THIS PROJECT IS CO-FUNDED BY THE EUROPEAN UNION

ANNEX REPORT

SMALL-SCALE FISHERIES IN A WARMING OCEAN: EXPLORING ADAPTATION TO CLIMATE CHANGE

Imprint

Publisher: WWF-Germany; International WWF Centre for Marine Conservation, Hamburg

Year of publication: 2020

Authors:

Léa Monnier & Didier Gascuel – AGROCAMPUS OUEST (France)

Juan José Alava & William Cheung – University of British Columbia (Canada)

Maria José Barragán & Jorge Ramírez – Charles Darwin Foundation (Galapagos)

Nikita Gaibor – Instituto Nacional de Pesca (Ecuador)

Philipp Kanstinger & Simone Niedermueller – Franck Hollander – WWF Germany

Editing: all authors, Evan Jeffries (www.swim2birds.co.uk)

Coordination: Franck Hollander (WWF Germany), Thomas Koeberich (WWF Germany)

Contact: franck.hollander@wwf.de, didier.gascuel@agrocampus-ouest.fr

Funded by: WWF-Germany, University of British Columbia (Canada)

Photo credits: Front cover photo: Fisherman watching storm cloud © Gettyimages / WWF

Citation: **Monnier, L., Gascuel, D., Alava, J.J., Barragán, M.J., Gaibor, N., Hollander, F.A., Kanstinger, P., Niedermueller, S., Ramírez, J., & Cheung, W.W.L.** 2020. Small-scale fisheries in a warming ocean: exploring adaptation to climate change. Annex report. WWF Germany.

This study was led by:

l'institut Agro
agriculture • alimentation • environnement
AGRO CAMPUS OUEST

TABLE OF CONTENTS

1. Analysis of climate change impact and risks 4

1.1 Methods: Vulnerability and risk of climate change impact 4

1.2 Complementary results 7

2. Stakeholders workshops methodology (by Maria José Barragán and Juan Jose Alava) 9

2.1 Qualitative and Quantitative Approaches 9

2.2 Organisation of the workshop (The Ecuadorian case study as an example) 12

2.2.1 First Day 12

2.2.2 Second Day 12

2.3 References of Chapter 2 17

2.4 Appendix of Chapter 2 20

3. CASE STUDY 1: Perception and vision of the current state of ancestral, scientific and management knowledge in the small scale fisheries of Ecuador's continental coast 27

3.1 Document Preparation 28

3.2 Workshop structure 28

3.3 Results: Workshop outcomes 29

3.3.1 Workshop Outcomes from the Focus Group 1 (fishers) Knowledge about Climate Change within the Artisanal Fishing Sector. 29

3.3.2 Workshop Outcomes from Working Groups Focus Group 1 (fishers) (Scientists/Researchers): Research and Implementation of effective adaptation to climate change in the artisanal fishery. 32

3.3.3 Group 3 (Decision /Policy Makers): Policies of adaptation / mitigation to climate change in the artisanal fisheries of Ecuador 35

3.3.4 Workshop outcomes from mixed working group (Fishers, Scientists and Decision Makers) 36

3.4 Discussion 43

3.5 Conclusions 44

3.6 References of Chapter 3 46

3.7 Annexes of Chapter 3 51

4. CASE STUDY 2: IMPACTS OF CLIMATE CHANGE IN THE ARTISANAL FISHERY OF GALAPAGOS: FISHERS KNOWLEDGE 61

4.1 Document preparation 61
4.2 Workshops structure 61
4.3 Results: workshop outcomes 62
4.3.1 How does Climate Change affect artisanal fisheries in Galapagos? 62
4.3.2 How prepared is the Galapagos Artisanal Fisheries Sector for Climate Change? 63
4.3.3 Proposals for actions to address climate change in artisanal fisheries in Galapagos 64
4.3.4 What is needed for successful stakeholder collaboration? 66
4.3.5 What issues should be investigated so that the Galapagos Fishing Sector has a better knowledge of how to face Climate Change? 67
4.3.6 What should the Galapagos Fishing Sector do to adapt to the impacts of Climate Change? 68
4.3.7 What can be done to ensure the sustainability of seafood products and ensure food sovereignty in general? 70
4.4 Discussion 71
4.4.1 Conjectural and external factors 71
4.4.2 What do we know? 73
4.4.3 How to adapt? 74
4.5 Scope and Limitations 76
4.6 Conclusions 77
4.7 References of Chapter 4 78
4.8 Annexes of Chapter 4 79

5. CASE STUDY 3: SOUTH AFRICA 102

5.1 Document preparation 102
5.2 Workshop structure 103
5.3 Results: Workshop outcomes 103
5.3.1 What were the changes in the last decade in the South African line fishery? 103
5.3.2 How prepared is the South African line fishery sector for climate change? 103
5.3.3 Proposals of actions addressing climate change in the South African line fishery 104

5.4 Discussion 107
5.5 Scope and Limitations 110
5.6 Conclusions 111
5.7 References of Chapter 5 111
5.8 Annexes of Chapter 5 112

6. CASE STUDY 4: THE PHILIPPINES 133

6.1 Document preparation 133
6.2 Workshop structure 133
6.3 Results: workshop outcomes 134
6.3.1 What were the changes in the last decade in the Filipino tuna handline fishery? 134
6.3.2 How prepared is the Filipino Tuna handline fishery Sector for Climate Change? 134
6.4 PROPOSALS FOR ACTIONS TO ADDRESS CLIMATE CHANGE IN THE TUNA HANDLINE FISHERY IN THE PHILIPPINES 135
6.5 Discussion 137
6.6 Scope and Limitations 141
6.7 Conclusions 141
6.8 Annexes 142

7. TRANSCRIPTION OF THE WORKSHOP 146

Glossary 171

SUMMARY

This report detail the methodology and the results of a study carried on the impacts of climate change on fisheries, and the perception of change by local stakeholder as well as the adaptations required in fishing practices and fisheries management, for three small-scale fisheries considered as case studies in: Ecuador, the Philippines and South Africa. It complements the report "Towards adaptation to climate change in small-scale fisheries – Exploring three case studies: Ecuador, the Philippines and South Africa. Scientific report."

1. Analysis of climate change impact and risks

1.1 Methods: Vulnerability and risk of climate change impact

The quantitative analysis aims to estimate the risk of climate impact on different species. We explored two of the four RCP (Representative Concentration Pathway) scenarios. These scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008). RCPs usually refer to the portion of the concentration pathway extending up to 2100, for which Integrated Assessment Models produced corresponding emission scenarios. Four RCPs produced from Integrated Assessment Models were selected from the published literature and are used in the Fifth IPCC Assessment as a basis for the climate predictions and projections:

- RCP2.6 One pathway where radiative forcing peaks at approximately 3 W m-2 before 2100 and then declines (the corresponding ECP assuming constant emissions after 2100). It is representative of the literature on mitigation scenarios aiming to limit the increase of global mean temperature to 2°C.

- RCP4.5 and RCP6.0 Two intermediate stabilisation pathways in which radiative forcing is stabilised at approximately 4.5 W m-2 and 6.0 W m-2 after 2100 (the corresponding ECPs assuming constant concentrations after 2150);

- RCP8.5 One high pathway for which radiative forcing reaches greater than 8.5 W m-2 by 2100 and continues to rise for some amount of time (the corresponding ECP assuming constant emissions after 2100 and constant concentrations after 2250). The RCP8.5 combines assumptions about high population and relatively slow income growth with modest rates of technological change and energy intensity improvements, leading in the long term to high energy demand and GHG emissions in absence of climate change policies. Compared to the total set of Representative Concentration Pathways (RCPs), RCP8.5 thus corresponds to the pathway with the highest greenhouse gas emissions. It is also called the "business as usual" scenario.

The two RCPs we have chosen to explore impacts of climate change on small-sale fisheries are the two extremes: RCP 2.6 and RCP 8.5.

The climate vulnerability and risk assessment framework used in this study is the one used by the fifth assessment report of the Intergovernmental Panel on Climate Change (IPCC) (Field et al., 2014).

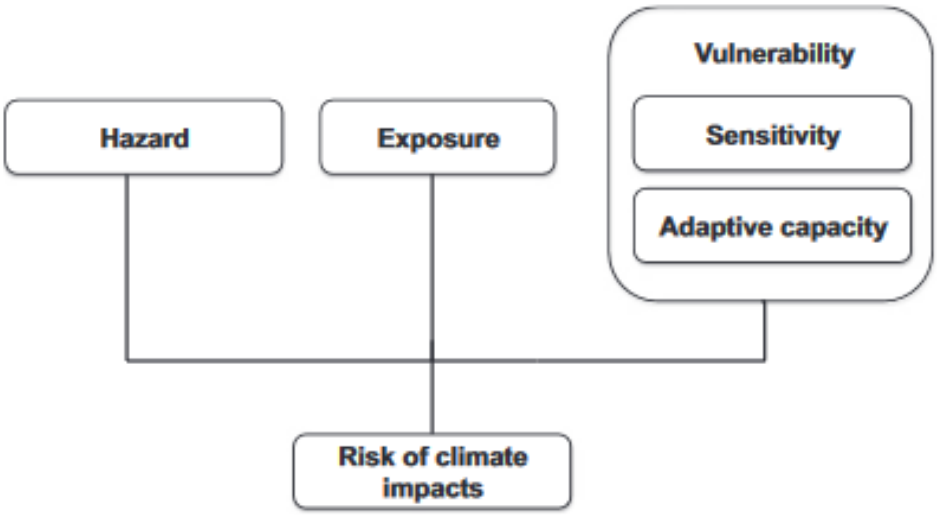


Figure II.3 Framework for assessing climate change vulnerability and risk adopted by the fifth assessment report of the IPCC (2014a)

Sensitivity of a species is here defined as the susceptibility to impacts from climate change. It is affected by species biological and ecological traits. Species' sensitivity may be moderated by their adaptive capacity, which reflects a species' ability to adapt and thus cope with, or avoid, the impacts of climate change. The analysis uses biological and ecological data that are available on FishBase (Froese & Pauly, 2017, http://fishbase.org).

The risk of impact is a combination of species vulnerability and their exposure to hazard.

For each of the two scenarios we explored, RCP2.6 and RCP8.5, we estimate the risk of impact in 2030 and in 2100.

To calculate exposure to hazard across a species range, we use the current range boundary for each species predicted using the Sea Around Us method. The range boundary was defined based on latitudinal and depth ranges, as well as expert-delineated range boundaries such as those published in FAO species catalogues. The range boundary was then subsequently rasterized on a 0.5° latitude 0.5° longitude grid.

Climate hazards are the predicted changes in physical environment. Here, climate hazard is calculated from projected changes in key ocean ecosystem drivers that have shown to affect species population viability: temperature, oxygen and pH (Pörtner et al., 2014). Projected sea surface and bottom temperature, oxygen concentration and hydrogen ion concentration from three Earth System Models: the Geo-physical Fluid Dynamics Laboratory's ESM 2G model (GFDL-ESM-2G), the Institut Pierre Simon Laplace's CM6-MR model (IPSL-CM6-MR), and the Max Planck Institute's ESM-MR model (MPI-ESM-MR). For each model three time periods were considered: 1951-2000, 2021-2040 (conventionally designed as projection 2030) and 2091-2100 (projection 2100).

Climate hazard is indicated by the mean change in each environmental variable between baseline (average between 1951 and 2000) and 2030 (average between 2021 and 2050) or 2100 (average between 2091 and 2100) divided by the standard deviation (SD) over baseline period (1951–2000). This division takes into account the interannual environmental variability a species would be accustomed to experiencing, thereby characterizing where the trend in the environmental variable becomes perceptible across each species' range.

$$ExV = \frac{\text{mean}(V_{2041-2060}) - \text{mean}(V_{1951-2000})}{SD(V_{1951-2000})} \quad (1a)$$

$$ExV(\text{Temperature}) = |ExV| \quad (1b)$$

$$Exv(\text{Oxygen}) = |\min(ExV, 0)| \quad (1c)$$

$$ExV(\text{Acidity}) = |\max(ExV, 0)| \quad (1d)$$

TABLE 1 The definition of rules used to classify into different categories to calculate an overall index of exposure to climate hazard (*ExV*) and the levels of attributes used to define categories of sensitivity and adaptive capacity

Categories and their resulting linguistic level				
Exposure	Low	Moderate	High	Very high
Exposure value (*ExV*)	1 > *ExV*	0.5 < *ExV* < 2	1 < *ExV* < 3	2 < *ExV*
Sensitivity	Low	Moderate	High	Very high
Temperature tolerance (TT, °C)	7 > *TT*	3 < *TT* < 10	7 < *TT* < 14	10 < *TT*
Maximum body length (BS, cm)	40 > BS	20 < *BS* < 60	40 < *BS* < 80	60 < *BS* < 80
Maximum body length & high coral reef association			20 < *BS* < 60 and coral reef association >1	40 > BS and coral reef association >1
Taxonomic group (ocean acidification)[1]	Fishes, crustaceans, sea cucumbers	Fishes, crustaceans, sea cucumbers	Crustaceans, molluscs, sea urchins	Molluscs, sea urchins
Adaptive Capacity	Low	Moderate	High	Very high
Latitudinal breadth (LB, degree)	19 > *LB*	10 < *LB* < 50	19 < *LB* < 70	70 < *LB*
Depth range (DR, m)	35 > *DR*	10 < *DR* < 200	35 < *DR* < 570	200 < *DR*
Fecundity (Fec, eggs or pups per year)	500 > *Fec*	500 < *Fec* < 10000	1000 < *Fec* < 100000	10000 < *Fec*
Habitat specificity (HS)	0.5 < *HS*	0.25 < *HS* < 0.75	0.1 < *HS* < 0.5	0.25 > *HS*

[1]Taxonomic groups and their corresponding linguistic categories of the sensitivity to ocean acidification.

Sensitivity

Attributes that are related to the sensitivity of marine fishes and invertebrates to climate change are identified based on published literature. For temperature related effects, sensitivity was based on species' temperature tolerance ranges and maximum body size. As species with large body size are suggested to be metabolically more sensitive to warming and ocean deoxygenation (Cheung, Sarmiento, et al., 2013; Pörtner et al., 2014; Simpson et al., 2011), body size was taken into account (see Table 1).

In addition, when coral reef is degraded by exposure to climate stressors such as warming, small-bodied coral reef fishes are suggested to be particularly sensitive to such impacts on their associated habitats (Graham et al., 2011). Species with small and medium body size and associated to coral reef have very high and high sensitivity.

Species sensitivity to ocean acidification based are categorized on published meta-analysis (Kroeker et al., 2013; Wittmann & Pörtner,2013).

Adaptive capacity

Adaptive capacity incorporated information on latitudinal breadth, depth range, association with specific habitats, and fecundity.

Species with larger latitudinal breadth and depth range as well as less demand for specific habitats (coral reef, seagrass, estuary or sea-mount) are considered to be more flexible in their environmental preferences and thus have larger scope to adapt to environmental changes through physiological (e.g., acclimation) and biogeographical(e.g., range shift) responses. Moreover, species with higher

fecundity have larger number of larvae or juveniles that are exposed to the changing environment, thus potentially result in a higher rate of selection and adaptation from these changes (Aitken, Yeaman, Holli-day, Wang & Curtis-McLane, 2008). A species' adaptive capacity to climate change is low when habitat specificity is high because of the possible restriction of a species to respond to climate change induced increase in sea temperature by range shift. All in all, small latitudinal or depth range, low fecundity or very high habitat specificity corresponds to low adaptive capacity, and vice versa (see Table 1).

1.2 Complementary results

Synthetic results on expected changes by 2100 in the RCP8.5 scenario are presented in the general report. Here, detailed results regarding the projected increase in SST by 2030 and 2100 are presented for each RCP scenario.

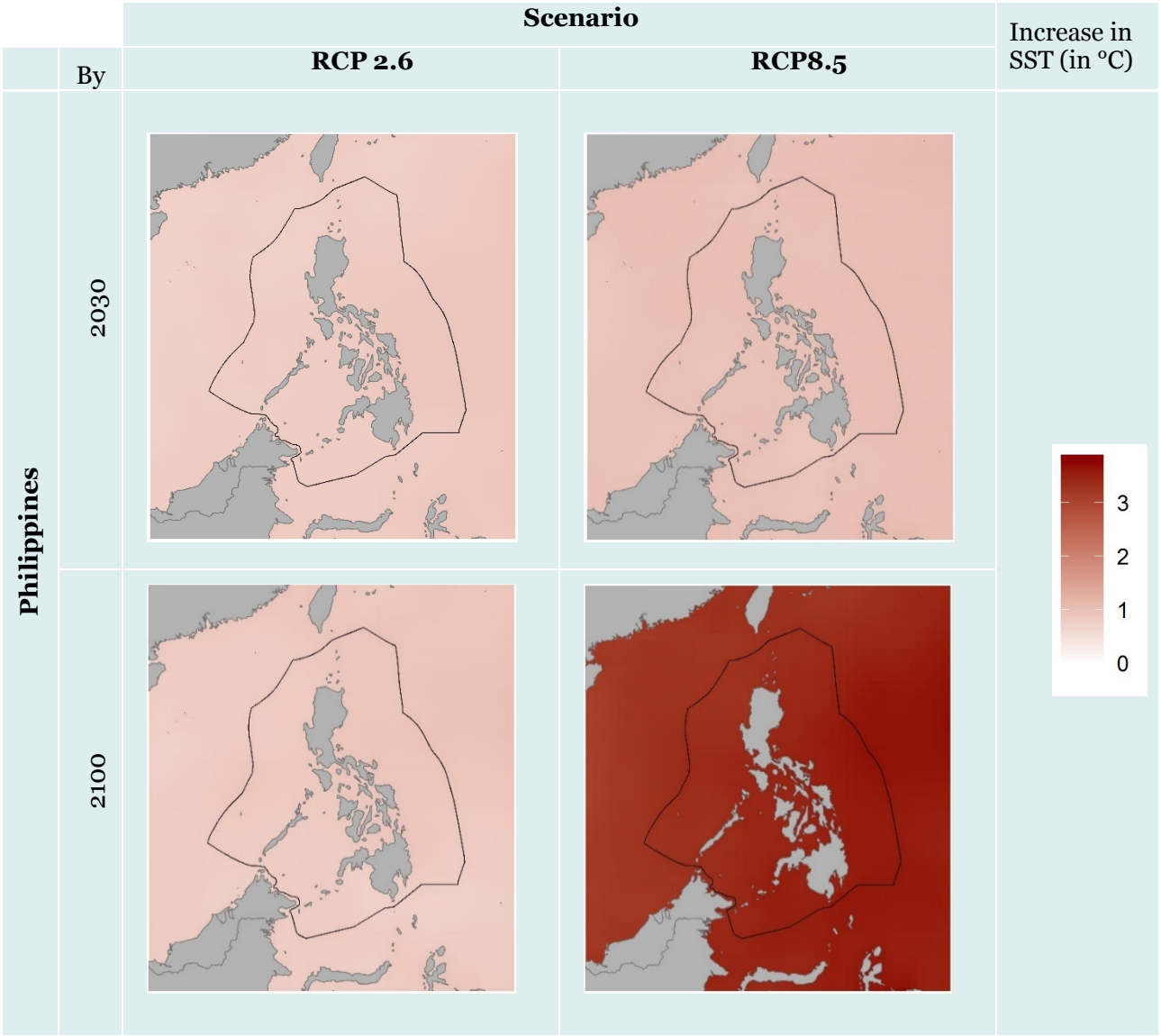


Fig 1: Increase in Sea Surface Temperature (SST) in °C around the Philippines under the 2 extreme scenarios (RCP2.6 and RCP8.5), by 2030 and by 2100. Mean of the 3 ESM (IPSL, GFDL, MPI).

