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UNIVERSITY OF CALIFORNIA SAN DIEGO

An overview of the kelp forest restoration discourse: perspectives, challenges, and solutions

A Thesis submitted in partial satisfaction of the requirements
for the degree Master of Science

in

Marine Biology

by

Kira Kawano

Committee in charge:

Octavio Aburto, Chair
Ed Parnell
Colleen Petrik

2023

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The Thesis of Kira Kawano is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

University of California San Diego

2023

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LIST OF ABBREVIATIONS

MHW	Marine heat wave
CDFW	California Department of Fish and Wildlife
NGO	Non-governmental organization
MCA	Multiple correspondence analysis

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ABSTRACT OF THE THESIS

An overview of the kelp forest restoration discourse: perspectives, challenges, and solutions

by

Kira Kawano

Master of Science in Marine Biology

University of California San Diego, 2023

Octavio Aburto, Chair

The marine heatwave in 2014 resulted in the mass mortality of kelp forests along the California coast. In particular, Northern California has lost approximately 95% of its historical kelp cover, resulting in the transformation of many areas into persistent urchin barrens. The dramatic shift in the Northern California ecosystem has prompted stakeholders in kelp forests to take action and invest in restoration efforts. These groups include commercial urchin divers, researchers, non-governmental organizations (NGOs), and government representatives. Grazer suppression is a method for restoring kelp that has gained interest in recent years. Although some

groups are pursuing this method of restoration, there are individuals who have expressed doubts about its effectiveness. This study aims to investigate the underlying factors that influence the perspectives of individuals across different stakeholder groups, and how these perspectives shape their perceptions of challenges and proposed solutions. Results show that NGOs and commercial urchin divers share similar perspectives, whereas researchers and government representatives hold differing views. All groups agree that the process of removing sea urchins is labor-intensive and expensive. However, not all groups were in agreement when discussing potential solutions. These results provide an overview of the diverse perspectives of important stakeholders involved in kelp restoration and serve as a progress report on restoration efforts.

INTRODUCTION

Kelp forests are crucial ecosystems that comprise a quarter of the world's coastlines (Krumhansl et al., 2016). These forests provide ecosystem services, including habitat and food resources (Jones et al., 1997) and serve as a refuge for commercially important species (Carr, 1994). Due to anthropogenic climate change, kelp forests worldwide have been experiencing a decline. As a result, there has been an increase in attempts to restore these ecosystems. A recent review of global kelp restoration efforts concluded that reducing grazer suppression of urchins is a crucial factor for successful restoration and highlighted California as one of the leading states in kelp restoration efforts (Eger et al., 2022).

In the southern region of California, kelp forests primarily consist of *Macrocystis* (Steneck et al., 2002). Restoration efforts aimed at protecting kelp forests date back to the late 1950s when quicklime was used to control grazing urchins in Southern California (Wilson and North, 1983) (see Figure 1). Urchin culling was another method that was used in the 1960s and 1970s. Some projects succeeded while others failed due to warming events, urchin incursions, and storms (Wilson and North, 1983).

Restoration efforts in California remained at a low level until the marine heatwave (MHW) in 2014-2015 impacted northern California. In this region, the forests consist mainly of *Nereocystis* (bull kelp) which support fisheries for red abalone and red sea urchin (Rogers-Bennett and Catton, 2019). The abnormal warming event, combined with several other stressors, led to the decline of kelp forests in northern California and the emergence of persistent purple urchin barrens. This shift to an unproductive system led to the closure of the recreational abalone fishery and the collapse of the red sea urchin fishery (Rogers-Bennett and Catton, 2019). It prompted a wide range of stakeholders to address recovery efforts in Northern California.

Stakeholders include commercial sea urchin divers, non-governmental organizations (NGOs), researchers, and government agencies. The California Department of Fish and Wildlife (CDFW) has been working with stakeholders to find solutions to various issues. Many of these projects focus on maintaining low grazer densities (Eger et al., 2022)

Despite the widespread interest in restoring kelp forests, some researchers have expressed doubts about the effectiveness of small-scale interventions in combating the significant anthropogenic threats that contribute to the loss of these habitats (Hughes et al., 2017). On the opposite end of the spectrum, some argue that these projects are undervalued and can actually help maintain species survival (Gordon et al., 2020). These opposing viewpoints contribute to a "conservation gridlock" that is driven by a preconceived dismissal of conservation approaches on a larger scale (Velde et al., 2019)

The aim of this study is to present a comprehensive analysis of the discourse surrounding sea urchin removal in California's kelp forests by examining the viewpoints of four key stakeholder groups: researchers, NGOs, commercial urchin divers, and government officials. This study is not intended to generalize about each group, but rather to help us comprehend the various perspectives on urchin removal among different stakeholders in kelp forests, identify perceived challenges, and propose potential solutions. By identifying points of contention and potential areas of agreement, this paper aims to increase transparency in the kelp restoration field and facilitate constructive conversations between different groups.

