# Hawai‘i fishing communities’ climate change vulnerability and adaptive capacity: An exploratory framework for future studies

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## Executive Summary

In this report, we propose a framework that could be useful to select candidate communities from the main Hawaiian Islands for future qualitative research on the vulnerability of fishing communities to climate change. We adopted the IPCC framework (2001) that defines climate change vulnerability as a function of sensitivity (S), exposure (E), and adaptive capacity (AC). We tested and finalized community selection criteria based on available quantitative data and CSVIs relevant to MHI communities' social and climate change vulnerability. In our evaluation of communities' dependence on highly climate change vulnerable species, we applied state commercial catch report data to approximate the share of MHI communities' catch made up of "High" and "Very High" climate change vulnerable species identified in the PIVA (Giddens et al. 2022). These local quotients made up one of two S indices. The second S index came from the CSVIs: recreational reliance. The sea level rise risk CSVI made up our E component, and the CSVIs related to economics, environmental justice, and poverty made up our AC component.

We applied our selection criteria (Table 9) to 41 MHI communities, or CCDs, resulting in fourteen candidate communities from six islands: North Kohala from Hawaiʻi Island, Ewa, Honolulu, Koʻolauloa, Koʻolaupoko, Wahiawā, and Waialua from the island of Oʻahu, Kekaha-Waimea from the island of Kauaʻi, East and West Molokaʻi from the island of Molokaʻi, Hāna and Kahului from the island of Maui, and Lānaʻi from the island of the same name (Table 13). Our selection criteria was intentionally flexible to allow for candidate communities to represent all six islands in the data, and various combinations of S, E, and AC in the determination of climate change vulnerability.

Our analysis identifies a preliminary list of candidate communities for qualitative data collection. These should be evaluated further in consultation with key informants such as subject matter experts, local knowledge and community leaders, and resource managers. This consultation process may also inform the development of data collection tools that will elicit discussions of climate change vulnerability that are meaningful to the communities themselves.

Future work may enlist use multiple research methods to examine different facets of MHI fishing communities' climate change vulnerability. These may include, but are not limited to surveys, gender-separated focus group discussions, and semi-structured interviews. The sampling universe might include community leaders, fisheries management officers, local scientists, and fishers and fishing businesses. Given several key limitations in applying national CSVIs to the Pacific Islands region and significant gaps in our understanding of the social-ecological systems that shape MHI fishing communities' vulnerability, future work may benefit from an inductive, qualitative approach. Such an approach would benefit our understanding of the complex trade-offs that occur between the S, E, and AC components of vulnerability (Cinner et al. 2018; Wongbusarakum et al. 2021), non-commercial fishing activities and values, and components of AC missing from quantitative indices like social cohesion, cultural, and political factors.

## Introduction

Fishing lends diverse benefits to communities in the main Hawaiian Islands (MHI), including commercial, cultural, subsistence, and recreational value (Leong et al. 2019; McCoy et al. 2018; Vaughan & Ayers 2016). To improve support of and decision-making around these benefits, researchers have sought to understand coastal communities' social vulnerability, which "measures the relative ability of people, communities or institutions to endure stress." (Kleiber et al. 2018, p. 2). Various studies aim to identify and validate quantitative indicators of fisheries and fishing communities' vulnerability to socioeconomic, environmental, and management changes throughout the U.S. (Jepson & Colburn 2013, Jacob et al. 2010, Jacob et al. 2013) and the Pacific Islands region (Kronen et al. 2010; Kleiber et al. 2018; Wongbusarakum et al. 2020; Wongbusarakum et al. 2021). These studies contribute to an extensive effort to develop and monitor quantitative Community Social Vulnerability Indicators (CSVIs) for the United States.

Research around the CSVI initiative has highlighted important limitations to the data on which it relies. First, the CSVIs do not adequately account for relevant sociocultural and political factors (Lavoie et al. 2018). For example, Jepson and Colburn (2013) emphasize the need to expand beyond the CSVIs' social, gentrification, and fisheries dependence indices to account for the role of social capital, cohesion, and fishing infrastructure in fishing community vulnerability. In their assessment of Micronesian fishing communities, Wongbusarakum et al. (2021) find that social adaptive capacity, which plays a key role in social vulnerability, has differential manifestations and impacts across gender, age, and fishery.

Second, the CSVIs may not appropriately represent the vulnerability of Pacific Island communities. Kleiber et al. (2018) point out that assumptions made by housing-related CSVIs are not representative of housing types available in the Pacific Islands region or the land tenure system in American Samoa. Additionally, labor force and poverty indicators may misrepresent communities' vulnerability given the relative prominence of subsistence livelihoods and decreased emphasis on market economies in the region. Fishery-specific indicators based on commercial data could similarly misrepresent fishing community vulnerability as the commercialization of fisheries may correlate with decreased social adaptive capacity (Wongbusarakum et al. 2021). Kleiber et al. (2018) also highlight that English speaking ability may not have the same relationship to vulnerability in the continental U.S. as it does in the Pacific Islands region, where other languages may be more prominent. English speaking ability is also evaluated differently by survey instruments used in the continental U.S. and the Pacific Islands region, making national comparisons difficult. Broadly, the validity of CSVIs for the unique Pacific Islands region is limited because all CSVIs except for the recreational fishing indicators are relative values calculated in the context of all U.S. coastal communities (NOAA Fisheries Office of S&T 2019).

Finally, the CSVIs provide limited opportunities to explore communities' vulnerability to climate change. Given their coastal proximity, fishing communities are more likely to be severely affected by tsunamis, high waves, erosion, and sea level rise (Pomeroy et al. 2006). Yet, the only CSVIs directly related to climatic impacts are sea level rise risk and storm surge risk.

Some researchers have explored fishing communities' vulnerability to climate change through target species' vulnerability (Hare et al. 2016; Giddens et al. 2022). Communities' vulnerability can then be inferred from the climate change vulnerability of their target species (Lavoie et al. 2018). For example, Colburn et al. (2016) assigned community vulnerability rankings based on the vulnerability level of the majority of their landed species. Pinnegar et al. (2019) assigned community sensitivity scores based on their catch composition and a weighted function of species' sensitivity to climate change. The vulnerability of fishing communities however, extends beyond their reliance on climate vulnerable species.

Extending beyond a species focused approach, frameworks also connect community vulnerability to climate change sensitivity, exposure, and community adaptive capacity. In 2014, the Intergovernmental Panel on Climate Change (IPCC) introduced a framework that defines vulnerability as one of three dimensions of risk, along with hazard and exposure. However, many climate vulnerability assessments subscribe to a former IPCC framework (2001) that defines fishing communities' vulnerability as a function of sensitivity (S), exposure (E), and adaptive capacity (AC) (Allison et al. 2009; Monnereau et al. 2017; Wongbusarakum 2019). These components represent the sensitivity of a system to changes in climate, the degree of exposure to climatic hazards, and the degree to which adjustments in practices, processes, or structures may mitigate damage, respectively (2001). Pinnegar et al. (2019) use a variation of the IPCC (2001) framework, which defines vulnerability as a function of four equally weighted components: E, AC, species sensitivity, and fisheries sensitivity. In a more distinct departure from the IPCC, Colburn et al. (2016) subscribe not to one framework, but a CSVI-climate change vulnerability hybrid. They present four domains derived from the CSVIs to describe communities' social and climate change vulnerability: fishing dependence, social vulnerability, climate change vulnerability, and catch diversity. The climate change vulnerability indicators established by Colburn et al. (2016) are sea level rise risk, revenue affected due to sea level rise, and reliance on vulnerable species. Instead of weighting and summarizing these domains to produce one vulnerability metric per community, each of the four domains and their indicators provide individual commentary on community vulnerability for the reader's consideration.