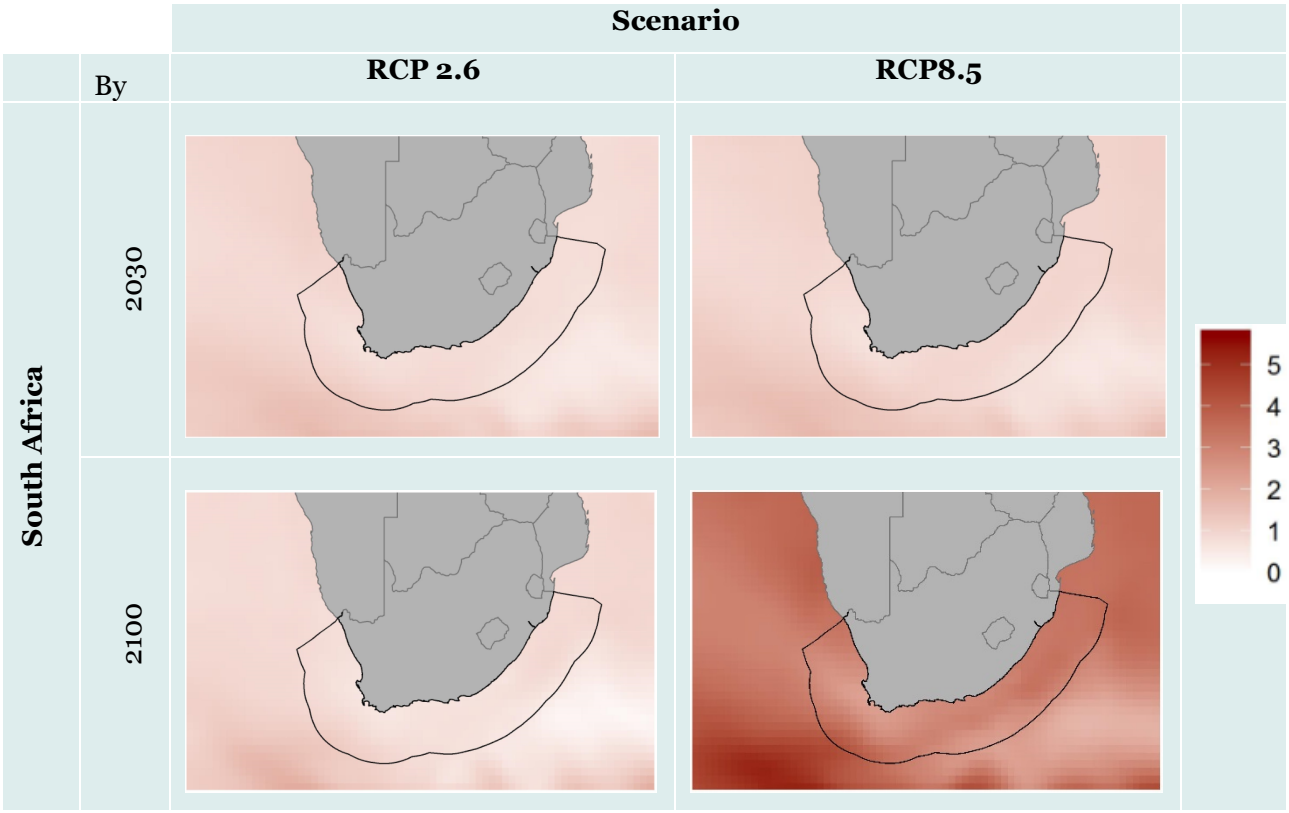


Fig 2: Increase in Sea Surface Temperature (SST) in °C around South Africa under the 2 extreme scenarios (RCP2.6 and RCP8.5), by 2030 and by 2100. Mean of the 3 ESM (IPSL, GFDL, MPI).

Table II.4 - Projected changes in catch potential (%) by 2050 and 2100 relative to 2000 under RCP2.6 and RCP8.5 based on outputs from the dynamic bioclimatic envelope models. The table shows the average change per EEZ as well as the variability (range) around the average, representing the different estimates from the array of climate models used to drive the fisheries projections. Adapted from FAO, 2018.

Country	2050				2100			
	RCP2.6		RCP8.5		RCP2.6		RCP8.5	
	Average	Range	Average	Range	Average	Range	Average	Range
Ecuador	-54.7	50.0	-79.4	36.5	-53.4	58.7	-82.4	40.5
Galapagos Islands (Ecuador)	2.7	5.2	2.9	18.7	2.5	4.4	-21.2	84.4
South Africa	-8.2	13.0	-15.3	16.3	-9.5	15.4	-21.2	25.2
Philippines	-8.3	19.6	-23.7	35.1	-11.2	15.3	-59.2	25.7

2. Stakeholders workshops methodology (by Maria José Barragán and Juan Jose Alava)

The fundamental pillar to assess whether the nation is ready to effectively adapt to climate change and/or implement climate change adaptation strategies in fisheries start with an assessment of the readiness of the nation to adapt to climate change by formulating and applying a set of open-ended questions during working and focused groups and participatory interviews to evaluate whether the country is ready or not ready to adapt to climate change. For each of the potential adaptation options identified during the workshop or/and from Table 1 and Table 2, their potential effectiveness for fisheries adaptation in different national context was assessed.

2.1 Qualitative and Quantitative Approaches

Qualitative Interviews

The outcomes and answers resulting from the set of questions of each participatory focus group will be considered as qualitative interviews, which is an approach that allocate and allow for open-ended questions leading to appealing and distinct understandings and rich narrative descriptions of perceptions from diverse perspectives (Bennett, 2016) coupled with "a key informant interview" approach (Walmsley et al., 2005) used as a central participatory technique for collecting insights on subjects of interest within the context of the research (Barragán-Paladines and Chuenpagdee, 2017) that in the case refers and applies to issues regarding the implementation of effective climate change adaptation strategies in the face of climate change. These methods will be useful to explore fishers' perceptions as information to support the evidence of climate change or environmental change impacts and effective interventions or adaptation strategies on fisheries and fishing communities. In the focus group, the leader of the group or facilitator must ensure that all perspectives and voices are heard. These activities will allow for the development of participatory approaches to co-produce knowledge and a trans-disciplinary database to implement effective climate change adaptation strategies and support adaptive policy formulation to help confronting climate change in small-scale fishing communities.

The value of the qualitative research - Fishers' and climate change adaptation strategies.

In *The Order of Things*, Foucault states that the study of individuals and society, what he calls the "human sciences,"[1] understands human beings in a dual manner: as constituting what counts as facts in these sciences and at the same time as an object for theoretical and empirical research. In order to understand human knowing, it is necessary to understand both poles of this duality, says Foucault (Flyvbjerg 2001). Today it is widely accepted that effective fishery governance should consider aspects of human behavior (Jacobsen, 2013) including fishers' ability to self-organize within the social and ecological domain of the fishery system (Mahon, McConney, & Roy, 2008).

The research used the triangulation approach (Clifford and Valentine, 2003) which looks at varied methods and instruments, as ways to find the answers to the research questions. Several methods were used to collect data and to analyze the adaptability of fishers to the climate change challenge. They include in-depth semi-structured and open-ended interviews with fisheries sector stakeholders,

[1] Here the term ''human sciences'' is used synonymously with ''social sciences'' meaning the study of human activity (Flyvbjerg 2001).

informal conversations with key informants, field observations, attendance of workshops, and review of secondary data (i.e., published governmental and non-governmental reports and grey literature. Guided conversations (Walmsley, et al., 2005) with local, and national representatives of fisheries sector, were also conducted. It also integrated field observations at numerous events, interactions, consultation sessions, and informal conversations. Additional supplementary review of relevant grey literature, academic publications, and local newspaper was taken into account.

Only knowledgeable local users were considered part of the process, and that condition was confirmed by their former involvement, in complementary projects, with activities currently conducted by the researchers with them, or in the past. Three main categories were identified and included, to select the participants, within the Guayaquil context (i.e., fisheries, including small-scale and large-scale fishers, authorities, researchers, NGOs, community members, fishing institution representatives). In the Galapagos context, only small-scale fishers were counted as participants.

The guided conversations followed a protocol (Walmsley, et al., 2005), which asked the people about the conditions and drivers leading strategies, measures, and tools to adapt to climate change threats, along with their understanding of how they were conceived and inspired. The conversations, interactions and interviews were face-to-face. They were involved within organized workshops that lasted between one and two days. Written notes and audio discussions were typed and recorded, by note-takers, simultaneously during the discussions in the workshops, given the inform consent and permission by the attendees. All conversations were conducted in Spanish and were subsequently digitalized and transcribed into English. All translations are the authors' own.

Sampling

This step was theoretical (or purposive) (Mays and Pope, 1995), rather than random or representative (Kerr and Swaffield 2012). This obeys to the rationale of informing a question, from a qualitative approach, where no statistical representativeness was demanded. The sampling combined the 'snow-ball' sampling technique (Goodman, 1961; Biernacki and Waldorf, 1981; Babbie 1989; Hernández-Sampieri, et al., 2006) used as a referral process, to approach previously referenced contacts in order to increase the set of interviews. And the 'key informant interview' approach (Walmsley, et al. 2005) used as a central participatory technique for gathering insights on subjects of interest within this research's context.

Formulation and Application of Open-Ended Questions

To support the workshop framework and assessment of climate change adaptation strategies, interviews in the focus group with a suit of open-ended questions, restricting the same type of questions of each group, are recommended for this task. Examples of questions to be answered for this assessment include:

How is climate change affecting or impacting fishers and livelihoods?

- Have you ever observed climate change in your lifetime?
- Does climate change poses a risk to your personal life?

Is climate change adaptation addressed in the fisheries and climate change policies of the country?

Is there any ongoing efforts for the implementation of climate change adaptation activities associated with these policies?

If climate change adaptation strategies do exist in the country:

- How and where are these strategies implemented?
- How can adaptive management or/and co-management promote flexible adaptation responses and also strengthen adaptation capacity?

If climate change adaptation strategies do not exist in the country:

- How can effective strategies be developed for adaptable and flexible fisheries and aquaculture policies within a broader oceans management framework?
- How to ensure sustainable aquaculture production as part of adaptation strategies?
- How to develop management responses that will be effective in securing seafood and the future sustainability of marine fisheries?

Is Traditional Knowledge and/or Culture taken into consideration in adaptive fisheries management of countries with implemented climate change adaptation strategies?

How can Traditional Knowledge and/or Culture be implemented in climate change adaptation strategies in countries lacking climate change adaptation strategies based on the compilation of local experiences?

This set of open-ended questions is part of the workshop framework offering several possible options to consider for effective climate change adaptation strategies for the specific fisheries system and local reality of the fishing communities of the assessed country (i.e. nation's specific climate change adaptation strategies). The proposed framework will allow us to identify a portfolio of adaptation options (Table 1; Appendix 1) for the countries where the case studies are located at.

Breakout Groups

Using and adapting the set of preliminary proposed open-ended questions aforementioned, three focus groups, including one for fishers, one for experts/scientist and one for officials/authorities and decision makers was conducted the first day of the workshop in separate rooms. A secretary or leader was elected from each of the focus group members to represent the group with the aim to report back inputs/outputs following one two hours and a half of participatory engagement and discussion to address and respond questions. During the second day an integral and mixed working group, composed by fishers, scientist/experts and officials/decision makers, was envisioned to integrate local and scientific knowledge and experience to respond the same set of questions (duration time: one hour and 15 minutes). In doing so, the following groups aimed to address and respond to the questions were planned for the workshops:

2.2 Organisation of the workshop (The Ecuadorian case study as an example)

2.2.1 First Day

Group 1 (Fishers): Knowledge of Climate Change within the Artisanal Fishing Sector.

1. Have you noticed some climate changes in the last 10 years, which ones?
2. How is climate variability (e.g. El Niño, La Niña) affecting you, fishermen, and their livelihoods?
3. On a scale of 1 to 10 (where 1 is not worried at all and 10 is very worried), how concerned are you with the impacts of the weather/climate?

1---2---3---4---5---6---7---8---9---10

4. Do you consider that the artisanal fishing sector is ready to adapt to climate change? Please, explain.
5. What should be done?

Group 2 (Scientist/Researchers): Research and Implementation of effective adaptation to climate change in the artisanal fishery

1. What information exists? What type?
2. What are the existing information gaps?
3. Do you know any example of adaptation strategies / mitigation to climate change in fisheries?
   3.1. How and where are these strategies implemented?
   3.2. How can management and / or co-management promote flexible adaptation / mitigation responses and capacity building?
4. What strategies can be implemented to improve knowledge of the impact of climate variability on fisheries?

Group 3 (Officials/Policy makers): Policies of adaptation / mitigation to climate change in the artisanal fisheries of Ecuador.

1. What and how can effective strategies be developed for adaptable and flexible fisheries and aquaculture policies within a broader ocean management framework?
   • How to guarantee sustainable production as part of adaptation strategies?
   • How to develop management responses that are effective in securing seafood and the future sustainability of marine fisheries?

Each focus group reported back about Exercise 1, independently.

2.2.2 Second Day

Overall Mixed Working Group (All: Fishers/ Researchers & Decision Makers): Exercise 2

Inputs and needs to adapt artisanal fisheries to climate change.

1. What are specific science efforts you would like to see undertaken?
2. What would you like to see your government do with regards to this issue?
3. What elements of collaboration are needed for success?
4. Who are the partners you would like to see engaged in this work?

5. What should be the policies that the Ecuadorian government considers to mitigate climate change in artisanal fisheries?
6. What effective strategies can be developed for the adaptation and mitigation of artisanal fisheries to climate change in Ecuador? (Strategies that should be adaptable and flexible within a broader ocean management framework).
7. How to develop management responses that are effective to ensure the products of the sea and the future sustainability of food sovereignty?

Report back about Exercise 2.

1. Discussion: "What next?"

Climate Change Adaptation Policy in Ecuador's mainland coastal small-scale fisheries, based on workshop activities for day 1 and day 2 (Questions Reports): *Implementation of effective adaptation / mitigation to climate change in artisanal fisheries: Next steps*

Coding – coding collaboratively

Coding implied finding common ideas, by examining, identifying, categorizing, and reporting data sets, as an iterative process of inductive line-by-line coding (Constas, 1992; Aronson, 1994; Chi, 1997; Braun and Clarke, 2006; Nicholas and McDowall, 2012, Zinda, 2012). After reading and marking the text, some significant passages were extracted (Seidman, 2006; Rubin and Rubin, 2005) and coded to conceptualize the ideas related to important aspects of the research (Rubin and Rubin, 2005). Certain judgement was exercised at this point while extracting 'significant' segments from transcripts.

According Saldaña (2009), writers of joint research projects advocate that coding in these cases can and should be a collaborative effort (Erickson and Stull, 1998; Guest an MacQueen, 2008). Multiple minds bring multiple ways of analyzing and interpreting the data: "a research team builds codes and coding builds a team through the creation of shared interpretation and understanding of the phenomenon being studied" (Weston et al. 2001, p. 382).

Ultimately, team members must coordinate and insure that their sometimes individual coding efforts harmonize, particularly if a central data base and CAQDAS system are employed. MacQueen et al. (2008, p. 132) strongly advise that one member of the team be assigned primary responsibility as "codebook editor" – the one who creates, updates, revises, and maintains the master list for the group.

Analysis

We used the thematic analysis technique (Braun & Clarke 2006) with a data-driven inductive approach (Boyatzis, 1998). This framework was used to identify common emerging themes or patterns within data that could describe the phenomenon under study. Consistency in observation and interpretation was emphasized to increase reliability as suggested by Boyatzis (1998). Analyzed data is presented with a narrative analysis, following MacDonald (1997). It was used to identify common emerging themes or patterns within data that are important to describe the phenomenon under study. By carefully reading and re-reading the data, we examined, identified, categorized, analyzed, and coded datasets (Constas, 1992; Chi, 1997; Nicholas and McDowall, 2012; Zinda, 2012).

Quotes from participants have been used as supporting evidence and include a referential code, written in brackets, that represents the participant number and the date when the interview was conducted.

Interviews and conversations were conducted in Spanish in Ecuador, in English in South Africa and in tagalog in the Philippines, with the written notes subsequently transcribed into English.

Toolkit: Identifying climate change risk reduction and adaptation tools for fisheries and aquaculture.

Based on the chapter 25 from the recent FAO report on Impacts of Climate Change on Fisheries and Aquaculture "*adaptation should be viewed as an on-going and iterative process, incorporating flexibility and feedback to learn from past experiences and avert new risks*" (FAO, 2018). Following the literature review conducted during the proposal development to compile and collate information and selected examples of climate adaptation policies and strategies for marine fisheries, a suit of official web sites, policy briefs, technical reports, working papers and peer reviewed articles on the topic from 2006 to 2018 are available in **Appendix 1**. These examples include the development and implementation of sectoral adaptation strategies, and examples of management adaptations strategies to provide guidance on potential adaptation tools in the fisheries sector. A list of adaptation options for fisheries will be identified based on the literature review and assessment. An example of specific adaptation options is presented in Table 1. In addition to these resources, the FAO toolbox (FAO 2016) of existing and recommended tools for climate change adaptation in fisheries and disaster responses that would enhance the resilience of the sector to climate change and to serve as guidance in communities, countries and other key stakeholders in their adaptation efforts will be used for the purposes of the workshop (Table 2).

The collated information can be synthesized and integrated into a tool kit for implementing adaptive strategies in fisheries management systems in a given developing countries facing protracted climate change risk.

***Table 1**. Portfolio of general climate change adaptation strategies as possible options to recommend and implement in selected developing countries.*

Fisheries Sector Component	Adaptation Strategy Options
Coastal Fishing Community	• Participatory engagement to develop community based-adaptation to climate change • Protection of well-being and infrastructure through geo-engineering and research-oriented solutions for climate change adaptations (i.e. aquaculture/mariculture) • Support and improvement of governance for climate change adaptation • Improve disaster risk management and build livelihood resilience to climate change • Support existing adaptive livelihoods strategies and resilience to adapt to climate change

Marine Fish and Fisheries	• Conservation of vulnerable fish species to climate change • Protection and enhancement of climate change resilient fish and habitat (corals, mangroves, coastal wetlands) • Rehabilitation and sustainable management of marine resources and fisheries • Promote best fisheries practices to eliminate and reduce fishing effort in overexploited fisheries
Seafood Security	• Alternatives for fishing (positive/good incentives) and strengthen livelihoods for poverty reduction, inequity and poor governance. • Sustainable supply of sea food • Ocean wise consumption

Table 2. Portfolio of adaptation tools for climate change in fisheries by categorical adaptation activities, i.e. institutions, livelihoods, and risk reduction and management for resilience (taken and adapted from Chapter 25, pages 544-545, in FAO 2018).

INSTITUTIONS
Public policies
Public investments (e.g. research, capacity building, sharing best practices and trials, communication)
Climate change adaptation policies and plans address fisheries
Provide incentives for fish product value addition and market development
Remove harmful incentives (e.g. for the expansion of fishing capacity)
Address poverty and food insecurity, which systemically limit adaptation effectiveness
Legal frameworks
Flexible access rights to fisheries resources in a changing climate
Dispute settlement arrangements
Adaptive legal rules
Regulatory tools (e.g. adaptive control of fishing pressure; move away from time-dependent effort control)
Institutional frameworks
Effective arrangements for stakeholders engagement
Awareness raising and capacity building to integrate climate change into research/management/policy/rules
Enhanced cooperation mechanisms including between countries to enhance the capacity of fleets to move between and across national boundaries in response to change in species distribution
Management and planning
Inclusion of climate change in management practices, e.g. EAF, including adaptive fisheries management and co-management
Inclusion of climate change in integrated coastal zone management (ICZM)
Improved water management to sustain fishery services (particularly inland)
Adjustable territorial use rights
Flexible seasonal rights
Temporal and spatial planning to permit stock recovery during periods when climate is favourable
Transboundary stock management to take into account changes in distribution
Enhanced resilience by reducing other non-climate stressors (e.g. habitat destruction, pollution)
Incorporation of traditional knowledge in management planning and advice for decision-making
Management/protection of critical habitats for biodiversity and recruitment

LIVELIHOODS
Within sector
Diversification of markets/fish products, access to high value markets, support to diversification of citizens' demands and preferences
Improvement or change post-harvest techniques/practices and storage
Improvement of product quality: eco-labelling, reduction of post-harvest losses, value addition
Flexibility to enable seasonal migration (e.g. following stock migration)
Diversify patterns of fishing activities with respect to the species exploited, location of fishing grounds and gear used to enable greater flexibility
Private investment in adapting fishing operations, and private research and development and investments in technologies e.g. to predict migration routes and availability of commercial fish stocks
Adaptation oriented microfinance
Between sectors
Livelihood diversification (e.g. switching among rice farming, tree crop farming and fishing in response to seasonal and interannual variations in fish availability)
Exit strategies for fishers to leave fishing
RISK REDUCTION AND MANAGEMENT FOR RESILIENCE
Risk pooling and transfer
Risk insurance
Personal savings
Social protection and safety nets
Improve financial security
Early warning
Extreme weather and flow forecasting
Early warning communication and response systems (e.g. food safety, approaching storms)
Monitoring climate change trends, threats and opportunities (e.g. monitoring of new and more abundant species)
Risk reduction
Risk assessment to identify risk points
Safety at sea and vessel stability
Reinforced barriers to provide a natural first line of protection from storm surges and flooding
Climate resilient infrastructure (e.g. protecting harbours and landing sites)
Address underlying poverty and food insecurity problems
Preparedness and response
Building back better in post-disaster recovery
Rehabilitate ecosystems
Compensation (e.g. gear replacement schemes)

Source: FAO. 2018. Impact of climate change on fisheries and aquaculture. http://www.fao.org/3/I9705EN/i9705en.pdf

2.3 References of Chapter 2

Allison, E. H., & Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. *Marine Policy*, *25*(5), 377-388.

Aronson J, 1994. A Pragmatic View of Thematic Analysis. The Qualitative Report, Volume 2, Number 1, Spring, 1994, http://www.nova.edu/ssss/QR/BackIssues/QR2-1/aronson.html

Babbie, E. (Ed.), 2001.The Practice of Social Research. Belmont: Wadsworth.

