Forgotten whales, fading codfish: Perceptions of 'natural' ecosystems inform visions of future recovery

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RESEARCH ARTICLE

Forgotten whales, fading codfish: Perceptions of 'natural' ecosystems inform visions of future recovery

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Abstract

1. Perceptions of past ecological change affect views of current ecosystem state, but how do baselines help to shape stakeholders' visions of an idealized future?
2. Here, we investigate links between perceptions of natural baselines and visions for the nearshore Gulf of Maine among a key stakeholder group, active lobster fishers. We ask three related questions: (1) What do fishers perceive as a 'natural' Gulf of Maine? (2) How do perceptions of the past predict individual and collective visions of an ideal future? and (3) How is existing management perceived as supporting these visions?
3. We found that fishers perceived the ecosystem to be 'natural' an average of one decade before they started fishing. Three species dominated views of natural systems: cod *Gadus morhua*, lobster *Homarus americanus*, and herring *Clupea harengus*, but while long-time fishers associated abundant cod with a natural nearshore Gulf of Maine, memories of a historically cod-rich Gulf of Maine were fading among some younger fishers who began their careers after the cod crash in the 1990s. Perceptions of 'natural' ecosystems dictated future visions for the majority of taxa; on average, fishers remembered and desired abundant cod and herring, but perceived halibut *Hippoglossus hippoglossus* and endangered right whales *Eubalaena glacialis* to have always been rare.
4. Fishers described a vision for the future based on views of past ecological and social baselines, including fisheries deconsolidation and diversification, but expressed a lack of shared vision with and trust in federal management institutions to achieve these goals. In particular, memories of cod abundance in the 1970s and 1980s were coupled with memories of a diversified and accessible fishery, but fishers doubted that the recovery of cod would result in their restored access to cod fisheries.
5. Together our results demonstrate that past personal experiences limit perceptions of what is possible, highlighting both the value and limitations of local ecological knowledge in places that have experienced ecological change over centuries. They also demonstrate how stakeholder perceptions of both social and ecological baselines shape visions for future ecosystems but are mediated by contemporary issues like trust in institutions and fisheries access.

KEYWORDS
Atlantic cod, environmental history, historical ecology, lobster, marine fisheries, right whale, shifting baselines

1 | INTRODUCTION

Perceptions of ecological baselines affect views of current ecosystem state (Pauly, 1995). Stakeholders with a long-term understanding of ecological change perceive more depletion relative to past baselines, with implications for fisheries (Lovell et al., 2020; Saenz-Arroyo et al., 2005), nonnative species management (Clavero, 2014), and species extinction (Turvey et al., 2010). Shifted baselines also directly inform future management. Stakeholders report higher willingness to pay for conservation when they perceive long-term change (McClenachan et al., 2018), and when historical baseline data are consulted, higher conservation targets are set for endangered species recovery and fisheries management (McClenachan et al., 2012).

Ecological baselines are powerful tools for creating a common understanding among stakeholders by articulating narratives of both the past changes and the future possibilities (Kittinger et al., 2014; McAfee et al., 2020). Yet, analyses of stakeholder engagement with ecological baselines have primarily focused on specific taxonomic groups or policy scenarios. As a result, it is less clear how more complex visions of ecosystem baselines connect to future visions and values among individual stakeholders, and how collectively these visions inform priorities for ecosystem management. In practice, conservation and resource management involves prioritization of resources, particular species or management goals (Wilson et al., 2009). In this context, it is useful to move beyond establishing baselines for particular species, and toward linking complex social values to equally complex ecosystems. This stakeholder-centred approach aims to determine which ecosystem components are valued, and how these values are expressed as both memories of the past and visions of the future.

The Gulf of Maine is an ideal location to identify narratives about past change and future values, and to place stakeholders' ideas about baseline visions in a complex social ecological system. The ecological and social history are well-documented, with strong evidence for long-term change across the marine food web (Bolster, 2008). Most well-known is a shift from finfish to lobster-dominated fisheries and ecosystems over the past three decades; the crash of Atlantic cod in the early 1990s occurred simultaneously with the rapid ascendency of lobster fisheries in that same decade (Dietz et al., 2003). Yet, the history of fisheries in Maine is longer and more species rich. Atlantic salmon *Salmon salar* and clams *Mercenaria mercenaria*; *Mya arenaria* were important Indigenous fisheries (Reeder-Myers et al., 2022). Iconic Atlantic cod *Gadus morhua* fisheries were central to early European settlement of coastal New England and maritime Canada and existed at order of magnitude higher abundances in the 1860s (Rosenberg et al., 2005). Populations of forage fish—including herring *Clupea harengus* and alewives *Alosa pseudoharengus*—that supported abundant inshore cod populations were equally robust (Alexander et al., 2009; Ames, 2004; McClenachan et al., 2015). Atlantic halibut *Hippoglossus hippoglossus*, predators of cod, were also historically abundant and culturally important in the 19th century coastal Gulf of Maine (Grasso, 2008).

Today, the Gulf of Maine is culturally and ecologically focused on lobster *Homarus americanus*. The thriving lobster industry is prominent example of a co-management success (Dietz et al., 2003), with stakeholder views incorporated into management through a robust co-management structure (Acheson, 2013; Acheson & Gardner, 2014). Yet, drivers of success in this fishery are complex, and ecological change over centuries has helped to support robust modern lobster populations. Release from predation associated with ecological degradation frequently benefits crustaceans (Howarth et al., 2014) and in the nearshore Gulf of Maine, overfishing of finfish has contributed to the growth of the lobster fishery, which grew to be the most valuable in the United States (Boudreau et al., 2015; Steneck & Wahle, 2013). Warming waters due to climate change have also benefited this industry. Thermally favourable areas for larval settlement have increased in Maine, and lobster populations have increased fivefold since the 1980s (Goode et al., 2019). Warming waters may also inhibit recovery of cod, a historically important predator (Pershing et al., 2015). This combination of ecological complexity, long-term change, and stakeholder interest in maintaining a thriving industry has contributed to competing narratives about drivers of high lobster abundance (Acheson & Steneck, 1997; Boudreau & Worm, 2010; McClenachan et al., 2019). Therefore, placing stakeholder ideas about baseline views and future visions is relevant in the context of the complex and highly altered ecosystems that support this fishery.

Finally, there are several ongoing and high-profile conservation conflicts that represent prioritization of particular species within Gulf of Maine marine ecosystems. Most notably, the federally protected Endangered right whale *Eubalaena glacialis* is the subject of an ongoing US federal lawsuit, which alleges that lobster gear poses a threat to species survival (Koubrak et al., 2021). Likewise, recovery efforts for historically depleted nearshore cod and other groundfish are ongoing with the goal of fisheries diversification and ecological restoration (Armstrong et al., 2013; Wroblewski et al., 2005). However, the prospect of recovering predators into an ecosystem where commercially valuable invertebrate fisheries have developed is often fraught, with divergent visions of idealized future ecosystems (Gregr et al., 2020; Howarth et al., 2014). Underlying these conservation conflicts is the codified belief that particular species should exist in particular abundances, and an inherent prioritization of one species over another.

Taken together, the ecological and social complexity of the past, present and future of the Gulf of Maine makes it an ideal location to develop a deeper and more integrated understanding of stakeholder baseline views and how these link to visions of ideal futures. We

ask three related questions: (1) When do lobster fishers perceive the nearshore Gulf of Maine to have been 'natural' and what contributes to these views? (2) How do perceptions of the past predict individual and collective visions of an ideal future? (3) How are existing management structures perceived as supporting these visions? Given Maine lobster's status as a prominent example of a co-managed fishery, identifying values embedded in stakeholder visions for healthy future ecosystems is essential for success.

