodiversity will likely require more attention on more vulnerable taxa like amphibians and invertebrates. Similarly, restoration of past structures and functions may reflect a prevailing focus on historic baselines (Schuurman et al., 2020) and a large restoration industry (BenDor et al., 2015), but riskier, novel strategies are also needed given unprecedented changes. A geographic distribution of attention that aligns with non-profit densities and public opinion on climate change is expected, but neglects those places with the highest exposure to climate threats.

We do not know the extent to which the areas of emphasis we identified (e.g., fish) have materialized into on-the-ground efforts; further research should address this question. However, we expect the gaps we encountered in proposals (e.g., amphibians) to be reflected on the ground, because it is unlikely that substantial efforts are underway in areas with only limited attention. Therefore, efforts to close these gaps will be needed.

We recommend the following to close the identified gaps and advance adaptation more broadly:

- Organizations conducting outreach and capacity building should encourage practitioners to consider climate change in areas where attention is lacking, such as specific geographies and non-profits focused on vulnerable but neglected taxa (e.g., amphibians, invertebrates).
- Lessons from subsectors and geographies receiving relatively more attention should be captured and transferred to aid in capacity building elsewhere. For example, practitioners working in forests might serve as a source of knowledge about efforts to facilitate change.
- Private and public grant-makers should create targeted funding streams and consider removing or reducing match requirements to incentivize efforts focused on under-represented regions, targets and strategies. Grant-makers should also consider reducing or removing match requirements for smaller organizations that may struggle to secure matching funds, which may broaden the number and type of organizations that can apply for funding and what they can propose.

- As others have suggested, researchers should collaborate with practitioners to develop, experiment with, refine and promote methods for facilitating change (Prober et al., 2019; Schuurman et al., 2020).
- Funders should work with researchers to develop outreach materials and RFPs that provide guidance on translating adaptation strategies into on-the-ground actions, especially for approaches that may be less familiar or comfortable, such as facilitating change.
- Researchers should help to develop evidence-based options for adaptation for vulnerable but neglected taxa and ecosystems.
- Beyond supporting implementation, funders should support research on the effectiveness of funded projects in order to maximize "learning by doing."

Overall, we recommend an absolute increase in available resources for adaptation in the conservation sector in order to fill the gaps we have identified, rather than diverting resources away from geographies or targets that are currently better supported. For example, shifting resources away from states with relatively high proposal densities is not desirable, because doing so may leave those states under-prepared, given the magnitude of predicted impacts. In other words, we need to increase the size of the pie rather than slice it differently. Finally, to ensure the long-term viability of conservation efforts, it is essential to take climate change into account. Therefore, we hope the illustration of specific, conventional management activities proposed to achieve climate adaptation serves to embolden practitioners to incorporate climate change into their on-the-ground conservation and stewardship efforts.

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CONFLICT OF INTEREST

The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTIONS

All authors conceived of the study. **Sarah Skikne** and **Molly Cross**: Designed the methods. **Sarah Skikne**: Collected and analyzed the data, and wrote the initial manuscript. All authors reviewed, edited, and revised the manuscript.

DATA AVAILABILITY STATEMENT

Restrictions apply to the availability and use of the data from this study. Data are available from the corresponding author with the permission of WCS.

ETHICS STATEMENT

The authors are not aware of any ethical issues regarding this work.

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REFERENCES

Anderson, M. G., & Ferree, C. E. (2010). Conserving the stage: Climate change and the geophysical underpinnings of species diversity. *PLoS One*, *5*, e11554.

Archie, K. M., Dilling, L., Milford, J. B., & Pampel, F. C. (2012). Climate change and western public lands: A survey of U.S. federal land managers on the status of adaptation efforts. *Ecology and Society*, *17*, 20.

Armsworth, P. R., Fishburn, I. S., Davies, Z. G., Gilbert, J., Leaver, N., & Gaston, K. J. (2012). The size, concentration, and growth of biodiversity-conservation nonprofits. *Bioscience*, *62*, 271–281.

Armsworth, P. R., Larson, E. R., Jackson, S. T., Sax, D. F., Simonin, P., Blossey, B., … Shaw, M. R. (2015). Are conservation organizations configured for effective adaptation to global change? *Frontiers in Ecology and the Environment*, *13*, 163–169.