Bennett, N.J. 2016. Using perceptions as evidence to improve conservation and environmental management. *Conservation Biology*, *30*(3): 582-592.

Berkes, F. (2003). Alternatives to conventional management: lessons from small-scale fisheries. *Environments, 31*(1), 1-16.

Boyatzis, R. E. 1998. Transforming qualitative information: Thematic analysis and code development. Thousand Oaks. Sage.

Braun, V. and V. Clarke. 2006. Using thematic analysis in Psychology. Qualitative Research in Psychology, 3:77–101.

Biernacki, P. and D. Waldorf, 1981. Snowball Sampling: problems and techniques of referral chain sampling. Sociological Methods and Research, 10(2):141–163.

Bystrom, A.B. 1,2,3, Helven Naranjo-Madrigal4,5 & Ingo S. Wehrtmann2,6 (2017) Indicator-based management recommendations for an artisanal bottom-longline fishery in Costa Rica, Central America. Rev. Biol. Trop. (Int. J. Trop. Biol. ISSN-0034-7744) Vol. 65 (2): 475-492, June 2017

Castilla, J. C., & Fernández, M. (1998). Small-scale benthic fisheries in Chile: on co-management and sustainable use of benthic invertebrates. *Ecological Applications, 8*, 124-132.

Castilla, J. C., & Defeo, O. (2001). Latin American benthic shellfisheries: emphasis on co-management and experimental practices. *Reviews in Fish Biology and Fisheries, 11*(1), 1-30.

Chi MTH, 1997. Quantifying Qualitative Analysis of Verbal Data: A Practical Guide. The Journal of the Learning Sciences 6(3):271–315.

Clifford, N.J, and G. Valentine. 2003. Key Methods in Geography.Sage Publications. 571 pp.

Constas MA, 1992. Qualitative Analysis as a Public Event: The Documentation of Category Development Procedures. American Educational Research Journal 29 (2): 253–266.

Defeo, O., & Castilla, J. C. (2005). More than one bag for the world fishery crisis and keys for co-management successes in selected artisanal Latin American shellfisheries. *Reviews in Fish Biology and Fisheries, 15*, 265-283.

Doney, S. C., Ruckelshaus, M., Duffy, J. E., Barry, J. P., Chan, F., English, C. A., ... & Talley, L. D. (2012). Climate change impacts on marine ecosystems. *Annual Review of Marine Science, 4*, 11-37.

Erickson, K., & Stull, D. (1998). Doing team ethnography:Warnings and advice. Thousand Oaks, CA: Sage.

FAO. 2018. Impact of climate change on fisheries and aquaculture. Food and Agriculture Organization. http://www.fao.org/3/I9705EN/i9705en.pdf

Flyvbjerg, F. (2001) Make Social Sciences Matter. Why Social Inquiries Fail and how to make it succeed again. Cambridge University Press.

Gergen, M.M. and Gergen, K.J. (2017) Qualitative Inquiry: Tensions and Transformations. Retrieved_06.06.17 https://www.swarthmore.edu/sites/default/files/assets/documents/kenneth-gergen/Qualitative_Inquiry_Tensions_and_Transformations.pdf

Goodman, L. A. (1961) Snowball Sampling. The Annals of Mathematical Statistics. 32(1)148–170.

Grbich C, 2007. Qualitative Data Analysis. An introduction. Sage: London.

Guest, G., & MacQueen, K. M. (2008). Handbook for team-based qualitative research. Lanham,MD:AltaMira Press.

Hernández-Sampieri, R., C. Fernández-Collado, P. Baptista-Lucio (2006) Metodología de la Investigación. Cuarta Edición. México: Mc Graw Hill

Jacobsen, R. B. (2013). Small-scale fisheries in Greenlandic planning - the becoming of a governance problem. *Maritime Studies, 12*(2). DOI: 10.1186/2212-9790-12-2

Kerr G and Swaffield SR, 2012. Identifying Cultural Service Values of a Small River in the Agricultural Landscape of Canterbury, New Zealand, Using Combined Methods, Society & Natural Resources: An International Journal, 25:12, 1330-1339.

Macdonald, T. 1997.The Conflicts in the Galapagos Islands, Analysis and Recommendations for their Management. Report for the Charles Darwin Foundation.

MacQueen, K.M.,McLellan-Lemal, E., Bartholow, K., & Milstein, B. (2008).Teambased codebook development: Structure, process, and agreement. In G. Guest & K. M. MacQueen (Eds.), *Handbook for team-based qualitative research* (pp. 119–35). Lanham, MD:AltaMira Press.

Mahon, R., McConney, P., & Roy, R. (2008). Governing fisheries as complex adaptive systems. *Marine Policy, 32*, 104-112.

Mays N and Pope C, 1995. Rigour in qualitative research. British Medical Journal,311:109–112.

Markus, T., Hillebrand, H., Hornidge, A.K., Krause, G. and Schlüter, J. (2017) Disciplinary diversity in marine sciences: the urgent case for an integration of research. Quo Vadimus. ICES Journal of Marine Science (2017), doi:10.1093/icesjms/fsx201. Downloaded from https://academic.oup.com/icesjms/advance-article-abstract/doi/10.1093/icesjms/fsx201/4642977 by SuUB Bremen user on 21 November 2017

Martín Míguez, B.; Calewaert, J.B., and McMeel, O. (2016). Best Practices in Stakeholder Engagement, Data Dissemination and Exploitation. AtlantOS. Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems Task 10.2, Deliverable 10.5. Seascape Consultants. Funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 633211.

Nicholas H and McDowall A. (2012) When work keeps us apart: a thematic analysis of the experience of business travellers. Community, Work & Family 15 (3):335–355.

Stapleton, K. and Wilson, J. (2016) Telling the story: Meaning making in a community narrative. Journal of Pragmatics 108 (2017) 60—80. http://dx.doi.org/10.1016/j.pragma.2016.11.003

Rubin HJ and Rubin IS (2005) Qualitative Interviewing. The art of Hearing Data. Second Edition. Sage, Thousand Oaks.

Saldaña, J. (2009) The Coding Manual for Qualitative Researchers. Sage Publications . London.

Seidman I. (2006). Interviewing as Qualitative Research. A Guide for Researchers in Education and the Social Sciences. Third Edition. Teachers College Press. New York.

de Vivero, J.L.S., Mateos, J.C.R. and del Corral, D.F. (2008). The paradox of public participation in fisheries governance. The rising number of actors and the devolution process. *Marine Policy*, *32*(3): 319-325.

Van Putten, I. E., Dichmont, C. M., Cabral-Dutra, L. X., Thébaud, O., Deng, R. A., Jebreen, E., ... & Thompson, C. (2016). Objectives for management of socio-ecological systems in the Great Barrier Reef region, Australia. *Regional Environmental Change*, *16*, 1417-1431.

Walmsley, S.F., C.A. Howard and P.A. Medley, 2005, Participatory Fisheries Stock Assessment (ParFish) Guidelines. London, MRAG.

Weston, C., Gandell, T., Beauchamp, J., McAlpine, L.,Wiseman, C., & Beauchamp, C. (2001).Analyzing interview data:The development and evolution of a coding system. *Qualitative Sociology 24*(3), 381–400.

Zinda JA, 2012. Hazards of Collaboration: Local State Co-optation of a New Protected-Area Model in Southwest China, Society & Natural Resources: An International Journal 25 (4):384–399. http://dx.doi.org/10.1080/08941920.2011.557826.

2.4 Appendix of Chapter 2

Appendix 1. Overview of climate change risk reduction and adaptation programs and strategies for fisheries and aquaculture. This inventory compiles examples of official web sites, policy briefs, technical reports, working papers and peer reviewed articles available in the existing literature on this topic for the period 2006-2018.

Topic Title	Geographical location	Actions/Strategies/Principles/Policy Initiatives	Source/reference
FAO-Climate change adaptation strategies	Global	**This FAO website provides guidance on the following actions/principles:** **1.** Development and application of data and knowledge for impact assessment and adaptation **2.** Support and improvement of governance for climate change adaptation **3.** Building of livelihood resilience to climate change **4.** Targeted approaches for conservation and sustainable management of biodiversity **5.** The identification, support and application of innovative technologies **6.** Improved disaster risk management	FAO (2018) http://www.fao.org/fishery/topic/166279/en
The European Climate Adaptation Platform (Climate-ADAPT): Marine and Fisheries	Europe (European Union)	The European Commission's web site posting the EU strategy on adaptation to climate change to addressing adaptation for coastal and marine areas. One of the key objectives that The EU Adaptation Strategy focuses on is: **'Climate-proofing' action at EU level** by further promoting adaptation in key vulnerable sectors such as agriculture, fisheries and cohesion policy, ensuring that Europe's infrastructure is made more resilient, and promoting the use of insurance against natural and man-made disasters.	European Union, 1995-2018 https://climate-adapt.eea.europa.eu/eu-adaptation-policy/sector-policies/marine-and-fisheries EU Adaptation Strategy: https://ec.europa.eu/clima/policies/adaptation/what_en
Adapting fisheries and their management to climate change: A review of concepts, tools, frameworks, and current Progress toward implementation	Global	This study reviews the current literature on how fisheries, fisheries management and fishing communities react and adapt to projected climate impacts by providing 1) a brief background on adaptation research; 2) available frameworks and tools to assess and foster adaptation to climate change; 3) case studies illustrating several key aspects (political, legal, economic, and social) influencing adaptation at the level of fisheries, communities and households worldwide. It illustrates that while a great wealth of local and regional knowledge, as well as tools and approaches to foster adaptation exists, examples of concrete adaptation actions and measures are surprisingly few, emphasizing the need to increase the general awareness of climate change impacts and to build a solid political, legal, financial and social infrastructure within which the available knowledge, tools and approaches can be set to practical use in implementing adaptation to climate change.	Lindegren & Brander 2018 in Reviews in Fisheries Science & Aquaculture DOI: 10.1080/23308249.2018.1445980 https://www.tandfonline.com/doi/abs/10.1080/23308249.2018.1445980?casa_token=x9AhDEYVJm8AAAAA:0Xr6Cq5smlwNKvPrlXpdgOLSvEBdjwo4TAI807anf_gvg7SJdXKaPrAvBd7GMXp3CS4aAhaxOQU

Building adaptive capacity to climate change in tropical coastal communities	Tropical regions	This paper highlights that to minimize the impacts of climate change on human wellbeing, governments, development agencies, and civil society organizations have made substantial investments in improving people's capacity to adapt to change. However, these investments have currently tended to focus on a very narrow understanding of adaptive capacity. This study proposes an approach to build adaptive capacity across five domains: the assets that people can draw upon in times of need; the flexibility to change strategies; the ability to organize and act collectively; learning to recognize and respond to change; and the agency to determine whether to change or not.	Cinner et al., 2018 in Nature Climate Change. https://www.nature.com/articles/s41558-017-0065-x
Guidelines for Integrating Climate Change Adaptation into Fisheries and Aquaculture Projects	Global	This study describes a range of multiple-benefit options for integrating climate change adaptation and mitigation into IFAD interventions in the fisheries and aquaculture sectors, based on a review of relevant literature on climate change, the fisheries and aquaculture sectors, and related activities of other international organizations	International Fund for Agricultural Development-IFAD, 2014 https://www.ifad.org/documents/38714170/39135645/fisheries.pdf/17225933-cea1-436d-a6d8-949025d78fbd
Climate Change Adaptation in Vietnamese Fisheries; A Look at Adaptive Capacity Using the National Adaptive Capacity Framework	Vietnam	This paper examines the preparedness of Vietnam to deal with the effects of climate change, particularly in the fisheries sector, including both fishing and fish farming. The analysis is guided by a set of related research questions: is climate change adaptation addressed in the fisheries and climate change policies of Vietnam, and if so, how and where? Is there an adaptive capacity framework or implementation of climate change adaptation activities associated with these policies?	Labrèche, R., 2014. (Major research Paper, University of Ottawa). https://ruor.uottawa.ca/bitstream/10393/32436/1/Labr%C3%A8che_Rose_2014_researchpaper.pdf
Adaptation of fisheries and mariculture management to extreme oceanic environmental changes and climate variability in Taiwan	Taiwan	This study suggests that responding to extreme climatic influences on fisheries and mariculture should include 1) establishing an early warning system by connecting fisheries agencies and marine research institutions to assist decision makers in performing time-adaptive measures; 2) temporarily suspending fishing activities after the occurrence of a natural disaster to help recover fishery resources and ecosystems; 3) altering the governance of farming fishing right so that fish farmers can temporarily transfer their aquaculture cages from high-risk areas to waters outside the influence of extreme weather events; and, 4) continually filing surveys to understand the recovery status of marine ecosystems.	Chang, Y., et al. 2013 in Marine Policy https://www.sciencedirect.com/science/article/pii/S0308597X12001698?via%3Dihub
Assessing adaptation options for climate change: A guide for coastal communities in the Coral Triangle of the Pacific. 3. Impact and adaptation assessment workshop	Regional: Coral Triangle of the Pacific: Solomon Islands, Timor-Leste	This assessment contains detail in how a community-based assessment of climate change was used in partnership with coastal communities and provincial and national-level stakeholders in Timor-Leste and Solomon Islands. It also provides four distinct, but related, steps focused on supporting community-level decision-making for adaptation through a series of participatory action research activities.	WoldFish (2013) Asian Development Bank; Global Environment Facility https://www.worldfishcenter.org/content/assessing-adaptation-options-climate-change-guide-coastal-communities-coral-triangle-9 http://pubs.iclarm.net/resource_centre/Assessing.adaptation.to.CC.Impact.and.adaptation.assessment.workshop.pdf

Assessing adaptation options for climate change: A guide for coastal communities in the Coral Triangle of the Pacific. 7. Ecosystem services mapping	Regional: Coral Triangle of the Pacific: Solomon Islands, Timor-Leste	This assessment contains detail in how a community-based assessment of climate change was used in partnership with coastal communities and provincial and national-level stakeholders in Timor-Leste and Solomon Islands. It also provides four distinct, but related, steps focused on supporting community-level decision-making for adaptation through a series of participatory action research activities.	WoldFish (2013) Asian Development Bank; Global Environment Facility https://www.worldfishcenter.org/content/assessing-adaptation-options-climate-change-guide-coastal-communities-coral-triangle-6 http://pubs.iclarm.net/resource_centre/Assessing.adaptation.to.CC.Ecosystem.services.mapping.pdf
Adaptation to climate-change effects on fisheries in the Shiretoko World Natural Heritage area, Japan	Japan	This study summarizes observed and anticipated effects of such climate change on fisheries in the heritage area and discusses policy and research needs for adapting to these changes and the need to combine several measures taking into account the various socio-ecological aspects of fisheries and scales of ecosystems. Such measures of adaptation should be incorporated also into the cross-sector coordination system and the Integrated Management Plan, which were established to manage the World Heritage area. Also, culture is an important part of society, and the World Heritage program may offer clues for creating a new and peaceful culture based on the Large Marine Ecosystem.	Makino & Sakurai, 2012 in *ICES Journal of Marine Science* https://academic.oup.com/icesjms/article/69/7/1134/749126
Responses to climate change: adaptation pathways to change	Regional: Coral Triangle of the Pacific, including Fiji, Papua New Guinea, Solomon Islands, Timor-Leste and Vanuatu	The project aims to build capacity among inland and coastal communities living within this region that are dependent on natural resources for their livelihoods, to enable them to respond and adapt to climate related change.	The WorldFish Center 2012 https://www.worldfishcenter.org/content/responses-climate-change-adaptation-pathways-change
Adapting to climate change: the ecosystem approach to fisheries and aquaculture in the Near East and North Africa region	Africa: near east and north Africa region	Workshop Proceedings on Ecosystem approach to fisheries and aquaculture to provide guidance on best practices for adaptive planning and management, and adaptive strategies in general, for coping with climate change.	Curtis et al. 2011 (FAO Fisheries and Aquaculture Circular No. 1066. Workshop Proceedings: FAO /WorldFish Workshop, Abbassa, Egypt, 10–12 November 2009). http://www.fao.org/docrep/014/i2146e/i2146e.pdf
The future is now: how scenarios can help Senegalese and Mauritanian fisheries adapt to climate change	Regional: West Africa (Senegal and Mauritania)	This article presents the construction of fisheries sector scenarios for Senegal and Mauritania required for the analysis of climate change adaptation policies	Badjeck, M.C., Diop, N. 2010 in Nature & Faune https://www.worldfishcenter.org/content/future-now-how-scenarios-can-help-senegalese-and-mauritanian-fisheries-adapt-climate-change http://pubs.iclarm.net/resource_centre/WF_2746.pdf

Building adaptive capacity to climate variability: The case of artisanal fisheries in the estuary of the Patos Lagoon, Brazil	Brazil	The paper identifies key factors that increase and/or minimize the vulnerabilities of the fishing communities in this lagoon with the objective of understanding: (a) the degree to which fishing communities are able to build adaptive and learning capacities to minimize/reduce vulnerabilities and maintain their livelihoods; and (b) how and under what circumstances external and internal factors may influence and disrupt the social-ecological resilience in this lagoon system.	Kalikoski et al. 2010 in Marine Policy https://www.sciencedirect.com/science/article/pii/S0308597X1000045X
Adaptation to climate change in marine capture fisheries	Global	This paper responds to the challenge of how and when to adapt marine capture fisheries to climate change and contributes with 1) a discussion of how management objectives and instruments influence resilience and adaptation; 2) a decision-making process to assess vulnerabilities to climate change and to manage adaptation responses; 3) an inter-temporal framework to assist decision- makers on when to adapt; 4) a risk and simulation approach to confront the uncertainties of the possible losses due to climate change and the net benefits of adaptation; 5) an explanation of how adaptive co-management can promote flexible adaptation responses and also strengthen adaptation capacity; and, 6) a selection of possible 'win–win' management actions.	Grafton, 2010 in Marine Policy https://doi.org/10.1016/j.marpol.2009.11.011 https://ac.els-cdn.com/S0308597X09001845/1-s2.0-S0308597X09001845-main.pdf?_tid=064ef2ad-61f3-4bd2-83d7-8ee3fc3eda8a&acdnat=1537920753_b828a2327d060e46418185451d9d7353
Marine Fisheries Management in a Changing Climate: A Review of Vulnerability and Future Options	Global	This paper uses a vulnerability assessment framework to examine the level of vulnerability of marine fisheries to climate change and the factors that will temper vulnerability such as adaptive capacity to prioritize systems in greatest need of intervention, understanding the drivers of vulnerability to identify future research directions, and more importantly, to review current fisheries management with the view to develop management responses that will be effective in securing the future sustainability of marine fisheries.	Johnson & Welch 2010 in Reviews in Fisheries Science & Aquaculture DOI: 10.1080/10641260903434557) https://www.tandfonline.com/doi/abs/10.1080/10641260903434557
The Economics of Adapting Fisheries to Climate Change	Global	This publication is the outcome of the Workshop on the Economics of Adapting Fisheries to Climate Change on 10-11 June 2010 in Busan, Korea, highlighting actions that are needed to respond to climate change: strengthening the global fisheries governance system, a broader use of rights-based management systems, ecosystem protection, industry transformation, ending perverse subsidies and a focus on demand for sustainable seafood. It portray the need for Policy Makers in how to ensure sustainable aquaculture production as part of adaptation strategies, and how to develop adaptable and flexible fisheries and aquaculture policies within a broader oceans management framework.	OECD, 2010. Organisation for Economic Co-operation and Development http://dx.doi.org/10.1787/9789264090415-en http://ctknetwork.coraltriangleinitiative.org/wp-content/documents/pdf/The-Economics-of-Adapting-Fisheries-to-Climate-Change.pdf
Climate change and fisheries: vulnerability and adaptation in Cambodia	Cambodia	Report on local climate change adaptation strategies for Cambodia	The WorldFish Center 2009 http://pubs.iclarm.net/resource_centre/WF_2492.pdf

FAO-Climate change implications for fisheries and aquaculture, Overview of Current Scientific Knowledge	Global	Technical paper about Reviews on possible adaptation and mitigation measures that could be implemented in fisheries and aquaculture-based livelihoods	Cochrane et al. 2009. FAO Fisheries and Aquaculture Technical Paper 530 based on Expert Workshop on Climate Change Implications for Fisheries and Aquaculture (Rome, 7–9 April 2008). http://www.fao.org/fileadmin/user_upload/newsroom/docs/FTP530.pdf
Climate change and adaptation in fisheries and aquaculture	Global	This working paper provides principles for investment in building capacity in Fisheries and Aquaculture to adapt to Climate Change: **1.** Support climate-change risk assessments **2.** Invest in initiatives to reduce fishing effort in overexploited fisheries **3.** Integrate disaster management and risk reduction planning, especially concerning planning coastal or flood defenses. **4.** Enhance resilience in fishing communities by supporting existing adaptive livelihood strategies **5.** Identify cross-sectoral factors that will increase or decrease impacts and adaptation potential in fishing communities	WorldFish Center 2007; Working Paper http://pubs.iclarm.net/resource_centre/WF_1051.pdf •

FAO-Building Adaptive Capacity to Climate Change - Policies to Sustain Livelihoods and Fisheries	Global	**This policy brief includes:**
		• A Review on adaptive livelihood and institutional responses to climate variability in fisheries.
		• Proposed policy actions and initiatives to help governments and fishing communities maintain and build adaptive capacity to climate change such as:
		  • Diverse and flexible livelihood strategies
		  • Flexible and adaptable institutions
		  • Risk reduction initiatives
		  • Planned adaptation
			FAO 2006
			http://www.fao.org/docrep/010/a1115e/a1115e00.pdf

FAO - Impact of climate change on fisheries and aquaculture	Global	General literature on climate change impact and worldwide analysis (+ adaptations) per region (e.g., chapter 10 is about Ecuador)	FAO 2018 http://www.fao.org/3/I9705EN/i9705en.pdf

Footnotes:

FAO Climate change adaptation strategies http://www.fao.org/fishery/topic/166279/en

Climate change implications for fisheries and aquaculture, Overview of Current Scientific Knowledge (Cochrane et al. 2009 in FAO Fisheries and Aquaculture Technical Paper 530). http://www.fao.org/fileadmin/user_upload/newsroom/docs/FTP530.pdf

FAO Impact of climate change on fisheries and aquaculture. http://www.fao.org/3/I9705EN/i9705en.pdf

Climate change and adaptation in fisheries and aquaculture (WorldFish Center 2007; http://pubs.iclarm.net/resource_centre/WF_1051.pdf).

