CLIMATE CHANGE VULNERABILITY OF RED BIGEYE (*Priacanthus sp.*) FISHERY IN MAJOR FISHING AREAS IN ALBAY GULF

An Undergraduate Thesis Presented to the
Faculty of the Fisheries Department
Bicol University Tabaco
Tabaco City, Albay

In Partial Fulfillment
of the Requirements for the Degree
Bachelor of Science in Fisheries

by

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ABSTRACT

CLIMATE CHANGE VULNERABILITY OF RED BIGEYE *(Priacanthus sp.)* FISHERY IN MAJOR FISHING AREAS IN ALBAY GULF, MARCH 2025

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The Red Bigeye *(Priacanthus sp.)* fishery in Albay Gulf is a vital resource for fishers and has economic and cultural significance in the locality. Like other resources, this fishery faces climate change-related impacts since Albay lies within the typhoon path. Therefore, understanding the vulnerability components, like exposure, sensitivity, and adaptive capacity of the fishery to climate-related influences, is crucial. This perceived vulnerability was assessed using the Fish Vulnerability Assessment Tool (FishVool) facilitated through key informant interviews with Red Bigeye fishers (n=50) in the Municipalities of Sto. Domingo, Legazpi, and Manito. The respondents have more than 10 years of fishing experience and thus were able to provide data on historical catch trends, community dependence on fisheries, exposure to climate disturbances, and adaptive strategies. The results revealed that the Red Bigeye fishery in major fishing areas in Albay Gulf has a moderate overall vulnerability due to having medium levels of sensitivity, exposure, and adaptive capacity. The moderate exposure may be due to the peak fishing season for Red Bigeye (February to April) not coinciding with the typhoon season in the Philippines (July to October), making fishing relatively safer. Furthermore, the fishers demonstrate diverse adaptive strategies in fisheries and the community. However, despite having moderate vulnerability, critical issues such as declining catch rate and reduction in fish size have been reported, indicating possible overfishing of the resource. These findings highlight the need for sustainable fisheries management, proactive adaptation strategies, and enhanced livelihood support to ensure the long-term resilience of the fishery and the communities.

Keywords: Sensitivity, exposure, adaptive capacity, potential impact, Kuwaw

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RECOMMENDATION FOR ORAL EXAMINATION

This thesis entitled, "**CLIMATE CHANGE VULNERABILITY OF RED BIGEYE (*Priacanthus sp.*) FISHERY IN MAJOR FISHING AREAS IN ALBAY GULF**" prepared and submitted by **HARRIETT B. BISCOCHO** and **MA. LOUISA A. CARLET** in partial fulfillment of the requirements for the degree of **BACHELOR OF SCIENCE IN FISHERIES**, is hereby recommended to the thesis committee for consideration and approval.

March 04, 2025

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EDITOR’S CERTIFICATION

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This is to certify that the ideas and information contained in this undergraduate thesis entitled **"CLIMATE CHANGE VULNERABILITY OF RED BIGEYE (*Priacanthus sp.*) FISHERY IN MAJOR FISHING AREAS IN ALBAY GULF"** are truly of the researchers and borrowed information are appropriately acknowledged.

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Date: March 07, 2025

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H.B.B.

M.L.A.C

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CHAPTER I

THE PROBLEM

Introduction

Global marine ecosystems and fisheries are seriously threatened by climate change impacts, which also affect the ecological balance and socioeconomic stability of the communities that depend on these resources. The Philippines ranks fourth among the countries most subjected to the consequences of climate change, according to the most recent long-term (2000-2019) global Climate Risk Index (CRI) analysis (Eckstein, 2021). Further, the fisheries sector in the Philippines can be affected by climate change by reducing the habitat suitability for marine fishes, which are considered economically important (Geronimo, 2018). Thus, the country's economic growth and income distribution may be negatively impacted (Suh & Pomeroy, 2020). The aforementioned issues illustrate how exposed the nation is to the effects of climate change.

Some impacts of climate change have been observed in the fishery industry, such as shoreline erosion, coral bleaching, changes in productivity, plankton dynamics, and seagrass reproduction patterns. Fishing communities may face constraints as they might relocate and have fewer options to diversify their sources of income (Capili *et al*., 2005). In the Philippines, various effects of climate change were identified in certain localities. For instance, small-scale fishermen in Davao Gulf reported the inconsistent reproductive patterns, reduced catch, and the necessity of fishing farther offshore (Macusi *et al*., 2021).

These results emphasized how crucial it is to evaluate climate change and its impact on the country's distinct fishing grounds.

Given these climate-related events, vulnerability assessments are significant in identifying and mitigating specific threats to fisheries and aquaculture. These evaluations contribute to the formulation of plans to minimize the effects of climate change and strengthen the resilience of coastal and marine ecosystems. Additionally, such an assessment helps to identify species, regions that are at risk, and stakeholders, which aims to prioritize actions and direct adaptation plans (Johnson & Welch, 2009; Li *et al.*, 2023). In this case, the exposure, sensitivity, and adaptive capacity can be evaluated through survey methodology or indicator-based modeling (Brugère & De Young, 2015; Comte, 2021). Hence, considering the vulnerabilities of the fishing sector, it is vital to improve its resilience to climate change impacts through vulnerability assessments.

Various tools were introduced to assess the sensitivity of the fisheries sector to climate change, including the Vulnerability Assessment Tool for Understanding Resiliency in Fisheries (VA-TURF) (Mamauag *et al*., 2013) and the Integrated Coastal Sensitivity, Exposure, and Adaptive Capacity for Climate Change (I-C-SEA Change) (Licuanan *et al*., 2015), which were applied to evaluate coastal communities. More recently, the Fisheries Vulnerability Assessment Tool (Fish Vool) has been utilized to identify the vulnerability of particular fisheries commodities (Jacinto *et al*., 2015). This tool is convenient to use and versatile, and it can be modified to target new fish species without the need for advanced technology or computational resources (Aguila *et al*. 2021). FishVool has proven to be an efficient tool in appraising several fishing commodities like tuna and sardines (Jacinto *et* *al.*, 2015), glass eel (Tattao *et a*l., 2023), and giant squid (De Chavez, 2021) in the Philippines. Thus, the availability of vulnerability assessment tools, notably FishVool, equips scientists and decision-makers with vital instruments to assess the susceptibility of the fishery sector.

Albay Gulf, part of the larger Lagonoy Gulf in the Philippines, is a significant fishing ground with diverse marine resources, one of which is the Red Bigeye *(Priacanthus sp.*), locally known as "Kuwaw." The species is both economically and culturally significant for the local fishing community. In fact, Barangay Buhatan in Santo Domingo, Albay, holds the "Kuwaw Festival" in March, celebrating the large quantities of seasonal fish harvested from February to March. Therefore, the economic and socio-cultural significance of Kuwaw necessitated understanding its vulnerability to climate change as a vital input for sustained fishery. The information generated in this study is critical for policy-making, particularly for robust adaptive strategies to enhance resilience, preserve cultural heritage, and safeguard the livelihoods of coastal communities while maintaining ecological health.

Objectives of the Study

Generally, this study evaluates the climate change vulnerability of the Red Bigeye fishery in the major fishing areas in Albay Gulf. Specifically, it aims to:

1. Assess the climate change vulnerability components of the Red Bigeye fishery, such as:
    a. Sensitivity

b. Exposure and;

c. Adaptive capacity

2. Evaluate the overall climate change vulnerability score of the Red Bigeye fishery.
3. Assess the perception of mitigating the impact of climate change in the aspects of exposure, sensitivity, and adaptive capacity.

Significance of the Study

This study evaluated how vulnerable the Red Bigeye fishery in the major fishing areas in Albay Gulf is to climate change. The study holds particular significance for the individuals and groups:

Researchers. This study addressed gaps in understanding climate change impacts on the fishery by evaluating fisher demographics and vulnerability components (sensitivity, exposure, and adaptive capacity). It offers localized data for developing targeted adaptation strategies, enhances knowledge on fishery vulnerability, and supports sustainable management practices amidst climate uncertainty.

Fisherfolk and coastal communities. The findings provided fisherfolk with the knowledge to anticipate and address climate impacts, promote resilience and sustainable practices, and support advocacy for adaptive strategies and policy interventions to protect marine resources and boost socio-economic well-being in coastal areas.

Fisheries students. The study provided fisheries students with practical insights into managing climate risks, emphasizing the integration of scientific knowledge with local expertise to enhance resilience and ensure the sustainability of coastal fisheries.

Government and policymakers. The information guided the development of targeted policies, promoted sustainable practices, and safeguarded marine resources. It supports evidence-based decision-making, aiding in the creation of effective conservation measures and resilience plans to ensure ecological integrity and socio-economic stability in coastal communities.

Body of knowledge. The findings of this study contributed to the growing knowledge on the vulnerability of the fishing community, particularly the Red Bigeye fishers in major fishing areas in Albay Gulf.

Scope and Delimitation

This study evaluated the climate change vulnerability of the Red Bigeye (*Priacanthus sp.*) fishery in the major fishing areas in Albay Gulf. Specifically, the research determined the demographic profiles of the fishers involved, assessed the vulnerability components—exposure, sensitivity, and adaptive capacity—and calculated the overall climate change vulnerability score. Data was gathered using FishVool, supplemented by information from key informants. Additional data was sourced from secondary information provided by the Bureau of Fisheries and Aquatic Resources (BFAR) and relevant published literature.

The research is geographically confined to the major fishing areas in Albay Gulf, specifically focusing on the municipalities of Sto. Domingo, Legazpi City and Manito. Without additional contextual adaptation, the findings of the study might not be directly applicable to other regions since it will focus on the Red Bigeye fishery in the target locations. Other factors not explicitly included in the methodology, such as locations, vulnerability assessment tools, and fish species, will be referred to as the study's limitations.

Definition of Terms

Fisheries Vulnerability Assessment Tool (FishVool) – A specialized framework that is developed to assess how vulnerable the fishery sector is to the effects of climate change. It is also designed to be both thorough and easy to use, minimizing the need for complicated procedures (Aguila *et al*., 2021). This tool will be used to determine the vulnerability of primary fishery commodities, particularly the red Bigeye *(Priacanthus sp.),* in major fishing areas in Albay Gulf in the areas of Sto. Domingo, Legazpi, and Manito.

Vulnerability – It is the susceptibility of a certain subject to damage when exposed to hazards, which represents the internal risk factor (Cardona, 2013). It was applied in this study to show how likely it is for the coastal communities and fishery resources of the major fishing areas in Albay Gulf to encounter harm or damage from climate-related events, as well as the ability to prepare for, respond to, and recover from these natural hazards.

Sensitivity – It refers to the natural characteristics of a certain subject that influence how it reacts to external changes, regardless of adaptation approaches (Füssel & Klein, 2006). In this study, sensitivity is measured by analyzing changes in catch rates and fish length over time, fishers' dependence on fishery resources, household age structure, and health conditions.

Exposure – The situation of people, infrastructure, housing, production capacities, and other tangible human assets located in hazard-prone areas (UNDRR, 2017). In this study, exposure describes how often and how severely Kuwaw fishers are affected by different weather disturbances in their household, community, and fishing ground.

Adaptive Capacity – It describes the circumstances required for successful adaptation and is an important factor in lowering vulnerability and building resilience in socio-ecological systems (Liu *et al*., 2024; Siders, 2019). Adaptive capacity was applied in this study, referring to the ability of individuals, communities, or organizations involved in the Kuwaw fisheries to respond to challenges, whether environmental, economic, or regulatory by means of implementing strategies, using resources, ad adopting various practices.

Potential Impact – The expected impacts of climate change that can affect ecosystems, communities, and local economies in many ways (Füssel, 2007). In this study, the potential impact is the result of cross-tabulating sensitivity and exposure of the Red Bigeye fishery.

Resilience – This describes the capacity of ecological, social, and economic systems to absorb, adapt, and recover from climate-forced disturbances and sustain their fundamental functioning (Bahadur *et al*., 2013). Resilience, in this study, is measured by taking into account the capacity of the fishers to recover and adapt to climate-related changes in the red Bigeye fishery.

CHAPTER II

REVIEW OR RELATED LITERATURE AND STUDIES

This chapter presents a review of related literature and studies on the effects of climate change on fisheries, small-scale fisheries vulnerability, and the possible threats of climate change to the Red Bigeye fishery in major fishing areas in Albay. It also provides the synthesis of the art and the gap bridge through the study.

Related Literature

Overview of the Impacts of Climate Change on Marine Ecosystem

Global research has projected the potential effects of climate change on the different facets of marine ecosystems, such as biodiversity (Cheung *et al*., 2009), the distributions of fish (Cheung *et al*., 2008), future fisheries production *(*Cheung *et al., 2010;* Stock *et al*., 2017), and economic outcomes (Sumaila *et al*., 2011). However, knowledge of the impacts of climate variability and the anticipated effects of long-term climate change is more developed in agriculture compared to fisheries (Geronimo, 2018). Since the Philippine government integrates climate variability (e.g., the onset of El Niño or La Niña) into crop production projections and plans as well as supplies climate-resilient crops, such an action is also needed for the fishery sector.

Scientific investigation of the marine fisheries industry has only recently started to study mechanisms of climatic variability and the impact of these on fisheries yield and fish production (Ferrera *et al*., 2017; Villanoy *et al*., 2011). To determine the ideal response of adaptation, developing a strong understanding of how local conditions will change in response to global climate change is necessary (Geronimo, 2018). It appears that there is a limited study on climate change in fishery and agriculture, which requires more specific studies in the oceans. While agriculture has been capable of adapting to climatic changes, fisheries are yet to fully understand their impacts. To guarantee successful interventions to foster both sustainability and livelihoods that depend on fisheries, there have to be new studies of local marine conditions and how fisheries respond.

Fisheries play a vital role in the economy and food security of the Philippines, which has a high level of poverty and a rising population (Santos *et al*., 2011). Climate change is a serious threat that will tend to reduce fish productivity and trigger economic shocks (Kelleher *et al*., 2009; Geronimo, 2018). Since the sector offers vital employment, food, income, and nutrition, the Philippines, as an archipelagic country, is more vulnerable to such impacts (Badjeck, 2010; FAO, 2016). Climatic variability affects fish stock productivity and species, resulting in population shift and, in extreme cases, crash or extinction (Lehodey *et al.*, 2006). The Philippines, whose sea surface temperature increased by 0.2°C every decade from 1985 to 2017, highlights its exposure and the requirement of adaptation strategies (Hoegh-Guldberg *et al*., 2017). Greater dependence of the Philippines on fisheries as a source of labor and food production increases vulnerability to impacts of climate change. Increased sea temperatures and the redistribution of fish stocks threaten productivity and employment, disrupting the economy. The application of timely adaptive measures, therefore, becomes imperative to protect this vital sector and ensure it is sustainable in the long term.