Ballew, M. T., Leiserowitz, A., Roser-Renouf, C., Rosenthal, S. A., Kotcher, J. E., Marlon, J. R., … Maibach, E. W. (2019). Climate change in the American mind: Data, tools, and trends. *Environment*, *61*, 4–18.

BenDor, T., Lester, T. W., Livengood, A., Davis, A., & Yonavjak, L. (2015). Estimating the size and impact of the ecological restoration economy. *PLoS One*, *10*, 1–15.

Bierbaum, R., Smith, J. B., Lee, A., Blair, M., Carter, L., Chapin, F. S., III, … Verduzco, L. (2013). A comprehensive review of climate adaptation in the United States: More than before, but less than needed. *Mitigation and Adaptation Strategies for Global Change*, *18*, 361–406.

Bottrill, M. C., Joseph, L. N., Carwardine, J., Bode, M., Cook, C., Game, E. T., … Possingham, H. P. (2008). Is conservation triage just smart decision making? *Trends in Ecology & Evolution*, *23*, 649–654.

Butcher, J. B., Nover, D., Johnson, T. E., & Clark, C. M. (2015). Sensitivity of lake thermal and mixing dynamics to climate change. *Climatic Change*, *129*, 295–305.

Capon S. J., Chambers L. E., Mac Nally R., Naiman R. J., Davies P., Marshall N., … Williams S. E. (2013). Riparian Ecosystems in the 21st Century: Hotspots for Climate Change Adaptation?. *Ecosystems*, *16*, 359–381. https://doi.org/10.1007/s10021-013-9656-1

Davies, T., Cowley, A., Bennie, J., Leyshon, C., Inger, R., Carter, H., … Gaston, K. (2018). Popular interest in vertebrates does not reflect extinction risk and is associated with bias in conservation investment. *PLoS One*, *13*, e0203694.

Evans, D. M., Che-Castaldo, J. P., Crouse, D., Davis, F. W., Epanchin-Niell, R., Flather, C. H., … Williams, B., et al. (2016). Species recovery in the United States: Increasing the effectiveness of the endangered species act. *Issues in Ecology*, *20*, 1–28.

Groffman, P., Kareiva, P., Carter, S., Grimm, N., Lawler, J., Mack, M., … Tallis, H. (2014). Climate change impacts in the United States chapter 8. In *National climate assessment* (Vol. 2014, pp. 195–219).Washington, D.C.: U.S. Global Change Research Program.

Hagerman, S. M., & Pelai, R. (2018). Responding to climate change in forest management: Two decades of recommendations. *Frontiers in Ecology and the Environment*, *16*, 579–587.

Harris, J. A., Hobbs, R. J., Higgs, E., & Aronson, J. (2006). Ecological restoration and global climate change. *Restoration Ecology*, *14*, 170–176.

Hayhoe K., Cayan D., Field C. B., Frumhoff P. C., Maurer E. P., Miller N. L., … Verville J. H. (2004). Emissions pathways, climate change, and impacts on California. *Proceedings of the National Academy of Sciences*, *101*, 12422–12427. https://doi.org/10.1073/pnas.0404500101

Heller, N. E., & Zavaleta, E. S. (2009). Biodiversity management in the face of climate change: A review of 22 years of recommendations. *Biological Conservation*, *142*, 14–32.

Jantarasami, L. C., Lawler, J. J., & Thomas, C. W. (2010). Institutional barriers to climate change adaptation in U.S. National parks and forests. *Ecology and Society*, *15*, 33.

Kates, R. W., Travis, W. R., & Wilbanks, T. J. (2012). Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences of the United States of America*, *109*, 7156–7161.

Kemp, K. B., Blades, J. J., Klos, P. Z., Hall, T. E., Force, J. E., Morgan, P., & Tinkham, W. T. (2015). Managing for climate change on federal lands of the western United States: Perceived usefulness of climate science, effectiveness of adaptation strategies, and barriers to implementation. *Ecology and Society*, *20*, 17.

Keppel, G., Van Niel, K. P., Wardell-Johnson, G. W., Yates, C. J., Byrne, M., Mucina, L., … Franklin, S. E. (2012). Refugia: Identifying and understanding safe havens for biodiversity under climate change. *Global Ecology and Biogeography*, *21*, 393–404.