Climate change and fisheries: vulnerability and adaptation in Cambodia (The WorldFish Center 2009) http://pubs.iclarm.net/resource_centre/WF_2492.pdf

The future is now: how scenarios can help Senegalese and Mauritanian fisheries adapt to climate change (Badjeck, M.C., Diop, N. 2010 in Nature & Faune) https://www.worldfishcenter.org/content/future-now-how-scenarios-can-help-senegalese-and-mauritanian-fisheries-adapt-climate-change

Adapting to climate change: the ecosystem approach to fisheries and aquaculture in the Near East and North Africa region (Curtis et al., 2011 in FAO Aquaculture Newsletter No. 45: 14-15) http://www.fao.org/docrep/014/i2146e/i2146e.pdf https://www.worldfishcenter.org/content/adapting-climate-change-ecosystem-approach-fisheries-and-aquaculture-near-east-and-north-0

Responses to climate change: adaptation pathways to change (The WorldFish Center 2012) https://www.worldfishcenter.org/content/responses-climate-change-adaptation-pathways-change

Assessing adaptation options for climate change: A guide for coastal communities in the Coral Triangle of the Pacific. 3. Impact and adaptation assessment workshop (WorldFish 2013). https://www.worldfishcenter.org/content/assessing-adaptation-options-climate-change-guide-coastal-communities-coral-triangle-9

The European Climate Adaptation Platform (Climate-ADAPT) for Marine Fisheries, (European Union, 1995-2018) https://climate-adapt.eea.europa.eu/eu-adaptation-policy/sector-policies/marine-and-fisheries

Building adaptive capacity to climate variability: The case of artisanal fisheries in the estuary of the Patos Lagoon, Brazil (Kalikoski et al., 2010) http://www.repositorio.furg.br/bitstream/handle/1/3651/Building%20adaptive%20capacity%20to%20climate%20variability%3A%20The%20case%20of%20artisanal%20fisheries%20in%20the%20estuary%20of%20the%20Patos%20Lagoon%2C%20Brazil.pdf?sequence=1

Adaptation to climate change in marine capture fisheries (Grafton, 2010 in Marine Policy https://doi.org/10.1016/j.marpol.2009.11.011).

Marine Fisheries Management in a Changing Climate: A Review of Vulnerability and Future Options (Johnson & Welch 2010 in Reviews in Fisheries Science & Aquaculture DOI: 10.1080/10641260903434557).

Adapting fisheries and their management to climate change: A review of concepts, tools, frameworks, and current Progress toward implementation (Lindegren & Brander 2018 in Reviews in Fisheries Science & Aquaculture DOI: 10.1080/23308249.2018.1445980).

The Economics of Adapting Fisheries to Climate Change (OECD, 2010). http://dx.doi.org/10.1787/9789264090415-en
http://ctknetwork.coraltriangleinitiative.org/wp-content/documents/pdf/The-Economics-of-Adapting-Fisheries-to-Climate-Change.pdf
Adaptation of fisheries and mariculture management to extreme oceanic environmental changes and climate variability in Taiwan. Chang et al., 2013 in Marine Policy https://doi.org/10.1016/j.marpol.2012.08.002

Guidelines for Integrating Climate Change Adaptation into Fisheries and Aquaculture Projects (International Fund for Agricultural Development-IFAD, 2014 https://www.ifad.org/documents/38714170/39135645/fisheries.pdf/17225933-cea1-436d-a6d8-949025d78fbd

Adaptation to climate-change effects on fisheries in the Shiretoko World Natural Heritage area, Japan (Makino & Sakurai, 2012 in ICES Journal of Marine Science, https://doi.org/10.1093/icesjms/fss098

Climate Change Adaptation in Vietnamese Fisheries; A Look at Adaptive Capacity Using the National Adaptive Capacity Framework (Labrèche, R., 2014. Major research Paper, University of Ottawa)

Building adaptive capacity to climate change in tropical coastal communities (Cinner et al., 2018 in Nature Climate Change)https://www.nature.com/articles/s41558-017-0065-x

3. CASE STUDY 1: Perception and vision of the current state of ancestral, scientific and management knowledge in the small scale fisheries of Ecuador's continental coast

FF2 Guayaquil (Ecuador) Workshop

Authors:

Nikita Gaibor
Subdirector Técnico - Científico
Instituto Nacional de Pesca
Guayaquil (Ecuador)

Juan José Alava
Research Associate
Institute for the Oceans and Fisheries
University British of Columbia
Vancouver (Canadá)

Jorge Ramírez
Researcher, Fundación Charles Darwin
Santa Cruz, Galápagos (Ecuador)

Maria José Barragán-Paladines
Science *Director,* Fundación Charles Darwin
Santa Cruz, Galápagos (Ecuador)

Cite as: Gaibor, N., Alava, J.J., Ramírez, J., &, Barragán-Paladines, M.J. 2019. Towards Climate Change Adaptation in small-scale fisheries in Ecuador's continental coast. Instituto Nacional de Pesca. Reporte Técnico, Número INP-01/2019, Revista de Ciencias del Mar y Limnología. Guayaquil, Ecuador.

3.1 Document Preparation

This document is the result of a two-day workshop organized by a team of interdisciplinary researchers from the World Wildlife Fund-Germany (WWF), Agro Campus Ouest (France), the University of British Columbia (Canada), the National Institute of Fisheries (INP) of Ecuador, and the Charles Darwin Foundation for the Galapagos Islands. In the workshop, artisanal fishers from several fishing communities along with national experts on fisheries, marine biodiversity, oceanography, and marine resource management came together to participate and analyze the impacts of climate change on artisanal fisheries and fisheries governance in Ecuador to envision climate change adaptation strategies in small-scale fisheries in Ecuador's main coast.

The FF2 workshop was held at the facilities of the National Fisheries Institute (INP) in the city of Guayaquil, between March 11 and 12, 2019 to receive perceptions and opinions on the impact of climate change on the small-scale fishery in Ecuador from three groups of actors/stakeholders: 1) small-scale fishers; 2) scientists and researchers involved in different studies on the marine ecosystem and artisanal fisheries; and, 3) decision-makers. All of them worked on: (a) assessing climate risk and vulnerabilities of artisanal fisheries in Ecuador; (b) evaluate adaptation options to reduce climate risk for artisanal fisheries; (c) identify possible adaptation options/strategies and (d) identify responsibilities for the immediate future. The comments, questions, and group discussion of these topics (except for the group of decision-makers) were recorded with the respective permission from the members of each group. Photos of the workshop activities were also taken.

Following the workshop, four undergraduate students, Alex Ichazo, David Crespo, Melani Martínez and Estefanía Cuadrados, from the Faculty of Natural Sciences of the University of Guayaquil, compiled the participants' notes and ordered the contributions of each working group from day 1, as well as the combined participatory workshop (day 2), in which the contributions from all participants were integrated. Dr. Nikita Gaibor performed the qualitative analysis and preliminary write up of the document with the later contribution of Dr. Juan José Alava, who also took part in the edition of the document in Spanish and the translation of it into English. Jorge Ramírez and María José Barragan also contributed to the report, significantly.

3.2 Workshop structure

The Ecuador's workshops consisted of three parts/componentsts to have an organized agenda and obtain results that are best linked to the national reality. These three parts are:

Part I (day 1).- Introductory talks (Annex III) by Ecuadorian experts on different topics related to biological diversity, oceanography, marine and estuarine ecosystems, biodiversity and small-scale fishery, so that participants, especially fishers, have well-defined concepts and inputs for working at the individual level and during collective groups. All these talks aimed to provide basic concepts and examples of changes in the behavior of certain species of fish and molluscs in the world due to climate warming, as well as to demonstrate the oceanographic changes that are occurring due to increasing sea surface temperature, as well as that the intensity of currents, in addition to specifying climate variability as a measure of the range in which climatic elements, such as temperature or rainfall, vary from year to year, indicating that climatic variability is greater at a regional or local level than at the hemispheric or global level. At the end of the talks, there were comments and questions to the experts.

Part II (day 1).- To obtain the perceptions of the participants on climate change and the impact that this could be having on fisheries, three Working Groups (WG) were created, to analyse fisheries, technical-scientific issues, and management of climate change in small-scale fisheries in Ecuador. Three focus groups were formed: a) small-scale fishers' group; b) Group of scientists, and; c) Group of decision-makers. In each group, different sets of questions were addressed and there was a broad discussion.

Part III (day 2).- This component was characterized by an integrative participatory approach with a mixed working group, where participants from the three aforementioned groups came together to answer specific questions, which were subsequently prioritized. Finally, all these questions were analysed and the results are presented in percentages, through descriptive statistics using frequency graphs (pie diagram and frequency bars) to infer and rank the responses' percent from the sets of questions and identify predominant needs, gaps and options in terms of climate change adaptation.

3.3 Results: Workshop outcomes

3.3.1 Workshop Outcomes from the Focus Group 1 (fishers) Knowledge about Climate Change within the Artisanal Fishing Sector.

Types of climate change impacts observed in the last 10 years: Have you noticed some climate changes in the last 10 years, which ones? Have you noticed any changes in the fish / shrimp / crabs / shells? (e.g., size, quantity, shape, location)?

- It is currently hotter, especially in the rainy season
- Very strong winds
- Exaggerated high tides. During the last high tides (spring tides) there has been much destruction to infrastructure
- Decrease, migration and disappearance of certain species of fish such as "gallo"/roosterfish (Nematistius pectoralis), gallito, "pámpano"/pampano (Trachinotus spp. Peprilus spp.) lisa/mullet (Mugil spp.), "bagre"/catfish (Bagre spp., Arius sp.)
- Fish species such as "dorado" (i.e. mahi mahi or dolphin fish, Coryphaena hippurus) and "corvinón" (i.e. tallfin croaker, Micropogonias altipinnis) are contaminated by parasites
- Variation in the size of crabs according to the proximity to the estuary. Higher sizes while they are far away from the water.
- Increase of sea lions in Puntilla de Santa Elena.
- Less presence of seabirds
- currently, no fish are entering the Gulf of Guayaquil to spawn
- Coastal lands have gone from being hard to muddy

Regarding El Niño and La Niña: How is climate variability (e.g. El Niño, La Niña) affecting you, fishers, and their livelihoods?

El Niño

- Stronger currents
- A lot of rain, thunder, lightning
- Overflow and flooding by rivers and the presence of water hyacinths [i.e. *Eichhornia crassipes*]
- The increasing water level affects the communities
- Waters are much warmer with increased current velocity
- The sea throws stones that damage the external cover/bottom of the fiberglass boats as the boat is landing
- The sea throws white shells and snails
- The waters become murky and there is no fishing
- The 5-inch fishing nets are entangled, and they also come full of jellyfish

- Too much water inside the mangrove destroys the "home" (i.e. burrows) of crabs [i.e. mangrove crabs, Ucides occidentalis]. They are unprotected.
- More trash/litter on the beaches
- The production of crabs is taken by the sea
- The winds damage fiberglass boats
- The price of the seafood products falls
- The burrows of crabs are affected by sedimentation. In some mangroves, there is thick sediment and the crab cannot grow anymore due to the ecological conditions of the site

La Niña

- Cooler waters so the fish species go deeper
- Drought
- Greater presence of small pelagic fish species such as "pinchagua" [i.e. thread herrings, Opisthonema spp.] and "chuhueco" [i.e. Pacific anchoveta/anchovy, Cetengraulis mysticetus]. Also other fish species arrive.
- The "corvineros" [croaker's fishers] spend 2 days at sea and do not bring fish
- Cold waters with less current velocity.

On a scale of 1 to 10 (where 1 is not worried at all and 10 is very worried), how concerned are you with the impacts of the weather/climate?

1---2---3---4---5---6---7---8---9---10

Participant	Degree of Concern
President of FENACOPEC (woman)	10
Fisher (male)	10
Fisher (female)	9
President of Fishing Cooperative A (male)	8
President of Fishing Cooperative B (female)	7
Fisher (male)	5
Fisher (male)	2
Technician A (female)	10
Technician B	8
Mean	**7.7**
SD*	**2.7**

*Standard Deviation

Do you consider that the artisanal fishing sector is ready to adapt to climate change? Please, explain.

- The fishing sector has a long way to go to take on this challenge, there is no personnel to promote it, but there are fishermen who are preparing to be information multiplier axes (i.e. key informants). In the past, we were ignorant but now is not like before as we look for the way to learn (fisher) by our own.
- There is no awareness of this problem (scientist).
- There is no advertising, nor more scientific information (fisher)
- Communities are not ready to adapt to climate change (fisher)
- Certain fishermen do not respect the concessions (fisher)
- No help from the Environment and Fisheries ministries (fisher)
- The cockles from Balao (a mangrove region in southern Ecuador) are very small in this area; we are harming ourselves (fisher).
- Basic resources are lacking in fishing communities (fisher)
- Security and corruption have not been addressed and affect artisanal fisheries; these issues must also be considered together or before we start talking about adapting to climate change (fisher).

What should be done?

- Provide government support so that the artisanal fishing sector can adapt in the face of climate change.
- Strengthen knowledge and awareness about climate change in artisanal fishing communities.
- Advertise the topic of climate change and adaptation
- Change the mentality and behavior of people
- Manage economic resources
- Advise the fishers with the help of aquaculture professional/college association
- Change imposed policies
- Change fishing closures to help maintain the resource
- Change mesh size
- Change fishing gear
- End the political lobbying towards the industrial fishing sector
- Urge and push the fishing authority to work on this issue
- Improve decision making by fisheries authorities
- Avoid the use of "bolichera nets" (fishing trawler/encircling nets) to avoid indiscriminate fishing
- Respect fishing regulations
- The government should provide credit or help with credits to the artisanal fishing sector
- Have knowledge about the status of fish stocks
- Implement sanctions to the industrial fishing sector ships that capture fisheries near the coastal zone; not allow them to operate within the 8 miles corresponding to the activity of the artisanal fishing sector
- Apply regulation and sanctions
- Respect concessions
- Promote added value products of artisanal fisheries
- Conduct a fishery census to have a baseline on the number of artisanal fishers

How can women face the problems of climate change?

- Women are hard-working people (not only do household activities, but also participate in fishing) and excellent administrators. They (we) can look for different job opportunities to survive; as well as exploring new markets.

3.3.2 Workshop Outcomes from Working Groups Focus Group 1 (fishers) (Scientists/Researchers): Research and Implementation of effective adaptation to climate change in the artisanal fishery.

What information exists? What type?

- There is specific information available. However, it is not yet well collected and articulated.
- Scientific information and observations are obtained during the monitoring by the Instituto Nacional de Pesca-INP (National Fisheries Institute) on El Niño. Certain species such as crustaceans (shrimps, Litopenaeus spp.) and dorado (C. hippurus) benefit from the increase in average sea temperature (Telmo de la Cuadra, INP, March 2019). The "dorado" itself is linked to warm waters and the species is present in Ecuadorian marine waters, even in water temperature anomalies between +1 °C and +2 °C. On the other hand, there is high abundance of small pelagic fish associated with low sea surface temperatures.
- There is a study on climate change impact on mangrove crab (U. occidentalis) (Cedeño, 2018), conducted under a consultancy agreement between INP and USAID in 2012, but there is no clear evidence or statistics on a relationship or influence of climate change in this species, thus there is a need to conduct more studies on the impact of climate change on this particular species of crustacean.
- There is ancestral knowledge of the mangrove communities (custodians) and their environment, which can help to implement true adaptation to climate change without relying on external adaptation plans (using the intrinsic knowledge of the community) (Wendy Chávez, Fundación Cerro Verdel, March 2019).
- There is information for the protection of marine protected areas, but an approach for the geographic connectivity range of biological corridor networks is needed along the coastal-marine zone. Although there is currently 1 mile zone of conservation and protection of marine species, where fishing should not be done, in practice fishing activity happens because there is lack of control or no control at all.

What are the existing information gaps?

- There is lack of information on adaptation to climate change in fisheries in Ecuador. Although there is a National Adaptation Plan for Climate Change listing the fisheries sector and aquaculture activity (aquaculture), there are no measured and /or explicitly strategies for fisheries. Under this context, it is necessary to build an adaptation strategy articulating science with ancestral knowledge of fishing communities.
- There are gaps in information on the biological cycles of species of commercial and ecological importance for communities that harvest / capture these species, such as mangrove crab, as well as associated mangrove fauna and other species that inhabit other coastal marine ecosystems.
- There is no knowledge about the distribution and adaptation of species in the face to the effects of climate change and regional climate variability in marine and estuarine areas of Ecuador.
- There is no integration of information on the mangrove ecosystem
- There is no updated fishery census of the artisanal fishing fleet along the Ecuadorian coast.

Do you know any example of adaptation strategies / mitigation to climate change in fisheries? How and where are these strategies implemented?

- Adaptation of fishing gear for selective fishing of present or abundant species during warmer water temperatures. For example, the fishing fleet for albacore (Thunnus alalunga) can modify its fishing gear to deploy direct fishing of "dorado" (C. hippurus) during December and April / May.
- Based on of participatory bottom-up processes, establish zones mangrove management, fishing zoning and seasonal fishing (closure) agreements. Examples of this participatory scope already exist in the mangroves of Esmeralda and El Oro provinces in Ecuador.
- Community-based management with socio-economic evaluation.
- Strengthen the abilities to explore effective adaptation measures for climate change in public research institutions such as the National Institute of Fisheries (INP), Oceanographic Institute of the Armada (INOCAR), and National Institute of Meteorology and Hydrology (INAMHI).
- Develop research to improve knowledge about the impact and scenarios of climate change.
- Develop oceanographic studies of marine biodiversity.
- Develop studies on ocean acidification.
- Develop studies on the impact of climate change on commercial fishery resources.
- Improve the capacity for local adaptation of the artisanal fishing sector.
- Establish strategies for comprehensive and trans-disciplinary adaptation to climate change.
- Incorporate and empower ancestral or traditional knowledge of coastal communities or/and mangrove communities to be used as a source of information in the formulation of measures or strategies to adapt to climate change.
- Promote the precautionary and ecosystem approach in artisanal fishing.
- It is necessary to consider and address studies on commonly utilized seafood species and fish in Ecuador that could be affected under an El Niño scenario and climate change.
- Information on economic valuation of ecosystem services is needed to be considered in the formulation of measures to adapt to climate change.
- Fisheries and territorial management measures need to have more ecosystem and species information.
- An updated fishery census is necessary to know who and how many are involved in the artisanal fishing sector.
- Identify and take into consideration alternative income sources (i.e. exit job alternatives) in times of fishing closure; for example, temporal or permanent jobs offered in shrimp farms established in the mangrove area and close to ancestral communities.
- Construct a strategy of adaptation with combining science with ancestral knowledge of fishing communities. There are no measures and / or strategies explicitly designed for fisheries in the National Plan of Adaptation to Climate Change.

How can management and / or co-management promote flexible adaptation / mitigation responses and capacity building?

- Promote and foster accompanying processes (researchers or scientist co-exist or live with the community for a certain time) and mutual learning between communities and academia towards a social change of habits to meet their needs.
- Address the economic valuation of marine and mangrove ecosystem services and impacts of climate change to assess adaptive capacity (ecosystem-based adaptation)
- Identify fishing alternatives with temperature resilient species (e.g., "dorado") as a measure of adaptation to climate change in the artisanal fishery. In this sense, it is recommended to promote the management and sustainable fishing of "dorado" as a key pilot species to encourage and to formulate adaptation strategies to climate change in artisanal fisheries and fishery certification. It is important to identify other species of pelagic fish (tuna, large pelagic fish) and their resilience to adapt to climate change and to develop new selective fishing gear for other target species that are present in El Nino conditions or oceanic warming.
- Build a climate change adaptation strategy that combines science with ancestral knowledge and perceptions of fishing communities in the custodians/concessions of mangroves and communities of the coastal zone of Ecuador
- Foster interinstitutional co-management and co-responsible territorial ordering plans (Governance, pluralism, adaptive management of heritage, social communication) in fishing communities.
- Open new markets for other species and access to credit programs.
- Promote awareness of climate change
- Encourage and formalize non-affiliated fishing organizations and associate independent fishermen

What strategies can be implemented to improve knowledge of the impact of climate variability on fisheries?