Philippine Fisheries under Changing Climatic Patterns

Eckstein (2021) stated that the Global Climate Risk Index ranks the Philippines among the countries most affected by climate change and is also leading in the long-term index and specific years. The Philippines has undergone successive disasters, including intense tropical cyclones like Typhoon Haiyan (Yolanda) in 2013 and Typhoon Mangkhut (Ompong) in 2018, which have had devastating impacts due to the country's geographical location. From 2000 to 2019, the Philippines was ranked fourth in the CRI with a mean score of 18.17 (Eckstein, 2021). Moreover, the country experienced 317 extreme weather events in the past two decades (PAGASA, 2024). These data show that the Philippines is still highly susceptible to climate-related disasters necessitating preparedness and resilience.

The climate change patterns in the Philippines have a significant impact on its fisheries, which are highly important to the economy and food security. Marine and coastal systems, as components of vulnerable Social-Ecological Systems (SESs), are exposed to impacts of increased ocean temperatures, acidification, increased storms, and sea level rise (Adger *et al*., 2005). When integrated with pollution and overfishing, these tendencies are restructuring systems fundamental to the welfare of coastal communities (Hollowed *et al*., 2013). Furthermore, the decline in fish catch threatens food security for subsistence fishers who obtain nutrients and protein from the sea (Allison *et al.*, 2009). Declining availability triggers changes that affect nutritional well-being and cultural resilience (Gazeau *et al*., 2007). Subsistence fishers, using Traditional Ecological Knowledge (TEK), have also reported seasonal pattern shifts and weather shifts, which are useful observations on climate change effects (Savo *et al*., 2017). Addressing such solutions is pivotal in ensuring food system and ecosystem resilience (Marshall, 2010). The creation of advanced adaptive strategies and integration of science and Traditional Ecological Knowledge (TEK) would facilitate further sustainability in the fisheries and strengthen the livelihood base of coastal residents.

Vulnerability Assessment in Fisheries

The world's marine fisheries already have a high-risk status, with almost 80% of the fish resources being overfished or exploited to their limit (UNEP, 2008). The coastal ecosystems suffer the most and provide more than 90% of marine food (Beddington *et al*., 2005). Even with attempts at better fisheries management, the FAO indicates that the potential from wild capture fisheries has already been maximized and that more effective strategies need to be used in order to restock depleted stock (FAO, 2006). There are other forces, including pollution, habitat loss, invasions by foreign species, and threats to marine fisheries (Nellemann *et al*., 2009). These forces make the impact of climate change even worse.

Climate change is now a critical long-term hazard to marine ecosystems, with human activities being identified by the IPCC as responsible for climate warming and recording its widespread impacts on marine ecosystems (Parry *et al*., 2007). Alterations such as ocean warming, acidification, and changes in currents are anticipated to impact marine species through shifts in distribution, reproduction, and food webs (Hobday *et al*., 2007). These changes in climate increase fisheries vulnerability, and therefore adaptive management measures are required to maintain marine resources. As climate change becomes more severe, fisheries are exposed and require adaptive management measures to offer marine resources. Specific vulnerabilities are identified in order to take targeted action to reduce impacts and enhance ecosystem resilience (Allison *et al*., 2009). As global warming occurs, there will be a necessity to encourage further scientific research and incorporate local knowledge in formulating effective adaptation strategies for marine fisheries.

Climate change threatens the world's fisheries and causes changes in species distribution, population, and ecosystem processes as a result of warming seawater, changed ocean circulation, and acidification of the ocean (IPCC, 2022). It impacts well-managed and poorly performing fisheries equally and has effects on food security and livelihood (Free *et al*., 2019). The impacts differ based on the socioeconomic and biological conditions of the involved regions and communities (Mason *et al.*, 2022; Payne *et al*., 2021). Thus, vulnerability analyses are necessary to determine the most vulnerable communities, species, and regions, thereby informing and setting priorities for adaptation measures for climate-resilient fisheries.

Assessment of vulnerability, considering exposure to climate change, sensitivity of species, and the capacity for adaptation, is essential in the identification of high-risk zones and in informing targeted management responses. The analyses can be modified to fit different settings, e.g., where there are limited scientific capacities, by integrating expert opinion and local knowledge, thus improving the generation of effective, locally relevant management interventions (Hobday *et al.*, 2007). As fisheries remain under the pressure of climate change, habitat loss, and over-exploitation, the upgrading of these estimates becomes crucial to increased ecosystem resilience and sustainable management of fisheries.

The development of climate vulnerability assessment (CVA) methodologies has become essential for prioritizing resources and addressing data gaps across regions. The IPCC strategy, considering exposure, sensitivity, and adaptive capacity as functions for understanding vulnerability, has been key to appreciating the effect of climate on fisheries (Parry *et al*., 2007). This framework has developed over the years, and the IPCC Fifth Assessment Report proceeded to employ risk-based approaches with the vulnerability perspective as inherent in a system (IPCC, 2014). These models have now been actively involved in extrapolating fish groups' climate vulnerability, ecosystems, and communities at different geographic scales from global to local scales (Allison *et al*., 2009). By combining these frameworks, fisheries management can establish more effective, evidence-based methods to create resilience to climate change.

However, decisions at the methodological level, i.e., how to define vulnerability and which indicators to choose, and measurement scale are critical in ensuring outcomes that are adequate and context-sensitive. Integrating a combination of various knowledge systems, i.e., indigenous and traditional knowledge, into CVAs is critical in ensuring the adaptive measures become relevant and effective (Mills *et al*., 2022). Assessments that examine exposure, sensitivity, and adaptive capacity measurements are important in accounting for the many effects of climate change on fisheries. The different methods used may be appropriate to varying contexts. Indicator-based methods are especially appropriate where there is wide data access to facilitate comparison in vulnerability across many regions or species (Li *et al*., 2023). Modeling techniques, however, are applicable in the prediction of future conditions and hence suitable for the prediction of long-term climate effects and adaptation advice (Comte, 2021). At smaller scales, survey-based approaches provide in-depth, context-specific insights by engaging local communities to better understand their vulnerabilities and adaptive capacities (Comte, 2021). Combining these strategies can make climate adaptation possible, and both indigenous and scientific knowledge can be used to inform sustainable fisheries management.

Indicator-based methods are quantitative and top-down, which combine statistical and modeling methods for estimating vulnerability through the connection of biophysical and economic attributes with the results of vulnerability. The approach is effective in large-scale evaluations where quantifiable data is available and required to comprehend the probability that risks will occur (O'Brien & Leichenko, 2000). Modeling-based methods are also top-down and quantitative in that they are used to model the effects of climate change on particular systems. Modeling-based methods are most useful when the prediction of future circumstances is important, e.g., estimating economic damage to fisheries under climate change (Nelson, 2009). In contrast, survey and participatory methods are bottom-up, qualitative methods. These are most similar to livelihoods and political economy methods, and these give a clearer understanding of vulnerability since they involve communities directly. These are most appropriate for low-level assessments where context at the local level and ability to adapt have important roles to play (Fellmann, 2012). This integration functions in complementing the climatic risk assessment so as to respond to vulnerabilities that are either widespread in scope or particular localized socio-economic conditions.

Lastly, integrative methods such as vulnerability mapping or agent-based modeling combine top-down and bottom-up methods. Such approaches enable one to undertake an integrated analysis with many variables and stakeholders' feedback and thus remain flexible to assessing vulnerability in intricate systems and communicating results effectively to policymakers and local stakeholders (Cinderby *et al*., 2008). From the integration of such methods, policymakers can develop more accurate and adaptive strategies to enhance the resilience of coastal communities and fisheries.

Reproductive Biology of Red Bigeye

The reproductive biology of *Priacanthus macracanthus*, also known as Red Bigeye or Dilat or Kuwaw in the Philippines, is one of the primary considerations for understanding its life cycle and guiding sustainable management. The Red Bigeye's reproductive capacity is a critical factor in the reproductive biology of the Red Bigeye. Jabbar *et al*. (2018) estimated that *P. macracanthus'* fertility differed substantially, ranging from 28,700 to 806,900 eggs at each spawning event in Palabuhanratu Bay, Indonesia. Red Bigeye spawning time is yet another aspect of reproduction. Liu *et al*. (2001) conducted their work in North Western Taiwan and stated that spawning was mainly between the months of April and July, with the highest activity seen between the months of May and June. Furthermore, the gonad growth of the Red Bigeye has also been reported using histological examination, which gives distinct stages of oocyte development. They noted that the Red Bigeye has five oocyte maturity stages, and it is a requirement to identify them in order to determine the initial maturity length and reproductive status of the population. Additionally, the Red Bigeye's reproductive success depends heavily on the environment. For example, variations in salinity, temperature, and food availability will determine spawning behavior and reproductive capacity. Jabbar *et al*. (2017) explained why these factors must be considered since they also impact reproductive performance and larval survival. The reproductive biology of the Red Bigeye, including its high reproductive potential, seasonality of spawning, complete oocyte maturity stages, and environmental sensitivity, is essential to give advice for effective, sustainable management and to provide assurance of the long-term sustainability of this species in its natural environment.

Cultural importance of Red Bigeye (Priacanthus sp.)

Throughout the Philippines, the Red Bigeye is also known by many other local names, including "Baga-baga," "Bukaw-bukaw," "Mata-hari," and "Siga." Appreciated for its high protein content, it is commonly prepared in a great deal of traditional Filipino cuisine (FishBase, 2024). The Kuwaw Festival, held yearly in Barangay Buhatan, Santo Domingo, Albay, recognizes the people's cultural and economic significance of the Red Bigeye fish, or "Kuwaw." In the 2024 festival, over a ton of kuwaw freshly caught was eaten for a boodle fight on a large scale as the highlight activity of the three-day festival. This celebration, which is already in its 11th year as a tradition, is a thanksgiving for the abundant harvest and for Buhatan's distinctive flavor of kuwaw. The celebration was a 200-meter-long table filled with fried kuwaw and had approximately 4,000 participants. Aside from its festive nature, the Kuwaw Festival also plays a role in advancing the local fishing business, which earns economic returns not only for fishers of Barangay Buhatan but for other fishers in the nearby locations as well. Such coordination between the barangay and municipality offers kuwaw-related activity and kuwaw buying support in the long term, hence its cultural and economic significance to the community (Luces, 2024). They also reinforce community resilience and identity, particularly when local fisheries are coming under increasing environmental and economic challenges.

Related Studies

Vulnerability Assessment Tools and their Application in Fisheries

Numerous tools have been established to assess the impacts of climate change on different commodities and aspects, mainly determining the degree to which the fisheries sector is impacted. For example, Mamauag *et al*. (2013) presented the Vulnerability Assessment Tool for Understanding Resilience of Fisheries (VA-TURF) to ascertain the vulnerability of tropical coastal fisheries ecosystems to climate change. VA-TURF has three main components, namely fisheries, reef ecosystems, and socioeconomics. Likewise, Paz-Alberto *et al*. (2021) measured the risk of climate change and exposure to disasters using remote sensing technology that gathers information on environmental change, such as sea level rise, flooding, and storm surges. This study gives geographical data essential to understanding exposure on coastlines, and Geographic Information Systems (GIS) are utilized for the analysis and depiction of such data to help identify exposed regions and at-risk populations. These studies also utilize indicator-based evaluations, wherein certain indicators are employed to demonstrate the exposure of marine and coastal systems and modeling methods in an effort to project future states in accordance with contemporary climate patterns.

Another important tool created to evaluate climate vulnerability in coastal regions is the integrated coastal sensitivity, exposure, and adaptive capacity for climate change (I-C-SEA Change), created by Licuanan *et al*. (2015). This tool is designed with a set of scoring rubrics to aid non-experts in assigning scores to the sensitivity and adaptive capacity components of vulnerability, particularly in coral reefs, seagrass beds, and mangrove forests, as well as fisheries and coastal integrity. I-C-SEA Change measures coastal community vulnerability to climate hazards such as storm surges, sea-level rise, and weather extremes through measurement of sensitivity, exposure, and adaptive capacity. Unlike highly technical models, this tool enables local decision-makers and stakeholders to become an integral part of the assessment process, hence a more inclusive and accessible approach to assessing climate risk.

Research by Candelaria & Baino (2023) was conducted using the I-C-SEA Change tool that analyzes climate change impacts on coastal regions in Albay. The researchers use rubrics to rate vulnerability in coastal habitat condition, near-shore reliance on fisheries, fisheries ecosystem reliance, population, and water quality. The assessment indicated that 12 out of 23 barangays are highly susceptible to climate change impacts such as waves, storm surges, sea level rise, high surface temperature, and heavy precipitation, primarily because of the lack of important marine habitats (coral reefs, seagrass/seaweeds, mangroves). In addition, the same study also revealed that eleven barangays were moderately vulnerable due to the presence of these habitats, though in poor condition, suggesting that prioritizing highly vulnerable barangays for coastal rehabilitation and disaster risk reduction is crucial. This assessment provides essential data for strategic planning to improve local climate change adaptation strategies.

The National Fisheries Research and Development Institute (NFRDI) recently developed a new application entitled the Fisheries Vulnerability Assessment (FishVool) tool, which aims to assess the vulnerability of certain fishery species specifically. FishVool seeks to determine the contribution of climate change in driving major fisheries sectors. The tool offers an easy way of acquiring data to assess the possible impacts of climate change on the fisheries sector. It can be applied to measure numerous fishery species and assists in identifying highly vulnerable areas to climate change effects. Fish Vool has been successfully applied in the fishery industry.

For instance, Jacinto *et al*. (2015) used FishVool to evaluate General Santos and Zamboanga City’s tuna and sardine fisheries, which are huge production units of the species. The evaluation showed that the two areas resulted in medium vulnerability, that is, low exposure, medium sensitivity, and low adaptive capacity. The indicator highlighted certain vulnerabilities, particularly concerning the sensitivity of communities to temperature changes and shifts in fish distribution.

The FishVool was also used to identify the climate vulnerability of the eel fisheries in Apari, Cagayan (Tattao *et al*., 2023). The research documented a mean monthly income of PHP 7,530.00, which is below the country's poverty line. Additionally, it was identified that the fishers are highly vulnerable to extreme weather like typhoons and rising sea levels.