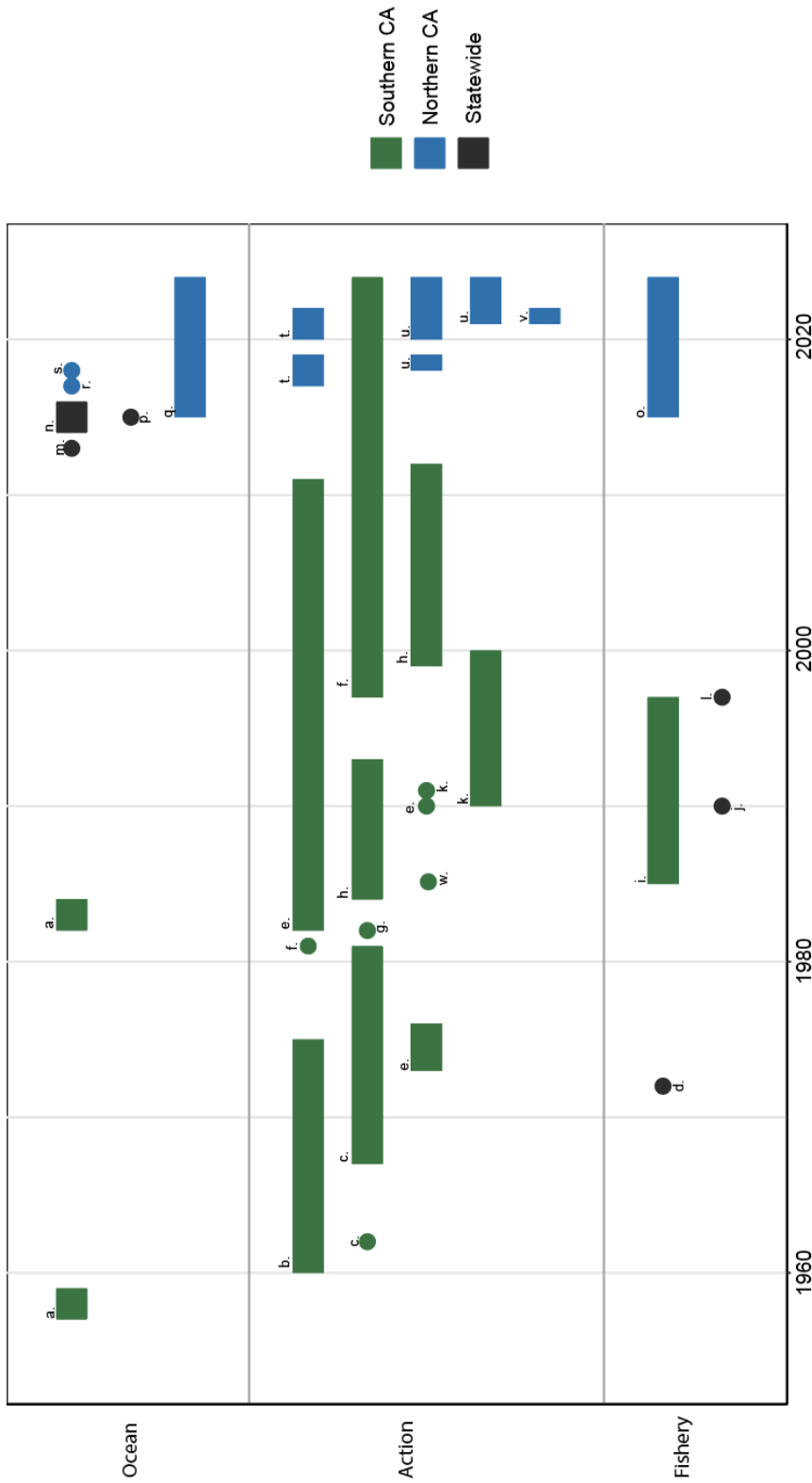


Figure 1: Timeline of kelp forest restoration and relevant events in California

- j. El Niño (Tegner and Dayton, 1991)
- k. Quacklime (Collins et al., 2001; Wilson and North, 1983)
- l. Sewage treatment improvement (Foster and Schiel, 2010)
- m. N. CA commercial urchin fishery opens (Wilson and North, 1983)
- n. Out planting kelp (Collins et al., 2001)
- o. Hammering urchins (Collins et al., 2001)
- p. Suctioning urchins (Collins et al., 2001)
- q. Artificial reefs (Danner et al., 1994)
- r. Withering syndrome (Lafferty and Kuris, 1993)
- s. Recreational abalone closure (Rogers-Bennett and Catton, 2019)
- t. Urchin removal by commercial divers (Hohman et al., 2019)
- u. Urchin removal by recreational divers (CDFW, 2021; Hohman et al., 2019)
- v. Purple urchin trapping (CDFW, 2021)
- a. Commercial red urchin fishing restrictions (CDFW, 2019)
- b. Control urchin grazing with artificial kelp (Collins et al., 2001)
- c. Closure of commercial abalone (Rogers-Bennett and Catton, 2019)
- d. Sea star wasting disease (Hewson et al., 2014)
- e. Marine heatwave (Lorenzo and Mantua, 2016)
- f. Collapse of red urchin fishery (Rogers-Bennett and Catton, 2019)
- g. High recruitment of purple urchins (Rogers-Bennett and Catton, 2019)
- h. Sea urchin barrens (Rogers-Bennett and Catton, 2019)
- i. Mass abalone mortality (Rogers-Bennett and Catton, 2019)

METHODS

This study focuses on stakeholders who are involved in kelp forests along the California coast. These stakeholders may include individuals whose livelihoods or research are centered around forests, as well as those who are actively working to manage these ecosystems. Those included in this study are commercial red urchin fishermen, academic researchers, NGOs, and government agencies.

This approach is similar to the one outlined in McNeill et al. (2018) where qualitative research is employed to provide an overview of stakeholder sentiment. Semi-structured interviews were conducted from December 2022 to April 2023 via phone, Zoom, or in-person and lasted between 20 minutes and two hours. After each interview concluded, participants were asked to recommend other individuals in their network who would be willing to participate in an interview. The questions covered various topics related to the removal of urchins, including thoughts and challenges associated with the process, the necessity of human intervention, recommended next steps, and opinions on the effectiveness of current state efforts. Snowball sampling (Goodman, 1961) was used to ensure that experts from each group were contacted, resulting in a total of 24 participants. Information from four participants was discarded because they did not answer all the questions, leaving a total of 20 interviews to be analyzed (Figure 2).