- Dissemination and communication about the knowledge of the impacts of climate variability in the media (e.g., radio and TV) and advertising spots at specific times.
- In primary and secondary education (schools), it is necessary to update the school curriculum with topics on climate change in the oceans.
- Promote and publicize the sense of the value of belonging and sense of place in relation to ecosystem functions and services (fisheries, tourism) within the context of adaptation to climate change (sense of belonging).
- Establish research grants on adaptation to climate change (alternatives) and promote research fronts in universities
- Prioritize the management and sources of funds for research (for example, The Secretariat of Superior Education, Science, Technology and Innovation of Ecuador, SENESCYT) focused on adaptation to climate change in fisheries and fishing communities.
- Abolish laws that affect the administration of funds for research.
- Create state policies to address climate change and improve the national plan and relevant laws for climate change.
- Prioritize research on resources or species on which ancestral communities depend on for their subsistence. This research must include biological cycles, feeding ecology for larval and adult stages of marine animals and ecosystem faunal compositions.

3.3.3 Group 3 (Decision /Policy Makers): Policies of adaptation / mitigation to climate change in the artisanal fisheries of Ecuador

Is there any example of adaptation strategies / mitigation to climate change in fisheries?

- There is a National Climate Change Strategy of Ecuador 2012-2025 (ENCC), but it contains nothing related to climate change adaptation in fisheries.

How and where are these strategies implemented?

- Incorporating the "artisanal fishing" theme in the National Climate Change Strategy of Ecuador (ENCC).
- Articulating science together with ancestral knowledge and the perceptions of fishing communities in the custodian /concessions of mangroves and other communities of the coastal zone of Ecuador.
- Developing direct adaptation measures to reduce vulnerability and impact of climate change on artisanal fishing activities, under the National Action Plan or special regulations.
- Inter-institutional co-management and co-responsible spatial planning (Governance, pluralism, adaptive management of heritage, social communication) in fishing communities.

How can management and / or co-management promote flexible adaptation / mitigation responses and capacity building?

- Improving the regulatory, political, and administrative framework to effectively and efficiently address the challenges and opportunities of climate change.
- Creating policies on behalf of the nation, addressing laws for climate change and improving the national plan for climate change.
- Developing direct adaptation measures aimed to reduce vulnerability.
- Promoting awareness of climate change among users of fisheries resources.
- Motivating independent fishers to join organizations and fishing cooperatives.
- Creation of a Technical Advisory Group on climate change for the Undersecretary of Fisheries Resources (SRP).

What strategies can be implemented to improve knowledge of the impact of climate variability on fisheries?

- Abolishing laws that spoil the administration of funds for research. For example, the funding granted to Public Research Institutes through agreements or from a direct application to do research must enter the administration of the Ecuador's government first. It is challenging for the government to return those funds on time and in full.
- Prioritizing research on resources or species, upon which ancestral fishing communities depend strongly for their subsistence, and which may be subject to climate change impacts.
- Including research related to biological cycles, food webs, larval and adult stages, as well as the composition of the fauna of marine-coastal ecosystems.

3.3.4 Workshop outcomes from mixed working group (Fishers, Scientists and Decision Makers)

The results of the mixed working group workshop (day 2), in which the participants from the three groups (fishers, scientists and decision makers) answered seven questions developed by the organizers, are shown below. Subsequently, the participants prioritized and sorted out the answers given for each question. A given vote could be repeated more than once. The answers are presented in percentages through percent/frequency graphs.

Question 1: How to develop management responses that are effective to ensure the sustainability of fisheries resources and the sustainability of food sovereignty?

For question 1, "*improving the control of fishing activities to ensure sustainable use*" was the priority response accounting for the highest percentage (21.6%) compared to the other answers (Figure 1) for a total of 51 outcomes generated from the participants. Both "*compliance and elaboration of laws in favour of fishery resources*" and "*capacity building and training for communities*" accounted close to 12% each one. (Figure 1) The range of percentages was 3.9 -21.6% with nine possible answers to the query. In general, this figure shows that there is a diversity of responses to the query and there is no predominance of any response. The information collected for each answer was as follows:

1. Capacity building and training for communities: (6/51)
2. Manage economic resources through NGOs: (3/51)
3. Work together with all the actors: (2/51)
4. Knowledge of the fishing resource of commercial interest as well as environmental pollution factors: (5/51)
5. Improve the control of fishing activities to ensure sustainable use: (11/51)
6. Create an effective communication network so that decision makers know the information: (6/51)
7. Organization at all levels from the user of the resources through universities for the research line to authorities: (8/51)
8. Create source of jobs: (4/51)
9. Compliance and elaboration of laws in favor of fishery resources: (6/51)

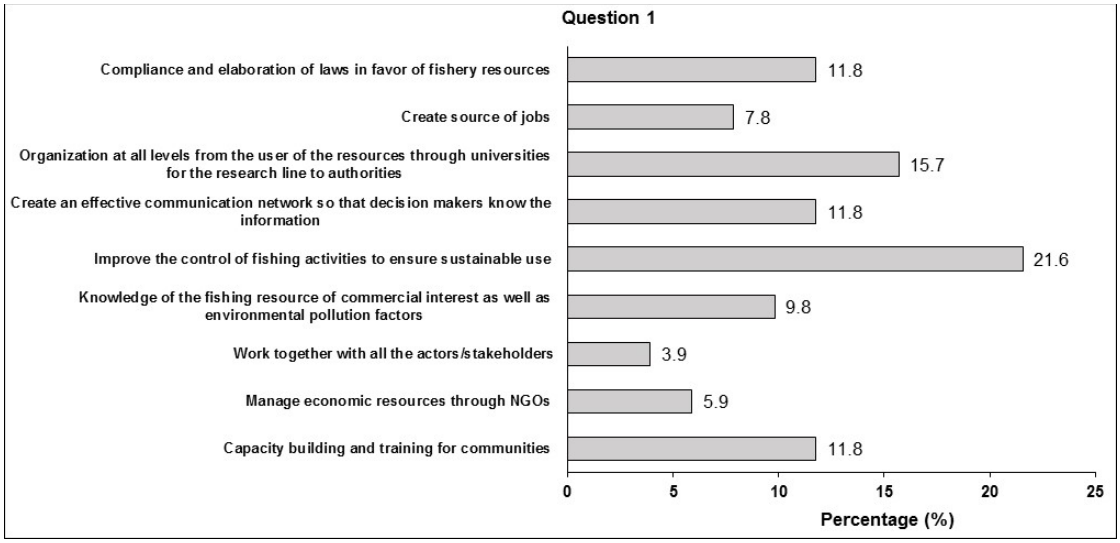


Figure 1. Percentage composition for the nine answers resulting from question 1 for a total of 51 outcomes. The numbers at the bars are the percentage for each answer relative to the total outcomes.

Question 2: What could be the policies that the Ecuadorian government considers for the adaptation / mitigation of climate change in artisanal fisheries?

High prioritization in the following items: promoting research front lines, and closing illegal shrimp farms and reforesting, both of which accounted to 15.7%. However, it can be noted that there is divergence in the answers obtained since there is no clear predominance towards a specific response. This is reflected in the range of percentages obtained ranging from 2.0% to 15.7% with 11 responses to this query from a total of 51 outcomes generated from the participants. The answers were:

1. Adaptation plan to climate change in artisanal fishing communities: (3/51)
2. Promote research front lines: (8/51)
3. Respond through Ecuador's state policies that oblige the local government to take care of the environment: (7/51)
4. Incentives in the regulation of fishers unions, associations and cooperatives: (6/51)
5. Financing and diffusion: (3/51)
6. Inclusion of the artisanal fishing sector: (3/51)
7. Respect the eight miles of fishing zones so that industrial fisheries do not depredate the living marine resources: (4/51)
8. Find solutions to the problem with independent fishers: (1/51)
9. Closure of illegal shrimp farms and reforestation: (8/51)
10. Criminal sanction/penalty to mangrove loggers (i.e. logging activities in mangrove forests): (6/51)
11. Shoreline cleaning up activities: (2/51)

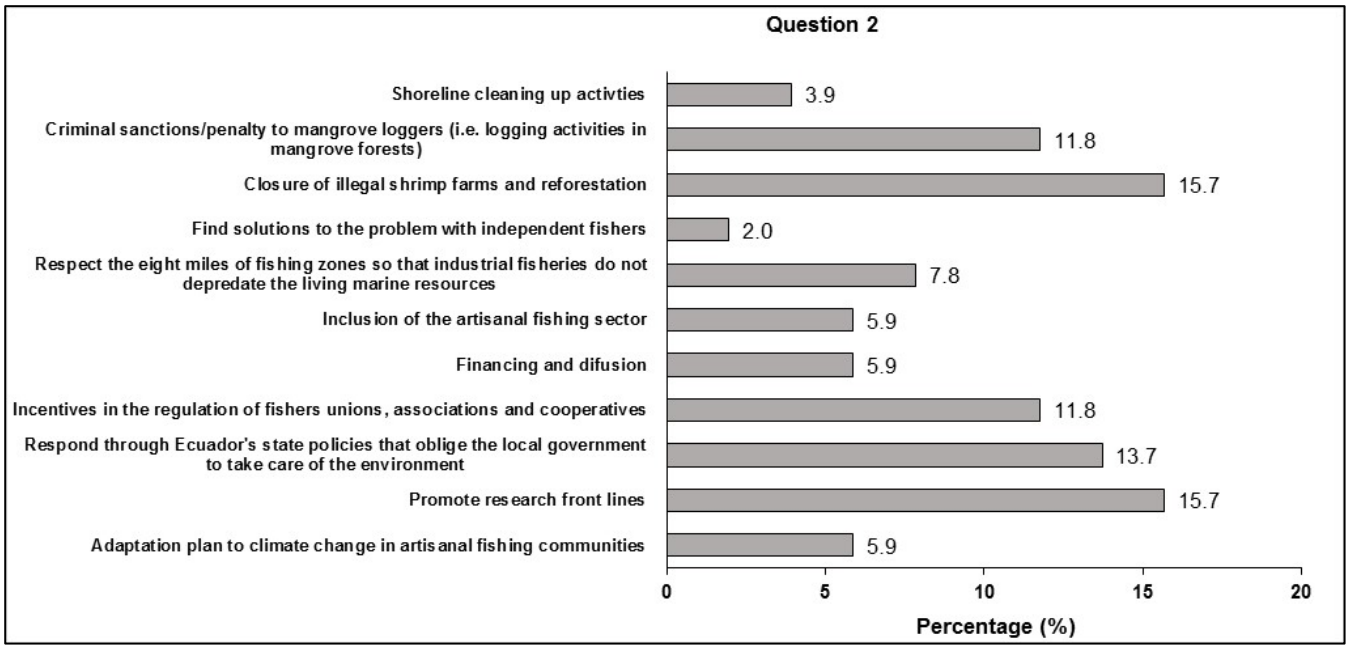


Figure 2. *Percent composition for the 11 answers resulting from question 2 for a total of 51 outcomes. The numbers at the bars are the percent for each answer compared to total outcome.*

Question 3: Who are the partners that you would like to see committed or engaged to work on this issue?

Question # 3 shows that 16% and 14% of respondents would like to see the communities/cooperatives/organizations, and the Instituto Nacional de Pesca/National Institute of Fisheries (INP), committed and actively participating in climate change issues (Figure 3). Followed by government agencies, including the Under-Secretariat of Fisheries Resources (SRP) and Ministry of Environment of Ecuador (MAE) accounting by 10% and 11%, respectively. However, Figure 3 shows that there is a diversity of responses, having obtained a total of 15 different answers for this question from a total of 89 outcomes. The following institutions were named:

1. National Institute of Fisheries (INP): (12/89)
2. Ministry of Environment of Ecuador (MAE): (10/89)
3. Armada: (3/89)
4. Police: (3/89)
5. Under-Secretariat of Fisheries Resources (SRP): (9/89)
6. Academia: (5/89)
7. Municipalities: (5/89)
8. Prefectures/districts: (3/89)
9. Decentralized Autonomous Governments (GADs): (5/89)
10. Non-government organizations (NGOs): (6/89)
11. Oceanographic Institute of the Ecuador's Armada (INOCAR): (3/89)
12. Business sector: (3/89)
13. Civil society: (5/89)
14. International Research Centre on El Niño (CIIFEN): (3/89)
15. Communities/cooperatives/fishing organizations: (14/89)

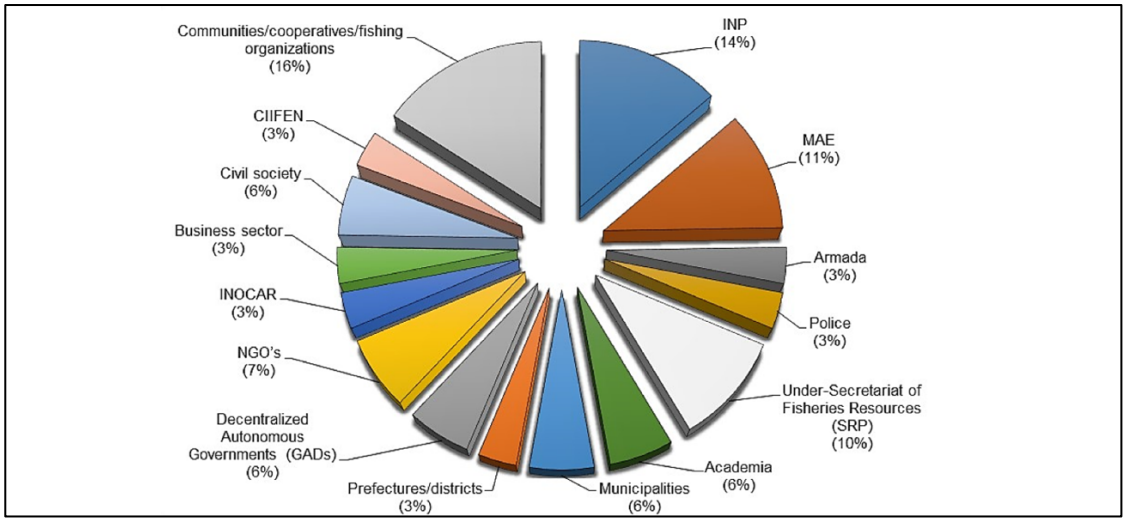


Figure 3. *Proportional breakdown by institutions that participants would like to see engaged and involved to address climate change issues and adaptation in small-scale fisheries in Ecuador's main coast based on the answers for Question 3 (i.e., who are the partners that you would like to see committed or engaged to work on this issue?).*

Question 4: What elements of collaboration are necessary to ensure success on this issue?

In question # 4, "*the allocation of adequate financing by the Ecuadorian government*" obtained a higher percentage of prioritization (20%), followed by *the political will* to make changes (12.7%) and *the replication of successful models for resource management* (12.7%), as shown in Figure 4. Overall, 10 different answers were obtained for this question from a total of 71 outcomes. The answers were:

1. Political will: (9/71)
2. Replicate successful models for resources: (9/71)
3. Community organization: (7/71)
4. Access to technical information: (8/71)
5. Generate advocacy at the political level: (2/71)
6. Apply research and training processes: (3/71)
7. International agreements aimed to establish projects and specific activities: (7/71)
8. Communication: (6/71)
9. Transparency: (6/71)
10. Assigning adequate financing by the Ecuadorian State: (14/71)

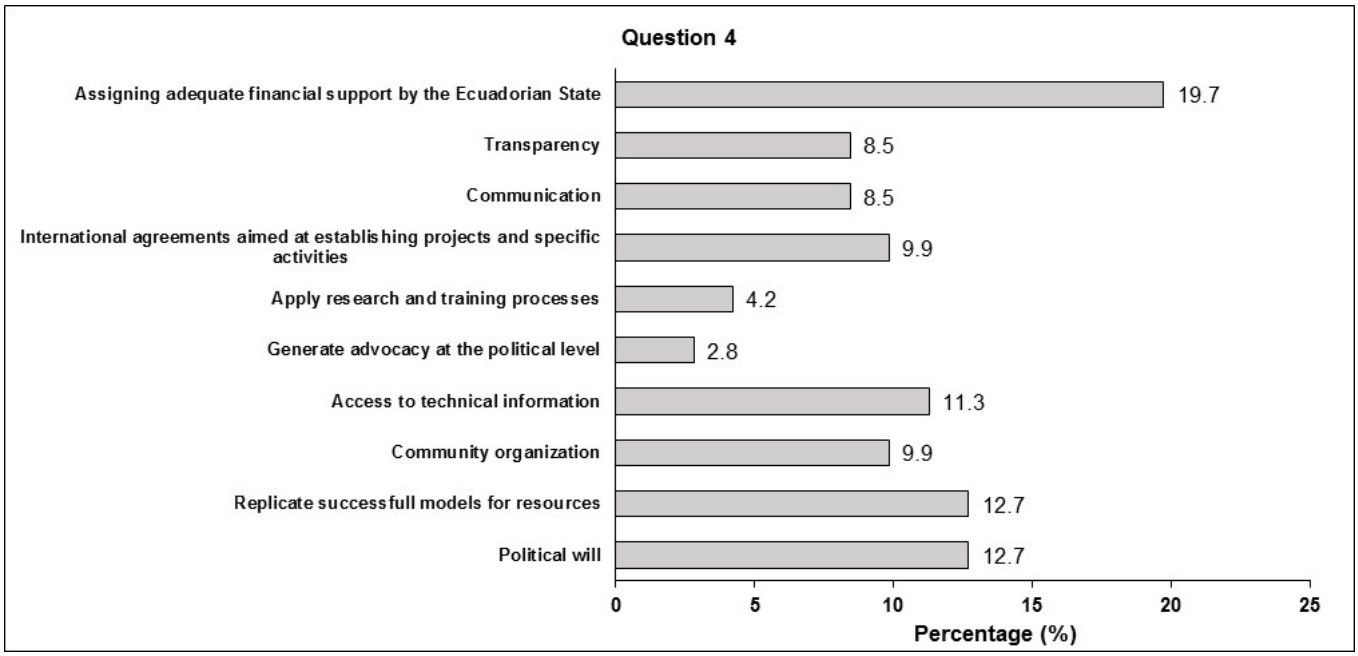


Figure 4. Percent composition for the 10 answers resulting from question 4 for a total of 71 outcomes. The numbers at the bars are the percentage for each answer relative to the total outcomes.

Question 5: What scientific effort would you like to see undertaken regarding to this topic?

Question # 5 obtained a percentage of prioritization of (12%) for "*studying the impacts of climate change on marine ecosystems*", and "*the recycling of polluting products*" (Figure 5). Variation is observed in the responses obtained because there was no predominance towards a specific response, which is reflected in the range of percentages obtained ranging from 2.0% to 12.0% with 12 responses to this question from a total of 50 outcomes. The answers were:

1. Studies on fisheries resources of commercial importance: (5/50)
2. Know the areas of recruitment: (2/50)
3. Assess environmental pollution: (5/50)
4. Water quality monitoring: (4/50)
5. Updating information of endangered marine species: (0/50)
6. Conduct research aimed at new species: (5/50)
7. Deliver publications in a simple/plain language: (4/50)
8. Conduct impact assessments of climate change on marine ecosystems: (6/50)
9. Study the impacts of ocean acidification: (2/50)
10. Have effective management tools: (1/50)
11. Feasibility studies to implement new fishing gears: (5/50)
12. Conduct fisheries census: (5/6)
13. Recycling of polluting products: (6/50)

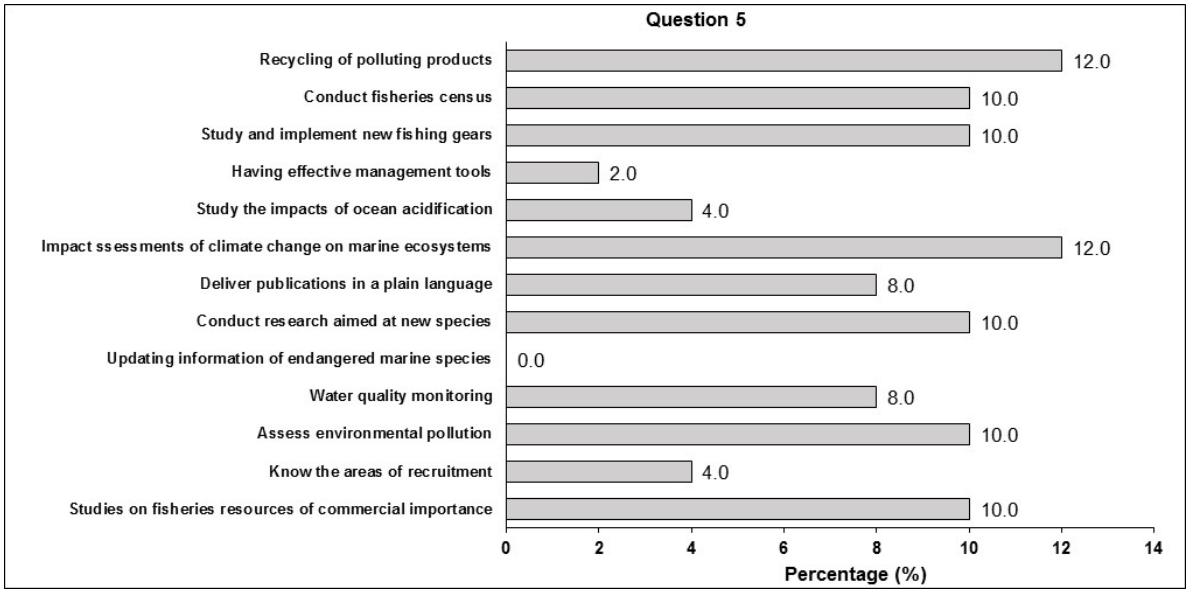


Figure 5. Percent composition for the 13 answers resulting from question 5 for a total of 50 outcomes. The numbers at the bars are the percent for each answer compared to the total outcomes.