Just as researchers draw different boundaries between S, E, and AC, they also highlight variable relationships between these components and their implications for overall vulnerability. Generally, increased sensitivity and exposure are thought to increase vulnerability, and increased adaptive capacity is thought to decrease vulnerability. Cinner et al. (2018) point out that these relationships are more complex. Correlations between vulnerability and S, E, and AC may be positive or negative, and the relationship between dimensions of S, E, and AC are dynamic and dependent on local context. This requires us to examine the ways bolstering one dimension of vulnerability might lead to trade-offs for others, like social justice or ecological resilience. These trade-offs occur across organizational, spatial, and temporal scales (Cinner et al. 2018). In their assessment of social adaptive capacity in Micronesian fishing communities, Wongbusarakum et al. (2021) examine AC across individual and institutional scales. They connect compromised AC to factors like exposure to pollution and erosion, and community dependence on threatened coral reef resources. They also highlight less intuitive relationships between components of vulnerability. For example, results from their household surveys suggest that higher formal education levels are associated with lower social adaptive capacity. This phenomenon could be due to a loss of local ecological knowledge and practice as households pursue higher education;

features that would otherwise benefit AC (Wongbusarakum et al. 2021). Understanding the dynamic context-specific and potentially non-intuitive relationships between such S, E, and AC is therefore critical to our understanding of community vulnerability (Lavoie et al. 2018).

The intent of this report is to lay a foundation for future in-depth explorations of MHI fishing communities' vulnerability to climate change. In this report, we select candidate MHI fishing communities for future research based on available quantitative data and indices from state and federal fisheries agencies. These data include state commercial catch reports of climate change vulnerable species identified in the Pacific Islands Vulnerability Assessment (PIVA; Giddens et al. 2022), and MHI communities' most recent CSVI vulnerability rankings (NOAA Fisheries Office of S&T 2019). The latter provides information on fishing engagement and reliance, environmental justice, economics, gentrification pressure, and sea level rise risk at the Census County Division (CCD) level. Candidate communities selected in this report will serve as a preliminary sampling pool for exploratory qualitative data collection and quantitative analyses which are described further in the Discussion section.

## Methods

This report represents a first foundational step in synthesizing available indicators and data relevant to MHI fishing communities' vulnerability to climate change. In this Methods section, we describe the data and frameworks we use in our analysis to select candidate communities for qualitative data collection.

The IPCC framework (2001) defines vulnerability as a function of Sensitivity (S), Exposure (E), and Adaptive Capacity (AC). For its widespread adoption in the literature and because it captures many dimensions of social and climate change vulnerability, we subscribe to this framework for our analysis. Table 1 identifies the available data and indices that we draw upon for our evaluation of MHI communities' S, E, and AC. All analyses were performed at the CCD level. Some limitations of these data were discussed in the Introduction. We elaborate on these limitations in subsections below.

### Table 1. Data used to evaluate communities' vulnerability to climate change.

| Vulnerability component | Indicator | Data source(s) | Used in this analysis? |
|---|---|---|---|
| Sensitivity | Share of catch made up of "High"/"Very High" climate change vulnerable species | PIVA (Giddens et al. 2022) & state commercial catch report data | Y |
| | Recreational reliance | CSVIs (NOAA Fisheries Office of Science and Technology 2019) | Y |
| | Commercial engagement | | N |
| | Commercial reliance | | N |
| | Recreational engagement | | N |
| Exposure | Sea level rise risk | | Y |
| | Storm surge risk | | N |
| Adaptive Capacity | Personal disruption | | Y |
| | Population composition | | Y |
| | Poverty | | Y |
| | Labor force | | Y |
| | Housing characteristics | | Y |
| | Housing disruption | | Y |
| | Retiree migration | | Y |
| | Urban sprawl | | Y |

## Sensitivity (S)

Communities' sensitivity to climate change was evaluated using two types of indices. The first represents communities' dependence on climate change vulnerable target species. All species assigned "High" or "Very High" climate change vulnerability scores in the PIVA (Giddens et al. 2022) were grouped into an aggregate that we refer to hereafter as "Highly Vulnerable Species" (HVS). This aggregate includes 37 species from the following PIVA-defined functional groups: deep slope, invertebrates, jacks, emperors, groupers, snappers (JEGS), other coral reef fishes, parrotfishes, pelagics, sharks, and surgeonfishes (Table 2). The only PIVA functional group not represented in the HVS aggregate is the coastal non-reef group, for which all six species received "Moderate" vulnerability scores (Giddens et al. 2022). Communities' regional and local quotients for HVS were calculated at multiple scales to explore patterns in the data. Regional quotient (RQ) values provide insight into statewide patterns of dependence on HVS. However, our analysis focuses on the vulnerability of communities at the scale of CCDs. We therefore rely on the community-level local quotient (LQ) to evaluate communities' climate change S component. The community-level LQ is the best available metric because it represents the proportion of each community's catch comprised of HVS, and therefore provides some adjustment for the differential volumes of communities' fisheries productivity.

### Table 2. PIVA species with High (HI) and Very High (VHI) climate change vulnerability comprising the HVS aggregate.

| Functional group (total # of species evaluated in PIVA) | Common name | Scientific name | Vulnerability score |
|---|---|---|---|
| Deep slope (10) | deepwater red snapper | *Etelis carbunculus* | HI |
| | pink snapper | *Pristipomoides filamentosus* | HI |
| | Hawaiian grouper | *Hyporthodus quernus* | HI |
| | slender armorhead | *Pentaceros wheeleri* | HI |
| Invertebrates (12) | sea cucumber | *Holothuria atra* | HI |
| | Kona crab | *Ranina* | HI |
| | spiny lobster | *Panulirus penicillatus* | HI |
| | ‘opihi | *Cellana sandwicensis* | VHI |
| | | *Tripneustes gratilla* | VHI |
| | | *Eunice viridis* | VHI |
| | | *Holothuria whitmaei* | VHI |
| | | *Tridacna maxima* | VHI |
| | | *Holothuria fuscogilva* | VHI |
| | | *Actinopyga mauritiana* | VHI |
| JEGS (8) | blacktip grouper | *Epinephelus fasciatus* | HI |
| | two-spot snapper | *Lutjanus bohar* | HI |

| Functional group (total # of species evaluated in PIVA) | Common name | Scientific name | Vulnerability score |
|---|---|---|---|
| Other coral reef fishes (16) | humphead wrasse | *Cheilinus undulatus* | HI |
| | whitesaddle goatfish | *Parupeneus porphyreus* | HI |
| | green damselfish | *Abudefduf abdominalis* | HI |
| | arceye hawkfish | *Paracirrhites arcatus* | VHI |
| | ornate butterflyfish | *Chaetodon ornatissimus* | VHI |
| Parrotfishes (10) | steephead parrotfish | *Chlorurus microrhinos* | HI |
| | | *Chlorurus frontalis* | HI |
| | bullethead parrotfish | *Chlorurus spilurus* | HI |
| | bumphead parrotfish | *Bolbometopon muricatum* | VHI |
| Pelagics (6) | striped marlin | *Kajikia audax* | HI |
| Sharks (6) | | *Triaenodon obesus* | HI |
| | oceanic whitetip | *Carcharhinus longimanus* | VHI |
| | pelagic thresher | *Alopias pelagicus* | VHI |
| | silky shark | *Carcharhinus falciformis* | VHI |
| | scalloped hammerhead | *Sphyrna lewini* | VHI |
| Surgeonfishes (8) | eyestripe surgeonfish | *Acanthurus dussumieri* | HI |
| | yellow tang | *Zebrasoma flavescens* | HI |
| | achilles tang | *Acanthurus achilles* | HI |
| | bluespine unicornfish | *Naso unicornis* | HI |
| | sleek unicornfish | *Naso hexacanthus* | HI |
| | | *Acanthurus nigricauda* | HI |