Out of all the participants, six were researchers from five different academic institutions, six were from various NGOs, four were urchin divers, and four were from three different government agencies. Due to time limitations, we were unable to interview all of the recommended contacts. The interviews were recorded with the participants' consent, and the transcription service, Sonix, was used to transcribe the audio. Recordings were reviewed for

accuracy, anonymized, and categorized by identifying group before being imported into Nvivo11 for qualitative analysis.

Within NVivo11, quotes from interviews were sorted into recurring themes. Based on the responses from the interviews, each participant was classified according to the categories outlined in Table 1. Similar to the approach taken by Parnell et al. (2010) we utilized multiple correspondence analysis (MCA) to identify variations among individuals based on their responses (Nenadic and Greenacre, 2005) The variables in this analysis The variables in this analysis include urgency, next steps, opinion on urchin removal, and opinion on state efforts. The factor analyzed in this study was the stakeholder group. Contingency tables were created for each individual. Due to the relatively small sample size, Fisher's exact test was performed on the contingency table to determine whether there were statistically significant differences between stakeholder groups.

Stakeholder groups were categorized based on their perspectives before analyzing the interviews to uncover the underlying factors that influence their opinions on urchin removal. Tables were created to display the perspectives of each group regarding urchin removal, perceived challenges, and potential solutions. The tables counted the frequency of themes that emerged in each interview. Examples of sorted quotations regarding perceived challenges can be found in Table 2. If a participant mentions a theme multiple times, it will only be counted once for that participant. However, if a participant mentions multiple themes, each theme mentioned by that participant is counted once. Since individuals can identify with multiple themes, MCA was not utilized.

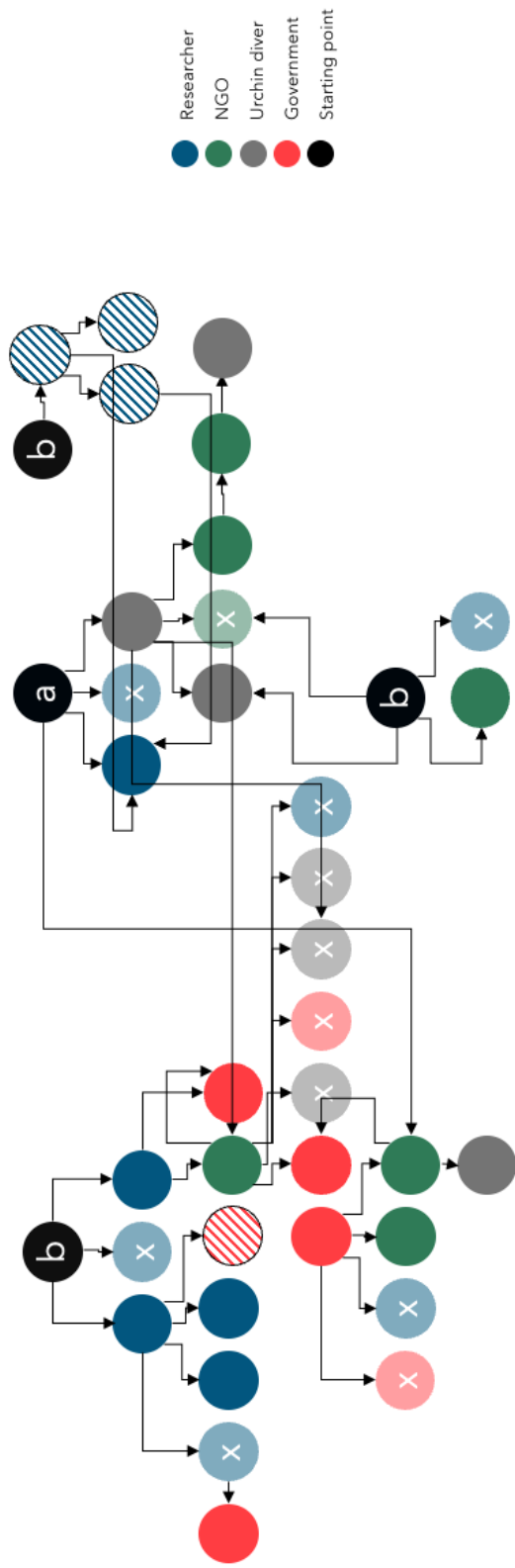


Figure 2: Diagram of the snowball method. Striped circles represent interviewed individuals that were not included in the final analysis. Transparent circles with an x represent individuals who were contacted but did not respond. a. researcher included in analysis. b. not included in analysis.

Table 1: Examples of categorized quotes for each variable.

Variable	Category	Quote example
Urgency	Urgent: Need to intervene, must act now	“But right now we have a collapse of our nearshore ecosystem and we should be really proactive and scaling a large collaborative experiment to remedy that and to figure it out.”
	Not urgent: Don't need to intervene, kelp will recover	“[kelp] is dynamic. They change quite a lot. And so maybe, we just don't need to freak out completely right now and just realize that in time it will switch back”
	More experiments: Need more research to determine intervention is successful/necessary	“There's definite value in setting up some of these pilot projects to see whether this approach is effective in the sense of ‘does kelp come back when you remove urchins?’”
	Active: Introducing or removing biotic or abiotic materials	“Really what we can manage as a management agency and in kelp restoration projects is reducing grazing pressure and out planting and trying to build resilience back into the ecosystem to better prepare for future disturbances.”
Next steps	Passive: Methods that don't manipulate kelp or their consumers	“MPAs for sure, I think can help. I mean, we've seen, for example, with sheephead with lobsters, right. It's really the larger individuals that are the ones that are eating urchins.”
	Positive: Believe it can be effective to restore kelp and should be supported	“It seems to my perspective at least, is removing the grazing pressure is pretty key and either humans have to do it or you're going to have to wait for the urchins to die.”
	Negative: Not effective, no point in intervening	“so there is this multidecadal fluctuation and but I just I don't think people swinging hammers can scale to the extent required to maintain massive areas.”
Opinion of urchin removal	Neutral: Still too early in pilot projects to form opinion	“I think it is too early, at least for the bull kelp system... the state is investing a lot in trying to fill these knowledge gaps, which I think is really important.”
	Positive: State is doing what they can, government agencies default	They're trying to be pretty proactive, know. I mean, they've funded a whole bunch of research projects to try to get at this issue and figure out what restoration techniques may work, which ones may not. And so I think, you know, they acted fairly quickly.”
Opinion of state efforts	Negative: State is not doing enough, frustration	“If something happens to the kelp, it should trigger an immediate state of emergency. Immediately fix it. All hands on deck. Whatever it takes. It's unacceptable.”