Question 6: What effective strategies can be developed for the adaptation and mitigation of artisanal fisheries to climate change in Ecuador? (Strategies that should be adaptable and flexible within a broader ocean management framework).

Question 6 generated a total of 15 responses of which two obtained a higher percentage of prioritization: *capacity building and training artisanal of fishers in adaptive management* (17%), and *developing and implementing studies of fishery resources that can be or are already impacted by climate change* (15%), as shown in Figure 6. Overall, 15 different answers were obtained for this question from a total of 71 outcomes. The answers to his question are as follows:

1. Implementing fishing zones: (1/86)
2. Change of outboard motors/engines: (3/86)
3. Delimit fishing efforts: (5/86)
4. Implement climate change adaptation plans in marine protected areas (MPAs): (7/86)
5. Foster sustainable mariculture: (3/86)
6. Application of seasonal fishing closures: (7/86)
7. Limit the number of fishers, number of boats and number of fishing gear: (0/86)
8. Capacity building and training of artisanal fishers in adaptive management: (15/86)
9. Create a network of artisanal fishers to monitor environmental variables: (6/86)
10. Identify fishing activity alternatives: (1/86)
11. Develop and implement a study of the fishing resources that can be or are already impacted by climate change: (13/86)
12. Changes in fisheries technology and fishing gear: (6/86)
13. Apply the knowledge by showing examples to the artisanal fishers (learning by doing processes): (9/86)
14. Identify fishing alternatives that have a low impact on climate change: (2/86)
15. Strengthening the skills of technicians offering assistance to communities: (8/86)

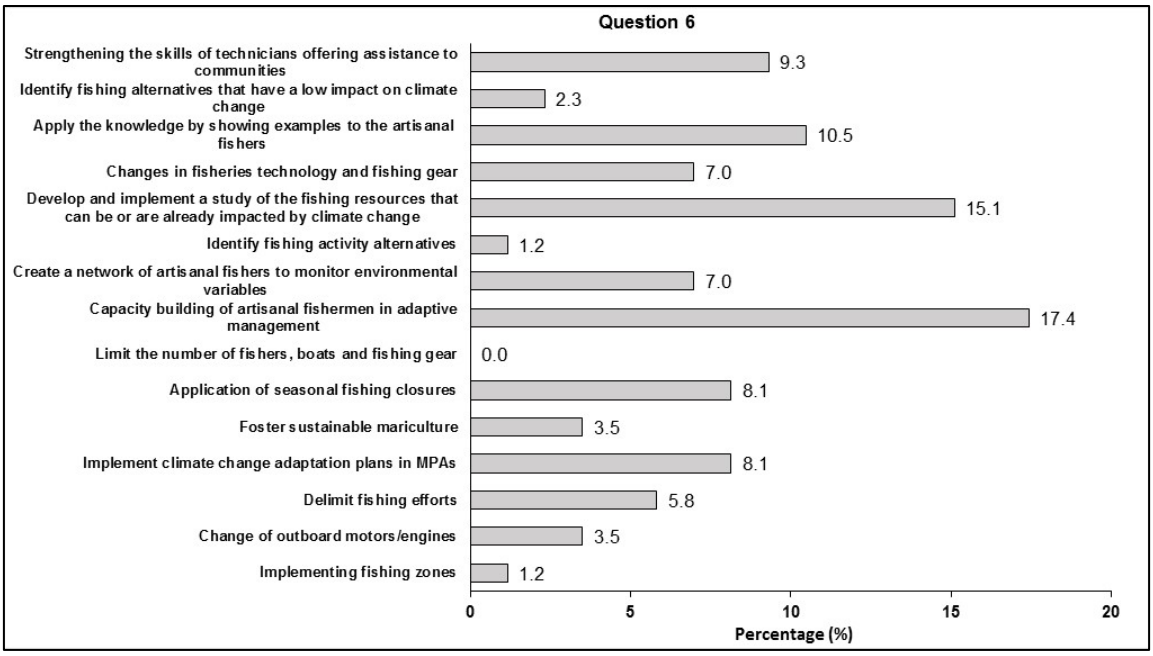


Figure 6. *Percent composition for the 15 answers resulting from question 6 for a total of 86 outcomes. The numbers at the bars are the percent for each answer relative to the total outcomes.*

Question 7: What would you like to see your government to do regarding this issue?

As for question # 7, a greater percentage (38%) of the stakeholders prioritized "*Direct interaction of the government with the financial sector, thus being able to carry out projects of social responsibility so that the public policy is executed in favour of the nature, the sea and the environment*," having the highest predominance of a total of 7 responses obtained from 64 outcomes. The response with the lowest percent (5%) was "*adapting national strategies to the national reality*" (Figure 7). The answers were:

1. Adaptation of integral strategies to the national reality: (3/64)
2. Improve communication between authorities and fishers: (11/64)
3. Research and constant monitoring of fisheries: (6/64)
4. Application of a specific fund for financing research/monitoring: (7/64)
5. Incorporation of ancestral knowledge in decision making: (6/64)
6. Update of the National Climate Change Strategy: (7/64)
7. Direct interaction of the government with the financial sector, thus being able to carry out projects of social responsibility so that the public policy is executed in favour of the nature, the sea and the environment: (24/64)

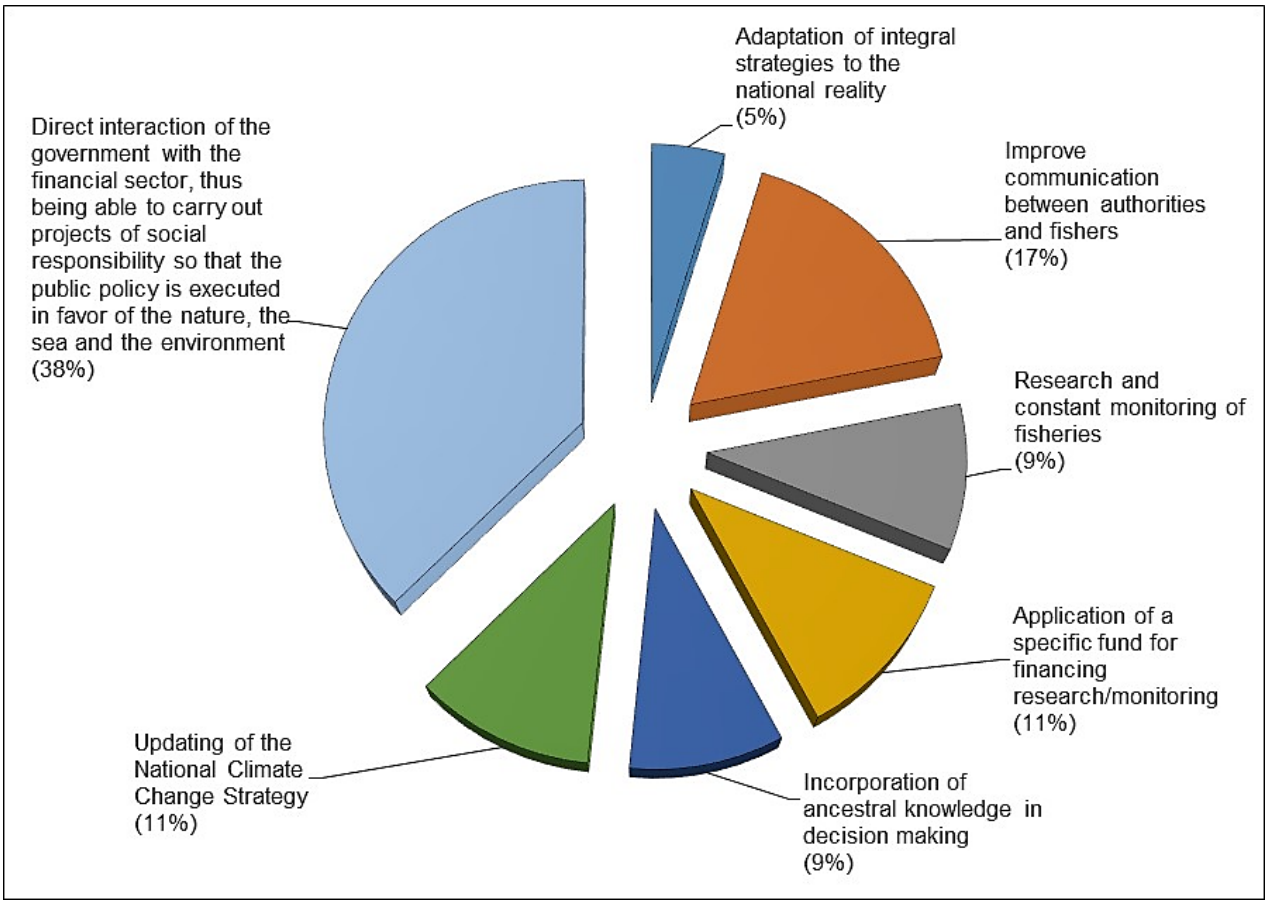


Figure 7. Proportional breakdown of answers from participants in response to Question 7 (i.e., what would you like to see your government to do regarding this issue?) to address climate change issues and adaptation in small-scale fisheries in Ecuador's main coast.

3.4 Discussion

Fisheries and climate change are very closely linked dimensions, within a large notion of ocean governance. It has been argued that this sector is seriously affected by climate-change impacts that compromise fisheries long term sustainability. Climate change impacts at multiple scales and imply different levels of complexity, diversity and dynamics. The role that fishers and fishing communities play at developing strategies to adapt to climate change seems to be of paramount importance as potential ways forward to mitigate the impact of global warming.

The impact of climate change factors contributes to the reduced productivity of tropical coastal ecosystems (Doney et al., 2012); therefore, the application of innovative development approaches to small-scale fisheries, resembles to be fundamental. Under that logic, Bystrom et al. (2017) suggest that the most important dimensions, include the livelihoods approach (Allison and Ellis, 2001), co-management or community-based management systems (Castilla and Fernandez, 1998; Castilla and Defeo, 2001; Defeo and Castilla, 2005), and adaptive management strategies, focused on maintaining the productive capacity and resilience of small-scale fisheries (Berkes, 2003). This socio-ecological system includes not only the communities where small-scale fishers inhabit, but also the coastal marine environment where they perform commercial activities (Van Putten et al., 2016). These environments are becoming vulnerable to the effect of climate change. Aligned with that notion, it has been recognized that the integration of varied disciplines are useful in dealing with these issues. Recent events and trends in international relations are making it necessary for scientists to design their projects in ways that can integrate disciplinary perspectives and learn how to communicate their results in governance processes (Bystrom et al. 2017). Thus, the interaction between climate change, marine resources and food security emphasizes the need to develop a framework for the integration of measures to adapt to climate change in fisheries for Ecuador. Of particular concern is the need to identify susceptible and vulnerable fishing communities in order to assess the risks for the most vulnerable fishermen and who are highly dependent on the nutritional value and micronutrients of fish.

Small-scale fishing in Ecuador is an ancestral activity in most of the coastal communities, concentrating much of their subsistence and food in products derived from the sea. The artisanal fisherman are mostly engaged in fishing large pelagic fish (e.g., tuna, billfish, swordfish, “dorado”/mahi-mahi or dolphinfish), small pelagic fish (e.g., “pinchagua”/thread herrings, mackerel, “chuhueco”/Pacific anchoveta, ”botellita”/bullet tuna), whitefish (e.g.,”corvina”/croakers, “pargos”/snappers, “robalo”/snook), crustaceans (e.g., shrimp, crab), and mollusks such as cockles, mussels, clams and squid (Alava et al. 2015, Martínez-Ortiz et al. 2015). Although the majority of artisanal fishers in Ecuador do not have a substantial alternative income source to fishing, some of the activities that small-scale fishers and associated workers carry out, especially in closed seasons, are intended to supplement family income.

The development of the fishery is closely linked to fishing gears and their different modalities that are used in relation to the target fisheries resource and the capture fishing zone, as well as to the influence of the currents, mainly El Niño or Panama and Humboldt or Peruvian currents, which act as modifying oceanographic factors of the ecological conditions of the coastal marines areas. Also the rivers and associated basins in each of the coastal provinces provide fish products, and export processes from the freshwater catches of artisanal commercial fishing, affect this development (Iwaszkiw and Lacoste, 2011). Fishing activity is present throughout the Ecuadorian coast. The main fishing areas are located in the Gulf of Guayaquil, Santa Elena peninsula, Manabí province, especially in the port of Manta, which is considered the most important tuna centre in the Eastern Pacific, and El Oro and Esmeraldas provinces. In addition to the marine catches off Ecuador’s main coast, fishing in continental and inland waters, including main estuaries and tributary streams or affluents formed by the Guayas, Chone, Cojimíes, Cayapas and Mataje rivers is of paramount importance. In the Galapagos Islands, fishing activity is exclusively artisanal.

FF2- Workshop in Guayaquil had among its objectives to identify main problems related to climate change and small-scale fisheries in Ecuador to understand vulnerabilities and risks, as well as explore adaptation and mitigation measures. Taking into account that global changes affects the conditions of the oceans and marine ecosystems and threatens the Ecuador’s marine biodiversity and coastal sea, which extends over 2,859 km from north to south and hosts 96 different marine ecosystems in 14

ecoregions (according to current classification by the Ministry of Environment of Ecuador) It is therefore expected that small-scale fisheries in Ecuador are also experiencing the impacts of climate change. These impacts may be already affecting their activity, production and food security as pinpointed by fishers in the working groups in the FF2-workshop in Guayaquil. Among the likely effects of climate change we have: displacement of people from coastal and marginal areas, repercussions on coastal infrastructures, alteration of fishing productivity and limited availability of fish, and indirect changes that can exceed or even overwhelm the biophysical tolerance of fish.

According to the perceptions of the focus group of artisanal fishers (Group 1) regarding the question: how concerned are you with the impacts of the weather/climate (on the scale of 1 to 10, where 1 is not worried at all and 10 is very worried), most of the fishers expressed a relatively high degree of concern on this issue (i.e. mean±SD = 7.7 ± 2.7). Likewise, based on the participatory groups (fishers and scientists), of particular interest was the information related to the presence of marine species such as crustaceans (e.g., shrimps, *Litopenaeus* spp., *Trachypenaeus* spp.) and "dorado" or mahi-mahi (*C. hippurus*) that seem to exhibit resilience and adaptation to warming conditions in the ocean as observed by fishers and scientists. Conversely, the fishers' focus group pointed out that as a result of climate change several species have migrated and/or disappeared, including "gallo"/roosterfish (*Nematistius pectoralis*), "pámpano"/pampano (*Trachinotus* spp. *Peprilus* spp.) lisas/mullets (*Mugil* spp., *Umbrina xanti*), "bagre"/catfish (*Bagre* spp., *Arius* sp.). The fishers' focus group also indicated that small pelagic fish such as "pinchaguas"/thread herrings, *Opisthonema* spp.) and "chuhueco"/Pacific anchoveta/anchovy (*C. mysticetus*) are present in cold water conditions during the la Niña event. Interestingly, the focus group of scientists/researchers (Group 2) also corroborated that small pelagic fish are basically absent during warming conditions. A crustacean of special consideration to assess the impact of climate change is the mangrove crab (*U. occidentalis*), which represents a key commercial species for crab harvester and artisanal fishers of mangrove communities for subsistence and to generate incomes. Fishers were very concerned that this crab species is already affected by climate change. For the specific case of Ecuador, these species may well be used for modelling the vulnerability of marine species to assess sensitivity (mean thermal tolerance) under climate change scenarios (i.e. increases in sea surface temperature, changes in dissolved oxygen, ocean acidification). Other fish species such as tuna (*Thunnus* spp.) should also be considered in future studies because these species represent a main commodity exported to European markets, similar to "dorado".

This document is the product of the WWF-FF2 project workshops and was initiated by a team of interdisciplinary researchers of World Wild Fund-Germany (WWF), Agro Campus Ouest, and the University of British Columbia (Canada), who together with the INP and the Charles Darwin Foundation commenced in Ecuador in March and April 2019, both on the continental coast and the Galapagos Islands, respectively. These first workshops are a pioneering effort to be applied as a model to other regions of the world, where this project is also contemplated. In doing so, this document provides an overview of the current knowledge of fishers, scientists and decision makers of Ecuador, on the perceptions and knowledge of each of the invited actors/stakeholders, as well as identifying measures of adaptation and mitigation against possible impacts and consequences of climate change on small-scale fisheries.

3.5 Conclusions

There is no doubt that climate change can no longer be seen only as a multiplier of risks and threats to marine ecosystems, biodiversity and fisheries, but as a real risk on its own, that in climatological, socio-economic and demographic terms, has the potential to exceed in impact level and severity of consequences any other risk and threat at the national level. The climate change problems occurring in the Ecuadorian coastal-marine zone and Galapagos Islands have scarcely been assessed in the existing literature on climate change and adaptation strategies in fisheries (e.g., Cornejo 2007; Cedeño 2018; Eddy et al., 2019; Marcos and Cornejo 2006). The interactions among scientists involved with climate change and fisheries during the workshop pointed out limitations, such as: (i) the lack of coordination within the scientific community since each climate change project has its own agenda that does not necessarily add to a national program; (ii) inadequate support, in terms of personnel, materials and financial resources; (iii) weak technical capacity for modelling work and projections, a critical

component in climate change studies; and, (iv) lack of involvement of fishers in these studies and poor interaction with them in decision-making processes. It is evident, therefore, that while the technical aspects of climate change have received a great deal of attention, the socio-economic dimensions, the extension of knowledge and applied social sciences have remained largely unexplored. The national agency to address the issues of climate change in Ecuador is the Ministry of the Environment (MAE). However, the National Strategy on Climate Change (ENCC) has not considered the artisanal fishing sector, so it is imperative to review this Plan to incorporate fisheries issues and effective adaptation strategies.

Along these lines, it is necessary to increase the awareness of artisanal fishers in regard to climate change and associated impacts. At the workshop, it was observed that few of them were aware of the topic, and that most of the participants did not know the terminology of "climate change". In addition, it is not clear, among fishers, what kind of links exist between climate change and changes in their own operating conditions such as changes in the composition of fish or a decrease in fish availability. As a result, there is even less awareness of how their own fishing practices are linked to climate change, including adaptation and mitigation measures. Therefore, there is a need to persuade and encourage fishing communities to undertake more responsible and sustainable fishing practices.

In the course of the discussion of the working groups, there were some other considerations, including the need to raise the awareness in government agencies and authorities that deal with climate change and the human and socioeconomic dimensions of climate change, so that these aspects are reflected in actions and practical measures within research frameworks and adaptation strategies. Responsible fisheries management, therefore, will contribute, among other things, to improving the capacity of fishing communities to cope with possible impacts of climate change. It is essential to ensure that fisheries management should be culturally and contextually *specific* and adaptable to respond in a timely manner to local changes and impacts. In this context, fishers emphasized the need for participatory bottom-up approaches that offer more flexibility including co-management and community-based fisheries management.

Acknowledgements

We greatly appreciate the support of the National Fisheries Institute of Ecuador, through its General Director, Pilar Solis Coello, and her administrative and technical team, who kindly provided the auditorium and offices for the development of the workshop. We also thank Franck Hollander, Simone Niedermueller and Philipp Kanstinger of the World Wildlife Fund, Dr. Didier Gascuel (Agro Campus Ouest, France), and Dr. William Cheung (Changing Ocean Research Unit, University of British Columbia, Canada), who provided valuable insights for the workshops' development and supported the logistics, as well as travel funding for the artisanal fishers to attend the workshop. We thank all the participants of the workshops for the contribution provided. We sincerely recognize their contributions with ideas and insights in the discussions that enriched the workshop to produce this document that will serve as the basis for future meetings and work related to climate change impacts on the small-scale fisheries and adaptation strategies. Last but not least, we thank the students of the Faculty of Natural Sciences of the University of Guayaquil, who were taking notes and documented the information used in this document.