Poor support systems and low incomes result in medium adaptive capacity and sensitivity. The same study recommends the high vulnerability of the eel fishery to climate change, and other fisheries of Northern Luzon may be exposed to the same circumstances.

De Chavez *et al.* (2021) also utilized the FishVool tool to evaluate the climate-change vulnerability of Marinduque, Philippines' "giant squid" fishery. The "giant squid" fishery was extremely climate-change vulnerable because (i) it is very susceptible to frequent tropical storms and monsoons, (ii) it is medium sensitive since catches are declining, fishing duration is longer, and costs are higher, and (iii) it is medium adaptive capacity since it is very reliant on the fishery, people are not aware, and there is limited climate information. The vulnerability analysis points out that Marinduque's "giant squid" fishery is highly climate-change-vulnerable. In addition to this, the research highlights the importance of the local fishers' knowledge in vulnerability assessment.

In aquaculture, Macusi *et al*. (2022) also utilized the FishVool to assess the climate vulnerability of shrimp farming in Mati City. This research reveals a medium vulnerability score with low adaptive capacity for the target commodity. The study has determined the functionality of FishVool in mapping at-risk areas and suggests intervention with priority areas. Macusi *et al*. (2021) also used the FishVool tool to examine the vulnerability of milkfish aquaculture and small pelagic fisheries using an online participatory process, which underscored the effects of climate hazards on the commodity's value chain. Temperature increase, typhoon, flood, and pandemic were the key stressors the study identified impacting fish production, market stability, fishers' livelihoods, and small-scale aquaculture farmers. The research noted that the vulnerability to risk rose among the fishers, and the poor adaptive capacity was caused by economic frailties and poor support systems, resulting in increased vulnerability in the sector. Furthermore, the study shows the necessity for infrastructure development, namely the cold storage, enhanced market access, and community interventions to increase resilience.

Studies focusing on the Red Bigeye

The Red Bigeye *(Priacanthus sp.)* is an economically important demersal fish species that is intensively exploited in the Philippines. It is mainly caught by bottom gillnet, and to a lesser extent by hand line and incidentally collected by lift net. The Red Bigeye inhabits coral reef environments, which play a significant role in the trophic structure of coral reef ecosystems (Jabbar *et al*., 2017). The same research highlights that the fishing season for red Bigeye fish previously varies from April to May or from October to December, but since 2010, it has occurred only from October to December, indicating a shift in the fishing grounds to deeper and further offshore areas. The canonical correlation analysis (CCA) revealed that the red Bigeye fish CPUE is significantly positive in correlation with the SOI index and trash fish resource, but negative in correlation with the PDO index and 100 meters depth salinity, which might mean that the resource is affected by La Niña's effect. In the study of Lin *et al.* (2023), in the southwestern waters of Taiwan, the Red Bigeye is the main species caught by bottom trawlers, with a significant increase in CPUE at depths of 100-200 meters.

The Red Bigeye catch and effort have been severely affected by climate change around the world. The fishery for this species in Palabuhanratu Bay, Indonesia, is predominantly dominated by bottom gilts, handlines, and lift nets. The length of the fish varies from 5-34 cm, with a mode of 21-22 cm (Jabbar *et al.*, 2017). Several studies on these species have reported a decrease in catch production in the Philippines and globally (Macale *et al.*, 2020). In the Philippines, climate change is projected to affect the distribution and abundances of several finfish species (Macusi *et al.*, 2021), possibly including the Red Bigeye.

The Red Bigeye *(P. macracanthus)* catch and effort have been severely affected by climate change around the world. The Red Bigeye is mostly overfished in Palabuhanratu Bay, Indonesia, and is dominated primarily in catches by bottom gillnets, handlines, and lift nets. The size varies from 5-34 cm, with the mode being 21-22 cm (Jabbar *et al*., 2017). Studies on such a fish species that have been tracking declining fisheries, not just in the Philippines but the entire world, have been conducted (Macale *et al*., 2020). The Philippines will experience a change in finfish distribution and abundances of some finfish species due to climate change (Macusi *et al*., 2021).

Population surveys of *P. macracanthus* in the Philippines may have been lacking. Nevertheless, some local research has been conducted, which has put forward information on the status of the Red Bigeye fishery. In the Java Sea, the stock has already been found to be overexploited. Likewise, in Malaysia and the northern South China Sea, the Red Bigeye fishery is considered to be overexploited or fully exploited (Jabbar *et al*., 2017). These results indicate that the Red Bigeye fishery of the Philippines might also be facing significant strain, although additional studies must be conducted in order to affirm its current status and trends in catches.

Synthesis of the state-of-the-art

Marine ecosystems are vulnerable to ocean acidification, ocean warming, sea level rise, and climate-related extreme weather events, which can alter fish habitats, distribution, and spawning, and lead to potential fish stock declines (Cheung *et al*., 2009). Thus, fisheries vulnerability should be explicitly measured in terms of exposure, sensitivity, and adaptive capacity (IPCC, 2014). In addition, demographic traits such as age, education, income, and dependency on fishery help determine the fishers' sensitivity and capacity for adaptation (Allison *et al*., 2009). Increasing literature suggests that the fishery sector is impacted by climate change, implying that the vulnerabilities of such a sector need to be assessed.

Various VA tools have been developed that utilize multiple methodologies and approaches. For example, O'Brien & Leichenko (2000) developed a VA tool derived from biophysical models. Furthermore, Mamaug *et al*. (2013) introduced VA-TURF, which is designed for fisheries, reef socio-economics, and ecosystems. Similarly, I-C-SEA Change of Licuanan *et al*. (2015) has been utilized to identify coastal ecosystems, fisheries, and coastal integrity, especially to quantify the impact of climate change on marine ecosystems and community resilience. The FishVool was recently developed by NFRDI to evaluate vulnerability for a particular fisheries commodity (Jacinto *et al*., 2015). Therefore, FishVool is a helpful tool for understanding fisheries' vulnerability.

FishVool has been applied to determine the vulnerability of some Philippine fisheries' commodities. For example, the tool was used in determining tuna and sardine fisheries of General Santos and Zamboanga City (Jacinto *et al*., 2015), eel fishery of Apari Cagayan (Tattao *et al*., 2023), and giant squid of Marinduque (De Chavez, 2021). Extending the application of FishVool to other fisheries might give insights into sustainable use of resources and adaptation to climate change for different species.

The Red Bigeye fishery is valuable to Sto. Domingo, Legazpi, and Manito. The fisher is mostly small-scale and susceptible to climate change, as they have limited resources (FAO, 2018). It has been reported that sea temperature fluctuations and the degradation of habitat with climate can influence Red Bigeyes' spawning duration and growth (Sumaila, 2011). Therefore, understanding the fishery's climate change sensitivity, exposure, and adaptive capacity is necessary. Adaptive capacity of the fishing community originates from institutional capacity, access to resources, and social networks. Therefore, improvement in capacity can be done through strengthening access to climate information, facilitating livelihood diversification, and strengthening governance systems (Cinner *et al*., 2018). Without anticipatory adaptation, the sustainability of the Red Bigeye fishery and livelihood of the dependent communities can be further endangered.

Gap Bridge by the Study

Despite fisheries vulnerability methods being extensively utilized, there is incomplete information, particularly for less common fish species. For instance, available research about the Red Bigeye Fishery is still inadequate. Recent studies on this specific species have focused on aspects of reproductive biology (Jabbar *et al*., 2018) and fisheries (Jabbar *et al*., 2017). Therefore, the impact of climate change on the Red Bigeye is a research gap that needs to be addressed. Thus, this study strengthens the knowledge about climate change's effects on Red Bigeye fishery and provides practical insight to those who aspire to promote sustainability in the major fishing areas in Albay Gulf.

Theoretical Framework

This study is based on proven theory and models combined into a functional framework. The Social-Ecological Systems (SES) Theory by McGinnis & Ostrom (2014) is most appropriate for aggregating and analyzing all elements of human societies and ecological systems, especially regarding climate change. The appropriateness of the SES Theory offers a more thorough approach to assessing vulnerability in the Red Bigeye fishery, linking sensitivity to climate change with minimal disruption. This theory provides a general view of how environmental changes (e.g., ocean warming and habitat destruction) correlate with human practices (e.g., fishing equipment and management policy). By applying SES theory as a point of reference to assess fish vulnerability, the current study starts with the ecological resilience of red Bigeye stocks and with adaptive capacities that have been maintained in fishing communities and regulatory frameworks in terms of the capacity to cope with environmental stressors. This strategy enables a more in-depth examination of the complex underlying factors that render the Red Bigeye vulnerable and how this could result in effective management measures ensuring ecological well-being and community resilience to the challenges of climate change.

Furthermore, Holling's (1973) Resilience Theory was also applied, which deals with the adaptive capacity and potential of the fishery to adjust to climatic change and is most applicable to the purpose of the study. It has a strong structure for comprehending and analyzing vulnerability in this context. The theory's emphasis on the fishery's ability to absorb and adjust to climate change pressures is perfectly aligned with the research objectives of measuring vulnerability. Using resilience theory, the research can examine the Red Bigeye fishery's response to shifting environmental conditions, such as shifting fish populations and habitat with sea-level rise. It emphasizes the importance of adaptive capacity, or the capacity of management systems and fishers to adapt practice and policy to sustain livelihoods and key functions in the face of climate uncertainties. Furthermore, it also focuses on adaptive capacity, particularly how management systems and fishers can change practice and policy to retain primary livelihoods and functions within climate uncertainty. Furthermore, resilience theory indicates the interdependence of socio-economic and ecosystems, which is significant for considering the extent to which climate change reaches beyond simply influencing fish stocks and into the socio-economic well-being of fishing communities dependent upon the Red Bigeye fishery.

Finally, the IPCC framework serves as the foundation for understanding the vulnerability of fisheries to climate change. Under the framework, the overall vulnerability can be determined by examining the fisheries' potential impact (exposure and sensitivity) and adaptive capacity. Figure 1 shows the theoretical paradigm of the study.

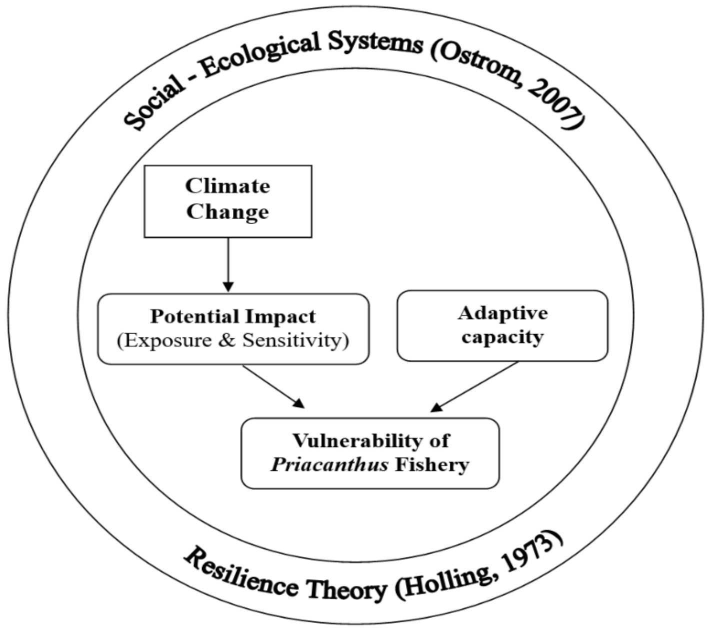

Figure 1. Theoretical paradigm of the study

Conceptual Framework

The present study is primarily based on the concept that the climate change vulnerability of fisheries depends upon (i) exposure to the climate change's physical effects, (ii) the sensitivity of the sector to such effects, and (iii) the adaptive capacity of the sector to offset the impacts of climate change (Allison et al., 2009). This concept was incorporated into the Fisheries Vulnerability Assessment Tool (FishVool) (Aguila *et al.* 2021), which was used for the three subcomponents of the framework, which include (i) fish, (ii) human, and (iii) community. These sub-components were assessed for their exposure to climate-related changes (e.g., sea level rise, temperature fluctuations, extreme weather events) and sensitivity (e.g., catch rate, size of fish, dependency on the resource, health condition, etc.). By combining the exposure and sensitivity, the potential impact of climate change was generated. Furthermore, the adaptive capacity was evaluated by considering the community's ability to adjust to changing conditions through awareness, education, and support systems. Finally, the overall vulnerability can be determined by considering both the potential impact and the adaptive capacity of the fishery (Figure 1).

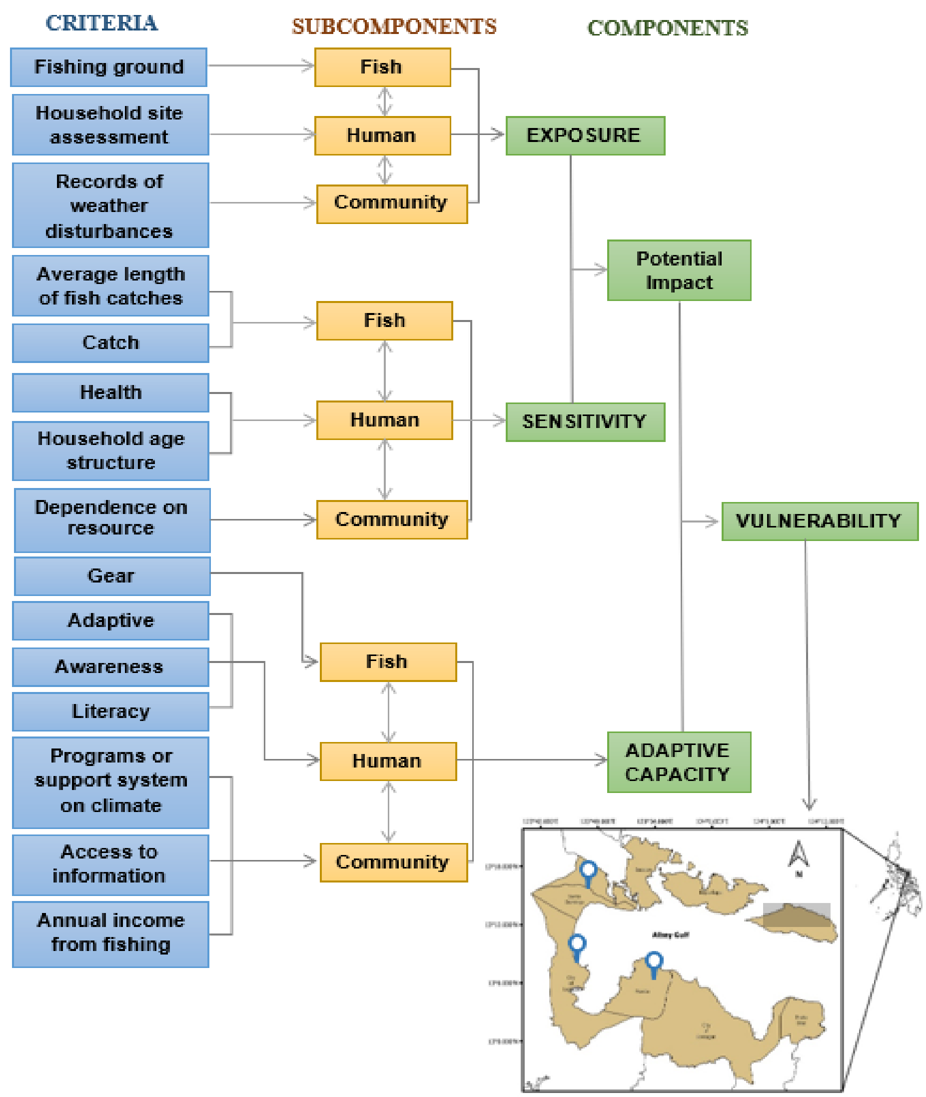

Figure 2. Conceptual paradigm of the study adapted from Fish Vulnerability Assessment Tool (FishVool) by Aguilla *et. al* (2021)

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

This chapter provides the materials and methods employed during the study. In particular, it contains the study's research design, methodology, data source, data collection method, data processing, and statistical analysis.