2 | METHODS

We conducted semi-structured interviews with Maine lobster fishers between July 2020 and February 2021. Interviews took place in person ($n = 17$) and over the phone ($n = 6$) and lasted between 45 and 90 min. Survey questions (Appendix S1) focused on three areas: Perceptions of past baselines, views of ideal future ecosystems and perceptions of management. The majority of our interview questions were open-ended in order to leave room for a range of possible responses and to allow for fishers to express their views as freely as possible. Our research design and survey instrument were reviewed by Colby College's Institutional Review Board and deemed exempt from IRB oversight. We ensured that our research met appropriate ethical standards. All interview results were anonymized and interviews were not recorded, ensuring confidentiality. We discussed confidentiality, the study's purpose and scope, and types of questions with participants prior to interviews, and participants gave verbal consent to participate. Verbal consent was considered adequate because the identities of subjects were completely anonymous and there was minimal risk involved in the study. Additionally, we reconfirmed that participants agreed for us to use their responses in our research after the interview was complete. We anonymized interview results by removing any identifying information (i.e. fishing port, gender) to ensure that individuals were not identifiable to the general public or their peers.

First, we asked respondents to identify when they thought the nearshore Gulf of Maine was 'natural', and justify this response. In both our conversations with fishers and reporting of our results we use both 'natural' and 'baseline' to mean the timeline or state that fishers associate with a natural Gulf of Maine. While there are differences in these two terms, baselines are commonly understood as the 'natural' state of a species or ecosystem (Ureta et al., 2020), and we chose to use them interchangeably. We next asked fishers to reference any animals they associate with a natural Gulf of Maine, and for perceptions of their abundance relative to today. While we asked about perceptions of what is natural, fishers' responses commonly referred to changes that occurred after their stated baseline, which is relevant to understanding their perception of the difference between a pre-impact natural state and today's Gulf of Maine.

Second, for six key taxa (lobster, cod, herring, halibut, alewives and whales), we asked respondents to quantify their perception of natural abundance and their desired future abundance relative to today. In all cases, responses about relative abundance were expressed on a five-point scale: (−2) A lot less, (−1) A little less, (0) Same, (1) A little more, (2) A lot more; responses were averaged in our analyses.

We wanted to know if length of experience fishing affected views of what is natural in the Gulf of Maine; therefore, we tested (1) the significance of correlations between experience (i.e. the year a fisher reported starting to fish) and the date given for a 'natural' Gulf of Maine and (2) whether perceptions of key species' natural abundance were related to experience. Here we focused on lobster and cod, whose importance to local fisheries changed dramatically over the past several decades, with a crash in cod landings and a rapid increase in lobster landings in the 1990s (Dietz et al., 2003). We also wanted to know if perception of 'natural' was a predictor of future desired state; therefore, we tested whether average responses were significantly different for each of the six key taxa.

Next, we asked about existing and potential future policies that were seen as helpful in supporting their idealized vision for a future Gulf of Maine, and those that were seen as most hindering to these goals. As noted above, many of our questions were open-ended. For example, in this part of the survey, we asked 'What existing policies do you see as most helpful in supporting the things you'd like to see in the future?' While many responses focused on the lobster fishery, some were more expansive, describing perceptions of policy and management of diverse fisheries and the interactions among them. Finally, we asked for respondents to quantify their trust associated with the two key management agencies, the Maine Department of Marine Resources (DMR) and the US National Oceanographic and Atmospheric Administration (NOAA). We asked both for the degree of trust each respondent had in each institution and the degree of trust they thought each institution had in the Maine lobstering community, on a scale of 0%–100%.

In our survey design, we were guided by recent literature on saturation in interview-based methods for inductive thematic analysis. Saturation is defined as the point in data collection and analysis when new incoming data produces little or no new information to address the research question. For example, Guest et al. (2006) concluded that saturation occurred within the first 12 interviews, with basic elements present in as few as six interviews. Similarly, Morgan et al. (2002) found that the first five to six interviews produced the majority of new information in the dataset, and that little new information was gained as the sample size approached 20 interviews. We concluded our interviews when additional interviews resulted in redundancy in new themes, which we identified using a saturation grid (Brod et al., 2009). In creating this grid, we focused the degree to which responses to our open-ended questions differed among respondents (Saunders et al., 2018). (e.g. What animals do you think of as part of a natural Gulf of Maine? Do any of the things you described as being part of a natural Gulf of Maine reflect what you'd like to see in the future? What existing policies do you see as most helpful/most hindering in supporting the things you'd like to see in the future?) Given our mixed method approach (i.e. both open-ended and questions generating numerical responses), we caution against generalizing from our quantitative results without the additional context

provided by the qualitative results. In our reporting of these results, we dovetail these two sets of data to provide this context.

3 | RESULTS

We interviewed 23 lobster fishers in nine municipalities and offshore islands in mid-coast Maine. Our respondents were similar to state averages in terms of age, experience, and boat size. The age of interviewees ranged from 15 to 70 years old, with a mean of 53, which is similar to the average age in the Maine fishery of 50 (Johnson & Mazur, 2018). However, relative to state averages, we interviewed more lobster fishers in the 60–69 age bracket (Appendix S2). Respondents represented a range of experience with our least experienced respondent reporting 6 years of experience, and our most experienced reporting 59 years. The average was 33 years, which also compares to the average in the Maine fishery of 30 years (Singer & Holland, 2008). Average boat size was 37 feet, which is also similar to that of the industry, whose average boat size is 32 feet (Singer & Holland, 2008). Information on experience and boat size for the state of Maine were not available in any format other than averages, though we would expect a relationship between age and experience. Our interviews differed from the population of Maine lobster fishers in terms of gender and geography. Of our interviewees, 9% were female, which is slightly higher than the state average of 5% (McClenachan & Moulton, 2022). We focused on mid-coast Maine, as Penobscot Bay is the geographic and economic center of lobstering in Maine (Greene et al., 2020). However, our results do not include the perspective of lobster fishers in southern or Downeast Maine.

3.1 | What do lobster fishers perceive as a 'natural' gulf of Maine?

Fishers provided a range of dates as being associated with a natural Gulf of Maine, the earliest of which was the year 1500, and the most recent baseline date was 'right now' or the year 2020. The majority (59%) of fishers reported a belief that a natural Gulf of Maine existed in the 1970s and 1980s, while 9% indicated baseline dates before 1900 and 17% selected a baseline date of 1990s or later (Figure 1a). The majority of reasons given for particular baselines were associated with fisheries, including past and current abundances of key species and the past use of less impactful gear in fisheries targeting these key species. Likewise, descriptions of change and movement away from this baseline focused on the same key fisheries (Figure 1b).