The regional quotient (RQ) was calculated at multiple scales. We present results at the state level, for which the RQ represents the proportion of the state's catch made up of HVS, and at the CCD level, for which the RQ represents each community's contribution to the state's total HVS catch. The local quotient (LQ) is calculated per CCD, and represents the percentage of a community's total landings comprised of HVS. Both the LQ and RQ provide commentary on communities' dependence on a fishery in terms of lbs/landings kept and sold, and revenue. We chose to omit longline data from our LQ and RQ analyses to avoid skewing the community selection process toward a few communities (namely Ewa, North Kona, and Honolulu) that are much more highly engaged in terms of volume/revenue (Hospital & Leong 2021).

This analysis, which integrates PIVA results with state commercial catch report data, has notable parameters and limitations. The PIVA evaluated the climate change vulnerability of 82 species that were selected based on expert opinion, stock status, commercial and recreational catch data, cultural and conservation significance, and ecosystem function (Giddens et al. 2022). The PIVA and our HVS aggregate therefore represents a subset of the species targeted in MHI fisheries chosen based on broad criteria. In contrast, the catch data we use in our analysis relies on reported commercial fishing activity in the state of Hawai‘i, and therefore does not account for a potentially larger volume of non-commercial fisheries and non-commercial fishing values (McCoy et al. 2018). Mismatch between the commercial catch data and the broader criteria used by PIVA to select species may result in an underrepresentation of certain target species that, for example, may have greater cultural or subsistence value in MHI fisheries. Catch from non-commercial fisheries is not included in this analysis given challenges extrapolating available data to the general population. Finally, the commercial catch data are associated with fisher zip codes rather than the location of fishing activity. Although commercial catch data is available by port of landing, this report's focus on fisher zip code was chosen to reflect communities (as defined by CCD) as the unit of analysis, and to ensure representation from all CCDs with active fishers. Analysis at the port level could constrain findings, limiting results to the subset of communities with port infrastructure across the State of Hawai‘i, and could provide extra influence to major population centers with multiple ports in a single CCD.

The second sensitivity indicator is recreational fishing reliance, taken from the CSVI data set. The CSVI data set contains indices for recreational fishing engagement and recreational fishing reliance. Both of these indices are derived from data collected by the Hawai‘i Marine Recreational Information Program (MRIP) as well as State of Hawai‘i commercial catch data (charter fishing reports). The recreational fishing engagement indicator is comprised of recreational fishing pressure estimates for shore-based, private boat, and charter fishing modes. For shore-based and private boat modes, a proxy for recreational fishing pressure is defined as the number of MRIP interviews by mode, by site (assigned to CCD). Similarly, recreational fishing pressure for the charter fishing mode is simply the reported charter fishing trips, by port (assigned to CCD).The only distinction between recreational reliance and engagement is that reliance adjusts values to control for population size (per capita). Thus, recreational reliance is used in this report because it reduces bias toward communities with larger populations. Notably, the recreational reliance index is not specific to our HVS aggregate, it is a non-species specific metric for recreational fishing activity that is heavily influenced by the charter/for-hire fisheries. We use it as a measure of recreational fishing activity to complement our commercially-dependent LQ and RQ values. Fishing engagement and reliance, which emphasize metrics of commercial value in their approximation of communities' fisheries dependence, were omitted from our analysis due to analytical constraints.

Recreational reliance rankings were pulled from 2018, the last available year of CSVI data (Social Indicators Tool 2018). For comparability, all CSVIs are assigned "Low," "Medium," "Medium High", or "High" vulnerability rankings based on their relationship to the mean (Table 3). The CSVIs relevant to Exposure and Adaptive Capacity were also pulled from 2018.

**Table 3. CSVI rankings (NOAA Fisheries Office of Science and Technology 2019).**

| Rank | Mathematical Description |
|---|---|
| High | At or above 1 standard deviation |

| Rank | Mathematical Description |
|---|---|
| Medium High | .50 to .99 standard deviation |
| Medium | 0 to .49 standard deviation |
| Low | Below 0 standard deviation |
| Not available | Insufficient data |

### Exposure (E)

The CSVIs provide two indicators relevant to climate change exposure: sea level rise risk and storm surge risk. The latter is excluded from our analysis because all communities were assigned "N/A" values for insufficient data. Thus, our Exposure component is based solely on sea level rise risk. Five communities received "Medium" sea level rise risk scores. Kea'au-Mountain View had insufficient data for this indicator, and the remaining 35 communities received "Low" sea level rise risk scores. We converted the Exposure component to a binary Y/N value according to the following question: Does the community have "Medium" sea level rise risk?

### Adaptive capacity (AC)

Three domains from the CSVI data contribute to our adaptive capacity component: environmental justice, economic, and gentrification pressure. Environmental justice consists of three indicators: personal disruption, population composition, poverty; economic domain consists of labor force and housing characteristics; and gentrification pressure consists of housing disruption, retiree migration, and urban sprawl. The assignment of these eight indicators to categorical domains has changed through time and depending on the analyst. And, all CSVIs except for the recreational fishing indicators are relative values calculated across all U.S. coastal communities (NOAA Fisheries Office of Science and Technology 2019). For these reasons and for the unique socioeconomic context of the Pacific Islands region discussed earlier, these indicators' specific relationship and proportional impact to communities' climate change vulnerability is unknown. We therefore consider each indicator individually instead of as a component of the environmental justice, economic, and gentrification pressure domains, and assume each indicator contributes equally to the overall Adaptive Capacity component of climate change vulnerability.

The CSVIs relevant to climate change adaptive capacity (Table 1) offered rankings across the full range of possible values (Table 3). We used the numeric values assigned to these rankings by the Social Indicators Tool (2018), in which "Low" = 1, "Medium" = 2, "Medium High" = 3, and "High" = 4, and added these to generate summative AC scores for each community.

### Defining selection criteria

The outcomes of vulnerability assessments are largely subject to the data and frameworks used (Monnereau et al. 2017). Researchers make decisions about the relative weight of vulnerability components based on expert opinion (Cinner et al. 2013) or by comparing outcomes from different weighting scenarios. In their assessment, Allison et al. (2009) found that weighting had little effect on communities' rank order vulnerability scores. To define the community selection criteria, we tested different definitions of S, AC, and the criteria used to relate S, E, and AC (see Table 9 for examples). We tested these in combination to ensure that the final criteria selected a largely reduced subset of candidate communities while also ensuring representation from each of the six islands in the data.