3.6 References of Chapter 3

Alava, J.J., Lindop, A., Jacquet, J. 2015. Reconstruction of Marine Fisheries Catches for Continental Ecuador, 1950–2010. UBC Fisheries Centre Working Paper # 2015-34. University of British Columbia, Vancouver, Canada. 25 pp.

Allison, E. H., Ellis, F. (2001). The livelihoods approach and management of small-scale fisheries. Marine Policy 25(5): 377-388.

Aronson, J. 1994. A Pragmatic View of Thematic Analysis. The Qualitative Report, Volume 2, Number 1, Spring, 1994, http://www.nova.edu/ssss/QR/BackIssues/QR2-1/aronson.html

Babbie, E. (Ed.). 2001. The Practice of Social Research. Belmont: Wadsworth.

Banco Interamericano de Desarrollo (BID). 2011. Estrategia Integrada del BID de Mitigación y Adaptación al Cambio Climático, y de Energía Sostenible y Renovable. Washington, D.C.

Barange, Manuel, Tarûb Bahri, Malcolm C.M. Beveridge, Kevern L. Cochrane, Simon Funge-Smith, Florence Poulain, 2018. Impacts of climate change on fisheries and aquaculture. Food and Agriculture Organization Of The United Nations (FAO). Rome, Italy. http://www.fao.org/3/I9705EN/i9705en.pdf

Bennett, N.J. 2016. Using perceptions as evidence to improve conservation and environmental management. Conservation Biology 30(3): 582-592.

Berkes, F. 2003. Alternatives to conventional management: lessons from small-scale fisheries. Environments 31(1): 1-16.

Boyatzis, R. E. 1998. Transforming qualitative information: Thematic analysis and code development. Thousand Oaks. Sage.

Braun, V., V. Clarke. 2006. Using thematic analysis in Psychology. Qualitative Research in Psychology 3:77–101.

Biernacki, P. and D. Waldorf, 1981. Snowball Sampling: problems and techniques of referral chain sampling. Sociological Methods and Research, 10(2):141–163.

Bystrom, A.B., Naranjo-Madrigal, H., Wehrtmann, I.S., 2017. Indicator-based management recommendations for an artisanal bottom-longline fishery in Costa Rica, Central America. Revista de Biologia Tropical (International Journal of Tropical Biology) 65 (2): 475-492.

Castilla, J. C., Fernández, M. 1998. Small-scale benthic fisheries in Chile: on co-management and sustainable use of benthic invertebrates. Ecological Applications 8: 124-132.

Castilla, J. C., Defeo, O. 2001. Latin American benthic shellfisheries: emphasis on co-management and experimental practices. Reviews in Fish Biology and Fisheries 11(1): 1-30.

Cedeño, I. 2018. Impacto del cambio climático en la abundancia relativa de cangrejo rojo de manglar (*Ucides occidentalis*) en el Golfo de Guayaquil. Revista Ciencias Del Mar Y Limnología 12(2): 60-71. https://doi.org/10.31876/rcm.v12i2.41

Cheung, W. W. L., Lam, V. W. Y., Sarmiento, J. L., Kearney, K., Watson, R., Zeller, D., Pauly, D. 2010. Large-scale redistribution of maximum fisheries catch potential in the global ocean under climate change. Global Change Biology 16: 24–35.

Cheung, W.W.L., Sarmiento, J.L., Dunne, J., Frolicher, T.L., Lam, V.W.Y., Deng Palo-mares, M.L., Watson, R., Pauly, D. 2013. Shrinking of fishes exacerbates impacts of global ocean changes on marine ecosystems. Nature Climate Change 3: 254–258.

Cheung W. W. L., Reygondeau G., Frölicher T. L. 2016. Large benefits to marine fisheries of meeting the 1.5 C global warming target. Science 354(6319): 1591–1594.

Cheung, W.W.L, Jones, M.C., Reygondeau, G., Frölicher, T.L. 2018. Opportunities for climaterisk reduction through effective fisheries management. Global Change Biology 00:1–15.
https://doi.org/10.1111/gcb.14390

Chi, M.T.H. 1997. Quantifying Qualitative Analysis of Verbal Data: A Practical Guide. The Journal of the Learning Sciences 6(3):271–315.

Clifford, N.J., G. Valentine. 2003. Key Methods in Geography.Sage Publications. 571 pp.

CMNUCC. 2011. Listados de Proyectos de CDM para Ecuador. https://cdm.unfccc.int/ Consulta en Febrero 15, 2012.

Constas, M.A. 1992. Qualitative Analysis as a Public Event: The Documentation of Category Development Procedures. American Educational Research Journal 29 (2): 253–266.

Cornejo, P. 2007. Ecuador Case Study: Climate Change Impact on Fisheries. No. HDOCPA-2007-48. Human Development Report Office (HDRO) Occasional Paper, United Nations Development Programme (UNDP). 42 pp.

Defeo, O., Castilla, J. C. 2005. More than one bag for the world fishery crisis and keys for co-management successes in selected artisanal Latin American shellfisheries. Reviews in Fish Biology and Fisheries 15: 265-283.

Eddy, T. D., Friedlander, A. M., Salinas de León, P. 2019. Ecosystem effects of fishing and El Niño at the Galápagos Marine Reserve. PeerJ, 7, e6878. https://doi.org/10.7717/peerj.6878

Erickson, K., Stull, D. 1998. Doing team ethnography: Warnings and advice. Sage, ThousandOaks, CA.

FAO. 2018. Impact of climate change on fisheries and aquaculture. Food and Agriculture Organization.
http://www.fao.org/3/I9705EN/i9705en.pdf

Flyvbjerg, F. 2001. Make Social Sciences Matter. Why Social Inquiries Fail and how to make it succeed again. Cambridge University Press.

Gattuso, J-P., Magnan, A.K., Bopp, L., Cheung, W.W.L., Duarte, C.M., Hinkel, J., Mcleod, E., Micheli, F., Oschlies, A.,Williamson, P., Billé, R., Chalastani, V.I., Gates, R.D., Irisson, JO.,

Gergen, M.M., Gergen, K.J. 2017. Qualitative Inquiry: Tensions and Transformations. Retrieved_06.06.17
https://www.swarthmore.edu/sites/default/files/assets/documents/kennethgergen/Qualitative_Inquiry_Tensions_and_Transformations.pdf

Goodman, L. A. 1961. Snowball Sampling. The Annals of Mathematical Statistics 32(1)148–170.

Grbich, C. 2007. Qualitative Data Analysis. An introduction. Sage: London.

Guest, G., MacQueen, K. M. 2008. Handbook for team-based qualitative research. AltaMira Press.Lanham, MD.

Hernández-Sampieri, R., C. Fernández-Collado, P. Baptista-Lucio. 2006. Metodología de laInvestigación. Cuarta Edición. Mc Graw Hill, México.

IPCC (Intergovernmental Panel on Climate Change). 2007. Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability. Contribution to the Working Group II for the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva. UNFCCC. 2011. Cancun Agreements. http://cancun.unfccc.int/

IPCC (Intergovernmental Panel on Climate Change). 2014. Climate change 2014: impacts, adaptation, and vulnerability. Part A, Global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of IPCC, ed. C.B.

Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea & L.L.White. Cambridge, UK & New York, USA, Cambridge University Press.

IPCC (Intergovernmental Panel on Climate Change). 2018: Annex I: Glossary [Matthews, J.B.R. (ed.)]. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press

Iwaszkiw, J., Lacoste, F. 2011. La pesca artesanal en la Cuenca del Plata (Argentina) y sus implicancias en la conservación de la biodiversidad. Revista del Museo Argentino de Ciencias Naturales nueva serie 13(1): 21-25.

Jacobsen, R. B. 2013. Small-scale fisheries in Greenlandic planning - the becoming of a governance problem. Maritime Studies 12(2). DOI: 10.1186/2212-9790-12-2

Kerr, G. Swaffield, S.R. 2012. Identifying Cultural Service Values of a Small River in the Agricultural Landscape of Canterbury, New Zealand, Using Combined Methods, Society & Natural Resources: An International Journal, 25(12): 1330-1339

Laffoley, D. d'A., Baxter, J.M. (Eds). 2012. Ocean Acidification: The knowledge base 2012. Updating what we know about ocean acidification and key global challenges. European Project on Ocean Acidification (EPOCA), UK Ocean Acidification Research Programme, (UKOA), Biological Impacts of Ocean Acidification (BIOACID) and Mediterranean Sea Acidification in a Changing Climate (MedSeA). 8pp.

Lotze, H.K. et al. 2019. Global ensemble projections reveal trophic amplification of ocean biomass declines with climate change. Proceedings of the National Academy of Sciences 201900194;
DOI: 10.1073/pnas.1900194116

Macdonald, T. 1997.The Conflicts in the Galapagos Islands, Analysis and Recommendations for their Management. Report for the Charles Darwin Foundation.

MacQueen, K.M., McLellan-Lemal, E., Bartholow, K., Milstein, B. 2008.Team based codebook development: Structure, process, and agreement. In G. Guest & K. M. MacQueen (Eds.), *Handbook for team-based qualitative research* (pp. 119–35). AltaMira Press. Lanham, MD.

Mahon, R., McConney, P., Roy, R. 2008. Governing fisheries as complex adaptive systems. Marine Polic 32: 104-112.

Mays, N., Pope, C. 1995. Rigour in qualitative research. British Medical Journal: 311:109–112.

Marcos, J.G.. M.P. Cornejo. 2006. Internal Report on "Adaptation Strategies to the Environmental and Socioeconomic Impacts of El Niño for Rural Communities in Ecuador and Peru". World Bank Project.

Markus, T., Hillebrand, H., Hornidge, A.K., Krause, G., Schlüter, J. 2017. Disciplinary diversity in marine sciences: the urgent case for an integration of research. Quo Vadimus. ICES Journal of Marine Science (2017), doi:10.1093/icesjms/fsx201. Downloaded from https://academic.oup.com/icesjms/advance-article-abstract/doi/10.1093/icesjms/fsx201/4642977 by SuUB Bremen user on 21 November 2017

Martínez-Ortiz, J., Aires-da-Silva, A.M., Lennert-Cody, C.E., Maunder, M.N. 2015. The Ecuadorian Artisanal Fishery for Large Pelagics: Species Composition and Spatio-Temporal Dynamics. PLoS ONE 10(8): e0135136.
doi:10.1371/journal.pone.0135136

Martín Míguez, B., Calewaert, J.B., McMeel, O. 2016. Best practices in stakeholder engagement, data dissemination and exploitation. AtlantOS. Optimising and Enhancing the Integrated Atlantic Ocean Observing Systems Task 10.2, Deliverable 10.5. Seascape Consultants. Funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no 633211.

Middelburg, J.J., Pörtner, H-O., Rau, G.H. 2018. Ocean Solutions to Address Climate Change and Its Effects on Marine Ecosystems. Frontiers in Marine Science 5:337. doi:10.3389/fmars.2018.00337

Ministerio de Electricidad y Energía Renovable (MEER). 2008ª. Estrategias para el Cambio de la Matriz Energética del Ecuador. Quito, Ecuador.

Ministerio de Electricidad y Energía Renovable (MEER). 2008b. Políticas Energéticas del Ecuador 2008-2020. Quito, Ecuador.

Ministerio del Ambiente. 2011. Segunda Comunicación Nacional sobre Cambio Climático. Convención Marco de las Naciones Unidas sobre Cambio Climático. Quito, Ecuador.

Nicholas, H., McDowall, A. 2012. When work keeps us apart: a thematic analysis of the experience of business travellers. Community, Work & Family 15 (3):335–355.

OLADE/ONUD. 2011a. Observatorio de energías renovables en América Latina y El Caribe, Ecuador, Informe Final, Producto 1: Línea Base de las Tecnologías Energéticas; Producto 2: Estado del Arte de las Energías Renovables.

OLADE/ONUD. 2011b. Observatorio de energías renovables en América Latina y El Caribe, Ecuador, Informe Final, Producto 3: Mecanismos Financieros

Rubin, H.J., Rubin, I.S. 2005. Qualitative Interviewing. The art of Hearing Data. Second Edition. Sage, Thousand Oaks.

Saldaña, J. 2009. The Coding Manual for Qualitative Researchers. Sage Publications. London.

Secretaria Nacional de Planificación y Desarrollo (SENPLADES), 2009. Plan Nacional para el Buen Vivir 2009-2013: Construyendo un Estado Plurinacional e Intercultural. República del Ecuador, Plan Nacional de Desarrollo. Quito, Ecuador.

Seidman, I. 2006. Interviewing as Qualitative Research. A Guide for Researchers in Education and the Social Sciences. Third Edition. Teachers College Press. New York.

Stapleton, K., Wilson, J. (2016) Telling the story: Meaning making in a community narrative. Journal of Pragmatics 108: 60-80. http://dx.doi.org/10.1016/j.pragma.2016.11.003

UNFCCC. 2015. The Paris Agreement. (FCCC/CP/2015/L.9/Rev.1). UNFCCC. New York, NY.

de Vivero, J.L.S., Mateos, J.C.R., del Corral, D.F., 2008. The paradox of public participation in fisheries governance. The rising number of actors and the devolution process. Marine Policy 32(3): 319-325.

Walmsley, S.F., C.A. Howard and P.A. Medley, 2005, Participatory Fisheries Stock Assessment (ParFish) Guidelines. London, MRAG.

Weston, C., Gandell, T., Beauchamp, J., McAlpine, L.,Wiseman, C., Beauchamp, C. 2001. Analyzing interview data:The development and evolution of a coding system. Qualitative Sociology 24(3): 381–400.

Zinda, J.A. 2012. Hazards of Collaboration: Local State Co-optation of a New Protected-Area Model in Southwest China, Society & Natural Resources: An International Journal 25 (4):384-399. http://dx.doi.org/10.1080/08941920.2011.557826.

Acronyms

CC	Climate Change
ENSO	El Niño Southern Oscillation
ENCC	National Strategy of Climate Change of Ecuador
HABs	Harmful Algal Blooms
FCD	Fundación Charles Darwin/Charles Darwin Foundation
FENACOPEC	Federación Nacional de Cooperativas Pesqueras de Ecuador/ National Federation of Fisheries Cooperatives of Ecuador
GHGs	Greenhouse Gases
INAMHI	Instituto Nacional de Meteorología/ National Institute of Meteorology
INOCAR	Instituto Oceanográfico de la Armada/ Oceanographic Institute of Ecuador's Armada
INP	Instituto Nacional de Pesca/ National Fisheries Institute
IPPC	The Intergovernmental Panel on Climate Change
MAE	Ministerio de Ambiente/Ministry of Environment of Ecuador
MPCIP	Ministerio de Producción, Comercio Exterior, Inversión y Pesca/ Ministry of Production, Foreign Trade, Investment and Fisheries
LPF	Large Pelagic Fish
SMF	Small Pelagic Fish
SRP	Subsecretaria de Recursos Pesqueros/ Under-Secretariat of Fisheries Resources

3.7 Annexes of Chapter 3

Annex 1-I: Workshop Agenda

Guayaquil, Ecuador (11 -12 March, 2019)

Monday, March 11, 2019	Activity
Day 1: morning	
8:30	Welcome and Introduction: Nikita Gaibor (INP Subdirector Científico)/Juan Jose Alava (IOF/UBC)
8:45	General description of the WWF-FF2 project: Juan Jose Alava
9:00	The impacts of climatic variability and climate change at the regional and local level: an oceanographic perspective: Dr. Eduardo Zambrano.
9:30	The known and unknown of the impact of climate variability on fisheries resources: Dr. Nikita Gaibor (Instituto Nacional de Pesca-INP).
10:00	Ecuador: Adaptation / mitigation policies to climate change in Ecuador. M Chiriboga (Subsecretaria de Cambio Climatico-MAE).
10:30	Coffee Break
11:00	**Working Groups:** **Group 1 (Fishers):** Knowledge of Climate Change within the Artisanal Fishing Sector. Facilitator: Jorge Ramirez, FCD
	Group 2 (Researchers): Research and Implementation of effective adaptation to climate change in the artisanal fishery. Facilitator: Juan José
	Group 3 (Policy makers): Policies of adaptation / mitigation to climate change in the artisanal fisheries of Ecuador. Facilitator: Nikita Gaibor, INP

Day 1: afternoon	
12:30	Lunch
13:30	Short presentations: • Adaptation to climate change in the mangrove communities of the Gulf of Guayaquil, Ecuador: The role of blue carbon: Wendy Chávez • Study of climate change in the marine and coastal zone:

14:45	Coffee Break
15:00	Continuation of Working Groups
16:00	Reports of Working Groups: Representatives of Groups 1, 2 &3 Facilitators: Nikita, Jorge Ramírez & Juan Jose
17:00	Adjourn

Tuesday, March 12, 2019	**Activities**
Day 2: morning	
9:00	Summary of day 1: Nikita, Pablo, María José or Juan José
9:30	*Inputs / Needs to adapt artisanal fisheries to climate change.*
10:45	Coffee Break
11:00	1. *Discussion: "What next?"* Nelson Zambrano, Raúl Carvajal, Juan Jose Alava
12:30	Final comments - Ending: Nikita,Juan Jose
12:45	Lunch
14:00-16:00	Inputs / Needs to adapt artisanal fisheries to climate change: Nikita, María José, Jorge Ramirez & Juan Jose
17:00	End of Workshop Teleconference with WWF-Germany: Franck Hollander, Phillip & Simone.

Annex 1-II: Participant List and consent release form

FF2 GUAYAQUIL WORKSHOP (11–12 MARCH, 2019)

#	NOMBRE	SPECIALTY	INSTITUTION
1.	Gabriela Cruz	Fishing leader/President of FENACOPEC	FENACOPEC (Federación Nacional de Cooperativas Pesqueras)
2.	Gina Gonzabay	Fishing leader	ASOCIACION CAMPO ALEGRE (Guayas)
3.	Manuel Humberto Chango López	President of fishing cooperative	ARTISANAL FISHING COOPERATIVE 14 DE JUNIO
4.	Alifio Parrales	Socio	ASOPESCAR - PUERTO LOPEZ
5.	Cesar Vásquez Macias	Vigilante	ASOCIACION - CAMPO ALEGRE
6.	Santo Genaro Vera Mite	President of Fishing Association	CERRITOS DE LOS MORREÑOS FISHING ASSOCIATION / JUMAPACON
7.	Alberto Efraim Campos Mejia	President of Fishing Association	RED UOPPAO
8.	Hebert Danny Angel Castellano	Fishing member of Association	RED UOPPAO
9.	Teodoro Cruz	Fishing leader	FENACOPEC
10.	Bemello B.		JARAMIJO
11.	Arturo González	Official -Aquaculture	WWF- ECUADOR
12.	Pedro José Jiménez Veintimilla	President of Fishing Association	FUNDACION ECUATORIANA MAMIFEROS MARINOS- ECUADOR
13.	Gustavo Domínguez	Professor / Researcher	ESCUELA SUPERIOR POLITECNICA DEL LITORAL (EPOL FCM)
14.	Eduardo Zambrano	Technical officer	CENTRO INTERNACIONAL DE INVESTIGACIONES DEL FENOMENO EL NINO (CIIFEN)
15.	Carlos Villón	Fishing Advisor	FENACOPEC
16.	Jorge Ramirez	Biologist	FUNDACION DARWIN
17.	Madeleine Calle	Biologist	ESPOL
18.	Natalia Molina Moreira	Professor-Researcher	UNIVERSIDD DE ESPECIALIDADES ESPIRITU SANTO (UESS)

19.	Juan Jose Alava	Professor	UNIVERSIDAD BRITISH COLUMBIA (UBC)
20.	Wendy Chavez	Climate Change Studies/ Fishing communities	INSTITUTO TECNOLOGICO IMAGENES
21.	Esteban Argudo	Researcher	UNIVERSIDAD SIMON BOLIVAR
22.	Stefan Dietricit	President of NGO	SCHALZUVALD E.V.
23.	Telmo De la Duadra	Oceanographer/Climate Change	INSTITUTO NACIONAL DE PESCA (INP)
24.	Mario Hurtado	Oceanographer/Climate Change	INP
25.	Raul Carvajal	Biologist/ Environmentalist	CONSERVACION INTERNACIONAL (CI)
26.	Maria Pena	Fishing Researcher (Crab Fishes)	INP
27.	Marco Herrera	Fishing Researcher (Large Pelagic Fishes)	INP
28.	Juan Moreno	Fishery Researcher	INP
29.	Renato Carpio	Biologist	Independent consultor
30.	Rubén Castro Rendón	Chemistry	Under secretariat of Quality and Safety
31.	Patricia Rosero	Officer of Environmental Ministry	Under secretariat of Coastal Marine Management
32.	Nelson zambrano	Environmentalist	Independent consultor
33.	Jonathan Javier Lòpez Bravo	Analyst 2	SRP
34.	Federico Koeller	Environmentalist	FUNDACION CERRO VERDE
35.	Nikita Gaibor	Policy/socio-ecology & fishery Researcher	INP
36.	David Crespo	Student	UNIVERSIDAD DE GUAYAQUIL
37.	Melani Martínez Márquez	Student	UNIVERSIDAD DE GUAYAQUIL
38.	Alex Ichazo	Student	UNIVERSIDAD DE GUAYAQUIL
39.	Estefanía Cuadrado	Student	UNIVERSIDAD DE GUAYAQUIL