Table 2: Examples of categorized quotes regarding opinion on urchin removal.

Challenges	
Labor intensive	“But I think that, you know, the challenges have been that there’s just so many urchin out there that you can clear an area and then a month later you need to clear it again. So that’s a huge challenge.”
Cannot be scaled up	“So I think it has good potential. Local restoration, but very large scale. I mean, my God, the scale of that effort, I think, is potentially unrealistic.”
Expensive	“They’re pretty well stuck on there. You have to shove it in the bag and then get to repeat until the bag is full, and then it has to be lifted up to a boat. And then the boat. So you have to have a boat, and then you have to have some dock support. And then there has to be some support at some facility offsite. And it becomes really expensive at that point.”
Constant maintenance	And for example, like the work I’ve been doing on Northern California, it was just like it’s a small, fairly small area, like less than a hectare. And it’s like you’re constantly going in there and taking urchins out.”
Site accessibility	“But then we had storms in the winter, we couldn’t get out there, and then those urchins just mowed that place down and it went from like six to 4 to 2 and a half, you know, kept getting smaller until over the winter. Then there wasn’t any help north of our site.”
Limited divers	“They are very supportive in a general sense of broad stroke, but I’ve tried to recruit divers to assist me in the project here around the Palos Verdes Peninsula and. They try it for a while and then they go back to urchin picking, because right now the bottom line is that there’s not enough money to pay them what they’re making urchin diving.”
Coordination	“You know, working with recreational divers, there’s a lot of challenges there in terms of coordination and logistics. And, you know, different recreational divers have different abilities. You know, there’s a huge range there and it takes a lot of. As I say, coordination.”
Lack of infrastructure	“We have to be really strategic about which locations we choose [for urchin removal] because if we remove urchins along the entire coastline, we just don’t have the infrastructure to even do that.”
Funding	“But then funding ended. But restoration projects don’t happen on that kind of time frame. So long term funding is definitely always a challenge, especially when you work with commercial divers because they’re not cheap.”
Permits slow	“Frankly, our permitting structure to be able to do restoration is pretty complicated and slow moving, which makes it pretty difficult to be able to plan like research initiatives in good timing... So it can be kind of challenging to kind of course out like how to do this work when the permitting itself takes a while.”

RESULTS

STAKEHOLDER PERSPECTIVES

The MCA analysis accounted for ~77% of the total observed variance. Dimension 1 accounted for 47.8% of the variance, with the primary drivers being the opinion of the state and the category of next steps. Dimension 2 accounted for 28.9% of the variance, with the primary factors being the opinion of removal and the sense of urgency. Figure 1 is a biplot that displays the distribution of individuals grouped by the qualities that tend to define them. The level of urgency and the opinion regarding removal account for most of the variability observed in dimension 1 and 2 (Figure 3).