We tested two framings of the S component of vulnerability. The first was based only on communities' HVS LQs, which again represent the proportion of each community's catch comprised of highly vulnerable species. As discussed earlier, the LQs and certain indicators for AC may not appropriately represent MHI communities' reliance on climate change vulnerable species or the systemic ways in which they are made vulnerable to climate change. Therefore, we adjusted the thresholds for qualifying HVS LQs and summative AC scores along a range of low values. The LQ component of sensitivity was defined as follows: HVS comprised X% of lb kept, lb sold, or revenue for at least Y number of years between 2000 and 2018. Tested definitions ranged from X = 10-20%, and Y = 5-10 years. The second framing of S included recreational reliance. When included, communities met this criterion if they received a recreational reliance ranking at or above either "Medium" in one testing scenario, or "Medium High" in another. Because we converted E to a binary value (Y/N "Medium" sea level rise risk), no adjustments were made to its definition. For the AC component, we tested various definitions requiring that the summative AC scores exceeded some threshold. We tested thresholds of 14, 12, and 11, which excluded communities below the mean, below the mean minus ½ standard deviation, and below the mean minus 1 standard deviation, respectively.

Three criteria were considered to relate the S, E, and AC components of vulnerability:

1. At least two of the following three defined thresholds met: S, E, or AC;
2. Thresholds for S, and either E or AC met; and
3. At least two of the following four defined thresholds met: The LQ component of S, the recreational reliance component of S, E, and AC.

Criterion 1 considers the components of vulnerability equally, while acknowledging that a community may be vulnerable even if it does not exhibit vulnerability across all three. Criterion 1 also enables flexibility given the aforementioned limitations to some of the adaptive capacity and sensitivity metrics used in this evaluation. Criterion 2 requires that all qualifying communities meet some threshold of S along with either the E or AC component. This emphasizes the importance of the S metric and places undue faith in its representation of the diverse ways communities rely on and derive value from climate change vulnerable species. Criterion 3 also weighs S more heavily in its equal weighting of the LQ component of S, recreational reliance component of S, E, and AC. Unique to this criterion, communities may qualify if they meet the defined thresholds for both LQ and recreational reliance, and neither of the E or AC thresholds.

The intent of our analysis is to identify a list of candidate communities for qualitative data collection. This list is preliminary, and should be vetted by community leaders and subject matter experts before final selection of communities for further research. This is critical because decisions about which communities and indicators to include affects the outcomes of vulnerability assessments (Monnereau et al. 2017).

# Results

## Descriptive trends across scales

We present here regional (RQ) and local quotients (LQ) for HVS at various geographical scales. These provide an overview of patterns of catch across the MHI, but were not used to select candidate communities for qualitative data collection.

### *Statewide RQ*

The statewide RQ tells us what contributions HVS makes to the state's fisheries. Statewide from 2000 to 2018, HVS comprised between roughly 2 and 5% of lb caught, and fluctuated between approximately 3 and 9% of fishing revenues (Figure 1). During this period, HVS was made up of average of 3.1% of lb kept, 3.4% of lb sold, and 5.8% of fishing revenues (Table 4).

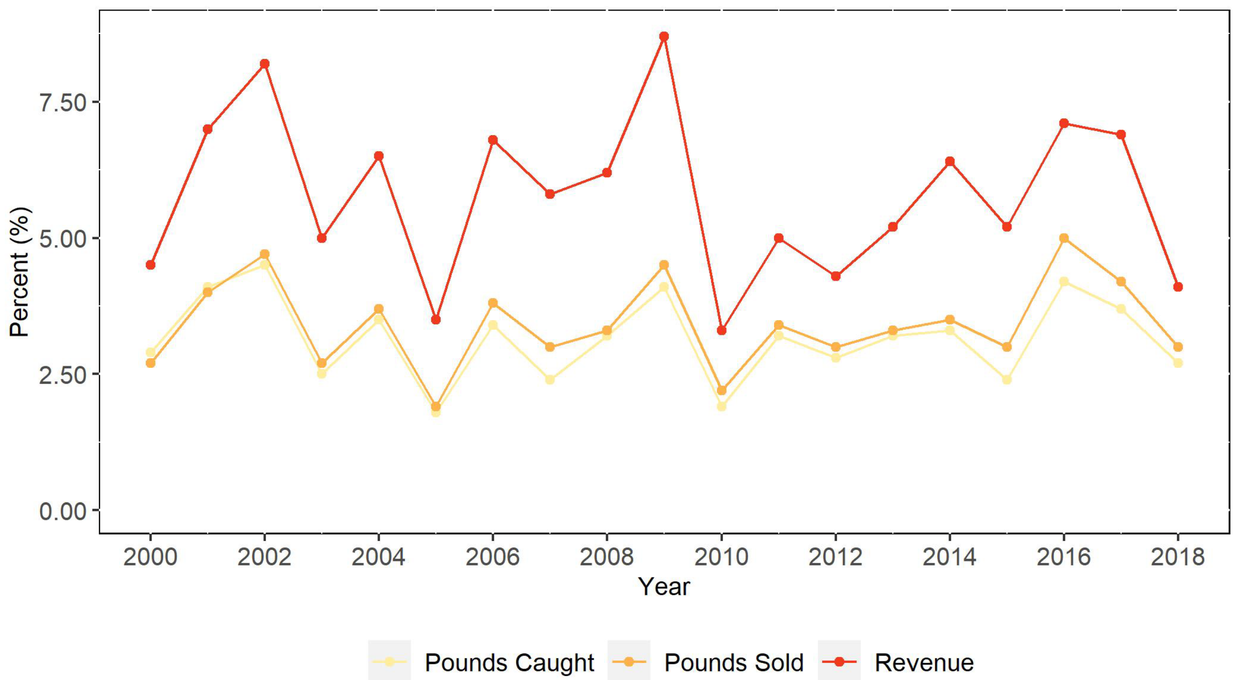


**Figure 1. Statewide HVS RQ (%) trends, 2000−2018.**

**Table 4. State-level HVS RQ (%), 2000−2018**

| | **Total lb kept** | **Total lb sold** | **Total revenue** |
|---|---|---|---|
| **MEAN** | **3.1** | **3.4** | **5.8** |
| MIN | 1.8 | 1.9 | 3.3 |
| MAX | 4.5 | 5.0 | 8.7 |

### *Island-level LQ*

The island-level LQs tell us how much of each island's fishery consists of HVS. Maui has the highest and most consistent HVS LQ (Figure 2) across the 2000−2018 time period, with HVS accounting for an average of 12.9% of its landings by lb (Table 5) and 21.7% by revenue (Table 6). Molokaʻi has marked increases in the share of its catch comprised of HVS in 2007, 2011, and to a lesser extent in 2014−2015 (Figure 2a). These increases in landings by lb produce a disproportionate increase in its revenue during the same years (Figure 2b). Lānaʻi appears to exhibit an increase in the share of its catch comprised of HVS in the recent years of 2015, 2016, and 2018 (Figure 2).