Lawler, J. J. (2009). Climate change adaptation strategies for resource management and conservation planning. *Annals of the New York Academy of Sciences*, *98*, 79–98.

Lonsdale, W. R., Kretser, H. E., Chetkiewicz, C. L. B., & Cross, M. S. (2017). Similarities and differences in barriers and opportunities affecting climate change adaptation action in four North American landscapes. *Environmental Management*, *60*, 1076–1089.

Mawdsley, J. R., O'Malley, R., & Ojima, D. S. (2009). A review of climate-change adaptation strategies for wildlife management and biodiversity conservation. *Conservation Biology*, *23*, 1080–1089.

Millar, C. I., Stephenson, N. L., & Stephens, S. L. (2007). Climate change and forests of the future: Managing in the face of uncertainty. *Ecological Applications*, *17*, 2145–2151.

Murphy, W. (2016). fiftystater: Map data to visualize the fifty U.S. states with Alaska and Hawaii insets. Retrieved from https://cran.r-project.org/package=fiftystater

Ontl, T. A., Swanston, C., Brandt, L. A., Butler, P. R., D'Amato, A. W., Handler, S. D., … Shannon, P. D. (2017). Adaptation pathways: Ecoregion and land ownership influences on climate adaptation decision-making in forest management. *Climatic Change*, *146*, 75–88.

Peterson St. Laurent, G., Oakes, L., Cross, M., & Hagerman, S. (2021). R-R-T (resistence-resilience-transformation) typology reveals differential conservation approaches across ecosystems and time. *Nature Communications Biology*, *4*, 39. https://doi.org/10.1038/s42003-020-01556-2

Prober, S. M., Doerr, V. A. J., Broadhurst, L. M., Williams, K. J., & Dickson, F. (2019). Shifting the conservation paradigm: A synthesis of options for renovating nature under climate change. *Ecological Monographs*, *89*, 1–23.

R Core Team. (2017). *R: A language and environment for statistical computing. Version 3.6.1*. Vienna, Austria: R Foundation for Statistical Computing Retrieved from https://www.r-project.org/

Schuurman, G. W., Hoffman, C. H., Cole, D. N., Lawrence, D. J., Morton, J. M., Magness, D. R., … Fisichelli, N. A. (2020). Resist-accept-direct (RAD)—A framework for the 21st-century natural resource manager. In *Natural resource report NPS/NRSS/CCRP/NRR—2020/2213*. Fort Collins, Colorado: National Park Service. https://doi.org/10.36967/nrr-2283597

Seavy, N. E., Gardali, T., Golet, G. H., Griggs, F. T., Howell, C. A., Kelsey, R., … Weigand, J. F. (2009). Why climate change makes riparian restoration more important than ever: Recommendations for practice and research. *Ecological Restoration*, *27*, 330–338.

Small, E. (2011). The new Noah's Ark: Beautiful and useful species only. Part 1. Biodiversity conservation issues and priorities. *Biodiversity*, *12*, 232–247.

Stein, B. A., Glick, P., Edelson, N., & Staudt, A. (Eds.). (2014). *Climate-smart conservation: Putting adaptation principles into practice*. Washington, D.C.: National Wildlife Federation.

Stein, B. A., Staudt, A., Cross, M. S., Dubois, N. S., Enquist, C., Griffis, R., … Pairis, A. (2013). Preparing for and managing change: Climate adaptation for biodiversity and ecosystems. *Frontiers in Ecology and the Environment*, *11*, 502–510.

Wickham, H. (2007). Reshaping data with the reshape package. *Journal of Statistical Software*, *21*, 1–20.

Wickham, H. (2009). *ggplot2 elegant graphics for data analysis*. New York: Springer-Verlag.

Wilke, C. O. (2016). cowplot: Streamlined plot theme and plot annotations for "ggplot2".

Yale Program on Climate Change Communication (YPCCC) & George Mason University Center for Climate Change Communication (Mason 4C). (2020). Climate Change in the American Mind: National survey data on public opinion (2008–2018) [Datafile and codebook].

Young, B. E., Dubois, N. S., & Rowland, E. L. (2015). Using the climate change vulnerability index to inform adaptation planning: Lessons, innovations, and next steps. *Wildlife Society Bulletin*, *39*, 174–181.

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