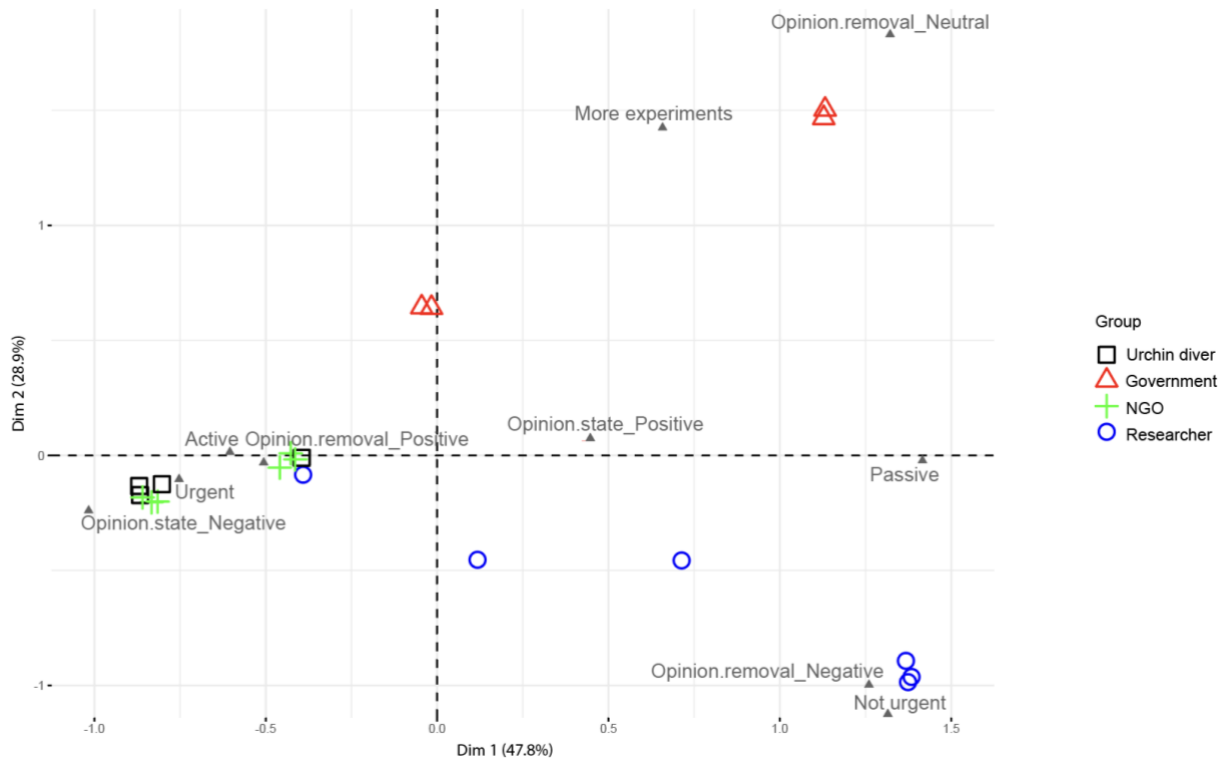


Figure 3: MCA plot of respondents and categories shown with jitter.

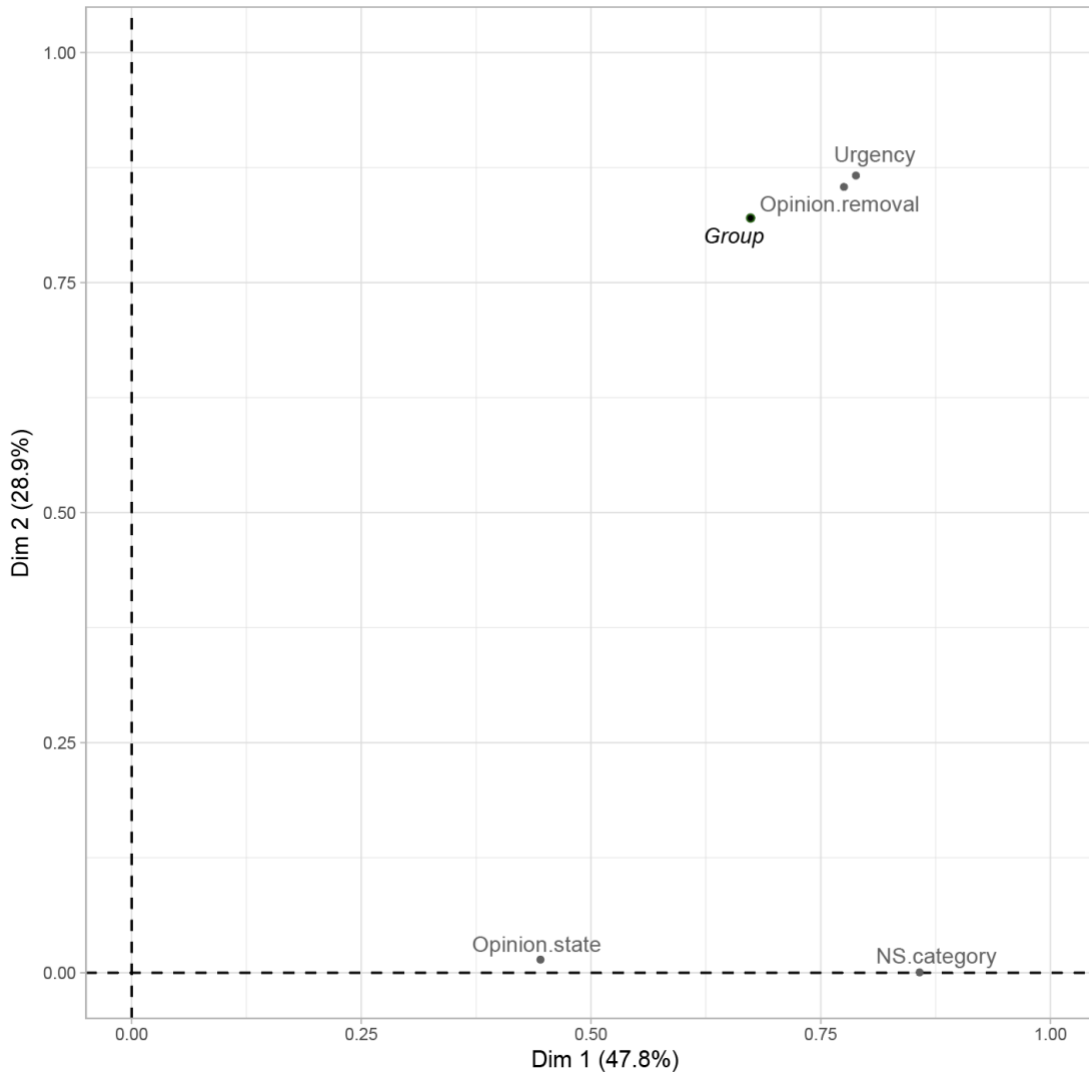


Figure 4: Correlation between variables and principle dimensions

NGOs and urchin divers exhibit a p-value $> .95$, whereas all other group combinations demonstrate a p-value $< .05$ (refer to Table 3). Results from the MCA and Fisher's exact test suggest that there are three distinct perspectives on kelp forest restoration among the interviewed participants. The study will investigate the perceived challenges and proposed solutions of respondents, categorized by their respective perspective groups. The following sections will provide a more in-depth analysis of each perspective, including the prominent themes that emerged during the interviews.