**Table 5. Island-level HVS LQ (%) by lbs 2000−2018.**

| lbs_LQ | Hawaiʻi | Oʻahu | Kauaʻi | Maui | Lānaʻi | Molokaʻi |
|---|---|---|---|---|---|---|
| MEAN | 1.4 | 3.7 | 2.0 | 12.9 | 1.5 | 4.2 |
| MIN | 0.5 | 0.9 | 0.1 | 4.8 | 0.1 | 0.0 |
| MAX | 2.6 | 6.4 | 3.1 | 21.2 | 5.5 | 17.0 |

**Table 6. Island-level HVS LQ (%) by revenue, 2000−2018.**

| rev_LQ | Hawaiʻi | Oʻahu | Kauaʻi | Maui | Lānaʻi | Molokaʻi |
|---|---|---|---|---|---|---|
| MEAN | 2.9 | 5.4 | 3.4 | 21.7 | 3.9 | 11.6 |
| MIN | 1.2 | 0.9 | 0.2 | 6.0 | 0.0 | 0.0 |
| MAX | 4.5 | 11.3 | 7.3 | 36.3 | 17.2 | 61.0 |

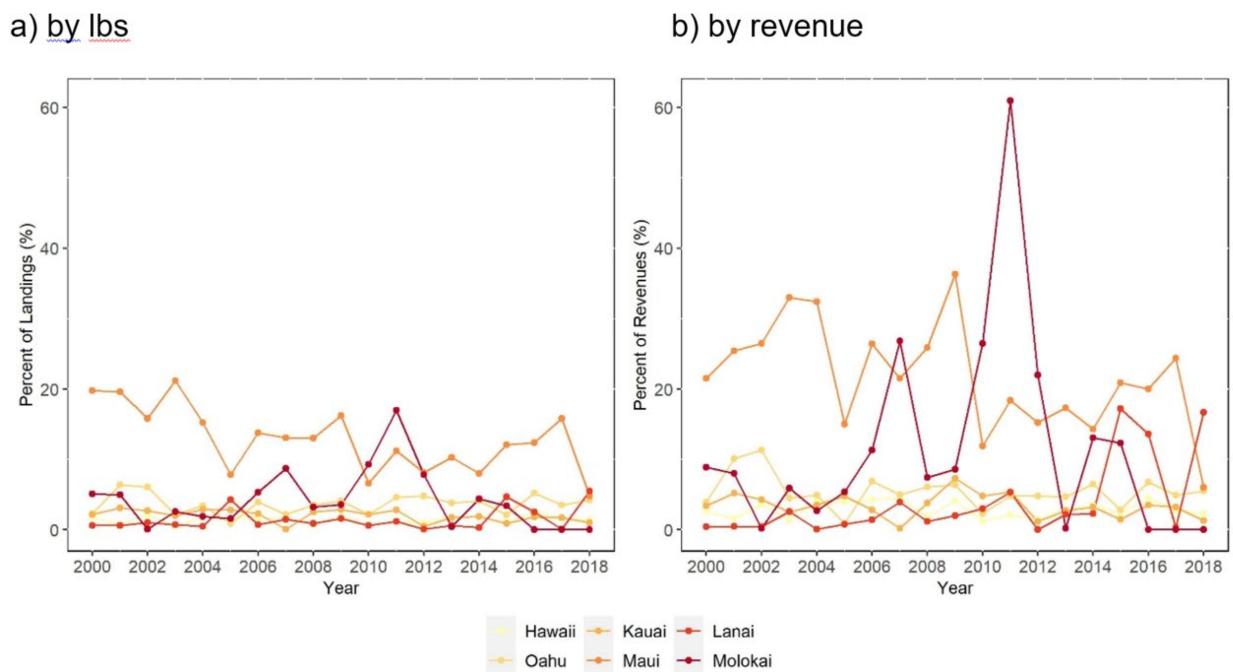


**Figure 2. Island-level HVS LQ(%) trends, 2000−2018.**

*Community-level RQ*

The community-level RQ tells us how much each community contributes to the statewide HVS fishery. We report on community-level RQs here to highlight those communities that contribute most to the state's HVS fisheries. Communities, on average, contributed to 3.4% of the state's HVS landings between 2000 and 2018 (Table 7). However, individual communities contributed up to approximately 30% of lb HVS caught or HVS fishing revenues made by the state.

**Table 7. Community-level HVS RQ (%), 2000−2018.**

| | Total lb kept | Total lb sold | Total revenue |
|---|---|---|---|
| **MEAN** | **3.4** | **3.4** | **3.4** |
| MIN | 0.0 | 0.0 | 0.0 |
| MAX | 31.7 | 29.6 | 30.1 |

Table 8 lists some of the most productive communities in terms of total HVS lb kept or sold and total HVS revenue generated. These nine communities had RQs greater than 0.15 in at least one year between 2000 and 2018. Notably, the RQ for Honolulu exceeded 0.15 by all metrics for 7−8 years across the 2000−2018 period. Only six communities contributed 15% or more of the state's HVS in total lb kept or sold in any year from 2000 to 2018. These communities are North Kona, Ewa, Honolulu, Waialua, Wai'anae, and Makawao-Pā'ia.

### Table 8. Percentage of years from 2000−2018 in which communities contributed 15% or more to the state's HVS.

| Island | Community | Total lb kept | Total lb sold | Total revenue |
|---|---|---|---|---|
| Hawai‘i | Hilo | - | - | 5 |
| | North Kona | 26 | 11 | 16 |
| O‘ahu | Ewa | 16 | 16 | 16 |
| | Honolulu | 42 | 37 | 37 |
| | Waialua | 5 | 5 | - |
| | Wai‘anae | 11 | 21 | - |
| Maui | Kīhei | - | - | 5 |
| | Makawao-Pā‘ia | 11 | 11 | 21 |
| | Wailuku | - | - | 10 |

## Selection criteria

As described in the Methods section, different definitions of S, AC, and the criteria relating S, E, and AC were tested in combination. We ran fourteen iterations of testing to select a set of criteria that produced the least number of qualifying communities while still ensuring representation from each island in the data (Table 14). The final community selection criteria that resulted from this process and two examples of the fourteen tested combinations are presented in Table 9. Note that not all tested definitions are represented in Table 9. In subsequent sections, we report on the results for S, E, and AC relevant to the final selection criteria.

### Table 9. Final and tested criteria used to select candidate communities for qualitative data collection.

| | | FINAL | Criteria example 1 | Criteria example 2 |
|---|---|---|---|---|
| Component definitions | S | **EITHER HVS comprises 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018** | HVS is made up of 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018 | HVS is made up of 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018 |
| | | **OR Rec Reliance MED-HIGH or greater** | Rec Reliance MED or greater | N/A |
| | E | **Sea level rise risk = MED** | Sea level rise risk = MED | Sea level rise risk = MED |
| | AC | **Summative score > 12** | Summative score > 11 | Summative score > 14 |

| | | FINAL | Criteria example 1 | Criteria example 2 |
|---|---|---|---|---|
| Criteria | | **At least TWO of the S, E, AC criteria fulfilled** | At least TWO of the FOUR criteria above fulfilled | At least TWO of the S, E, AC criteria fulfilled |
| Outcomes | # communities | **14** | 21 | 9 |
| | # islands represented | **6** | 6 | 4 |

## Applying the selection criteria: Components of climate change vulnerability and qualifying communities

### *HVS community-level local quotients (S)*

Because our analysis focuses on the vulnerability of communities at the scale of CCDs, the community-level LQ is the only quotient we use in our community selection criteria. The community-level LQs represent the share of each community's commercial reported catch comprised of the HVS aggregate. They serve as our first Sensitivity index. On average between 2000 and 2018, HVS was composed of approximately 7% of total lb kept, 9% of total lb sold, and 11% of total revenue at the community level (Table 10). Within the 2000−2018 period, the maximum annual share of community catch that HVS accounted for exceeded 50% of commercially reported lb kept, 90% of commercially reported lb sold, and 90% of revenue generated. These maximum values came from only two communities: East Moloka‘i and West Moloka‘i.