Three key species were most frequently associated with a natural Gulf of Maine: lobster, cod, and herring; 82% of respondent named at least one of these species. Individually, cod were identified

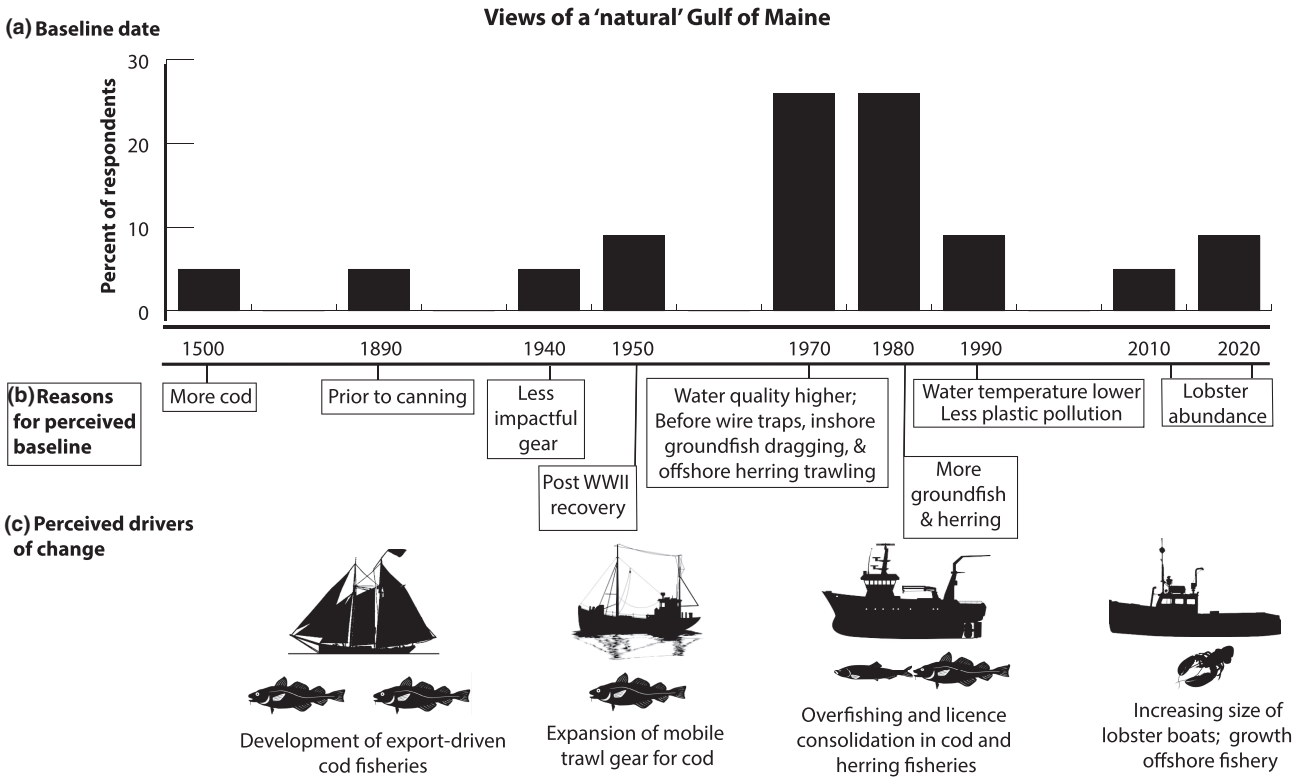

FIGURE 1 Baseline views of the Gulf of Maine. (a) Baseline dates ranged from 1500 to 2020, but the majority of fishers perceived the Gulf of Maine as natural in the 1970s and 1980s. (b) Reasons for perceived baselines included perceived abundances of key species, less impactful gear, and higher water quality. (c) Perceived divers of change were linked to developments in key fisheries over time, including cod (1500–1980), herring (1970–1980) and lobster (1990–2020).

by 47% of respondents, while herring and lobster were each identified by 35%. One respondent described lobster as 'the most important thing' in Gulf of Maine ecosystems with other species helping to create an environment for lobsters to thrive. Cod were described as historically important as the subject of economically and socially valuable fisheries for centuries. Changes in the local abundance of nearshore herring also marked inflection points for many respondents. Herring were frequently mentioned for their importance for the modern bait fishery, historical food fish fisheries, and ecological importance as a forage fish. Fishers described a natural Gulf of Maine as hosting additional species, including hake *Merluccius bilinearis* (20% of respondents), cusk *Brosme brosme* (12% of respondents), dogfish *Squalus acanthias* (12% of respondents), haddock *Melanogrammus aeglefinus* (12% of respondents), shrimp *Pandalus borealis* (12% of respondents), and flounder *Pleuronectidae* (12% of respondents). Notably, with the exception of dogfish, all of these species once supported valuable fisheries.

The earliest time periods in fishers' perception of natural baseline and subsequent change to the Gulf of Maine were all associated with cod (Figure 1b,c). The fishers who selected baseline dates before 1900 associated these with the development of early European export driven cod fisheries and the development of canneries associated with early industrial multispecies fisheries. Cod also dominated views of change in the first half of the twentieth century. Fishers noted that the onset of 'dragging', or otter trawling, in the cod fishery, which was expanded offshore in the 1950s (McKenzie, 2018), marked a turning point for human impact on this coastal ecosystem.

The fishers who selected the 1970s and 1980s as baseline dates associated both cod and herring with a natural Gulf of Maine at this time, which they highlighted as the key decades for change due to industry consolidation and developments of mobile gear which together led to spatial expansion and subsequent overfishing of both cod and herring (Figure 1b,c). Within the cod fishery, the increasing use of trawl gear in inshore water in the 1970s was identified as an inflection point because of new 'rock hopping' gear that allowed trawls to be used on the more complex rocky bottoms that characterize the inshore Gulf of Maine. This gear change resulted in overfishing because as opposed to the stationary benthic long line gear that had been used previously, one respondent noted, 'When you can chase fish in a boat [with a trawl] then you're changing the schools'. For herring, fishers described key changes as occurring in the 1980s, with a similar focus on the development of intensive mobile fishing gear. One respondent noted that that herring were traditionally caught close to shore with weirs (which passively trapped fish in enclosed nets) and stop seines (which were set across a cove entrance after fish had moved inshore to feed or spawn); both of these gears were largely retired by 1980. Another respondent described the 'overfishing by midwater trawlers' that occurred in the 1980s. Federal subsidies in the late 1970s and early 1980s drove the expansion of industrialized US fisheries (Finley, 2017); fishers described midwater trawlers as first causing depletion in local nearshore herring; this decline in herring stocks after spawners were prevented from coming inshore, then drove the fishery farther offshore, culminating in a temporary federal shutdown of the Gulf of Maine herring fishery in 2020 (NOAA, 2020).

Finally, fishers who highlighted baseline dates in the 1990s or later largely focused on developments in the lobster fishery, along with increases in water temperature and plastic pollution. Specifically, respondents linked recent developments in engine type and boat size to the growth of the offshore lobster fishery, a spatial expansion noted as having negative impacts on both lobster population and Maine's more remote island communities. One offshore-island based respondent said, 'electronics like 3D bottom plotters [first introduced in 2007] mean that the shedders [newly molted lobsters] all get caught so quickly'. Respondents reported that these technologies allowed fishers to more successfully intersect lobsters farther offshore during their migration inshore to moult, effectively reducing the ability for fishers working closer to shore to catch these same individuals.

3.2 | Does experience affect the perceived baseline?