Research Design

The present study utilized a descriptive research design to establish the demographic profile of Red Bigeye fishers and the elements of vulnerability to climate change in the Red Bigeye fishery in Albay Gulf. A questionnaire was used to measure sensitivity, exposure, and adaptive capacity using score sheets, which were adapted from the semi-structured questionnaire derived from Aguila *et al*. (2021) framework.

Description of the Study Area

The study areas include Sto. Domingo, Legazpi, and Manito Albay which are located on the Western side of the Albay Gulf (Figure 3)**.** Albay Gulf is a large water body in the Bicol Peninsula of Luzon Island in the Philippines (13.124°N latitude and 123.99°E longitude). The Gulf has an approximate area of 770 square kilometers, surrounded by the municipalities of Bacacay, Sto. Domingo, Manito, Rapu-rapu, and Legazpi City of Albay Province, as well as municipalities of Prieto Diaz, Bacon District, and Sorsogon City of Sorsogon Province. Albay Gulf has a tropical climate, where the temperature ranges from 24°C to 31°C all year round.

The Gulf is one of the major fishing grounds in the Bicol Region, serving as a vital source of livelihood, income, and employment for fishing families in coastal communities. The waters surrounding Albay Gulf sustain diverse species and support local fishery, thereby making the area a vital location for biodiversity and the economy at the regional scale (Macale *et al*., 2020). The gulf produces an estimated catch of 11,756.46 metric tons annually, where fishing is primarily carried out with handlines (41.46%), entangling nets (16.91%), and other types of gears (Macale *et al*., 2020).

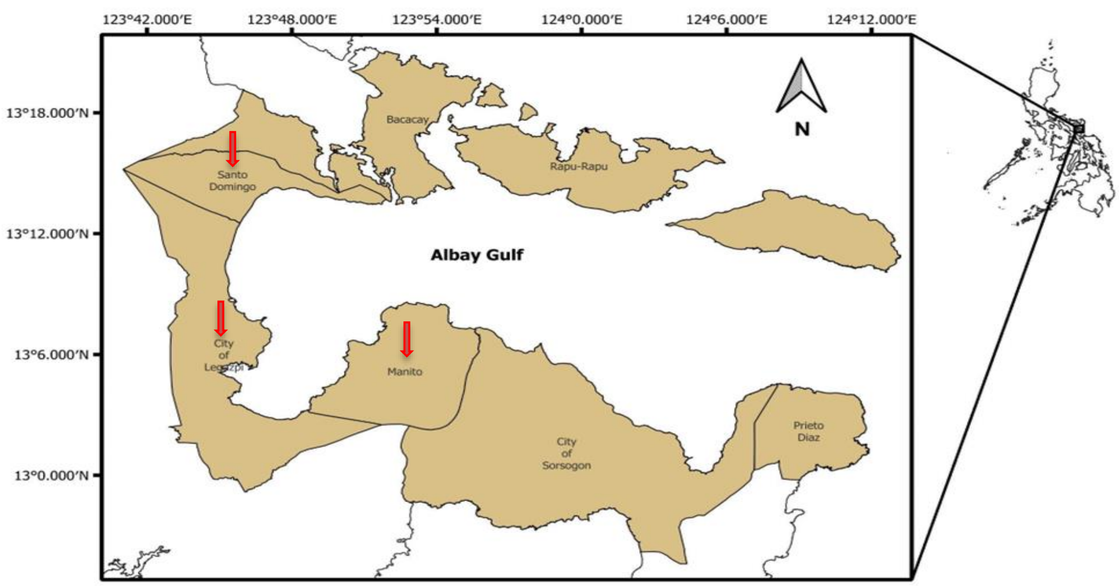

Figure 3. Geographical location of major fishing areas in Albay Gulf showing the three study areas

Data Collection

a. Pre-testing of the research instrument

The research instrument was pre-tested in Buhatan, Sto. Domingo, to assess its overall efficacy, organization, and clarity. Suitable respondents who were Red Bigeye fishers were selected with the help of Barangay authorities. During the pre-test process, some parts of the questionnaire were not easy to engage in a free-flowing conversation. Thus, revisions made were to improve its structure, offering a more precise flow and eliminating unnecessary questions. Upon these changes, a more interpretable and informative questionnaire was developed and adopted for use in the study areas.

b. Conduct of Interview

The snowball sampling approach was initiated with the assistance of LGU and Barangay officials in each municipality to identify initial key informants among fishers engaged in Red Bigeye fishing. Prior consent was secured from the respondents before conducting the interview. These key informants then referred additional participants, allowing the sample to expand through a chain of referrals. This method effectively reached a broader network of fishers who might have been difficult to contact. Fifty (50) respondents were interviewed from the three study areas. The questionnaire, initially composed in English, was translated into the Bicol dialect during the interviews to ensure accessibility and clarity for local fishers.

c. Scoring for Sensitivity

The assessment of the vulnerability components was undertaken using the FishVool framework (Jacinto *et. al*., 2015). The sensitivity factors used in the FishVool were the trends or changes in catch from catches made 10–20 years ago, the size of the fish catch in terms of length, the community's dependence on fishery resources, the household age structure, and their health conditions (Table 1). Sensitivity scoring follows a structured rubric, where each criterion is rated on a scale of 1 to 5. Low (1-2) indicates stable or improving conditions, Medium (3-4) reflects steady or fluctuating trends, and High (5) signifies a decline, suggesting vulnerability. For instance, in catch rates (S1), scores are based on whether the rate has increased, remained stable, or decreased over time. Each sensitivity factor was assessed using information gathered from key informants, ensuring a comprehensive evaluation of the fishery's vulnerability.

Table 1. Sensitivity rubrics for scoring

		Sensitivity		
		Score		
CRITERIA		**LOW**	**MEDIUM**	**HIGH**
		(1-2)	(3-4)	5
Compare catch rate 10-20 years ago (catch rate = Number of kgs added or deducted from the catch 10-20 years ago compared to present)	S1	(1) 50-100% increased catch rate over the years; (2) 0-50% increased catch rate over the years	(3) Normal catch rate over the years (steady); (4) Normal catch rate over the years (fluctuating)	Decreasing catch rate over the years
Average length of fish catches	S2	(1) 50-100% increase in average length size of fish catches compared years ago; (2) 0-50% increase in average length size of fish catches compared years ago	(3) Normal average length size of fish catches compared years ago (steady); (4) Normal average length size of fish catches compared years ago (fluctuating)	Decrease in average length size of fish catches compared years ago
Dependence on resource (Fishery)	S3	(1) Household income resource dependency is less than 20%; (2) Household income resource dependency is 20-40%	(3) Household income resource dependency is 41-60%; (4) Household income resource dependency is 61-80%	Household income resource dependency is more than 80%

Household Age structure	S4	(1) 15-25 years of age; (2) 26-40 years of age	(3) 41-55 years of age; (4) 56-65 years of age	Above 65 or below 15 years of age
Health conditions	S5	(1) No special health needs; (2) No special health needs (with medications i.e. vitamins)	(3) Symptomatic diseases (minor); (4) Symptomatic diseases (major)	With special health needs (maintenance)

d. Scoring for Exposure

The exposure factors used in the FishVool are the frequency and degree of exposure of the fishing grounds, households, and community to weather disturbances (Table 2). Exposure is scored on a scale of 1 to 5, where Low (1-2) corresponds to 0-2 weather disturbances per year, Medium (3-4) reflects 3-6 disturbances, and High (5) signifies more than six (6) disturbances annually, indicating greater environmental risk. The number of disturbances is assessed based on the key informant insights, providing a measure of the fishery's exposure to climatic hazards.

Table 2. Exposure rubrics for scoring

Exposure				
CRITERIA		Score		
		LOW	**MEDIUM**	**HIGH**
		(1-2)	(3-4)	5
Fishing ground (annual occurrence)	E1	(1) 0-1 weather disturbance; (2) 2 Weather Disturbances	(3) 3-4 weather disturbances; (4) 5-6 weather disturbances	More than 6 weather disturbances

Household Site Assessment (annual occurrence)	E2	(1) 0-1 weather disturbance; (2) 2 weather disturbances	(3) 3-4 weather disturbances; (4) 5-6 weather disturbances	More than 6 weather disturbances
Community Site Assessment (annual occurrence)	E3	(1) 0-1 weather disturbance; (2) 2 weather disturbances	(3) 3-4 weather disturbances; (4) 5-6 weather disturbances	More than 6 weather disturbances

e. Scoring for Adaptive Capacity

The adaptive capacity factors used in this study are presented in Table 3. For each factor, classifications from low to high are given based on scores ranging from 1 to 5. Low (1-2) indicates high dependence on fishing (more than 60% of income), Medium (3-4) reflects moderate dependence (20-60%), and High (5) signifies low dependence (less than 20%), suggesting greater financial diversification. A higher score represents stronger adaptive capacity, as households with diverse income sources are better positioned to cope with changes in fishery conditions.

Table 3. Adaptive capacity rubrics for scoring

Adaptive Capacity				
CRITERIA		**Score**		
		LOW	**MEDIUM**	**HIGH**
		(1-2)	**(3-4)**	**5**
Annual income obtained from fishing	AC1	(1) More than 80% of annual income generated from fishing; (2) 61-80% of annual income generated from fishing	(3) 41-60% of annual income generated from fishing; (4) 20-40% of annual income generated from fishing	Less than 20% of annual income generated from fishing

Awareness to climate change	AC2	(1) Less than 20% of the household members know about Climate Change; (2) 20-40% of the household members know about Climate Change	(3) 41-60% of the household members know about Climate Change; (4) 61-80% of the household members know about Climate Change	More than 80% of the household members know about Climate Change
Access to information	AC3	(1) No source of information; (2) 1-2 sources of information	(3) 3-4 sources of information; (4) 5-6 sources of information	More than 6 sources of information
Adaptive strategy	AC4	(1) No precautionary measure undertaken; (2) 1-2 precautionary measures undertaken	"(3) 3-4 precautionary measures undertaken; (4) 5-6 precautionary measures undertaken"	More than 6 precautionary measures undertaken
Literacy	AC5	(1) Most of the household members are out-of-school youth; (2) Most of the household members are elementary non-graduate or graduate	(3) Most of the household members are high school non-graduate; (4) Most of the household members are high school graduate or skilled	Most of the household members are college student or graduate; vocational student or graduate
Gear modification or gear replacement for the past 10 years	AC6	(1) No gear modification, no knowledge, and no resources (budget); (2) With some gear modification, with some knowledge, and no resources (budget)	(3) With some gear modification, with some knowledge, and with limited resources; unsuccessful; (4) With some gear modification, with some knowledge, and with limited resources; with limited success.	With full gear modification, with some knowledge, and with resources; successful modification

Programs or support systems against climate change	AC7	(1) No programs or support system in response to climate change done; (2) 1 program or support system in response to climate change done	(3) 2 programs or support systems in response to climate change done; (4) 3 programs or support systems in response to climate change done	More than 3 programs or support systems in response to climate change done

Data Analysis

a. Computation for Category Average Score

The average score for each vulnerability category (sensitivity, exposure, adaptive capacity) was computed using the formula below (Aguila *et al.*, 2021).

Sensitivity Average Score:

$$\boldsymbol{S_T} = \frac{\boldsymbol{S1+S2+S3\ldots}}{\boldsymbol{Ns}}$$

Legend: $\boldsymbol{S_T}$ = Total Sensitivity Score
$\boldsymbol{S_{1,2,3\ldots}}$ = Indicating Variable Score
$\boldsymbol{N_S}$ = No. of Indicating Variable considered

Exposure Average Score:

$$\boldsymbol{E_T} = \frac{\boldsymbol{E1+E2\ldots}}{\boldsymbol{N_E}}$$

Legend: $\boldsymbol{E_1}$ = Total Exposure Score
$\boldsymbol{E_{1,2,\ldots}}$ = Indicating Variable Score
$\boldsymbol{N_E}$ = No. of Indicating Variable considered

Adaptive Capacity Average Score:

$$\boldsymbol{AC_T} = \frac{\boldsymbol{AC1+AC2+AC3\ldots}}{\boldsymbol{N_{AC}}}$$

Legend: $\boldsymbol{AC_1}$ = Total Adaptive Capacity Score

$\boldsymbol{AC}_{\mathbf{1,2,3,\ldots}} =$ Indicating Variable Score
$\boldsymbol{N}_{\boldsymbol{AC}} =$ No. of Indicating Variable considered

b. Translation of vulnerability scores to categories

The average score for sensitivity, exposure, and adaptive capacity was translated into a rank system corresponding to low, medium, and high. The ranking for each category varied depending on the average score obtained. Scores less than or equal to 2 corresponded to low, scores within the range of 2.001 to 4 corresponded to medium, and scores greater than or equal to 4.001 corresponded to high (Table 4).