### Table 10. Community-level HVS LQ mean, minimum and maximum values (%), 2000−2018.

| | Total lb kept | Total lb sold | Total revenue |
|---|---|---|---|
| **MEAN** | **6.9** | **8.7** | **10.8** |
| MIN | 0.0 | 0.0 | 0.0 |
| MAX | 50.5 | 93.7 | 92.1 |

Nineteen communities from all six islands represented in the data met the final threshold for HVS LQ in the community selection criteria (Table 11). HVS was made up of 10% or more of these nineteen communities' total lb kept, total lb sold, or total revenue for at least 5 years between 2000 and 2018.

**Table 11. Percentage of years between 2000 and 2018 in which HVS LQ ≥0.10 (communities with none across all categories omitted).**

| Island | Community | Total lb kept | Total lb sold | Total revenue | At least 5 years for any metric? |
|---|---|---|---|---|---|
| Hawaiʻi | Kaʻū | - | - | n.d.* | |
| | North Kohala | - | - | 26 | Y |
| | Pāʻauhau-Paʻauilo | - | - | n.d. | |
| | Pāhoa-Kalapana | - | - | n.d. | |
| | Papaikou-Wailea | n.d. | n.d. | 21 | |
| | South Kohala | - | n.d. | n.d. | |
| | Ewa | n.d. | 16 | 26 | Y |
| | Honolulu | - | - | 37 | Y |
| | Koʻolauloa | 47 | 58 | 42 | Y |
| | Koʻolaupoko | - | - | n.d. | |
| | Wahiawā | 37 | 42 | 37 | Y |
| | Waialua | 21 | 26 | 21 | Y |
| | Waiʻanae | n.d. | n.d. | n.d. | |
| | Kaumakani-Hanapēpē | - | n.d. | 21 | |
| Oʻahu | Kekaha-Waimea | n.d. | 21 | 26 | Y |
| | East Molokaʻi | 58 | 63 | 63 | Y |
| Molokaʻi | West Molokaʻi | 53 | 63 | 63 | Y |
| | Haʻikū-Pauwela | - | - | 21 | |
| | Hāna | 21 | 32 | 37 | Y |
| | Kahului | 42 | 32 | 58 | Y |
| | Kīhei | 68 | 63 | 63 | Y |
| | Kula | 37 | 53 | 74 | Y |
| | Lahaina | 26 | 42 | 53 | Y |
| | Makawao-Pāʻia | 58 | 74 | 74 | Y |
| | Spreckelsville | 42 | 37 | 58 | Y |
| | Waiheʻe-Waikapū | 63 | 68 | 68 | Y |
| Maui | Wailuku | 58 | 68 | 68 | Y |
| Lānaʻi | Lānaʻi | 26 | 42 | 37 | Y |

*Not disclosed because fewer than three observations made.

### *CSVIs (S, E, and AC)*

The 2018 CSVIs provided values for recreational reliance, which serves as our second Sensitivity index, and the Exposure and Adaptive Capacity indices. Table 12 compiles all of the most recent available CSVI values applied to our selection criteria for all 41 MHI communities (Social Indicators Tool 2018). The online Social Indicators Tool (2018) allows users to view color-coded maps of communities' vulnerability one indicator at a time; for example, displaying a heat map of the MHI's personal disruption index. Oliver et al. (2020) created color-coded maps reflecting aggregate CSVI scores for the MHI. Although in this report we generate aggregate AC scores for each community, we do this as a step to select communities for further qualitative research rather than to meaningfully discuss or map communities' climate change vulnerability. The relevant limitations of CSVIs in understanding communities in the Pacific Islands region are discussed in the introduction.

In Table 13 we present results for S, E, and AC components for the fourteen communities that met our selection criteria. Again, these communities qualify based on the criteria that at least two of their three S, E, and AC components met the required thresholds. The S component can be fulfilled by either the HVS LQ or recreational reliance indices. The fourteen qualifying communities with representation from six islands are: North Kohala from Hawaiʻi Island, Ewa, Honolulu, Koʻolauloa, Koʻolaupoko, Wahiawā, and Waialua from the island of Oʻahu, Kekaha-Waimea from the island of Kauaʻi, East and West Molokaʻi from the island of Molokaʻi, Hāna and Kahului from the island of Maui, and Lānaʻi from the island of the same name.

Our selection criteria produces a list with various interpretations of climate change vulnerability. Ewa, Honolulu, and East Molokaʻi met all three S, E, and AC criteria, but East Molokaʻi was the only community to meet thresholds for both the HVS LQ and recreational reliance Sensitivity indices. We also have representation from communities that satisfied only the S and E components (Kekaha-Waimea), S and AC components (North Kohala, Koʻolauloa, Wahiawā, Waialua, ʻEleʻele-Kalaheo, West Molokaʻi, Hāna, Kahului, and Lānaʻi), and E and AC components (Koʻolaupoko) of vulnerability.

**Table 12. 2018 CSVI values for the indicators used in the community selection criteria.**

| Island | Community | S | E | AC | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Rec Reliance | Sea Level Rise Risk | Personal Disruption | Population Comp. | Poverty | Labor Force | Housing Characteristics | Housing Disruption | Retiree Migration | Urban Sprawl |
| Hawai‘i | Hilo | LOW | LOW | MED | MED-HI | MED-HI | MED | MED | LOW | MED | LOW |
| | Honoka‘a-Kukuihaele | LOW | LOW | MED | HIGH | MED | MED | MED | MED-HI | HIGH | LOW |
| | Ka‘ū | LOW | LOW | HIGH | HIGH | HIGH | HIGH | MED-HI | LOW | MED-HI | LOW |
| | Kea‘au-Mountain View | LOW | N/A | MED | MED-HI | MED-HI | LOW | MED-HI | MED | LOW | LOW |
| | North Hilo | LOW | LOW | MED | MED | MED-HI | MED-HI | MED | HIGH | MED-HI | LOW |
| | North Kohala | LOW | LOW | MED | MED-HI | LOW | LOW | MED | MED | MED | LOW |
| | North Kona | HIGH | LOW | LOW | MED | LOW | LOW | LOW | MED-HI | LOW | LOW |
| | Pā‘auhau-Pa‘auilo | LOW | LOW | MED | MED-HI | MED | MED | MED | HIGH | MED-HI | LOW |
| | Pāhoa-Kalapana | LOW | LOW | MED-HI | MED | HIGH | MED-HI | MED | HIGH | MED-HI | LOW |
| | Papaikou-Wailea | LOW | LOW | MED | MED-HI | HIGH | MED-HI | MED | MED-HI | MED-HI | LOW |
| | South Kohala | LOW | LOW | LOW | MED-HI | LOW | LOW | LOW | MED | LOW | LOW |
| | South Kona | LOW | LOW | LOW | MED-HI | MED | MED | MED | MED | MED | LOW |
| O‘ahu | Ewa | LOW | MED | LOW | HIGH | LOW | LOW | LOW | LOW | LOW | HIGH |
| | Honolulu | LOW | MED | LOW | HIGH | LOW | LOW | LOW | LOW | LOW | HIGH |
| | Ko‘olauloa | LOW | LOW | LOW | MED-HI | LOW | LOW | LOW | HIGH | LOW | HIGH |
| | Ko‘olaupoko | LOW | MED | LOW | MED | LOW | LOW | LOW | MED-HI | MED | HIGH |
| | Wahiawā | LOW | LOW | LOW | MED-HI | LOW | LOW | LOW | MED | LOW | HIGH |
| | Waialua | MED | LOW | LOW | MED-HI | LOW | LOW | LOW | HIGH | LOW | HIGH |
| | Wai‘anae | LOW | LOW | MED-HI | HIGH | HIGH | MED | LOW | MED-HI | MED | MED-HI |
| Kaua‘i | ‘Ele‘ele-Kalaheo | HIGH | LOW | LOW | MED-HI | LOW | LOW | LOW | HIGH | MED | LOW |
| | Hanalei | HIGH | LOW | LOW | LOW | LOW | LOW | LOW | HIGH | MED | LOW |
| | Kapa‘a | MED-HI | LOW | LOW | MED-HI | LOW | LOW | LOW | MED-HI | LOW | LOW |
| | Kaumakani-Hanapēpē | LOW | LOW | LOW | HIGH | LOW | LOW | MED | MED | MED | LOW |
| | Kekaha-Waimea | LOW | MED | LOW | MED-HI | LOW | LOW | MED | MED | LOW | LOW |
| | Koloa-Poipu | LOW | LOW | LOW | MED | MED | LOW | LOW | MED-HI | MED | LOW |
| | Lihue | HIGH | LOW | LOW | MED | LOW | LOW | LOW | HIGH | LOW | LOW |