Relative to their own experience, a majority viewed the Gulf of Maine as natural around or just before they started fishing (Figure 2a). The median baseline view of the Gulf of Maine was 11 years prior to the start of fishing. Approximately one third (35%) of respondents selected a baseline date within the same decade that they entered the fishery, and the largest number (43%) selected a baseline date prior to their entry into commercial fishing by one to three decades. There were also several notable deviations from this view. Two respondents selected baseline years substantially earlier (76 and 506 years before they started fishing), and 13% of respondents selected a baseline more than a decade after their own entry into to commercial fishing. No respondent selected a baseline date in the future. Experience (i.e. the year a fisher started fishing) and age were both linearly correlated to baseline date (experience: $R^2 = 0.3863$, $p = 0.001$; age: $R^2 = 0.3041$, $p = 0.01$) but only if one extreme outlier baseline date (1500) was excluded (Figure 2b). Boat size was not correlated with baseline date. Additionally, experience predicted baseline date with a first order polynomial regression ($R^2 = 0.4185$; $y = -0.02285x^2 + 91.86993x - 90351.39894$); though we caution that the relatively low sample size used in this study limits the generalizability of these results.

Our results also suggest a shifting baseline of perceived ecological dominance, from cod to lobster, over the course of two decades, which aligns closely to the decrease in cod landings and increase in lobster landings in the 1990s (Figure 2c). While a large majority of respondents viewed a 'natural' Gulf of Maine as having more cod and less lobster (Table 1), there were significant differences in these views based on when respondents began their fishing careers. Those who perceived a natural Gulf of Maine as containing more cod began fishing on average in 1982, while those who perceived

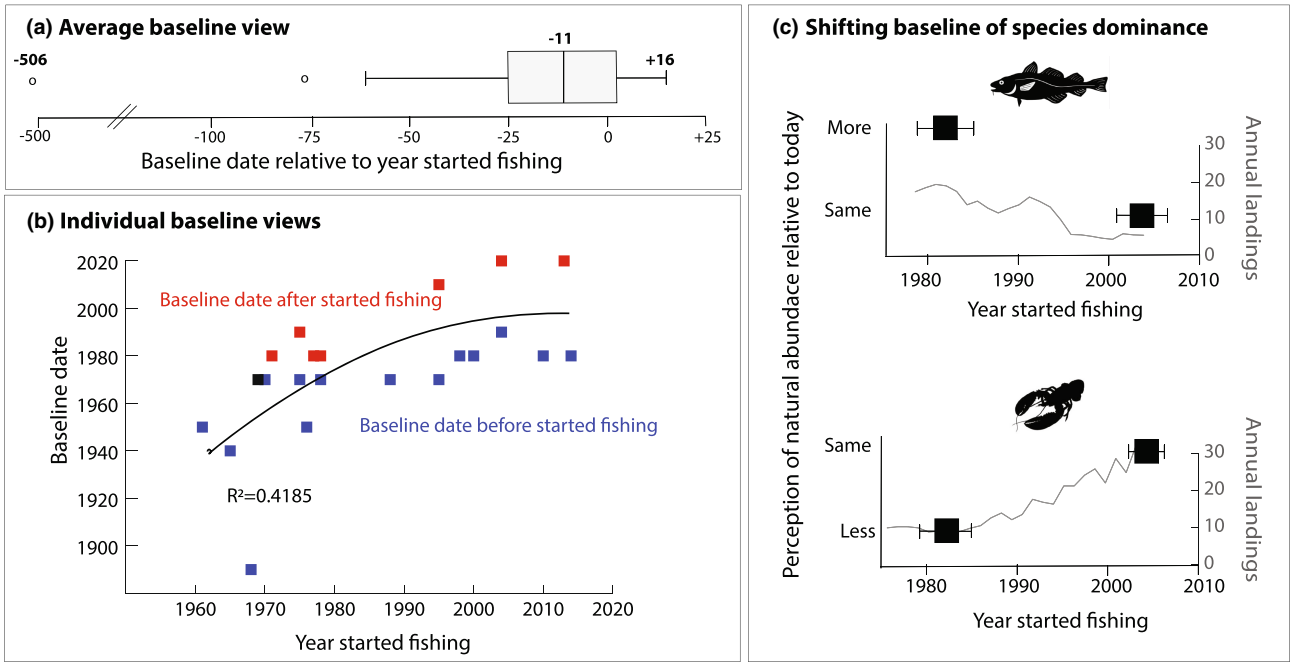

FIGURE 2 (a) Average baseline view. On average, fishers considered the Gulf of Maine to be 'natural' 11 years before they started fishing, but responses ranged from >500 years to 16 years after they began their careers. (b) The relationship between perceived baseline date and experience; red points indicate baseline dates after the start of a fisher's career began; blue points represent baseline dates before the start of a fisher's career. (c) Shifting baseline of species dominance. The majority of respondents viewed the past Gulf of Maine as having more cod and less lobster (Table 1), but some fishers who entered the fishery after the cod crash of the 1990s viewed today's abundances of cod and lobster as natural; changes in these views correspond with a shift in dominance in the fishery over two decades. (Points represent means; bars represent standard error; landings data represented in millions of kilograms, from Dietz et al., 2003.)

TABLE 1 Perceptions of past abundances and future visions for key marine animals. The percentage of respondents who reported perceiving or desiring less, the same or more of each taxa. See also Figure 3.

	Past baseline			Future vision		
	Less	Same	More	Less	Same	More
Cod	0%	18%	82%	0%	14%	86%
Herring	5%	5%	90%	0%	6%	94%
Halibut	11%	47%	42%	0%	44%	56%
Whales	11%	58%	32%	0%	80%	20%
Lobster	91%	9%	0%	0%	87%	13%
Alewives	50%	19%	31%	0%	13%	87%

a natural Gulf of Maine as containing the same amount of cod as today began fishing on average in 2004 (Figure 2c; $t(21) = -1.89$, $p < 0.01$). Our semi-structured interview responses confirmed this shifted baseline for cod, with a small number of less-experienced fishers expressing a lack of knowledge of cod in the Gulf of Maine. For example, one respondent who began fishing in 2010 reported a view that 'back then there was not so much [cod] fishing', though this respondent also acknowledged that this personal view was linked to entry into the fishery after the groundfish fishery had crashed. Another respondent who began fishing in 2013 reported no knowledge of cod having existed at any abundance, reporting 'I don't really think about fish. I have never seen a codfish'.

The same types of differences existed in perceptions of natural lobster abundances; those who perceived a natural Gulf of Maine as containing less lobster than today began fishing on average in 1983, while the small number who perceived a natural Gulf of Maine as containing the same of amount of lobster as today began fishing on average in 2008 (Figure 2c, $t(21) = -2.6$, $p < 0.01$). Our semi-structured interview responses added more nuance to views of more experienced fishers that lobster populations were at an all-time high. One respondent who had been fishing since 1965 said, 'This is the most lobsters there's ever been'. Some also noted that the size structure of lobster populations has also changed over time, with fewer large lobster replaced by more abundant small ones. Fishers provided several reasons for the increase in lobster numbers, including the reduction of predators like groundfish, the use of baited traps to subsidize lobster diets, and warming water temperatures. Differences in perception across different levels of experience did not exist for any other taxa.

3.3 | How do perceptions of the past connect to visions of an ideal future?