Table 4. Vulnerability category rank system

Score	**Vulnerability Category**
2	Low
2.001 – 4	Medium
4.001	High

c. Cross-tabulation to generate potential impact

Potential impact was determined by cross-tabulating the categories for sensitivity and exposure. The intersection of the two categories represents the potential impact on the Red Bigeye fishery (Table 5).

Table 5. Cross-table for Potential Impact (Exposure x Sensitivity)

		Potential Impact		
		Sensitivity		
		L	**M**	**H**
Exposure	**L**	L	L	M
	M	L	M	H
	H	M	H	H

d. Cross-tabulation to get the overall vulnerability

As the potential impact was already determined, the yielded potential impact was cross-tabulated with the adaptive capacity rank to determine the degree of vulnerability of the area. The intersection of the column and row from the parameters identified in the topmost row and leftmost column reveals the overall vulnerability category (Table 6).

Table 6. Cross-table for Vulnerability (Potential Impact x Adaptive Capacity)

Overall Vulnerability				
		Adaptive Capacity		
		L	**M**	**H**
Potential Impact	**L**	M	L	L
	M	H	M	L
	H	H	H	M

CHAPTER IV

RESULTS AND DISCUSSION

This chapter analyzes and interprets the study's findings. A comprehensive discussion follows after each major finding.

Demographic Profile of Red Bigeye Fishery

A total of 50 Red Bigeye fishers were interviewed during the duration of the study. The majority (30 individuals) are from Sto. Domingo Albay. The remaining fishers are from Manito (11) and Legazpi City (9). All the respondents (100%) are male, indicating a male-dominated fishery. The majority (85%) of the fishers are married, which suggests that fishing serves as a primary livelihood supporting their families. In terms of experience, 24% of respondents have been fishing for 10–20 years, while 46% have fished for 21–30 years, and 30% have been fishing for 31-50 years, reflecting a long-standing dependence on the fishery.

Table 7. Demographic profile of Red Bigeye fishers in major fishing areas in Albay Gulf

Characteristics	Description	No. of Respondents	Percentage (%)
Gender	Male	50	100
	Female	0	0
Civil Status	Single	6	11
	Married	47	85
	Widowed	2	4
Number of Years as Red Bigeye Fisher	10-20 years	12	24
	21-30 years	23	46
	31-50 years	15	30

Sensitivity (S)

The overall sensitivity of the Red Bigeye fishery for all the municipalities was observed to be moderate (3.73). Specifically, moderate sensitivity scores were observed in Sto. Domingo (3.87), Legazpi (3.85) and Manito (3.47). Such observation is comparable to the squid fishery (De Chavez *et al*., 2022) and glass eel fishery (Tattao *et al.*, 2023). Specifically, sensitivity scores were observed in Sto. Domingo (3.87), Legazpi (3.85) and Manito (3.47). The overall sensitivity score is a reflection of various sensitivity components such as the catch rate, length of fish, household fishing dependency, and household members' age structure and health conditions. However, despite having moderate sensitivity, some vital aspects of the sensitivity components of the Red Bigeye fishery demand attention.

S1. Catch Rate (kg)

The comparison of weekly catch rates between the past (10-20 years) and present years reveals a clear trend of consistently lower harvest for all the municipalities. Overall, the present catch rate is perceived to be about 54% lower than that of the past (Figure 4). Specifically, the average catch rate at present is 48.89 kg per week, which is comparatively lower than that of the past (112 kg/week), possibly indicating a reduction in fish availability on the fishing ground.

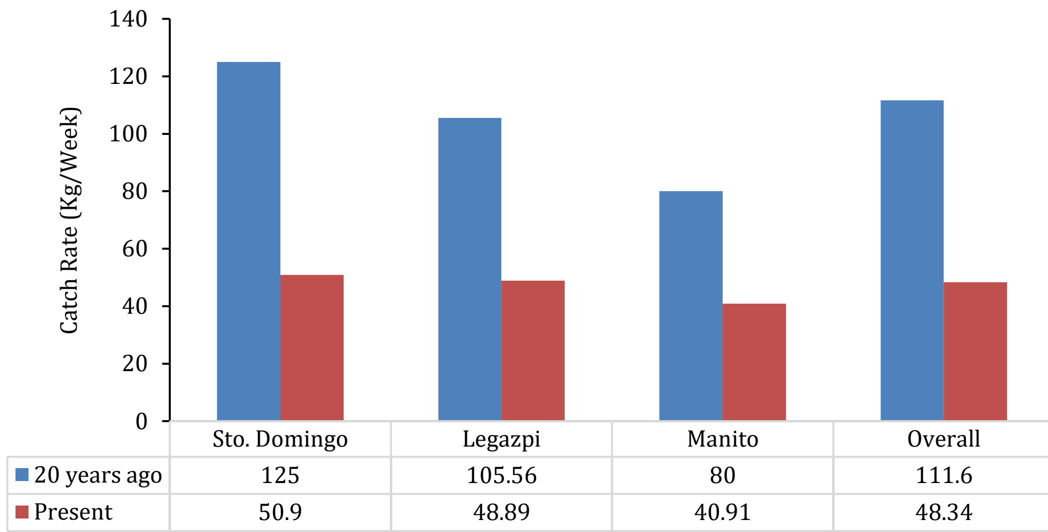

Figure 4. Comparison of catch rates between the past (10-20 years ago) and the present

S2. Average Length of Fish Catches (cm)

According to fishers, the average fish size has decreased from 18 cm (past) to 14 cm (present). Table 8 shows the average catch length of Red Bigeye across three municipalities in Albay Gulf, reflecting a reduction of about 22% from the previous size. The reduction in fish size is a possible indication of overfishing of the species (Pauly, 1987). Specifically, growth overfishing, where fish are harvested before reaching maturity, is a significant concern, particularly for species like Kuwaw, which can grow up to 35.7 cm but are often caught at 5–23 cm (Jabbar *et al.*, 2017). In addition, intensive fishing pressures tend to lead to younger and smaller fish becoming dominant in catches (Anticamara & Go, 2016). Fisheries catch and species composition in many regions are already impacted by warming oceans and shifting primary production, which affects fish growth, reproduction, and survival (IPCC, 2019). Therefore, the combination of intense fishing pressure and climate change-related events may have contributed to the current condition of the Red Bigeye fishery in the Gulf. A stock assessment study on Red Bigeye in Albay Gulf is underway, which will further provide the current stock condition in the fishing ground.

Table 8. Average length of Red Bigeye in the past (10-20 years ago) and present

Municipality	Average Length of Catch	
	Present	**10-20 years ago**
Sto. Domingo	15.13	19.13
Legazpi City	13.56	17.00
Manito	12.64	17.27
OVERALL	13.78	17.80

S3. Household Dependency on Fishery

The household dependency on fisheries resources varied for each municipality. For instance, fishers in Legazpi City show the highest dependency, about 88.35%, followed by Sto. Domingo is at 86.04%, both of which fall under the high dependency category. On the other hand, the dependency in Manito is 70.92%, which is within the medium category. On average, the region's overall dependency is 81.77%, classifying the major fishing areas in Albay Gulf under high dependency.

Other aspects contributing to the sensitivity include the household dependency on fishing and the household age structure. For the Red Bigeye fishers, the average dependency stands at 83%, indicating that the majority of respondents rely heavily on the fishery, with only a minimal portion having alternative sources of income. This finding corroborates the report of Labayo and Preña (2021), showing 94% of fishing households dependent on fishing, with only 2%–9% engaging in alternative livelihoods. This high resource dependency is also comparable to other fisheries in the country, such as eel harvesting (Tattao *et al*., 2023) and giant squid fishing (De Chavez *et al*., 2022), representing the common condition among fisherfolk in the Philippines.

S4-S5. Household Age Structure and Health Conditions

The fisher's household shows a varying average age of family members (Figure 5). About 40% of the fishers' families are from the age group of 26-40 years, 34% from 15 to 25 years, 16% from 41 to 55 years, 8% from 56 to 65 years, and only 2% 15 older than 65 years or older. Moreover, most individuals (60%) reported no special health needs, and 32% have no special health needs but are taking vitamins. Very few, 4% experience minor symptomatic diseases, while another subset has major symptomatic diseases that could significantly impact their quality of life. Additionally, the household age structure of fishers in Albay Gulf shows that 36% fall within the 26 to 40-year-old range, a relatively younger demographic compared to the average age (50 years old) for fishers in Region V (BFAR, 2021). Thus, the younger age profile of the Red Bigeye fishers offsets the high dependency on fishing, resulting in a moderate sensitivity.

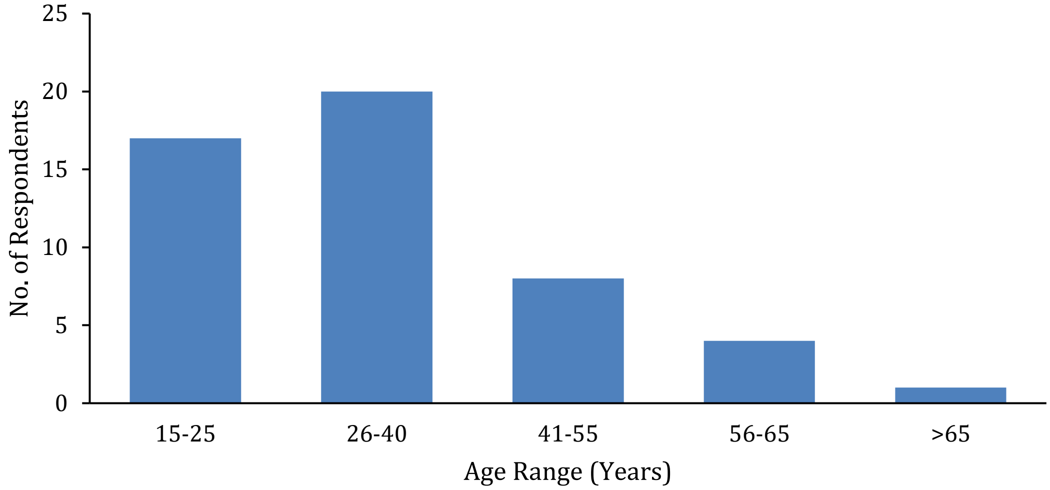

Figure 5. Household age structure of fisher’s family

Exposure (E)

The average Exposure for major fishing areas in Albay was 3.76, placing it in the medium category (Table 9). Fishers from Sto. Domingo and Legazpi City have medium exposure to climate change-related events, with average values of 3.48 and 3.67, respectively. Interestingly, high exposure was revealed for fishers in Manito (4.12).

Table 9. Annual number of weather disturbances experienced by fishers in major fishing areas in Albay Gulf

Municipalities	**Annual Number of Weather Disturbances**			**Exposure Score**
	Fishing Ground	Household	Community	
Sto. Domingo	3	3	6	**M**
Legazpi City	3	4	4	**M**
Manito	4	6	8	**H**

E1. Annual occurrence of weather disturbances in the Fishing Ground

Among the three municipalities, approximately 78% of fishers from Legazpi, 55% are from Manito, and 37% from Sto. Domingo experiences three to four weather disturbances annually. Additionally, a limited number of respondents have experienced more than six disturbances, while no respondents reported that they had not experienced any or at least one.

In Albay Gulf, the peak season for catching Red Bigeye occurs from late January to March. This period coincides with the time when tropical cyclone (TC) activity is relatively low. According to the PAGASA (2024), about 20 typhoons enter the Philippine Area of Responsibility (PAR) annually. The peak of the typhoon season in the Philippines is from July to October, with about 70% of the typhoons developing during this period. Frequent and destructive storms and typhoons disrupt fishing activities, damage boats and gear, and reduce fish catches, directly affecting the economic stability of fishers (Israel *et al.*, 2016). Therefore, the reduced frequency of storms during the Red Bigeye season makes fishing conditions more favorable.

In the Philippines, some marine species have unique fishing seasons. For instance, giant squid are typically caught during June to October in different fishing grounds within and around the country, such as the Camotes Sea in Central Visayas, Calauag Bay in Quezon, Ormoc Bay in Leyte, and off Mindoro Island (Dickson *et al.*, 2000). Similarly, the catch per unit effort (CPUE) of eels in Cagayan Province starts increasing from August through February (Ame *et al.*, 2013). Therefore, the fishing season for both the giant squid and eel fishery aligns with the typhoon season, which leads to the possible high exposure of these fishery to weather disturbances, while fishing for Red Bigeye in Albay Gulf remains relatively less prone to such weather disturbances.

Other than frequent storms, other environmental concerns, such as increasing sea temperatures and ocean acidification, also threaten marine life by disrupting fish behavior, migration patterns, and reproduction cycles (FAO, 2018). The combination of extreme weather events—such as high waves, stronger winds, heavy rainfall, and droughts contributes to habitat degradation and increased flooding, ultimately diminishing the productivity of fishing grounds (Lasco *et al*., 2020). Such climate change-related events continue to pose a threat to fisheries globally.

E2. Household Site Assessment and E3. Community Site Assessment

The highest proportion of respondents reported experiencing five to six weather disturbances per year in their households, with Manito having the largest percentage (55%), followed by Legazpi (44%) and Sto. Domingo (43%). A smaller percentage (7%) of households reported experiencing two (2) disturbances, with Sto. Domingo has a higher share in these lower categories. Significantly, Legazpi and Manito recorded a significant portion of households experiencing more than six (6) disturbances per year, suggesting a higher exposure to extreme weather events. In terms of community site assessment, about 91% of respondents from Manito reported encountering more than six weather disturbances each year in their community, making it the highest percentage among the surveyed areas. This was followed by Legazpi, where 44% of respondents reported similar experiences, and Sto. Domingo, with 43%. Interestingly, only 7% of those in Sto. Domingo reported experiencing just two weather disturbances annually.

Given these household and community-level findings, the overall exposure of each municipality to climate-related hazards becomes evident. Among the municipalities, Manito recorded the highest exposure (4.12) compared to Legazpi (3.67) and Sto. Domingo (3.48), indicating relatively more significant challenges. This heightened exposure in Manito is attributed to the significantly higher frequency of weather disturbances reported by fishers, with an annual average of 20 events ncluding extreme heat, storm surges, stronger typhoons, stronger winds, changes in sea temperature, sea level rise, high waves, heavy rainfall, and drought compared to the 13 disturbances experienced in Legazpi and Sto. Domingo. Specifically, Manito faces unique hazards such as flooding and landslides, which were not reported in the other two areas. Communities like Brgy. Catungawan in Manito, the lowest-lying among surveyed areas, is particularly vulnerable to severe flooding. Studies show that Manito experiences one of the highest flood vulnerability levels in the region due to inadequate drainage and rising sea levels (Azotea *et al*., 2017). Therefore, the geographical condition of the fishing villages in Manito contributes to its high exposure to climate-related disturbances.