| Island | Community | S | E | AC | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Rec Reliance | Sea Level Rise Risk | Personal Disruption | Population Comp. | Poverty | Labor Force | Housing Characteristics | Housing Disruption | Retiree Migration | Urban Sprawl |
| | Puhi-Hanamāʻulu | LOW | LOW | LOW | HIGH | LOW | LOW | LOW | HIGH | MED | LOW |
| | Wailua-Anahola | LOW | LOW | LOW | MED | LOW | LOW | LOW | MED-HI | LOW | LOW |
| Molokaʻi | East Molokaʻi | MED-HI | MED | LOW | MED-HI | LOW | MED | MED-HI | MED | MED-HI | LOW |
| | West Molokaʻi | LOW | LOW | MED | MED-HI | HIGH | MED-HI | MED-HI | LOW | MED | LOW |
| Maui | Haʻikū-Pauwela | LOW | LOW | LOW | MED | LOW | LOW | LOW | HIGH | LOW | LOW |
| | Hāna | LOW | LOW | LOW | MED-HI | LOW | LOW | MED | MED | MED-HI | LOW |
| | Kahului | LOW | LOW | LOW | HIGH | LOW | LOW | LOW | MED-HI | MED | LOW |
| | Kīhei | MED-HI | LOW | LOW | MED | LOW | LOW | MED | MED | LOW | LOW |
| | Kula | LOW | LOW | LOW | LOW | LOW | LOW | LOW | MED-HI | MED | LOW |
| | Lahaina | MED-HI | LOW | LOW | MED-HI | LOW | LOW | LOW | MED | LOW | LOW |
| | Makawao-Pāʻia | LOW | LOW | LOW | MED | LOW | LOW | LOW | HIGH | LOW | LOW |
| | Spreckelsville | LOW | LOW | LOW | LOW | MED | LOW | N/A | MED | LOW | HIGH |
| | Waiheʻe-Waikapū | LOW | LOW | LOW | MED-HI | LOW | LOW | LOW | LOW | LOW | LOW |
| | Wailuku | LOW | LOW | LOW | MED-HI | LOW | LOW | LOW | MED | LOW | LOW |
| Lānaʻi | Lānaʻi | LOW | LOW | LOW | HIGH | LOW | MED-HI | MED | HIGH | MED-HI | LOW |

**Table 13. Candidate communities for qualitative data collection.**

| Island | Community | S | | E | AC |
|---|---|---|---|---|---|
| | | HVS ≥10% lb Kept, Sold or Revenue for 5+ Years between 2000 and 2018? | Rec Reliance > MED | Sea Level Rise Risk = MED? | Summative Scores |
| Hawaiʻi | North Kohala | Y | N | N | 14 |
| Oʻahu | Ewa | Y | N | Y | 14 |
| | Honolulu | Y | N | Y | 14 |
| | Koʻolauloa | Y | N | N | 16 |
| | Koʻolaupoko | | N | Y | 15 |
| | Wahiawā | Y | N | N | 14 |
| | Waialua | Y | N | N | 16 |
| Kauaʻi | ʻEleʻele-Kalaheo | | Y | N | 14 |
| | Kekaha-Waimea | Y | N | Y | 12 |
| Molokaʻi | East Molokaʻi | Y | Y | Y | 16 |
| | West Molokaʻi | Y | N | N | 19 |
| Maui | Hāna | Y | N | N | 14 |
| | Kahului | Y | N | N | 14 |
| Lānaʻi | Lānaʻi | Y | N | N | 19 |

## Future Work

In this report, we propose a framework that could be useful to select candidate communities from the main Hawaiian Islands for future qualitative research on the vulnerability of fishing communities to climate change. We adopted the IPCC framework (2001) that defines climate change vulnerability as a function of sensitivity (S), exposure (E), and adaptive capacity (AC). We tested and finalized community selection criteria based on available quantitative data and indices from state and federal fisheries agencies relevant to MHI communities' social and climate change vulnerability. In our evaluation of communities' dependence on HVS, we applied state commercial catch report data to approximate the share of MHI communities' catch comprised of "High" and "Very High" climate change vulnerable species (the "HVS" aggregate) identified in the PIVA (Giddens et al. 2022). These HVS local quotients made up one of two S indices. The second S index came from the CSVIs: recreational reliance. The sea level rise risk CSVI made up our E component, and the CSVIs related to economics, environmental justice, and poverty made up our AC component. Future work may explore a third index of Sensitivity: catch composition diversity. Others have adopted this index under the assumption that increased catch diversity decreases sensitivity (Colburn et al. 2016; Pinnegar et al. 2019). Future analyses may also explore data external to federal and state fisheries organizations to make unknowns in the CSVI database—like storm surge risk for MHI communities—known, and integrate them into our consideration of climate change vulnerability.

We applied our selection criteria (Table 9) to 41 MHI communities, or CCDs, resulting in fourteen candidate communities from six islands: North Kohala from Hawaiʻi Island, Ewa, Honolulu, Koʻolauloa, Koʻolaupoko, Wahiawā, and Waialua from the island of Oʻahu, Kekaha-Waimea from the island of Kauaʻi, East and West Molokaʻi from the island of Molokaʻi, Hāna and Kahului from the island of Maui, and Lānaʻi from the island of the same name (Table 13). Our selection criteria was intentionally flexible to allow for candidate communities to represent all six islands in the data, and various combinations of S, E, and AC in the determination of climate change vulnerability. Diversity and representation in the community selection process is important because the degree of disagreement between existing quantitative indicators and on-the-ground realities may vary across communities (Lavoie et al. 2018). This disagreement between quantitative indicators and community realities may be more pronounced, for example, in communities that rely more heavily on subsistence fisheries.