3.3.1 | Past ecosystem baselines predict future ecosystem vision

Perceptions of natural baselines aligned with desired future state for four of six of the key taxa (Figure 3); there was no significant

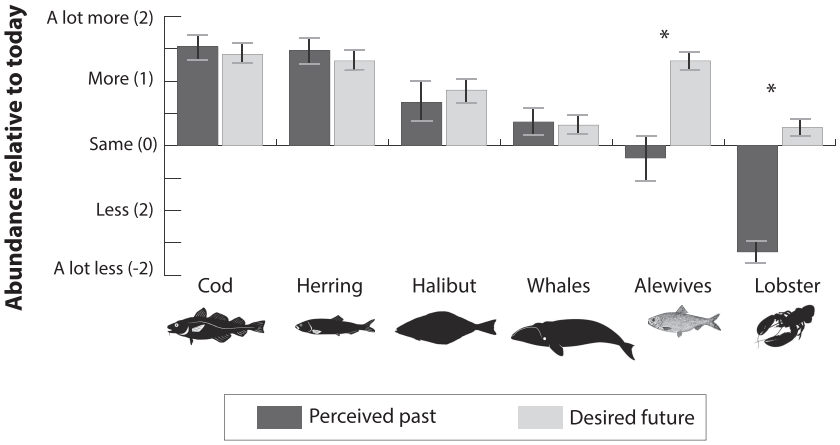

FIGURE 3 Perceptions of past abundances and future visions for key marine animals. Respondents' perception of past abundance relative to today matched their desired future for the majority of animals, but diverged for alewives and lobsters for which mean values were statistically different. (Abundance expressed in mean values; bars represent standard error). See also Table 1.

difference between perceived baseline and desired future state. Notably, no respondents reported wanting less of any taxa in the future (Table 1).

Most respondents (82%) viewed a natural Gulf of Maine as containing 'more' or 'a lot more' cod (mean = 1.55), drawing both on experience and collective knowledge. Most fishers (86%) reported a desire for future cod populations to increase in the future, and to recover to levels equivalent to those of the past (mean = 1.31), expressing the sentiment, 'I would love to see the codfish come back'.

Herring were widely perceived as historically abundant (mean = 1.45) and desirable in equivalent quantities in the future (mean = 1.44; Figure 3); 90% of respondents perceived herring as more abundant in the past and 94% desired more herring in the future (Table 1). Respondents commonly referenced herring as an essential component of a 'balanced' ecosystem, saying 'we need food left in the ocean for the ecosystem. We have to allow for everyone, not just people. We need enough food for the fish'. Several respondents indicated that they believed that herring recovery was underway. One reporting wanting more, but that 'there seems like a lot right now'.

Halibut was considered to be both historically more abundant and a desirable component of future ecosystems, but to a lesser degree than other finfish species. Only 42% expressed a belief that there were more halibut in the past, and 56% wanted more in the future (Table 1). Fishers considered halibut to be only slightly more abundant in the past (mean = 0.58) and desired only slightly more in the future (mean = 0.78; Figure 3). Interview responses were brief and expressed less direct experience and interaction with to this species than to other species, but demonstrated a view that the presence of this top predator is an 'indicator of ocean health'.

Whales were perceived to be only slightly more abundant in the past (mean = 0.28), and desired only at a marginally greater abundance in the future (mean = 0.28; Figure 3). The majority of fishers (58%) believed that whale populations were the same in the past and 80% expressed a view that whale populations should remain the same in the future, with 20% of fishers expressing a desire for more whales in a future Gulf of Maine. The historical presence of whales was frequently linked to specific geographies. One older fisher said 'You don't see the whales up in the bays like you used to', and another said 'Seeing whales on Jeffrey's [Ledge] was a beautiful sight'. The view that whales are not naturally present in inshore waters was prevalent. One respondent said, 'I don't think there's a single fisherman who wants to hurt whales. I just don't think they're an issue here. They're following the food north and passing by Pen[obscot] Bay. There is no proof that they're here'. In particular, respondents emphasized the rarity of right whales, both inshore and offshore. For example, one reported having 'seen lots of big whales, finbacks and humpbacks, rolling through the gear', but having never seen a right whale. One older fisher reported having 'never seen a right whale in more than 50 years of fishing, including offshore'. Across our interviews, only one person reported having ever seen a right whale, while 'offshore fishing for herring'. Notably, this respondent had the most experience of the fishers we spoke with, with a career beginning in 1961. This rarity made it difficult for some respondents to identify natural baselines for this species. For example, one respondent reported having no reference point for right whales because they are not regularly seen, emphasizing 'I'm as likely to see a sabertooth tiger inshore as to see a right whale'. This rarity was sometimes highlighted as a distinction between right whales and other large whales. For example, one respondent stated wanting to see the same amount of whales in the future but clarified, 'There's plenty already except for right whales'.

3.3.2 | Visions of a more abundant future

In contrast, perception of past abundances did not align with visions of future for two species; significant differences existed between baselines and desired future abundances for lobster and alewives. In both cases, fishers desired more in the future than their perceptions of the baseline. Lobster fishers described an ideal future that continued to include more lobster than they thought existed in the past. A majority (91%) of fishers believed that lobster populations were lower in the past, with 9% reporting that past populations were the same as today. A majority (87%) wanted modern abundances to be the same in the future with 13% desiring higher lobster abundances (Table 1). On average fishers reported baseline lobster populations relative to today as a lot less (mean = −1.64), but expressed a desire for sustained abundances and stability of lobster catches, with slightly more lobster in the future (mean = 0.28; $t(43) = -10.72$,

$p < 0.0001$; Figure 3). While most fishers expressed a desire for the nearshore Gulf of Maine to remain in the same stable state of lobster dominance, several respondents noted that lobster populations were starting to decline, with one expressing worry that 'they're starting to drop off', and another 'recogniz[ing] that it's going to crash'.

Finally, respondents viewed alewives—migratory fish that migrate up rivers to spawn, where they are caught and used as lobster bait—as the same or slightly less abundant in the past as compared to today (mean = −0.19), but desired a higher abundance of this fish in the future (mean = 1.31; $t(30) = -3.85$, $p < 0.001$; Figure 3). Half of respondents reported that alewife populations were lower in the past, and only 31% reported a belief that alewives were more abundant in the past (Table 1). One respondent recognized this 'loss due to dams' hundreds of years ago meant that 'they need hundreds of years of time to recover'. Most (87%) wanted alewife populations to increase, while 13% wanted populations to remain the same in the future (Table 1). Several respondents noted that alewife recovery had begun, citing several prominent dam removal projects throughout the state. One respondent said that the species is 'climbing back, and getting a lot of attention'. Yet, many lobster fishers did not express direct observation of and experience with alewives in the same way that they did with herring and other marine fish, with one saying 'Those are a freshwater fish'. Another noted, 'I don't want them to go anywhere because they're important for bait. But bait is the only reference I have to this species. I do not see them alive'.

3.3.3 | Future visions mediated by management and ecological interactions

Interviews also revealed ways in which baseline views were mediated by views about management failures and ecological interactions, particularly with respect to groundfish recovery and right whale conservation efforts.

First, interviews revealed that lobster fishers' desire for cod recovery was dampened by a lack of access to the cod fishery. One young fisher reported 'I would like to go groundfishing, but we can't get any permits'. This view is based on observations of licence consolidation that has favoured large-scale corporate groundfish fishing, and was shared across fishers of all ages, with one older fisher who had been involved in multispecies fisheries in the past saying that he 'can't see multispecies fishery ever coming back… [because] the permits are too restrictive'. Associated with this equivocal view of cod recovery was the acknowledgement that the recovery of a lobster predator would not be ideal for the lobster fishery, which has thrived in part due to release from predation. For example, one young fisher said 'I think [cod] are an important part [of the Gulf of Maine], but I would never want to see anything that would hurt lobster'.