Adaptive Capacity (AC)

The overall Adaptive Capacity for major fishing areas in Albay was 3.27, indicating a medium level. The three municipalities' adaptive capacity assessment showed that gear modification (AC6) had the lowest value at 1.67, which was classified as low. In contrast, the adaptive strategy (AC4) had the highest value at 4.72, which is categorized as high. The remaining indicators, awareness (AC2) at 2.71, literacy (AC5) at 3.60, programs or support systems on climate change (AC7) at 3.05, access to information (AC3) at 3.89, and annual income from fishing (AC7) at 3.24, were all categorized as medium.

AC1. Annual Income obtained from Fishing

The income distribution indicates that Legazpi is most dependent on fishing, as the majority of its total average income comes from this sector. Sto. Domingo follows closely, also showing a strong reliance on fishing as a primary source of earnings (Table 10). In contrast, despite having the highest total average income among the three municipalities, Manito has a lower proportion of income derived from fishing.

The adaptive capacity of the Red Bigeye fishery has been assessed as moderate. This classification reflects the fishery's ability to adapt moderately to environmental changes and management strategies. One component of adaptive capacity is the fisher’s annual income, ranging from PHP 39,000.00 to PHP 186,000.00, with most of their earnings coming from fishing, revealing a high dependency on this activity. In addition to fishing, many respondents engage in skilled labor such as net-making (hikot), laundry, copra production, and various small businesses. Although most respondents earn an average of over PHP 7,722.00 per month, their annual income remains below the national income standard. In 2023, the Philippine Statistics Authority reported that a family needed at least PHP 13,873 per month to meet their minimum basic food and non-food needs, highlighting a significant gap between actual earnings and the cost of living.

Table 10. Total average income of various municipalities in major fishing areas in the Albay Gulf

Municipality	Total Average Income	Average Income from Fishing	% Contribution of Fishing Income
Sto. Domingo	P 91,034.40	P 80,616.00	87.39
Legazpi	P 88,581.80	P 81,491.00	90.44
Manito	P 100,750.00	P 63,000.00	63.63

AC2-AC3. Awareness of Climate Change and Access to Information about Climate Change

Meanwhile, the awareness of household members shows that the majority, 78%, of all family members are aware of climate change. In comparison, 18% mentioned that most of their family members have heard about it. Only 4% shared that none of their family members know about climate change. And they rely on multiple sources of information to gain knowledge and awareness about climate change. Most respondents relied on multiple sources of information, with 60% accessing 3–4 sources. A smaller proportion, 32%, utilized 1–2 sources, while only 8% accessed 5–6 sources. Notably, no respondents reported having no source of information or more than six sources.

Despite this educational limitation, respondents demonstrate a high level of climate change awareness (84%), identifying key indicators of climate change such as temperature fluctuations, sea-level rise, and extreme weather events. Some respondents also highlighted concerns about pollution, improper waste disposal in oceans and rivers, and the use of chemicals. This aligns with a study conducted in Palawan, where 82% of respondents acknowledged climate change, linking it to rising temperatures and excessive rainfall, while 60% associated sea-level rise with coastal erosion and mangrove degradation (Alcantara *et al*., 2023). The high awareness of fishers on climate change observed in the Red Bigeye fishery positively affected their adaptive capacity. Such results are mainly due to access to various sources of information, commonly using three to four primary platforms, such as radio, television, and digital platforms like Facebook and YouTube.

AC4. Adaptive Strategy

Furthermore, most respondents (50%) reported undertaking 5 to 6 precautionary actions during or before extreme weather events, highlighting their proactive approach to safety. Additionally, 42 % implemented 3 to 4 precautionary measures, while 4% took 1 to 2 actions. A small proportion (4%) reported taking more than six precautionary actions, and no respondents indicated taking no precautionary measures (Figure 6).

With available information, fishers exhibit a proactive approach to safety during extreme weather events. These measures include moving boats to safe locations and securing fishing gear to prevent damage, ensuring that their assets remain protected while staying informed through updates from authorities. Moreover, economic resilience is evident, as some fishers find alternative work when fishing incomes decline. They adjust their fishing routines to mitigate environmental challenges by changing fishing times to avoid extreme heat and relocating to different fishing spots.

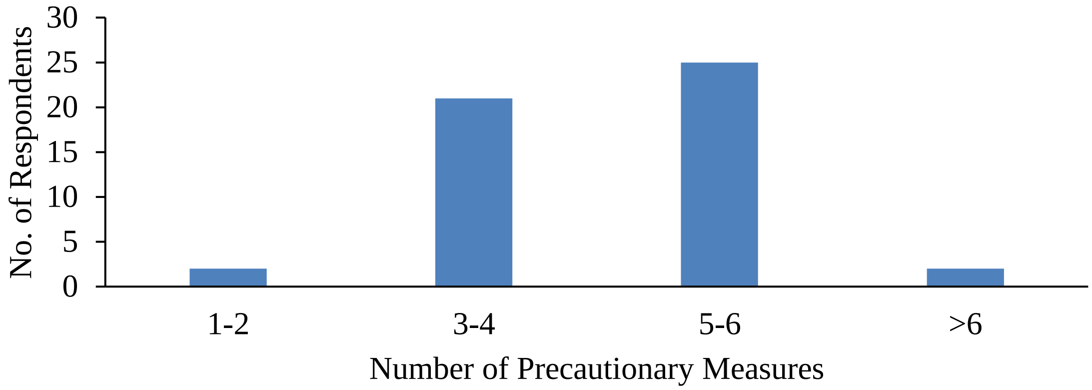

Figure 6. Precautionary measures undertaken by fisherfolk

AC5. Literacy

In addition, educational attainment varied, with 44% of Fisher's family either non-graduates or graduates, and 26% were high school non-graduates. Around 16% had either graduated from high school or acquired skills training, while 14% were college students, graduates, or vocationally trained.

It was also revealed that many fishers have limited formal education, often completing only the elementary level. Similar trends are observed in other regions, where fishers rely more on experience than schooling (Mendoza *et al*., 2021). These findings highlight the reliance on hands-on experience over formal schooling in fishing communities. However, education through extension may give each fish farmer or fisherman the foundation they need to grow and develop by equipping them with new skills and information that will benefit their line of work (Singh, 2019).

AC6. Gear modifications

Of the 50 respondents, 42% made full gear modifications using their knowledge and available resources, resulting in successful adjustments. Another 36% made partial modifications with limited resources, achieving limited success, while 22% made modifications without budget, relying only on their knowledge.

To sustain their livelihoods, fishers in the major fishing areas in Albay Gulf diversify their fishing methods and modify gear for efficiency. Most fishermen own more than one type of fishing gear, adjusting their use based on the season and the availability of target species. Fishers engaged in Red Bigeye *(Priacanthus sp.)* fishing primarily use kitang (bottom-set longline), as it is particularly effective in capturing larger kuwaw *(Priacanthus sp.)* Other fishing methods, such as og-og (multiple handline) and pangke (bottom-set gill net), are also utilized. The most commonly used hook size for kitang is 5/65, though variations such as 5/64, 5/66, 5/69, and 5/63 are also recorded. Each box (1 set of kitang) contains 80 hooks, with some fishers using up to 40 boxes, while larger-scale operators handle as many as 800 hooks per box. When using kitang, fishers often use bait such as bolinao (anchovy) and artificial bait. During the off-season for Red Bigeye, many shift to og-og due to its lower operational cost.

AC7. Programs or Support systems

Regarding access to programs or support systems for climate change adaptation, respondents reported varying levels of availability in their respective areas. Notably, no respondents indicated the complete absence of such programs. About 31% of respondents reported access to only one support. Additionally, 24% of respondents had access to two programs or support. 27% of respondents identified three available programs, while 18% reported access to more than three programs. This indicates a moderate adaptive capacity across all study areas Sto. Domingo, Legazpi, and Manito regarding the availability of programs or support systems addressing climate change adaptation. Overall, all areas reflect a medium level of climate change adaptation support. Table 11 shows the ranking of the various supports provided to the fishers.

Most fishers perceive adaptation programs as effective in addressing climate-related challenges. Adaptation programs effectively enhance fisheries' resilience by providing financial assistance, training, and policy support (Wongnaa *et al.*, 2024). Financial subsidies help fishers offset income losses from declining fish stocks and extreme weather conditions (Bograd *et al*., 2024). Training in sustainable fishing practices strengthens adaptation capacity and resource management (Trimedianto *et al*., 2024). Policy-driven efforts promote responsible fisheries governance through climate monitoring and resource regulation (Wilhelm *et al*., 2025). However, ongoing evaluation and refinement of these policies are necessary to ensure they remain responsive

However, ongoing evaluation and refinement of these policies are necessary to ensure they remain responsive to the evolving challenges faced by fishing communities. Sustaining and improving financial aid, education, and policy measures based on direct feedback from fishers will be essential for long-term adaptation to climate change.

Table 11. Programs and Support systems provided in major fishing areas in Albay for climate change adaptation

Programs or Support		
Types of support are provided	**No. of Respondents**	**Percentage%**
Financial assistance or subsidies	47	86
Training and Education	30	56
Access to new technologies or gear	20	32
Policy support (e.g., regulations, guidelines	22	38
Community-based initiatives	9	18
No program	3	6
others	2	4

Overall Vulnerability Category

The final vulnerability score remains moderate for the Red Bigeye fishery in all municipalities. Such a result is due to almost all components in all the municipalities having moderate scores (Table 12). Only the exposure component in Manito was found to be high.

Table 12. Overall vulnerability category for the Red Bigeye fishery in major fishing areas in Albay Gulf

Municipalities	Sensitivity	Exposure	Adaptive Capacity
Sto. Domingo	M	M	M
Legazpi	M	M	M
Manito	M	H	M

Similarly, the potential impacts of climate change-related events were revealed to be moderate in major fishing areas in Albay Gulf (Table 13). Given that the potential impact and adaptive capacity is moderate (M), their intersection in the cross-table results in a moderate (M) overall vulnerability classification (Table 14).

Table 13. Cross-table for Potential Impact (Sensitivity x Exposure)

POTENTIAL IMPACT				
		Sensitivity		
Exposure		*L*	*M*	*H*
	L	L	L	M
	M	L	**M**	H
	H	M	H	H
	Potential Impact			**M**

Table 14. Cross-table for Vulnerability (Adaptive Capacity x Potential Impact)

VULNERABILITY				
		Adaptive Capacity		
Potential Impact		*L*	*M*	*H*
	L	M	L	L
	M	H	**M**	L
	H	H	H	M
	Overall Vulnerability			**M**

Perception of Management Options, Adaptations, and Mitigating Measures

Fishers strongly support environmental protection, registration, and livelihood programs, with nearly full approval (Table 15). Training, participation in policymaking, and community-led management also receive high acceptance. Enforcement of regulations, compliance with marine protected areas, and research on sustainability are well-supported. Conservation measures such as shifting target species, banning juvenile harvest, and implementing closed seasons have lower approval. The least favored option is fishing effort regulation through catch quotas.

While fishers rely on adaptation strategies to cope with climate-related challenges, structured management interventions are essential for long-term sustainability. Interestingly, the choice of management options for Red Bigeye fishers leans more towards soft management measures such as (i) formalizing the fishing sector into organized groups, (ii) proper waste disposal, and (iii) provisions of alternative livelihood during the lean season, to name a few. On the contrary, the least liked management option by Kuwaw fishers appears to be the hard measures, including (i) prohibition of harvesting of juvenile or immature fish, (ii) implementing a closed season for harvesting Kuwaw during spawning seasons, and (iii) regulating fishing effort through reduction or catch quotas. Many fishers may view these strategies as threats to their livelihoods, emphasizing the need to balance regulatory measures with community well-being (Peterson & Stead, 2011). Ensuring that effective and socially acceptable management strategies are crucial for fostering compliance and long-term success.

Table 15. Perception of Management Options for Kuwaw Fisheries

Management Options	Average	Rank
Register Kuwaw fishers, boats, and fishing gear	4.92	1
Proper disposal of used engine oil and other wastes	4.92	1
Provide alternative livelihood during the lean season	4.82	3
Attend meetings, seminars, and training organized by MAO	4.76	4
Participate in the management planning and formulation of fishery ordinances	4.74	5
Manage coastal areas by local communities	4.68	6
Form and join Kuwaw fishery organizations	4.62	7
Conduct research on Kuwaw and the impacts of climate change	4.58	8
Strengthen enforcement against illegal fishing practices	4.56	9

Ensure compliance with Marine Protected Area (MPA) rules and regulations	4.48	10
Promote the use of biofuel in motorized Banca	4.32	11
Shift targeted species to reduce pressure on Kuwaw resources	3.69	12
Prohibit harvesting of juvenile or immature Kuwaw resources	3.36	13
Implement a closed season for harvesting Kuwaw during spawning season	3.24	14
Regulate fishing effort through reduction or catch quotas	1.92	15

CHAPTER V

SUMMARY, CONCLUSION, AND RECOMMENDATION

This chapter summarizes the study's key findings, conclusions, and recommendations based on the implications of the results.

SUMMARY

This study assessed the climate change vulnerability of the Red Bigeye *(Priacanthus sp.)* fishery in the major fishing areas in Albay Gulf by analyzing its exposure, sensitivity, and adaptive capacity by using the matrix from the Fish Vulnerability Assessment Tool (Fish Vool) described in Aguila *et al*. (2021). While the overall sensitivity score is 3.51 (medium), issues like the declining catch rate and smaller average length of catch, an indication of overfishing, remain prominent. Additionally, fishers in the major fishing areas in Albay Gulf heavily depend on fishery resources, with an overall dependency rate of 88.71%. Furthermore, most fisher households have members aged between 26 and 40, and most do not have any special health needs, contributing to the moderate sensitivity score.

Fishers are exposed to climate-related events annually, reporting numerous weather disturbances in their fishing grounds. These disturbances include typhoons, changes in sea temperature, high waves, strong winds, heavy rainfall, and some also noted harmful algal blooms. Furthermore, households and the community experience droughts, storm surges, extreme heat, and more intense typhoons. Manito shows high exposure to climate change-related events due to the geographical conditions of fishing villages, while Legazpi and

Sto. Domingo remains moderate in exposure. Therefore, this resulted in an overall medium exposure score of 3.76.