Our analysis identifies a preliminary list of candidate communities for qualitative data collection. Other important considerations for community selection include communities' general dependence on fishing activity, pertinence of fisheries issues and climate impacts to the community, representativeness of islands on which they are located, feasibility of data collection, and the utility of social-ecological analysis for local and regional management (Wongbusarakum et al. 2021). These should be evaluated further in consultation with key informants such as subject matter experts, local knowledge and community leaders, and resource managers (Leong et al. 2019). Local expert guidance may help us to revise our selection criteria, enlightening us to novel considerations or highlighting the relevance of existing quantitative indicators like the community-level regional quotients (Table 8). This consultation process may also inform the development of data collection tools that will elicit discussions of climate change vulnerability that are meaningful to the communities themselves. This is a critical first step given that decisions about which communities and indicators to include affect the outcomes of vulnerability assessments (Monnereau et al. 2017).

Qualitative researchers use multiple research methods to examine coastal communities' vulnerability from various angles. Wongbusarakum et al. (2021) applied household surveys, focus group discussions separated by gender, interviews with community leaders, fisheries management officers, and local scientists in their study of Micronesian fishing communities' social adaptive capacity. Jacob et al. (2013) compiled historical background information, conducted unstructured interviews with fishers, fishing businesses, community officials, economics and real estate developers, compilation of historical/contextual background info, and conducted surveys on fishing infrastructure. They described their approach as grounded theory, designed to discover “the concepts of vulnerability and resiliency as they relate to each study site… [and] reality of the interviewees” (Jacob et al. 2013, p. 88). Data were then woven into succinct qualitative narratives that related themes like risk exposure, prominence of fisheries relative to other industries, infrastructure for fisheries and disaster mitigation, stakeholder conflict, and social cohesion. Outside of survey implementation, these studies use open-ended questions to preserve community perspectives and avoid influence of researcher bias (Jacob et al. 2013; Lavoie et al. 2018).

Some qualitative research on communities’ social and climate change vulnerability has focused on ground-truthing quantitative indices with subjective vulnerability indices derived from ethnographic data (Lavoie et al. 2018; Jacob et al. 2010; Jacob et al. 2013). However, as outlined in the Introduction and Methods sections, there are several key limitations in applying national CSVIs to the Pacific Islands region and significant gaps in our understanding of the social-ecological systems that shape MHI fishing communities’ vulnerability. For example, the data we used in our community selection criteria emphasize commercial reported activity and underrepresent main Hawaiian Island non-commercial fishing activities and values. Other important elements of adaptive capacity like social cohesion, cultural, and political factors are not represented at all in the data. We therefore suggest that future work focuses on an inductive exploration of locally relevant concepts of climate change vulnerability instead of relying on the existing CSVI framework to develop deductive research methods. Qualitative data will then complement and expand upon (instead of validate) established quantitative CSVIs and species focused approaches to vulnerability assessment.

Although an inductive approach defers to locally relevant and meaningful conceptions of climate change vulnerability, the IPCC’s 2001 framework, which defines vulnerability as a function of S, E, and AC, may provide a useful structure to organize data after they are collected, especially because it allows for complex evaluations of social vulnerability and resilience in its AC component (Wongbusarakum 2019). The analysis of qualitative data may thus consist of an inductive first round of content analysis (Lavoie et al. 2018), with subsequent rounds focused on coding results to broader frameworks used in the literature (Lavoie et al. 2018).

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## Appendix

**Table 14. Fourteen combinations of tested criteria in successive order (yellow highlighted cells and bolded text indicate criteria that differ from the previous set of tested criteria, and the orange highlighted row represents the final selected criteria).**

<table>
<tr><th colspan="4">Component definitions</th><th rowspan="2">Criteria</th><th colspan="2">Outcomes</th></tr>
<tr><th colspan="2">Sensitivity</th><th>Exposure</th><th>Adaptive Capacity</th><th># communities</th><th>across # islands</th></tr>
<tr><td colspan="2">HVS comprises 10% of lb kept/sold or revenue for at least 10 years between 2000 and 2018</td><td>=MED</td><td>SUM>5<br>(for 0−3 scale)*</td><td>At least 2 of the S, E, AC criteria fulfilled</td><td>7</td><td>3</td></tr>
<tr><td colspan="2">HVS comprises 10% of lb kept/sold or revenue for at least 10 years between 2000 and 2018</td><td>=MED</td><td>SUM>5*</td><td>S + either E or AC</td><td>4</td><td>3</td></tr>
<tr><td colspan="2">HVS comprises 10% of lb kept/sold or revenue for at least 7 years between 2000 and 2018</td><td>=MED</td><td>SUM>5*</td><td rowspan="2">S + either E or AC</td><td>7</td><td>4</td></tr>
<tr><td colspan="2">HVS comprises 10% of lb kept/sold or revenue for at least 7 years between 2000 and 2018</td><td>=MED</td><td>SUM>5*</td><td>10</td><td>4</td></tr>
<tr><td colspan="2">HVS comprises 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018</td><td>=MED</td><td>SUM>5*</td><td>At least 2 of the S, E, AC criteria fulfilled</td><td>13</td><td>6</td></tr>
<tr><td colspan="2">HVS comprises 20% of lb kept/sold or revenue for at least 5 years between 2000 and 2018</td><td>=MED</td><td>SUM>5*</td><td>At least 2 of the S, E, AC criteria fulfilled</td><td>6</td><td>3</td></tr>
<tr><td colspan="2">HVS comprises 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018</td><td>=MED</td><td>SUM>14<br>(for 1−4 scale)**</td><td>At least 2 of the S, E, AC criteria fulfilled</td><td>9</td><td>4</td></tr>
<tr><td>EITHER HVS comprises 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018</td><td>OR Rec Reliance MED-HIGH or greater</td><td>=MED</td><td>SUM>14**</td><td>At least 2 of the S, E, AC criteria fulfilled</td><td>9</td><td>4</td></tr>
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</table>

| Component definitions | | | | Criteria | Outcomes | |
|---|---|---|---|---|---|---|
| Sensitivity | | Exposure | Adaptive Capacity | | # communities | across # islands |
| **HVS comprises 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018** | Rec Reliance **MED-HIGH or greater** | =MED | SUM>14** | **At least 2/4 of the above fulfilled** | 11 | 5 |
| HVS comprises 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018 | **Rec Reliance MED or greater** | =MED | **SUM>11**** | At least 2/4 of the above fulfilled | 21 | 6 |
| **EITHER HVS comprises 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018** | OR Rec Reliance **MED-HIGH or greater** | =MED | SUM>11** | **At least 2 of the S, E, AC criteria fulfilled** | 19 | 6 |
| EITHER HVS comprises 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018 | OR Rec Reliance MED-HIGH or greater | =MED | **SUM>12**** | At least 2 of the S, E, AC criteria fulfilled | 14 | 6 |
| HVS comprises 10% of lb kept/sold or revenue for at least 5 years between 2000 and 2018 | | =MED | SUM>12** | At least 2 of the S, E, AC criteria fulfilled | 13 | 6 |

*In which "Low" = 0, "Medium"= 1 "Medium High" = 2, and "High" = 3.
**In which "Low" = 1, "Medium" = 2, "Medium High" = 3, and "High" = 4.