Similarly, visions of whale recovery were influenced by the threat of the ongoing federal right whale lawsuit. Most respondents held equivocal views, and commonly expressed future vision that balanced a desire for recovery with the practical needs of the fishery. For example, one respondent said, 'If they [whales] were to come back, I would love that. More nature is better. But I would not want [the lobster fishery] to get shut down because of the whales'. At the same time, several interviews revealed a perceived link between localized herring abundance and whales; the abundance and location of herring schools was seen as a driver of whale abundance over both time and space. One respondent reported the view that whales were more abundant in the 1970s, because of abundant offshore herring. In contrast, several respondents explained low whale abundances today as related to herring depletion, saying, 'There is no food in the Gulf of Maine'. One of our interviewees took this ecological link further, stating that a desire to limit herring recovery inshore was linked to the goal of keeping whales away from inshore lobster fisheries. 'If there's too much baitfish inshore, we will draw in too much trouble, like whales. We don't want to endanger animals by having them come up and get entangled. This is a benefit of local bait fishing, keeping baitfish [populations] down and whales away'.

3.4 | How do stakeholders perceive existing management as supporting their visions?

3.4.1 | Achieving future visions with social baselines: Diversified, small-scale fisheries

Fishers described a vision for the future that matched their views of the ways that fisheries were structured in the past, which we identify as 'social baselines'. One respondent who had been fishing since the early 1960s described these small-scale, diversified fisheries: 'We used to fish year-round and we wouldn't start lobstering until September. We would scallop in December and January, we would shrimp January to March, March to May we would go haking [hook and line groundfishing], and in the summer fish for herring'. Reflecting these memories, fishers identified a desire for small scale, gear restricted, multi-species fisheries that recreated the diversified fisheries economy in the Gulf of Maine that existed historically. One said, 'For all the Gulf of Maine, we need deconsolidated fisheries that do not turn the fish in the sea into a 'stock' that you can chop up and sell as an investment'. Another respondent said 'I wish every fishery was small scale and not corporate'.

While fishers acknowledged that it was not possible to recreate a full suite of diversified fisheries, two types of fisheries were highlighted as having the ability for successful community-based management to be recreated. First, 'bait' fisheries, largely herring and menhaden *Brevoortia tyrannus*, were identified as fisheries that had the potential for small-scale fishers to succeed with the right policies. Second, some respondents also suggested that community-based management success could be replicated in groundfish fisheries. Articulated visions suggested strong pushback against federal consolidation of ownership in the groundfish fishery that had occurred over the past two decades, with respondents providing visions of a 'very communal' groundfish fishery that was state-managed, restricted to small boats fishing only with hook and line, and with access assigned by lottery across districts.

To achieve this goal, fishers identified the lobster fishery as a model of small-scale equitable fisheries that stood in contrast to other fisheries in the region. Many of the fishers that we talked to expressed appreciation for the history of management in the Maine lobster fisheries, which they considered to be a rare model of a consistently deconsolidated and equitable fishery. One described the value of the fishery to communities by saying 'Not a lot of other fisheries are that equitable in terms of opportunity and the money stays local'. In particular, fishers highlighted key elements that supported their vision of this small-scale and decentralized fishery, including the requirement that boat owners operate their own vessel, limits on the number of traps each fisher can operate, the ability of lobster fishing communities to exclude outsiders from the fishery through both formal and informal mechanisms. While these practices do not always act to increase diversity (McClenachan & Moulton, 2022), the ability to exclude outsiders is central to achieving success in co-management frameworks (Ostrom, 1990). Fishers expressed that together, they believe that these policies and practices means that 'the right voices are amplified and there aren't investor-based lobbyists influencing management like in other fisheries'.

Despite this faith in the structures supporting a decentralized lobster fishery, fishers also identified recent trends that they believed were threatening past success. For example, federal tax incentives to overcapitalize, via investments in large boats whose depreciation could be deducted as a business expense (IRS, 2011), were indicated as driving expansion of the offshore lobster fishery. One fisher summarized, 'You don't need a million-dollar boat to fish inshore, but the current tax structure encourages overcapitalization'. Some noted that this high investment also makes the lobster fishery less nimble. For example, one respondent expressed that gear reductions would be difficult for 'guys with 1.25 million-dollar boats'. This high capital investment—sometimes referred to as a 'gilded trap' (Steneck et al., 2011)—was perceived as closely linked to the growth of the offshore fishery. One respondent said, 'This fishery is so heavily invested in offshore lobster, it can't get out'. The offshore fishery was frequently described as larger scale, less equitable and less bound by the conservation ethic that has characterized the inshore lobster fishery. One fisher expressed that this spatial expansion is hindering town-based management, and other simply reported that they felt that 'offshore fishing is ruining our industry'. The high capital investments in the offshore fishery were described as fundamentally changing the nature of the lobster fishery, with one fisher noting that this focus on maximizing profits to support high-value boats leads to 'a myopic view of the world' and that high costs meant that 'a lot of guys are too strapped right now to see the big picture'. Another described newer entrants into this fishery as 'just more mercenary. They're trying to get rich'.

3.4.2 | Reciprocated trust in and by institutions

The fishers we talked with did not believe they held a shared vision with the federal the National Oceanographic and Atmospheric Administration (NOAA), but reported more alignment with the Maine Department of Marine Resources (DMR). These differences are reflected in the perception of reciprocal trust in these two key institutions. The mean level of reported trust in DMR was 70%, more than double that of trust in NOAA (34%; $t(44) = 4.45$; $p < 0.0001$; Figure 4). Fishers reported feeling trusted by these agencies in similar proportions: 65% by DMR and only 28% by NOAA. Notably, several ($n = 3$) respondents reported feeling 100% trust in DMR, and several ($n = 4$) reported feeling 0% trust from NOAA. Fishers reported that DMR had actively worked to build this trust. One respondent said, 'DMR has a cooperative relationship with fisheries'. Another described the ways in which DMR had built trust and engaged the fishing community through collaborative research, highlighting the different level of respect toward fishers conferred by the naming of DMR's Sea Sampling Program—a voluntary collaboration between fishers and DMR to collect data used in stock assessments—as contrasted to NOAA's National Observer Program, saying 'the word "sea sampler" as compared to the word "observer" is huge. Nobody wants to be observed'. One noted that NOAA did not have any 'boots on the ground'. In contract, this respondent described feeling like lobster fishers could have a voice in communications with DMR saying, 'I feel like we have a two-way street with DMR'.

Two key issues dominated fishers' perception of whether state and federal fisheries management agencies share visions for the future of the Gulf of Maine. First, across the board, Maine fishers expressed resentment for the National Oceanographic and Atmospheric Administration (NOAA) as an agency that has supported fisheries consolidation to the detriment of Maine communities, in particular in the context of the federal groundfish permit structure. One respondent said that the 'federal government just

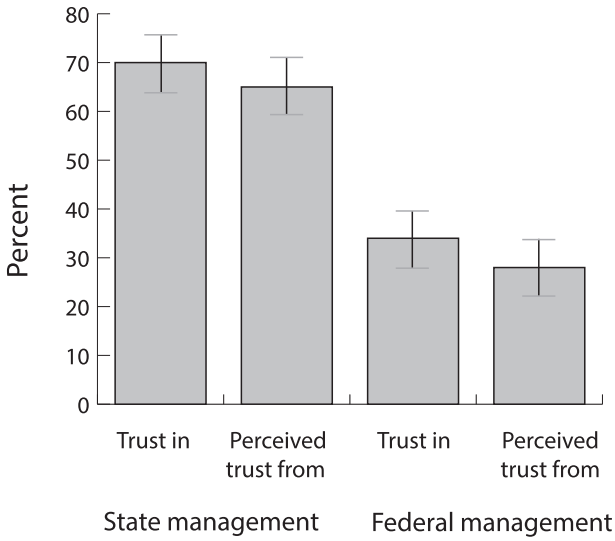

FIGURE 4 Trust in management agencies. Fishers reported reciprocal trust in and from state management (Maine Department of Marine Resources) as significantly higher than federal management (National Oceanographic and Atmospheric Administration). (Percents are expressed as mean values; bars represent standard error.)