However, fishers from Sto. Domingo and Legazpi have significantly higher average fishing incomes than Manito, which has the lowest income among the three municipalities. This result suggests that Sto. Domingo and Legazpi are highly dependent on fishing, while Manito, with its diverse sources of income, relies less on this industry. Furthermore, the educational attainment remains low, with most of the fishers being high school undergraduates, relying more on experiential knowledge than formal education. Despite this, 78% of the fishers' family members are still aware of climate change, as they have access to various sources of information such as radio, television, and social media.

Since fishers are affected by extreme weather events, the majority reported undertaking 5 to 6 precautionary actions during or before such events. These actions include moving boats to safe locations, securing fishing gear to prevent damage, obtaining updates from authorities, seeking alternative work when fishing income is low, and adjusting fishing times to avoid extreme heat. Further, about 42% of the respondents stated that they modified their gear to catch Kuwaw by utilizing their knowledge and available resources. These successful adjustments included increasing the number of hooks, changing bait, lengthening fishing lines, and using solar or battery-powered lights. In addition, programs and support systems are available to fishers in their communities or from local governments, such as financial assistance or subsidies, training and education, access to new technologies or gear, policy support, and community-based initiatives. Therefore, factors like economic reliance on fishing, climate awareness, adaptive strategies, education, innovation, and access to support are interconnected and contribute to the overall adaptive capacity of these communities.

Lastly, the perception of management options for Kuwaw fisheries reveals a consensus among the fishers favoring the management options that have less impact on their livelihood. Conversely, hard management measures like possible closed fishing seasons and catch size restrictions remain the least favored options, as such will directly affect their livelihood.

CONCLUSION

The study concludes that the Red Bigeye fishery in Eastern Albay Gulf is moderately vulnerable to climate change, as reflected in its medium sensitivity, exposure, and adaptive capacity scores. However, some glaring issues must be addressed despite a medium overall climate vulnerability level. For instance, declining catch rates, reduced fish size, and high dependency on the fishery make fishers more susceptible to climate-induced disruptions and economic instability. The high exposure to extreme weather events, particularly in Manito, further threatens the stability and productivity of the fishery, as frequent typhoons and storm surge disrupt fishing activities and damage infrastructure. Although fishers have developed some adaptive strategies, their effectiveness may be limited by financial constraints, lack of access to advanced technology, and insufficient government support. The seasonality of Red Bigeye (January to March) further intensifies economic challenges, as fishers struggle to find stable income sources during the off-season. The unwillingness to adopt stricter conservation measures, such as closed seasons and catch limits, also poses challenges to the sustainability of the fishery. If left unaddressed, these vulnerabilities could lead to further depletion of fish stocks, reduced economic stability, and long-term environmental degradation. However, since the fishery remains at moderate vulnerability, implementing proactive adaptation strategies, sustainable fisheries management, and improved livelihood support can still mitigate these risks and ensure the long-term resilience of the Red Bigeye fishery and the communities that depend on it.

RECOMMENDATIONS

To address the issues revealed by this study, the researchers recommend the following actions:

1. **Conduct a Comprehensive Stock Assessment of the Kuwaw (Red Bigeye) Fishery**

   A comprehensive scientific assessment of the status of the stock and exploitation of Kuwaw in the Gulf of major fishing areas in Albay should be undertaken with regard to its spawning patterns and the catch rates in order to estimate sustainable harvest. Such findings will help design evidence-based policies and management strategies to promote long-term sustainability for this fishery.

2. **Promote Alternative, Climate-Resilient Livelihoods**

   Reducing fishers' dependence on an increasingly unstable fishery is crucial for economic security. Livelihood diversification could be enhanced by the government and various stakeholders through support mechanisms for alternatives on incomes that can be derived sustainably from seaweed farming, aquaculture, and ecotourism.

3. Strengthen Climate Change Education and Fisheries Management Training

Regular training programs should incorporate orientation to the known and very possible effects of climate change, its adaptation strategies, and how fisheries management approaches need to adjust to the change.

4. Enhance Community-Based Climate Adaptation and Disaster Preparedness

Coastal communities must be equipped to respond to climate-related disasters, such as typhoons and storm surges, which threaten both livelihoods and fisheries infrastructure. Early warning systems, resilience shelters that are climate-reinforced, and community-based risk management plans will be introduced to enhance local resilience.

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APPENDICES

APPENDIX A

AVERAGE SCORES AND VULNERABILITY INDEX FOR SENSITIVITY, EXPOSURE, AND ADAPTIVE CAPACITY OF THE RED BIGEYE FISHERY IN MAJOR FISHING AREAS IN ALBAY GULF.

VA Components	Parameters	Scores	Corresponding Rank	Average Scores	Overall Rank System
SENSITIVITY	Average length of fish catches (S1)	4.78	H	3.76	**M**
	Catch comparison (S2)	4.52	H		
	Dependence on resource (S3)	4.46	H		
	Household age structure (S4)	2.10	M		
	Health Conditions(S5)	3.08	M		
EXPOSURE	Fishing ground (E1)	2.59	M	3.74	**M**
	Household site assessment (E2)	3.81	M		
	Community site assessment (E3)	4.35	H		
ADAPTIVE CAPACITY	Annual income from fishing (AC1)	1.54	M	3.29	**M**
	Awareness (AC2)	4.70	H		
	Access to information (AC3)	2.76	M		
	Adaptive Strategy AC4)	3.52	M		
	Literacy (AC5)	3.00	M		
	Gear Modification (AC6)	3.98	M		
	Programs or Support (AC7)	3.40	M		

APPENDIX B

HOUSEHOLD AGE STRUCTURE AND EDUCATIONAL ATTAINMENT OF RED BIGEYE FISHERS IN THE MAJOR FISHING AREAS IN ALBAY GULF

HOUSEHOLD		
AGE	NO. OF RESPONDENTS	PERCENTAGE
15-25 years old	18	33
26-40 years old	20	36
41-55 years old	11	20
56-65 years old	5	9
Above 65 years	1	2

APPENDIX C

HOUSEHOLD EDUCATIONAL ATTAINMENT OF RED BIGEYE FISHERS IN MAJOR FISHING AREAS IN ALBAY GULF

LITERACY			
Educational Attainment	Sto. Domingo	Legazpi	Manito
Out-of-school youth	0	0	0
Elementary non-graduate or graduate	14	5	4
High school non-graduate;	9	1	5
High School graduate or skilled	5	3	2
College student or graduate	4	2	1

APPENDIX D

CLIMATE-RELATED DISTURBANCES EXPERIENCED IN RED BIG EYE FISHERIES IN MAJOR FISHING AREAS IN ALBAY GULF

FISHING GROUND

Climate events	No. of respondents	Percent%
Storms or typhoons	46	84
Changes in sea temperature	43	78
Sea level rise	28	51
Ocean acidification	27	49
Extreme Heat	11	20
Heavy Rainfall	15	27
Drought	5	9
Red Tide	4	7
High Waves	4	7
Strong Winds	10	18

COMMUNITY ASSESSMENT

Climate Events	No. of Respondents	Percent%
Flooding	37	67
Drought	30	55
Extreme heat	49	89
Landslide	25	45
Storm surge	28	51
Stronger typhoons	47	85
Stronger winds (Habagat and Amihan)	43	78
Changing monsoonal occurrence	21	38
Increasing sea surface temperature	36	65
Heavy rainfall	42	76

HOUSEHOLD ASSESSMENT		
Climate events	No. of respondents	Percent%
Flooding	9	16
Sea level rise	22	40
Drought	52	95
Extreme heat	8	15
Landslide	15	27
Storm surge	48	87
Strong Typhoons	26	47
Strong Winds	44	80
Changing monsoonal occurrence	6	11
Heavy Rainfall	36	65

APPENDIX E

PRECAUTIONARY ACTIONS TAKEN BY THE RED BIGEYE FISHERS

PRECAUTIONARY MEASURES		
Precautionary Measures	No. of Respondents	Percent%
Move boats to a safe place	53	96
Secure fishing gear to prevent damage	52	95
Get updates from authorities	51	93
Fish less to save resources	16	29
Find other work if fishing income is low	20	36
Change fishing times to avoid extreme heat	25	45
Move or change fishing spots	23	42
Use new tools or equipment	11	20

APPENDIX F

Letter to LGUs and Barangay Captains

REPUBLIC OF THE PHILIPPINES
BICOL UNIVERSITY
TABACO
Tayhi, Tabaco City
Email: butc-dean@bicol-u.edu.ph

ISO 9001: 2015
SOCOTEC SCP000722Q

BAGONG PILIPINAS

September 5, 2024

HON. JOSELING B. AGUAS JR.
Mayor, Municipality of Sto. Domingo
Albay Province

RECEIVED
MAYOR'S OFFICE
STO DOMINGO, ALBAY
BY:
DATE: 9/20/24

Dear Mayor Aguas:

Good day!

We are student researchers from Bicol University Tabaco, currently conducting a study entitled "Climate Change Vulnerability of *Priacanthus sp.* in the Eastern Part of Albay Gulf." As part of our research, we have selected Sto. Domingo, specifically the fisherfolk communities in Poblacion and Buhatan, as one of our study areas. Our research aims to assess the impact of climate change on the Red Bigeye (locally known as Kuwaw) fishery and the vulnerabilities faced by fisherfolk in this region.

In this regard, we would like to respectfully request permission from your office to conduct surveys with the fisherfolk in the aforementioned communities. The survey will be conducted in adherence to ethical standards and research protocols.

We would appreciate your favorable response and any guidance you can provide to ensure smooth coordination with the local fisherfolk.

Thank you very much and more power to you.

Sincerely,

HARRIETT B. BISCOCHO
BSFi Student

MA. LOUISA A. CARLET
BSFi Student

Noted by:

PROF. IAN CRIS R. BUBAN
Thesis Adviser

REPUBLIC OF THE PHILIPPINES
BICOL UNIVERSITY
TABACO
Tayhi, Tabaco City
Email: butc-dean@bicol-u.edu.ph

ISO 9001: 2015
SOCOTEC SCP000722Q

BAGONG PILIPINAS

September 5, 2024

HON. REBECCA D. CHEN
Mayor, Municipality of Manito
Albay Province

Manito Municipal Government
Manito, Albay, 4514
RECEIVED
DATE: 11/29/24 TIME. 9:39
BY:

Dear Mayor Chen:

Good day!

We are student researchers from Bicol University Tabaco, currently conducting a study entitled "Climate Change Vulnerability of *Priacanthus sp.* in the Eastern Part of Albay Gulf." As part of our research, we have selected Manito, specifically the fisherfolk communities, as one of our study areas. Our research aims to assess the impact of climate change on the red bigeye fishery (locally known as Kuwaw) and the vulnerabilities faced by fisherfolk in this region.

In this regard, we would like to respectfully request permission from your office to conduct surveys with the fisherfolk in the aforementioned communities. The survey will be conducted in adherence to ethical standards and research protocols.

We would appreciate your favorable response and any guidance you can provide to ensure smooth coordination with the local fisherfolk.

Thank you very much and more power to you.

Sincerely,

HARRIETT B. BISCOCHO
BSFi Student

MA. LOUISA A. CARLET
BSFi Student

Noted by:

PROF. IAN CRIS R. BUBAN
Thesis Adviser

09701164262 JUDITH D. BAYNA OA STAFF

REPUBLIC OF THE PHILIPPINES
BICOL UNIVERSITY
TABACO
Tayhi, Tabaco City
Email: butc-dean@bicol-u.edu.ph

ISO 9001: 2015
SOCOTEC SCP000722Q

BAGONG PILIPINAS

HON. OSCAR ROBERT H. CRISTOBAL
Acting Mayor, City of Legazpi
Albay Province

RECEIVED
OCT 15 2024
8:20 AM

Dear Mayor Cristobal:

Good day!

We are student researchers from Bicol University Tabaco, currently conducting a study entitled "Climate Change Vulnerability of *Priacanthus sp.* in the Eastern Part of Albay Gulf." As part of our research, we have selected Legazpi City, specifically the fisherfolk communities in Puro and Victory Village 27 and 28, as one of our study areas.

Our research aims to assess the impact of climate change on the red bigeye fishery (locally known as "Kwaw") and the vulnerabilities faced by fisherfolk in this area. In this regard, may we respectfully request permission from your office to conduct surveys with the fisherfolk in the aforementioned communities.

The survey will be conducted in adherence to ethical standards and research protocols. Your support would significantly contribute to this study's success and provide valuable insights into the local fisheries sector.

We would appreciate your favorable response and any guidance you can provide to ensure smooth coordination with the local fisherfolk.

Thank you for your time and consideration.

Sincerely,

HARRIETT B. BISCOCHO
BSFi Student

MA. LOUISA A. CARLET
BSFi Student

Noted by:

PROF. IAN CRIS R. BUBAN
Thesis Adviser

REPUBLIC OF THE PHILIPPINES
BICOL UNIVERSITY
TABACO
Tayhi, Tabaco City
Email: butc-dean@bicol-u.edu.ph
ISO 9001:2015
SOCOTEC SCP000722Q
BAGONG PILIPINAS

September 17, 2024

Hon. Jerry B. Bañeyn
Brgy. Sto. Domingo
Sto. Domingo

Dear Barangay Captain:

Good day!

We are student researchers from Bicol University Tabaco, currently conducting a study entitled "Climate Change Vulnerability of *Priacanthus sp.* in the Eastern Part of Albay Gulf." As part of our research, we have selected you Barangay as one of our study areas.

Our research aims to assess the impact of climate change on the red bigeye fishery (locally known as Kuwaw) and the vulnerabilities faced by the fisherfolk in this region. We respectfully request permission from your office to conduct surveys with the fisherfolk in your Barangay.

The survey will be conducted in adherence to ethical standards and research protocols. Your support would greatly contribute to the success of this study and provide valuable insights for the local fisheries sector.

We would appreciate your favorable response and any guidance you can provide to ensure smooth coordination with the local fisherfolk.

Thank you for your time and consideration.

Sincerely,

HARRIETT B. BISCOCHO
BSFi Student

MA. LOUISA A. CARLET
BSFi Student

Noted by:

PROF. IAN CRIS R. BUBAN
Thesis Adviser

Received by: 10/03/04
Lea B. Balderama
Brgy. Kgwd.
09505792256

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REPUBLIC OF THE PHILIPPINES
BICOL UNIVERSITY
TABACO
Tayhi, Tabaco City
Email: butc-dean@bicol-u.edu.ph

BAGONG PILIPINAS

September 17, 2024

HON. ERNESTO D. DAEN
Barangay Captain
Cawit, Manito, Albay

Dear Barangay Captain:

Good day!