Table 3: P-values of each stakeholder group

	Researcher	Government	NGO	Urchin diver
Researcher	x	0.03879	0.0008812	0.002213
Government	x	x	0.001926	0.005307
NGO	x	x	x	0.9867

1. URCHIN DIVERS AND NGOS

The first perspective is held by individuals who consider the recent decline in kelp as an urgent matter. They have a favorable view of urchin removal and prefer active intervention. However, they hold a negative opinion of the current state efforts. This group was primarily composed of respondents categorized as NGO workers and urchin divers, with the exception of one respondent from the researcher category.

1.1. Kelp forest degradation as a motivator

Many respondents within this particular group viewed the deforestation of kelp as an urgent matter and suggested that urchin removal should be implemented along California's coastline (Table 4). This group also comprises individuals whose livelihoods have been directly and adversely affected by kelp declines, as well as those who are actively collaborating with those affected. A common theme among respondents in this perspective group was their connection to the kelp forest and how the transformation of the kelp forests into urchin barrens motivated them to become involved in restoration efforts. One respondent recounts their experience, "When I saw Lovers Cove become destroyed, it just got wrecked and full of urchins.

That was kind of the tipping point for me." Another described, "I'd have people coming to my office on the regular... old men that have been diving here forever, crying in my office saying 'I've never seen it like this. What can we do? How can I help?'"

1.2. Dissatisfaction with current management

A common theme among this group was dissatisfaction with the current state management efforts and the slow pace at which the issue of kelp deforestation was being addressed. Some respondents expressed that there appears to be a significant amount of "stagnant activity, where nobody is really doing anything." Individuals from this group reported that they were assured of proactive management from the government, but they feel disappointed and let down. As explained by one respondent, "There seems to be a temporal disconnect, where the state is really looking five to ten years out and the community is looking back and saying, look, it's been ten years and how much have we done?"

When asked to provide their opinion on state efforts, commercial urchin divers explained that their lack of trust was due to past actions taken by the state. Commercial urchin divers have expressed distrust due to their inability to regulate the abalone population, past unsuccessful attempts to reintroduce otters, and current efforts to establish Marine Protected Areas (MPAs). Overall, individuals in this group believe that the state works too slowly to address urgent matters.

1.3. Frustration with academic institutions

Although the questions did not explicitly ask for opinions on the research efforts of academic institutions, respondents expressed frustration with these institutions. Some

respondents expressed frustration with researchers who focus on conducting more studies to "describe the water that we're drowning in" instead of taking affirmative action. It was also mentioned that some respondents from this perspective group had attempted to collaborate with these academic institutions by reaching out to them, but they were rejected. Researchers are still criticized for "preaching from their ivory tower" instead of getting involved. One respondent describes the relationship between academic institutions, government, and larger NGOs as a "revolving door" that creates an illusion of action.

1.4. Need to work with impacted communities

There is also concern that not enough attention is being directed towards the communities that are directly impacted by the decline in kelp forests along the coastline. One respondent expressed that they feel like there is a lot of talk but not enough action in their community.

1.5. Blaming fishermen

Some commercial urchin divers have expressed that they are often unfairly blamed for the collapse of fisheries. They argue that it is actually the responsibility of the state to properly manage resources. One respondent explains, "a lot of people who are not involved will usually point to a fishermen and blame them for their greed, accusing them of taking it all at once. But there's a way to fish responsibly. Before, we didn't even have size limits."

Table 4: Summary of opinions on urchin removal by stakeholder group

Opinion	Description of opinion	Number (%) of interviews coded to this theme		
		Researcher (n=6)	Government (n=4)	NGO + Urchin Diver (n=10)
Positive	Successful	5 (83%)		9 (90%)
	Important	3 (50%)	2 (50%)	9 (90%)
	Immediate payoff	1 (17%)	1 (25%)	1 (10%)
	Divers supportive			3 (30%)
	Can be scaled up	1 (17%)		3 (30%)
Negative	Not necessary	3 (50%)	1 (25%)	
	Larger issue	4 (67%)	3 (75%)	4 (40%)
Neutral	Too early		2 (50%)	

Note: Themes where more than half (50%) of individuals in a stakeholder group agree are in bold.

2. RESEARCHERS

This perspective is held by individuals who consider the recent decline in kelp as a non-urgent issue, hold a negative view towards urchin removal, prefer passive intervention, and have a positive opinion of the current state efforts. This group consists of individuals categorized as researchers.

2.1. Negative opinion of urchin removal

Respondents in this perspective group were aware of the success of these efforts and did not deny the fact that removing urchins can lead to kelp recovery. However, unlike individuals in the first perspective, respondents in the second perspective group voiced that intervention methods may not always be necessary due to the natural variability of kelp (refer to Table 4). Respondents often discussed kelp on larger spatial and longer temporal scales than those mentioned in perspective one. One respondent explains that "yes, there has been a concerning number of kelp declines and urchin barrens. But I don't think that just because we're seeing kelp

declines in some states, we should just go out and put all hands on deck to clear out as many urchins as possible."

Some expressed a more pessimistic view, stating that intervening would be pointless if efforts were to be erased by the increasing frequency of warming events caused by climate change. "No matter how well you prepare the bottom and set up a wonderful octopus's garden, the climate can still throw a nasty wrench into it."

2.2. Passive intervention

Respondents in this group also preferred passive interventions, such as MPAs and slot fisheries, which operate on longer timescales than active interventions. These restoration methods targeted predators in Southern California, such as the sheepshead and spiny lobster. One respondent explains, "MPAs can definitely help, I think. We have seen, for example, with sheepshead and lobsters. It is primarily the larger individuals that are the ones eating urchins... So if you want these predators to come back and perform this role, you have to limit or restrict fishing."