does not like a lot of boats, because it's too hard to control, so they support consolidation'. Another said 'NOAA has always targeted the lower guys first in cutbacks. Across the board, big fishermen are rewarded'. Respondents consistently expressed frustration at feeling politically powerless in the face of larger, corporate fisheries. In expressing these views, fishers were likely referencing a series of management measures aimed at reducing effort in the New England groundfish fleet following cod population crashes in the 1990s; namely, a 'days at sea' limitation introduced in 1993 and a catch-share policy introduced under sector-based management in 2010 are both believed to have benefitted fishers with larger operational capacity (Bradley, 2011). In particular, catch shares are a form of individual transferable quotas, which have been long-criticized for their potential to result in the consolidation of access into fewer individuals or firms in the absence of policy mechanisms to support smaller fishers (Copes, 1986). In addition, fishers expressed frustration over policies were that they perceived as bad for citizens more broadly, such as policies aimed at expanding and modernizing the US fishing fleet in the 1970s, and buyback programs instated as the management of these fisheries failed. 'As tax payers, we paid twice for all those boats. The first time with incentives to expand the fishery, the second time we bought them back when they were worn out'. This comment underscores the degree to which feelings of frustration with groundfish management in New England are embedded in decades-long debates over how to manage failing resources (Acheson & Gardner, 2011). In contrast, this acrimonious history does not exist for Maine lobsters (Acheson & Gardner, 2014). During these same decades, lobster catch rates have increased and co-management structures developed with buy-in from the fishing community (Alden, 2011; Steneck et al., 2011). Reflecting this difference, fishers reported that DMR is engaged with small-scale lobster fishers; one said 'DMR is way ahead of NOAA'.

Second, ongoing conflict over management of right whales affected views of NOAA, and directly linked to notions of trust. One said the issue with 'whales is one of the reasons that trust has been lost in NOAA'. In contrast, DMR was more widely perceived to support lobster fishers. One respondent said 'DMR is on our side but NMFS [the National Marine Fisheries Service] is not'. These differences in perception among lobster fishers are consistent with the different mandates of these two agencies. Unlike DMR, NOAA has a dual mandate to manage fisheries sustainably and to protect species listed under the Marine Mammal Protection and Endangered Species Acts. Protecting right whale populations from extinction has been a priority for decades (Kraus et al., 2005), and recent rapid declines have resulted in the lowest right whale population size in the last 20 years (Pettis et al., 2022), triggering the 2018 lawsuit to enforce the Endangered Species Act (Besky, 2021). While many fishers acknowledged the need to protect whales, they also pointed to specific points of frustration, which they linked to notions of industry consolidation discussed above. In particular, proposals to reduce impacts on endangered right whales that require ropeless fishing technologies were cast as a force of industry consolidation because of the cost associated with this new technology. One respondent said 'the gear upgrades are prohibitively expensive' estimating his cost to comply would be close to $300,000. While still in development, cost estimates suggest that these upgrades would represent a 40-fold increase from traditional gear (Besky, 2021; Canon, 2021). A second issue raised was linked back to perceptions that right whales do not exist in inshore water where they fish. One noted that restriction should focus on deeper waters, and this lack of geographic distinction among federal regulators was 'one of the reasons that trust has been lost in NOAA'. Another acknowledged the importance of protecting right whales, but expressed frustration at NOAA for a lack of understanding of the lobster fishery's complexity, saying 'NOAA is just not attuned to regional and local differences' within the lobster fishery and that 'view of this as too black and white to gain any traction with fishermen'.

4 | DISCUSSION

Our results suggest that individual visions of the future are broadly aligned with individual perceptions of what was natural; baselines dictated the desired future state for the majority of taxa. In particular, cod and herring emerged as key taxa in a perceived past, natural nearshore Gulf of Maine, which were desired in equally high abundances in the future. Notably, these fisheries have been locally important within the lifetimes of most of our respondents. In contrast, halibut—a fishery whose population crashed in the 19th century (Grasso, 2008)—and whales—hunted to rarity in the 18th century (Reeves et al., 2007)—were perceived as always rare. We also identified two taxa for which where perceptions of baselines were significantly lower than desired future abundances. First, most fishers accurately perceived lobster populations to be at an all-time high, and while they desired this upward trend in abundance to continue, did not expect it to. Alewives were another exception; while fishers desired more in the future, they perceived baselines only slightly lower than today. This difference may be due to the fact that the most significant impacts to this anadromous fish occurred centuries in the past with the onset of river damming (Hall et al., 2012; McClenachan et al., 2015), which was outside of the temporal and geographic focus of the lobster fishers we spoke with. Alternatively, the desire for more alewives in the future may be due to the direct economic value they have to the lobster fishery as bait. The misalignment between past baselines and desired future abundances for these two species demonstrate that both current economic interests and ideas of natural baselines contribute to stakeholders' opinions about their desired future state.

Respondent's views on desired future abundance reveal implicit prioritization of particular species within the ecosystem. Not surprisingly, lobster fishers report a desire for continued high abundances of lobsters in the future. At the same time, fishers expressed a desire for the past higher abundances of cod and herring, suggesting the high value placed on these locally iconic and commercially valuable species. Across all six taxa, fishers reported a desire for more abundant marine animals. Yet the desire for the recovery of

finfish—including cod and other predatory groundfish—to support diversified fisheries, while maintaining high lobster abundances also reveals divergent and incompatible visions of idealized future ecosystems, as inevitable tradeoffs exist among these goals. The recovery of cod populations would certainly alter nearshore trophic dynamics (Zhang et al., 2012), and managing the recovery of predators in the context of highly valuable invertebrate fisheries that have developed in their absence is fraught (Gregr et al., 2020; Howarth et al., 2014). Interview responses reveal the ambivalence that some lobster fishers feel about this potential recovery, and the recognition that managing lobster for highest productivity may be at odds with a recovery of their predators to their natural abundances in the ecosystem.

At the same time, our interviews also underscore the relative lack of focus on climate change. While climate has impacts on both lobster (Goode et al., 2019) and the potential for cod recovery (Pershing et al., 2015), only a small number of respondents mentioned climate as a key driver of change. These responses are consistent with previous work showing that while Maine lobster fishers have observed warming waters, they view climate change as less important than other drivers of change in the Gulf of Maine (McClenachan et al., 2019, 2022).