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Thank you for your time and consideration.

Sincerely,

HARRIETT B. BISCOCHO
BSFi Student

MA. LOUISA A. CARLET
BSFi Student

Noted by:

RECIEVED BY: BRGY. ERNESTO D. DAEN
BRGY. CAPTAIN
NOV. 28, 2024

PROF. IAN CRIS R. BUBAN
Thesis Adviser

REPUBLIC OF THE PHILIPPINES
BICOL UNIVERSITY
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Tayhi, Tabaco City
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ISO 9001: 2015
SOCOTEC SCP000722Q

BAGONG PILIPINAS

September 17, 2024

Hon. Alvin B. Bigneras
Barangay Captain
San Juan

Dear Barangay Captain:

Good day!

We are student researchers from Bicol University Tabaco, currently conducting a study entitled "Climate Change Vulnerability of *Priacanthus sp.* in the Eastern Part of Albay Gulf." As part of our research, we have selected you Barangay as one of our study areas.

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Thank you for your time and consideration.

Sincerely,

HARRIETT B. BISCOCHO
BSFi Student

MA. LOUISA A. CARLET
BSFi Student

Noted by:

PROF. IAN CRIS R. BUBAN
Thesis Adviser

recieved by: ANTHONY B. BAGUETAS
BRGY. KAGAWAD
SAN JUAN SDA
09:12am 10-03-24

REPUBLIC OF THE PHILIPPINES
BICOL UNIVERSITY
TABACO
Tayhi, Tabaco City
Email: buto-dean@bicol-u.edu.ph

ISO 9001 2015
SOCOTEC SCP000722Q

BAGONG PILIPINAS

September 17, 2024

HON. ELEUTERIO N. DAEP JR.
Barangay Captain
Pawa, Manito, Albay

Dear Barangay Captain:

Good day!

We are student researchers from Bicol University Tabaco, currently conducting a study entitled "Climate Change Vulnerability of *Priacanthus sp.* in the Eastern Part of Albay Gulf" As part of our research, we have selected you Barangay as one of our study areas.

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Thank you for your time and consideration

Sincerely,

HARRIETT B. BISCOCHO
BSFi Student

MA. LOUISA A. CARLET
BSFi Student

Noted by

PROF. IAN CRIS R. BUBAN
Thesis Adviser

REPUBLIC OF THE PHILIPPINES
BICOL UNIVERSITY
TABACO
Tayhi, Tabaco City
Email: butc-dean@bicol-u.edu.ph
ISO 9001: 2015
SOCOTEC SCP000722Q

BAGONG PILIPINAS

September 17, 2024

Hon. Marilia A. Capino
Brgy 27 Victory Village
North

RECEIVED
OCT 1 6 2024
09855657935

Dear Barangay Captain:

Good day!

We are student researchers from Bicol University Tabaco, currently conducting a study entitled "Climate Change Vulnerability of *Priacanthus sp.* in the Eastern Part of Albay Gulf." As part of our research, we have selected you Barangay as one of our study areas.

Our research aims to assess the impact of climate change on the red bigeye fishery (locally known as Kuwaw) and the vulnerabilities faced by the fisherfolk in this region. We respectfully request permission from your office to conduct surveys with the fisherfolk in your Barangay.

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Thank you for your time and consideration.

Sincerely,

HARRIETT B. BISCOCHO
BSFi Student

MA. LOUISA A. CARLET
BSFi Student

Noted by:

PROF. IAN CRIS R. BUBAN
Thesis Adviser

BASILIA A. CAPINO
P.B

11-14-24

APPENDIX G

Bicol University Tabaco Campus
Tayhi, Tabaco City
Date of interview: ____________

CLIMATE CHANGE VULNERABILITY OF RED BIGEYE FISHERY IN MAJOR FISHING AREAS IN ALBAY GULF

PART I. INFORMATION ON THE HUMAN COMPONENT

A. PERSONAL AND HOUSEHOLD INFORMATION

1. Respondent: ______________________________
2. Municipality: ____________________, Barangay: ____________________
3. Civil Status: Single _____ Married _____Others (Specify) _______, Religion ________
4. Household Information:

Members	(4.1) Gender	(4.2) Age	(4.3) Educational Attainment	(4.4) Health Conditions	(4.5) **AC1 Annual Source of Income** (**P =** primary, **S =** secondary)		
					Fishing	*Red Bigeye Fishery*	*Others*
Father							
Wife							
Child 1							
Child 2							
Child 3							
Child 4							
Child 5							
Child 6							
Child 7							

Educational background:* **OS: Out of school youth **E:** Elementary (Grad or Non-grad)
HSN: High school (Non-grad) **HSS:** High school grad (Skilled)
VG: Vocational grad **CG:** College grad
UG: College Undergraduate

Existing health condition:* **NS: No special health needs
SV: No special health needs with medication (i.e vitamins)
MN: With minor symptomatic disease
MJ: With major symptomatic disease
SH: With special health needs (e.g., taking maintenance drugs or regular checkups)

5. Household dependency on Red Bigeye Fishery (%): ______________
6. Organizational Affiliation:
a. Civic ________ b. Religious________ c. Environmental _______ d. Fisherfolk association ___________

PART II. RED BIGEYE FISHERIES INFORMATION

7. Number of years in Red Bigeye fishery: ____________

8. Type of fishing gear used (and descriptions, e.g., no. of units, mesh size, hook size, no. ofhooks):

- Kitang ______________________________
- Og-og__________________________
- Pangke____________________
- Others _______________

9. Have you replaced or modified your fishing gear to catch Kuwaw?
- No gear modification, no knowledge, and no resources (budget)
- With some gear modification, with some knowledge, and no resources (budget)
- With some gear modification, with some knowledge, and with limited resources; unsuccessful
- With some gear modification, with some knowledge, and with limited resources; with limited success.
- With full gear modification, with some knowledge, and with resources; successful modification

10. If yes, what modifications or replacements have been made? (Please select all that apply)

- Increase no. of hooks
- Change bait
- Increase the length of fishing line
- Use smaller mesh size
- Others____

11. What were the main reasons for these modifications or replacements?
(Please select all that apply)
- To target different species/resources
- To reduce environmental impact

- To improve efficiency
- Others (Please specify): ___________

12. How satisfied are you with the performance of the modified or new gear?
    - Very satisfied
    - Somewhat satisfied
    - Not satisfied
    - Not sure

Fishing Seasonality

Season	Month	(13.3)	**S2** (13.4)		(13.5)	**S1** (13.6)		(13.7)
		Fishing Ground	**Size** *cm* (present)	Size *cm* (10-20 years ago)	Price	Catch rate *kg* (present)	Catch rate *kg* (10-20 years ago)	Fishing Frequency (no. of days in week)
Peak	(13.1)							
Lean	(13.2)							

** if Tub/Banyera, how many and how much is the weight per Tub/Banyera:*_________

14. If there is a decrease in fish abundance, what do you believe is the main cause?

PART III. CLIMATE CHANGE IMPACTS AND ADAPTATION OF HOUSEHOLD AND COMMUNITIES

15. Have you and your family members heard about climate change?
    - Yes, all of us heard about it
    - Yes, most of us heard about it
    - Yes, very few of us heard about it
    - No, we haven't heard about it

16. What do you understand about climate change? *(Rate from 0%-100%)*
    - Changes in temperature: (0%_________________100%) Value: ____ %
    - Sea level rise: (0%_________________________100%) Value: ____ %
    - Extreme weather events: (0%___________________100%) Value: ____ %
    - Others (please specify): (0%___________________100%) Value: ____ %
17. What are your sources of information on the impacts of climate change?

- Radio
- TV
- Newspaper
- Trainings
- Facebook
- YouTube
- TikTok
- Others:_____________

18. What climate change-related events has your household experienced?
    - Flooding
    - Sea level rise
    - Drought
    - Extreme heat
    - Landslide
    - Storm surge
    - Stronger Typhoons
    - Stronger winds (Habagat and Amihan)
    - Changing monsoonal occurrence
    - More heavy rainfall
    - Other _________________
19. How often has your household been affected by these climate change-related events?
    - Never
    - Rarely (1-2 times per year)
    - Occasionally (3-5 times per year)
    - Frequently (6-10 times per year)
    - Very Frequently (more than 10 times per year)
20. What types of climate change-related events have impacted your community?
    - Flooding
    - Drought
    - Extreme heat
    - Landslide
    - Storm surge
    - Stronger typhoons
    - Stronger winds (Habagat and Amihan)
    - Changing monsoonal occurrence
    - Increasing sea surface temperature
    - Heavy rainfall
    - Others: ________
21. How often has your community been affected by these climate change-related events in the past year?
    - Never
    - Rarely (1-2 times per year)
    - Occasionally (3-5 times per year)
    - Frequently (6-10 times per year)
    - Very Frequently (more than 10 times per year)
22. What adaptive strategies have been implemented by your household and the community? (Please select all that apply)
    - Strengthening household through renovations
    - Building infrastructure (e.g., levees, seawalls)
    - Community training and education
    - Improved early warning systems
    - Relocation of vulnerable populations
    - Adjusting work practices (e.g., changing fishing times, crop cycles)
    - Others (Please specify): ___________
23. How effective do you think these measures have been in reducing your community's exposure to climate-related events?
    - Not effective at all
    - Slightly effective
    - Moderately effective
    - Very effective
    - Extremely effective

PART IV. CLIMATE CHANGE IMPACTS AND ADAPTATION ON FISHING

24. What types of climate-related events have impacted your fishing grounds?

- Storms or typhoons
- Changes in sea temperature
- Sea level rise
- Ocean acidification
- Others (please specify): ___________________________

25. How often do you experience these events in a year?
    - Never
    - Rarely (1-2 times per year)
    - Occasionally (3-5 times per year)
    - Frequently (6-10 times per year)
    - Very frequently (More than 10 times per year)
26. Before or during extreme weather events, do you take any precautionary measures?
    - Yes
    - No
27. What precautionary measures do you take before and during extreme weather events? (Check all that apply)
    - Move boats to a safe place.
    - Secure fishing gear to prevent damage.
    - Get updates from authorities.
    - Fish less to save resources.
    - Find other work if fishing income is low.
    - Change fishing times to avoid extreme heat.
    - Move or change fishing spots.
    - Use new tools or equipment
    - Other:______________
28. Are there any programs or support systems available in your area to help with climate change adaptation?
    - Yes
    - Not sure
    - No
29. If yes, what types of support are provided? (Please select all that apply)
    - Financial assistance or subsidies
    - Training and education
    - Access to new technologies or gear
    - Policy support (e.g., regulations, guidelines)
    - Community-based initiatives
    - No program
    - Others (Please specify): ___________________
30. How would you rate the effectiveness of these programs in supporting your adaptation efforts?
    - Very effective
    - Moderately effective
    - Not effective
31. Are there any programs or support systems available in your area to help with climate change adaptation?
    - Yes
    - No
    - Not sure

32. What recommendations or additional insights do you have for improving adaptive strategies, gear modification, or support systems to help your community/industry adapt to climate change? (open-ended)

____

____

IV. PERCEPTION OF MANAGEMENT OPTIONS, ADAPTATION, AND MITIGATING MEASURES

Below are statements relating to possible policy, management options, adaptation, and mitigating measures for RedBigeye resources. Based on your opinion, please rate from 1 to 5, where 1 is the lowest and 5 is the highest.

Statements	Definitely not support (1)	Probably will not support (2)	No opinion or I don't know (3)	Probably will support (4)	Definitely will support (5)
33. Prohibit harvesting of juvenile or immature Kuwaw resources					
34. Regulate fishing effort through reduction or catch quotas					
35. Implement a closed season for harvesting Kuwaw during spawning season					
36. Shift targeted species to reduce pressure on Kuwaw resources					
37. Conduct research on Kuwaw and the impacts of climate change					
38. Promote the use of biofuel in motorized Banca					
39. Strengthen enforcement against illegal fishing practices					

40. Ensure compliance with Marine Protected Area (MPA) rules and regulations					
41. Manage coastal areas by local communities					
42. Proper disposal of used engine oil and other wastes					
43. Register Kuwaw fishers, boats, and fishing gear					
44. Attend meetings, seminars, and training organized by MAO					
45. Participate in the management planning and formulation of fishery ordinances					
46. Form and join Kuwaw fishery organizations					
47. Provide alternative livelihood during the lean season					

PLATES

Plate 1. Researchers conducting survey on the Red Bigeye fishers within the three municipalities—Sto. Domingo, Legazpi, and Manito

Plate 2. Image of Red Bigeye *(Priacanthusmacracanthus)* or locally known as Kuwaw from Buhatan, Sto. Domingo

Plate 3. Fishing gears used in catching Red Bigeye (Kuwaw),
kitang or bottom-set longline (right) and og-og or multiple handline (left)

CURRICULUM VITAE

CURRICULUM VITAE

Name:	**HARRIETT B. BISCOCHO**
Age:	22
Date of Birth:	January 29, 2003
Place of Birth:	Sta. Cruz, Malilipot, Albay
Religion:	Roman Catholic
Civil Status:	Single
Parents:	Marietta B. Biscocho
	Herbert B. Biscocho

Educational Attainment

Elementary:	Malilipot Central School
	Bonafe St. Malilipot, Albay
	(2009-2015)
Junior High School:	Malilipot National High School
	Brgy. 4, Malilipot, Albay
	(2015-2019)
Senior High School:	Malilipot National High SchoolMalilipot
	Brgy. 4, Malilipot, Albay
	(2019-2021)
Tertiary:	Bicol University Tabaco
	Tayhi, Tabaco City
	(2021-Present)

CURRICULUM VITAE

Name:	**MA. LOUISA A. CARLET**
Age:	22
Date of Birth:	March 18, 2003
Place of Birth:	San Ramon, Tabaco City
Religion:	Roman Catholic
Civil Status:	Single
Parents:	Marilou A. Carlet
	Jimberth C. Carlet

Educational Attainment

Elementary:	San Ramon Elementary School
	San Ramon, Tabaco City
	(2009-2015)
Junior High School:	Tabaco National High School
	Panal, Tabaco City
	(2015-2019)
Senior High School:	Tabaco National High School
	Panal, Tabaco City
	(2019-2021)
Tertiary:	Bicol University Tabaco
	Tayhi, Tabaco City
	(2021-Present)