2.3. State is doing what they can to address kelp deforestation

Individuals in this perspective group hold a generally positive opinion of the current state efforts and believe that the California Department of Fish and Wildlife (CDFW) acted fairly quickly in addressing the situation. "They're trying to be proactive. They have funded a whole bunch of research projects to address this issue and figure out what restoration techniques may work, which ones may not. And so, I think they acted fairly quickly." Respondents from this perspective group acknowledge that the state faces many challenges when balancing the needs of

the environment and fishermen. “Could they do more? Sure, of course they could do more. But compared to other states, I think ours is quite proactive... They're very aware of the problem and they're actively trying.”

2.4. Subdivision within researchers

A few individuals did not cluster with the second perspective group; instead, they were spread out along the first dimension. These respondents are those who choose to actively intervene and hold a favorable view towards removing urchins, which places them closer to the group of respondents who align with the first perspective. A common theme among these interviews was the recognition of the significant issue of climate change, coupled with a pressing need to reduce some of its adverse effects.

3. GOVERNMENT REPRESENTATIVES

This perspective consists of individuals who prefer conducting more experiments before determining the urgency of the situation. They hold a neutral opinion regarding urchin removal and prefer passive intervention.

3.1. Too early in the process

A common theme that emerged during the interviews was that it was still too early in the pilot projects to determine whether or not the participants supported the removal of urchins (refer to Table 4). Respondents explained that further research is necessary to comprehensively understand the consequences of restoration efforts. One individual stated, "I believe that studying a variety of methods and understanding both the consequences of it and the costs... and

understanding what's going to happen and think about how this might be scalable or might not be scalable, or what are some unintended consequences that hadn't been anticipated in the initial design of some management technique.” This person is currently working to fill knowledge gaps in order to develop a statewide management plan to address kelp deforestation.

3.2. Subdivision within government representatives

Similar to the researcher group, some individuals in the government representative stakeholder group were positioned further to the left. These respondents supported active intervention and viewed kelp deforestation as an urgent matter.

GRAZER SUPPRESSION CHALLENGES

All groups expressed concerns about the challenges associated with removing urchins. Table 5 displays a breakdown of the types of challenges mentioned during interviews, categorized by perspective group. All groups agreed that removing urchins can be labor-intensive and expensive. However, some groups mentioned additional challenges that were specific to their situation. This section will highlight some of the challenges on which all groups agree, as well as some of the unique challenges of urchin removal mentioned during interviews by each perspective group.

Table 5: Challenges described by stakeholder group

Challenge	Number (%) of interviews coded to this theme		
	Researcher (n=6)	Government (n=4)	NGO + Urchin diver (n=10)
Labor intensive	5 (83%)	3 (75%)	8 (80%)
Cannot be scaled up	4 (67%)	2 (50%)	
Expensive	4 (67%)	3 (75%)	7 (70%)
Constant maintenance	2 (33%)		2 (20%)
Site accessibility	3 (50%)	1 (25%)	6 (60%)
Limited divers	2 (33%)	1 (25%)	3 (30%)
Coordination		1 (25%)	1 (10%)
Lack of infrastructure		1 (25%)	
Funding	1 (17%)	1 (25%)	6 (60%)
Permit issues			6 (60%)

Note: Themes where more than half (50%) of individuals in a stakeholder group agree are in bold.

All perspective groups agreed that grazer suppression is both costly and requires a lot of labor, although this sentiment was most strongly expressed by respondents in perspective three. Respondents in the first and third perspective groups also expressed that these were two of the main reasons why they did not see it as feasible to be scaled up. However, some respondents in the third group expressed that large-scale removal efforts were never part of the plan. Instead, they suggested focusing on small areas to protect the genetic diversity of kelp. Some respondents in the first perspective group expressed that the state should be proactive in scaling up a large collaborative experiment to remedy the issue and figure out a solution.

Some challenges were unique to specific perspective groups. Respondents in the first perspective mentioned challenges related to securing long-term funding and obtaining necessary permits for conducting restoration efforts. Respondents stated that the majority of funding is provided on a yearly basis, which can make it challenging to plan restoration efforts. Respondents reported experiencing difficulties in obtaining permits for restoration projects. They stated that the permitting process is complex and slow-moving, making it challenging to plan research initiatives in a timely manner.

Although the issue of limited divers was not mentioned by the majority of those in perspective one, it was raised by almost all of the urchin divers and therefore deserves to be addressed. The interviewed urchin divers stated that many individuals in the commercial urchin diving community are concerned about the kelp forests. One diver recounts, "It has always been a reward in itself just to be down there and witness this amazing underwater wonderland playground. I feel like most of the sea urchin divers will feel that." They are willing to assist in the restoration efforts. However, fishing is more profitable than the compensation they would receive for restoration work, making it difficult for them to support removal efforts.

SUGGESTED SOLUTIONS

This section outlines the recommended next steps for each perspective group, as shown in Table 6. There was no consensus among the group regarding the next steps. Researchers opted for long-term solutions, such as MPAs and further research. Government representatives expressed interest in exploring market-based solutions, such as restorative aquaculture, incentivizing urchin divers to participate in removal efforts, and conducting further research. Urchin divers and NGOs offered various solutions, but they mostly agreed on the need for faster permitting processes. During the interviews, respondents also mentioned some other potential issues that may arise with the proposed solutions. The discussion regarding certain concepts is presented in Table 7.