Our results highlight that while local ecological knowledge is important, it may also temporally limited in a place like the Gulf of Maine with longer term change, as past personal experiences limit perceptions of what is possible. On average, lobster fishers identified baselines just over one decade before they started fishing, and more experienced fishers have fundamentally different views of the abundance of key species in the Gulf of Maine than those just entering the fishery with a more limited knowledge of its past. Cod was at the centre of the European settlement and coastal development in eastern Canada and New England, until the crash of cod populations in the early 1990s (Haedrich & Hamilton, 2010). Across our interviews, fishers who had been active in the 1960s, 1970s, and 1980s had strong memories of high cod abundance, while a small number of those who began fishing after the cod crash had little or no knowledge of this fishery. Given the relatively high number of fishers we spoke with in their 60s as compared to those in their 40s and 50s, it is likely that we captured more of these memories than we would have if our sample had mirrored the age brackets of the fishery more closely. The 1990s also marked the point at which lobster landings surpassed cod landings (Figure 2c); Maine lobster then grew to be the most valuable fishery in the United States (NOAA, 2019); branding initiatives and the development of coastal tourism have made lobster a cultural symbol of the state of Maine (Claesson et al., 2005; Lewis, 1989). Fishers active before the 1990s remembered a natural Gulf of Maine with less lobster than a small number of those who entered the fishery after the 1990s, who considered today's highly abundant lobster populations to be natural. While the majority of fishers do remember a Gulf of Maine with more cod and less lobster, this result underscores the speed at which perceptions of what is natural in an ecosystem can shift, and highlights importance of living memory to constructing a narrative of change. Yet even the experience of older fishers could not capture the entirety of change in the Gulf of Maine, which has experienced intensive exploitation for fish, whales, seabirds since early European settlement (Bolster, 2012).

This limitation in the temporal scope of local ecological knowledge argues for the importance of environmental history to modern conservation. In the Gulf of Maine, our results suggest that the current debate over the future of the endangered north Atlantic right whale depends in part on perceptions of the past. In particular, we identified a perception that the right whale was never found nearshore, and therefore should not be expected to ever be encountered by inshore lobster fishing boats. This perception motivates mistrust in ongoing management aimed at protecting this species from interactions with fishing gear. Yet historical evidence suggests that right whales were found in these inshore waters. Montserrat et al. (2015) estimated that across their range, right whales were more than an order of magnitude more abundant prior to intensive hunting. Tens of thousands of baleen whales were present in the Gulf of Maine in the 17th century, and right whales were hunted in coastal waters in the Gulf of Maine at this time, with estimate of a minimum of 2500 right whales killed in coastal waters between Delaware and Maine from 1696–1734 (Reeves et al., 2007). Right whales were described as swimming just off the beaches of nearby Cape Cod around 1630, but by the 18th century, coastal whales were essentially eradicated. One observer in 1794 noted, 'Seventy or eighty years ago, the whale bay fishery was carried on in boats from shore, to great advantage. This business employed nearly 200 men for three months of the year, the fall and beginning of winter. But few whales now come into the bay, and this kind of fishery has for a long time (by this town at least) been given up' (Bolster, 2008). In the late 19th century, a brief but intense shore-based whale fishing developed, focused on humpback and fin whaling (Reeves et al., 2002). The early decline and lack of subsequent recovery for right whales means that these inshore populations have been forgotten, which has implications for the ongoing controversy around the recovery and conservation of this species. This loss of ecological memory through time, or shifting ecological baseline, is similar to those reported from marine systems around the world (e.g., Lovell et al., 2020; Saenz-Arroyo et al., 2005).

Our results suggest that in addition to shifting ecological baselines, the concept of social baselines is also important in assessing stakeholder views of change. Stakeholder views of the past were based not just on perceptions of past ecosystems, but also on perceptions of their access to a complex suite of fisheries that they targeted seasonally throughout the year, and which supported small-scale, owner-operated fishing fleets along the Maine coast. Specifically, fishers expressed memories of and desire for multispecies diversified fisheries based on restored groundfish and forage fish populations, but simultaneously held the view that management has worked toward consolidation within the industry effectively blocking this outcome. By the 1980s, nearshore populations of cod were highly depleted (Ames, 2004), with population crashes throughout the region in the early to mid-1990s. Among some of the people we interviewed, memories of cod abundance in

the 1970s and 1980s were coupled with memories of a diversified and accessible fishery, but fishers doubted that the recovery of cod would result in their restored access to cod fisheries. These perceptions are based on experience and observations of statewide licence consolidation that has occurred over the past four decades (Stoll et al., 2016). In particular, the consolidation of groundfish licences has helped to concentrate wealth into the hands of fewer and larger vessel owners and marginalized small-scale fishers. Across New England, the number of ports with active fishers declined by at least 30% between 1997 and 2009, with small, rural ports losing the most access (Bradley, 2011). In Maine, fishers' access to licences has decreased by 50% between 1990 and 2014 (Stoll et al., 2016). The responses we heard from fishers demonstrated frustration at this outcome. Together our results show how stakeholder perceptions of both social and ecological baselines shape visions for future ecosystems, but are mediated by contemporary issues such as trust in institutions and fisheries access.

The results of our study should be considered in light of several limitations. First, our small sample size means that the quantitative results are best understood in the context of the qualitative results that we derived from the open-ended interview questions. Second, we spoke only with one stakeholder group. Representatives of environmental groups, government agency employees, and members of Indigenous communities are likely to have different views of the past baseline and desired future state of the Gulf of Maine. In particular, given differences in oral histories and cultural engagement with the ocean (Wiseman, 2005), Indigenous perspectives on baselines for the Gulf of Maine would likely reflect different priorities and narratives of change. Maine has a strong tradition of employing fishers' knowledge (e.g. Ames, 2004), yet such work has focused almost exclusively on settler communities (Besky, 2021). Emerging work in the state (de Leon, 2022; Newsome et al., 2021), as well as broader calls to create more substantive models of reciprocal engagement with Indigenous perspectives in fisheries (Reid et al., 2021) suggest that Indigenous voices will be an important part of future work employing local ecological knowledge in marine fisheries in this region.

Together, this case studies demonstrates that fishers' memories are important but insufficient to recover past productivity in marine ecosystems. Similar insights about the value of local ecological knowledge to conservation have emerged from diverse research with applications including biodiversity conservation, understanding climate changes and impacts, and migratory bird conservation (Brook & McLachlan, 2008). Here, we found evidence of a consolidation of views of a 'natural' Gulf of Maine existing in the 1970s and 1980s, but that this vision is limited by age and turnover; the 'graying of the fleet' has been observed to create a large gap between generations of fishers (Johnson & Mazur, 2018) and the loss of leadership and social capital associated with the turnover of this aging fishery (Henry & Johnson, 2015) also means a loss of this local knowledge. These results demonstrate the essential role of local knowledge to preserve these memories of finfish-dominated ecosystems that supported diversified, small-scaled fisheries. Yet, fishers' memories are insufficient to recovering productive and diversified fisheries in the face of institutional barriers. For example, if recovery of productive cod fisheries is a goal, memories of abundant cod in a more natural nearshore Gulf of Maine must be preserved, but the processes of fisheries consolidation must also be undone, including restoring access of small-scale fishers. Likewise, if limiting the spatial expansion of lobster fisheries and preserving the strong co-management structure in the Maine lobster fishery is a goal (Alden, 2011), incentivizing investments in large lobster vessels to fish offshore is counterproductive. Finally, our results highlight the hard limitations of local knowledge in the context of conservation and recovery of species like the endangered right whale, whose populations declined centuries in the past; perceptions of a natural Gulf of Maine exclude this species entirely. Together this case study demonstrates the complex ways in which baselines interact with contemporary values in managing fisheries and coastal ecosystems, and demonstrates the value and limitations of local knowledge to ecosystem management and recovery.

AUTHOR CONTRIBUTIONS

Loren McClenachan and Benjamin Neal designed the survey, conducted interviews and edited the manuscript. Loren McClenachan analysed the data and wrote the manuscript.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

Interview data are confidential due to ethical considerations.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Appendix S1: Interview questions.

Appendix S2: Sample age range as compared to state averages.

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