Table 6: Summary of suggested next steps by stakeholder group

Challenge	Solution	Discourse
Labor intensive	<ol style="list-style-type: none"> 1. Urchin traps 2. Increase predation pressure 	<ol style="list-style-type: none"> 1. Some participants skeptical. Argue that traps would only bring in more urchins 2. [see site accessibility]
Expensive	<ol style="list-style-type: none"> 1. Work with volunteers 2. Restorative aquaculture 3. Fertilizer/other uses 	<ol style="list-style-type: none"> 1. Requires lots of coordination. Need to develop curriculum/training to ensure safety of volunteers. 2. Expensive process that only targets larger purple urchins. 3. Can target smaller urchins, but may not produce enough revenue to fund removal efforts.
Site accessibility	<ol style="list-style-type: none"> 1. Increase predation pressure <ol style="list-style-type: none"> a. MPAs b. Sunflower star reintroduction c. Sea otter reintroduction 	<ol style="list-style-type: none"> 1. Urchin divers expressed that they are not supportive. 2. Some respondents skeptical about their role as sea urchin predators. Some concern about resilience toward increased warming events. 3. Urchin divers heavily opposed.
Permit problems	<ol style="list-style-type: none"> 1. Speed up permitting 2. Allow for more experimentation 	<ol style="list-style-type: none"> 1. Requires state to invest in own offices. 2. State does not have the money to fund every single experiment.

Table 7: Solutions to urchin removal challenges and their accompanying discourse

Suggested solution	Number (%) of interviews coded to this theme		
	Researcher (n = 6)	Government (n = 4)	NGO + Urchin diver
Urchin traps			2 (20%)
Allow for more experimentation	1 (17%)		4 (40%)
MPAs	3 (50%)		
Slot fishery	2 (33%)		1 (10%)
Sunflower star reintroduction	1 (17%)	1 (25%)	3 (30%)
Sea otter reintroduction			1 (10%)
Restorative aquaculture	1 (17%)	2 (50%)	3 (30%)
Restorative fishery		1 (25%)	2 (20%)
Long-term funding	1 (17%)	1 (25%)	3 (30%)
Invest in smaller orgs			2 (20%)
Public education	1 (17%)	1 (25%)	3 (30%)
More studies	5 (83%)	4 (100%)	2 (20%)
Faster permitting	1 (17%)		5 (50%)
Incentivize urchin divers	2 (33%)	2 (50%)	3 (30%)

Note: Themes where more than half (50%) of individuals in a stakeholder group agree are in bold.

DISCUSSION

This study revealed three prominent perspectives on grazer suppression and reflects current collaboration efforts among stakeholder groups. The MCA and Fisher's exact test reveal that stakeholder groups often consist of individuals who share similar perspectives on grazer suppression. The strongest disagreements were observed between perspective one and two, as well as one and three. Individuals from perspective one expressed their dissatisfaction and frustration with government agencies and researchers. This dissonance has been observed before among stakeholder groups in previous studies. Many fishermen have displayed distrust toward government agencies and researchers (Clarke et al., 2016; Wilson and Wilson, 2014). Fishermen often feel powerless when policies are imposed from the top-down, which reinforces their skepticism of research projects (Ebel et al., 2018).

The respondents are clustered under the first perspective, representing either an NGO or a commercial urchin diver. It should be noted that most of the urchin divers who participated in this study were referred to by either a researcher or an NGO. Some urchin divers who may not want any affiliation with scientists would refuse to participate in this study. It should be noted that there are individuals who identify as a particular stakeholder group but may not necessarily share the same perspective. These individuals are actively working with members of the other perspective group. These findings are consistent with those of Ebel et al. (2018) and indicate that individuals who strongly identify with their defining perspective should invest more effort in building meaningful relationships with those who hold different perspectives.

This study serves as a check-in for current restoration efforts by providing insights into the challenges that different stakeholders are facing. It suggests potential areas for collaboration between groups. All groups agreed that the process of removing can be labor-intensive and expensive. However, they had different approaches to resolving these issues. Researchers viewed these as reasons to invest in other solutions such as MPAs or suggested that more research is needed, whereas NGOs and fishermen suggested a variety of other solutions that provide support for restoration efforts. NGOs and fishermen recommended a wide variety of solutions, but they mostly agreed on speeding up the permitting process to enable the implementation of more projects. Members of this group prefer more active intervention measures, while those in the researcher group prefer long-term solutions that may take longer to yield results. Government agencies share the researchers' view that more research is needed, but they also suggest other solutions such as incentivizing divers and exploring market-based approaches.

Each perspective group has a distinct approach to achieving restoration goals. Disagreements about the exact process can impede progress in restoration efforts and lead to frustration with lack of activity. These results raise some points of contention that should be addressed in collaborative meetings.

Although this study identified common themes within each stakeholder group, its findings are limited by the small sample size of participants. The snowball sampling technique presents its own limitations and may lead to biased samples. This is because individuals who have no connection to the original interviewee may be excluded from the study (Cohen and Arieli, 2011). This can become apparent when a stakeholder group is further divided into smaller subgroups. This bias has been observed among fishermen, as some individuals are willing to cooperate with researchers while others refuse to participate. Because snowball sampling relies

on referrals, it may exclude potential participants who do not necessarily belong to the specific network being accessed (Meter, 1990). This issue was addressed by implementing multiple starting points to access various networks. However, we still could not reach the more exclusive and uncooperative fishermen. Due to time constraints, we were unable to interview all of the recommended contacts. These participants could have broadened the project's scope to encompass additional stakeholder groups, such as indigenous groups, recreational users, and other relevant parties. Future studies should prioritize the inclusion of all stakeholders' perspectives.

CONCLUSION

This study identified three types of narratives surrounding the discourse on kelp restoration in California and explored the challenges and potential solutions mentioned by respondents in each perspective group. Although all groups agreed that removing urchins was labor-intensive and expensive, there was little consensus on how to address these challenges. Identifying and understanding the various perspectives on critical conservation issues should be a crucial consideration in future conservation and restoration planning. Highlighting areas of disagreement and consensus can provide decision-makers with the tools to facilitate productive discussions between groups. Potential solutions for minimizing polarized views include cultivating meaningful relationships, involving community members throughout the research process, and increasing transparency in the research conducted (Ebel et al., 2018)

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