GROUPS:

- FISHERS
- SCIENTISTS
- **DECISION-MAKERS**
- STUDENTS

Annex 1-III: Workshop Photos

Photo 1. *Presentations of technical talks by the organizers and invited instructors during the first day of workshop.*

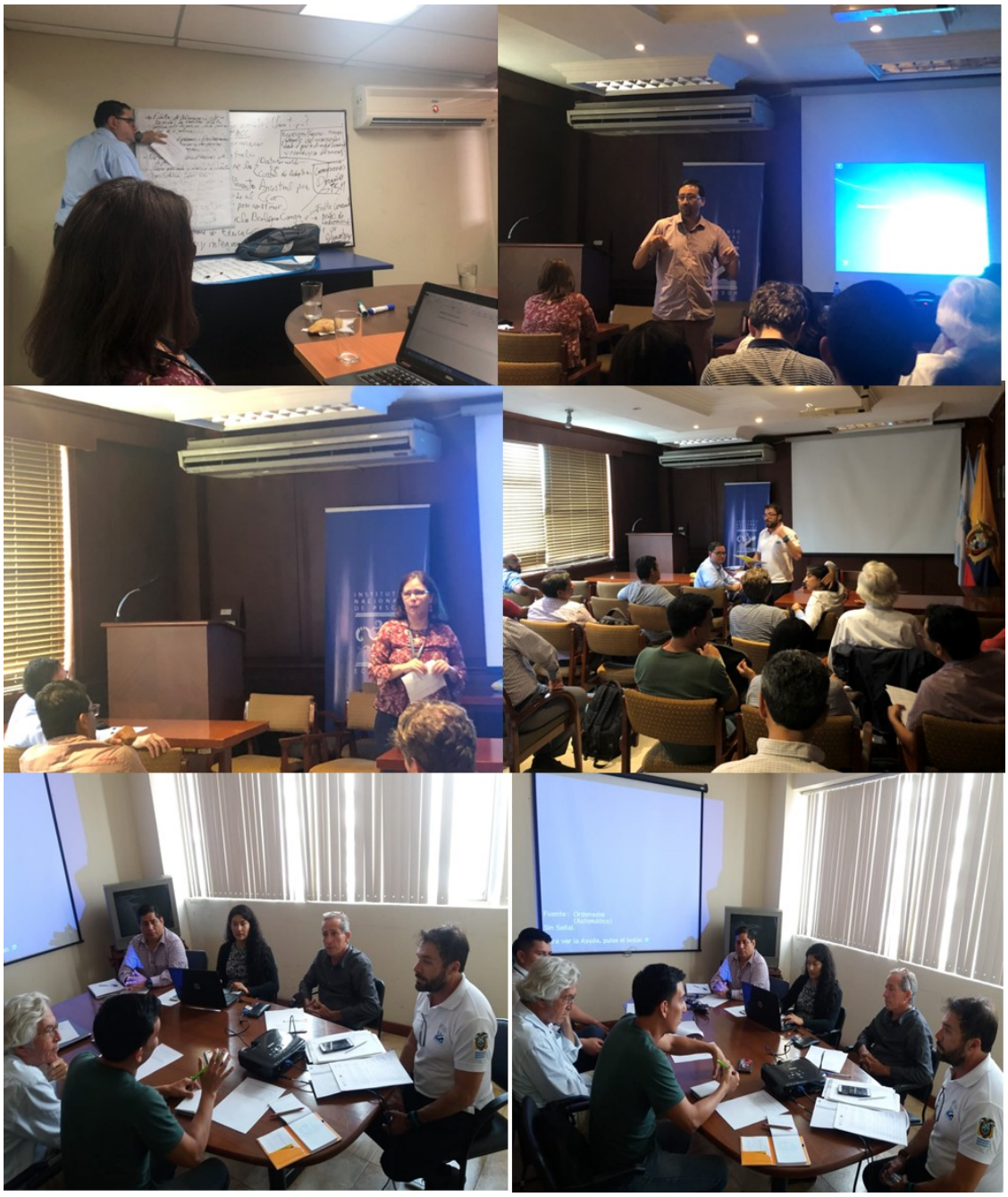


***Photo 2**. Participatory activities for focus groups, including fishers (Group 1), scientists (Group 2) and decision makers (Group 3) during the first day of workshop.*

***Photo 3**: Mixed working group (fishers, scientists and decision makers) interacting during the second day of workshop.*

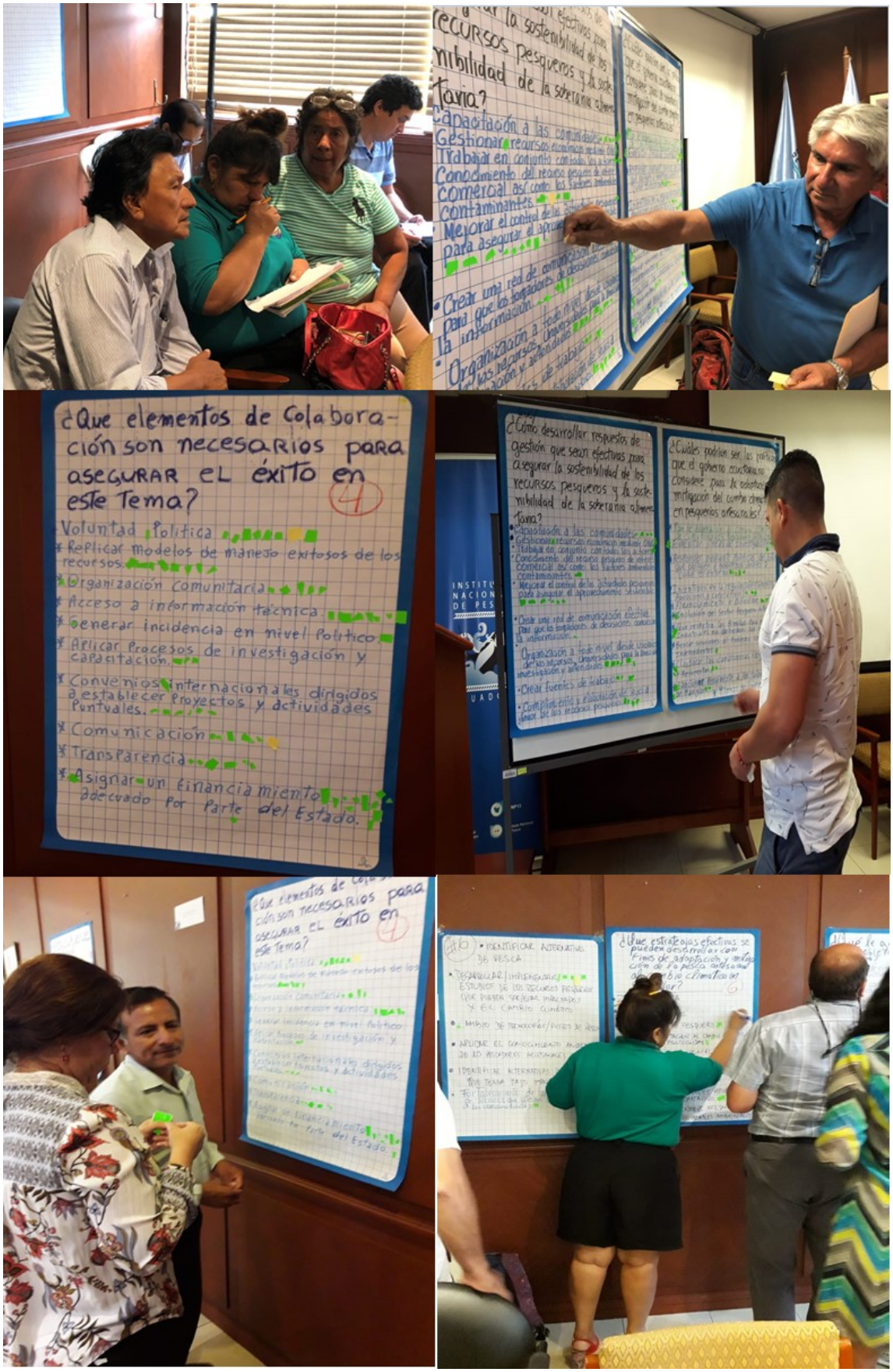


Photo 4: *Fishers and researchers participating and interacting in the mixed working group during the second day of the Guayaquil's workshops*

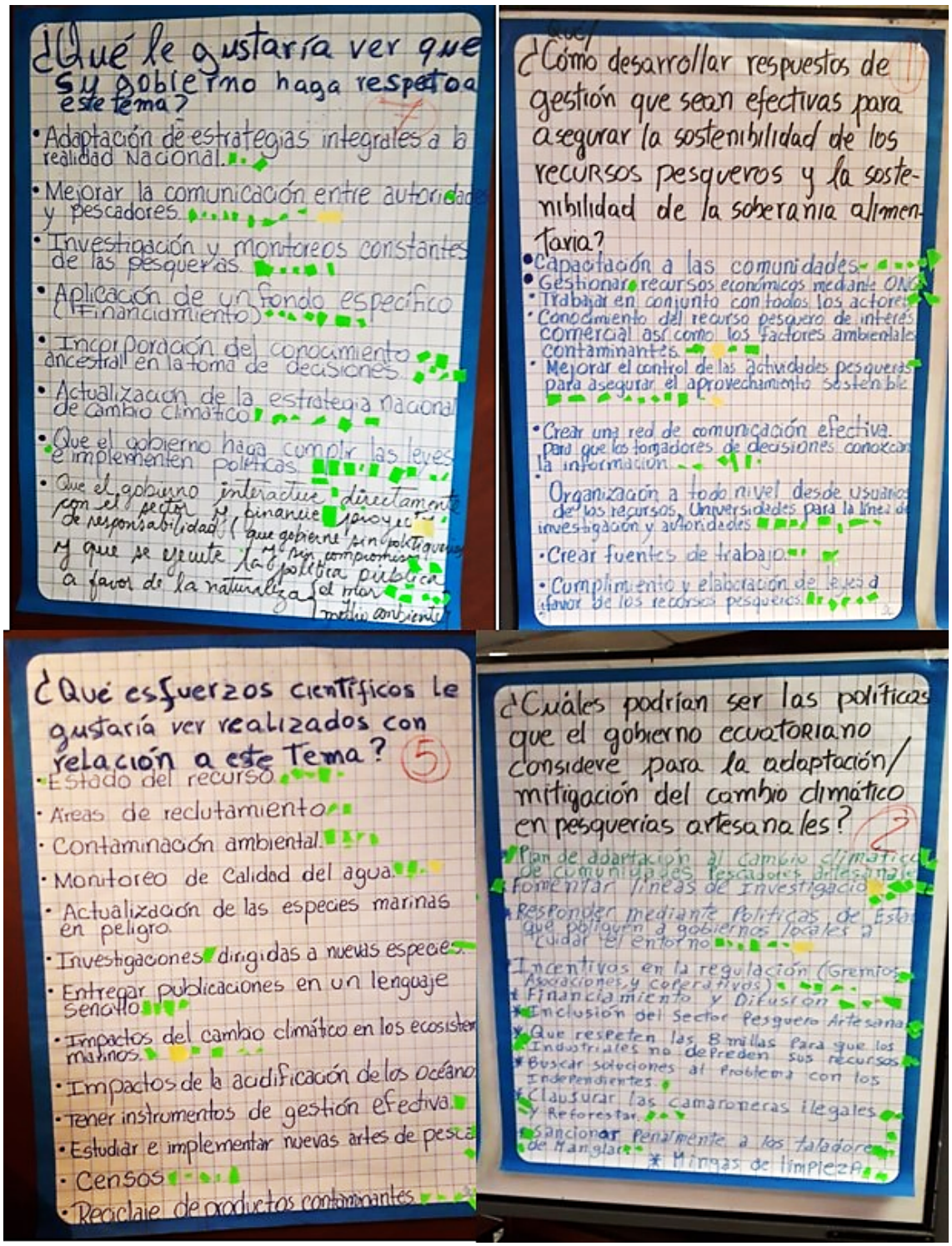


Photo 5: *Examples of answers depicting the perceptions as a result of the mixed group participation of fishers, scientists and decision makers.*

Photo 6: *Artisanal fishers and the organizers (Juan Jose Alava & Nikita Gaibor) at the end of the workshop (top); and most of the participants who attended the WWF-FF2 workshop in March 2019.*

4. CASE STUDY 2: IMPACTS OF CLIMATE CHANGE IN THE ARTISANAL FISHERY OF GALAPAGOS: FISHERS KNOWLEDGE

4.1 Document preparation

This document was prepared by Gabriela Rodríguez-Jácome (Correspondence author: gabriela.rodriguez@fcdarwin.org.ec), Solange Andrade-Vera, María José Barragán-Paladines, Nicolás Moity, Jorge Ramírez-González, from the Charles Darwin Foundation.

This report presents "Impacts of climate change on the Galapagos small scale fishery: fishers' knowledge ". This research answers the question: how does the knowledge of fishers determine strategies and mechanisms for adaptation to climate change? During this study, four workshops were held in the Galapagos Islands between April and September 2019.

During the workshops, it was possible to learn about the effects of climate change on small scale fisheries in Galapagos, about the preparedness of the Small Scale Fishing Sector, about the actors and actions in the light of climate change in Galapagos, and finally about proposed actions to face climate change with an emphasis on the sustainability of seafood products and food sovereignty. The amount of perceptions and knowledge of Galapagos fishers regarding climate change recorded during the workshop was significant. This research is an exercise showing how perceptions and knowledge can be integrated into climate change adaptation mechanisms in the fisheries sector.

This report is part of the results of the study "Fish Forward 2 Warming Oceans and Effective Adaptation in a Changing Climate" in the Galapagos Islands, Ecuador.

Within the FF2 project it was aimed to a study that included results from workshops in different parts of the world (Latin America, Africa and Asia) to explore and understand the knowledge of small scale fishers on their mechanisms of adaptation to climate change. In the case of Latin America, Ecuador was chosen to hold two workshops, one in Guayaquil and the other in Galapagos. INP led the organization of the workshop in Guayaquil and CDF in Galapagos.

This project intends to know the ways of knowledge of the small scale fishermen and fisherwomen (i.e. fishers, hereafter) in Galapagos and has answered the following questions: What is Climate Change and Climate Variability? What are its consequences? What are the impacts on small-scale fisheries? And what adaptation strategies can be effectively implemented in fishing communities to address Climate Change? To answer these questions, four workshops were held with small-scale fishers from the Galapagos Islands (see Methods section).

The results of this research are a contribution to generate climate change adaptation measures, as well as to improve fisheries management considering the knowledge, needs, and perceptions of small-scale fishers in the Galapagos Islands. In addition, the results shall build a bridge between fishers' local ecological knowledge and scientific knowledge as drivers for biodiversity conservation.

4.2 Workshops structure

To carry out this research in Galapagos, a total of four participatory workshops were held, and attended by 26 fishers from the Galapagos Islands. The first workshop held on April 5, 2019, called "Impacts of Climate Change on Galapagos Artisanal Fisheries: Traditional Knowledge of Fishermen and Fisherwomen" identified knowledge, experiences and perceptions on the social, economic and environmental impacts of Climate Change on fisheries, from resource extraction to commercialization, as well as adaptation tools (Annex 1: list of participants).

This workshop was held in the meeting room of the Charles Darwin Foundation (CDF) in Puerto Ayora and brought together 16 artisanal fishers from Galapagos to share their knowledge concerning the impacts of climate change on their fisheries. Other stakeholders and partners, including a facilitator and technicians from the Charles Darwin Foundation (CDF), the Directorate of the Galapagos National Park (DGNP), the National Institute of Fisheries (INP), WWF Germany and Agrocampus Ouest of France were also present in the workshop. The workshops were facilitated by Sergio Larrea. The facilitator and technicians facilitated the dialogue and provided relevant information to enrich the discussion between fishers and other participants (See Annex 2: key concepts; Annex 3: workshop agenda and Annex 4: workshop methodology).

For the socialization and validation of results, three workshops on "Socialization and validation of results of from the Workshop Impacts of Climate Change on Artisanal Fisheries in Galapagos: traditional knowledge of fishermen and fisherwomen" were subsequently carried out. They were held with the participation of a total of 10 fishers on Santa Cruz Island (July 12, 2019), San Cristobal Island (August 15, 2019) and Isabela Island (September 7, 2019).

The purpose of these workshops was to share the findings with the fishers of each of the islands and to validate them through this process. These workshops were held in Santa Cruz at the Charles Darwin Station, on the island of San Cristobal at the COPESAN cooperative and in Isabela at the Oasis center. The workshops were also participatory, receiving feedback and recording new information. This report analyzes the final results of these four workshops and includes the recommendations identified by fishers in the workshops.

4.3 Results: workshop outcomes

At a general level the workshops aimed to investigate following issues: the **effects** of climate change on artisanal fisheries in Galapagos, how **prepared** is the Artisanal Fishing Sector, the **actors and actions** to face climate change in Galapagos and finally the **proposals** and **mechanisms** for actions to face climate change with an emphasis on the sustainability of seafood products and food sovereignty.

4.3.1 How does Climate Change affect artisanal fisheries in Galapagos?

***"It affects my economy and therefore the wellbeing of my family"* Pescador (fisher), Isabela Island**

The small-scale fishers of the GMR identified changes between 2009 and 2017 in several aspects: climate, fishing and its marketing and quality of life. The historical diagrams prepared by the fishers of each of the islands can be seen in Annex 5.

Climate changes refer to changes in sea temperatures, solar radiation, changes in ocean conditions (sea levels, water visibility, wave levels and types) and atmospheric conditions (currents, winds). It was also possible to record knowledge regarding indicators of climate change through indicator species: "*Billfishes surf in waves*". The existence of more or less predators: "*A lot of sea lions and sharks*"; *there were no penguins*". And habitat changes of species "*Lobería moved to the landing site*".

The effects on **fishing and marketing** refer to changes in marine catches/landings (higher and lower according to species), level of fishing intensity/fishing effort, levels of fishing resource per island, volumes of fish. We also recorded knowledge about: changes in habitats and species: "*Climate change has affected animals on the shore (sea urchins, marine snails/slugs, corals) and that's why there is no sea cucumber*. Fishing pressure on the resource: "*6 months are granted to fish lobster. The 6 months to fishing lobsters have affected the resource, it should be 4 months*. Changes in volumes of fish according to diversification of fishing: "*Increases volume of fish because there is deep-sea fishing*". *Changes in*

temperature and life cycle of species: "The higher the temperature, the more spawning female lobster".

Fishers identified effects on their **quality of life as a** result of climate change. They reported that the life quality of fishermen and fisherwomen has been reduced as they are currently short of fish due to climate change. They mentioned an increase of accidents in underwater/diving fishing (lobster, sea cucumber) due to the increasing difficulty of obtaining the resource. Also, they reported the difficulty to work and the "hard" climatic conditions.

Concerning fishing and commercialization in the Galapagos, fishers reported two periods. Isabela Island's fishers identified that between 2009 and 2014, the availability of the resource was much higher than the availability perceived between 2015 and 2017. The fishers of Santa Cruz identified the opposite, that is, the time of greatest volume of fisheries was from 2015 and less fishing over the period 2009-2014. The fishers of San Cristobal Island identified external factors such as commercialization, which influenced and affected their economic and life quality. It is important to consider that fishing gear, level of fishing fleet (number of fishing vessels), fishing effort, number of fishers and type of fishery vary from island to island.

4.3.2 How prepared is the Galapagos Artisanal Fisheries Sector for Climate Change?

Do you think the artisanal fishing sector is ready to adapt to climate change?

***"We are not ready, but we are worried"* Pescador (fisher) San Cristóbal Island**

Most fishers (56%) expressed that **they are not ready** to adapt to climate change (Annex 6) due to lack of knowledge regarding the subject and its consequences, because their fishing is affected by ocean warming and because they consider that they have no alternatives other than fishing. Therefore, they do not see alternatives to resolve climate change. They mention: "*You react to the moment you face the situation.*"

14% of fishers say they **are ready** to adapt because they consider the fishing sector as prepared and mention: *"Yes, as a sector we are ready to work, although we are very concerned."* On the other hand, fishers consider that "*they are ready to endure the inclemency, but not to face it".*

Finally, 28% of fishers say that they are **not that ready** and the remaining 14% did not answer the question. Those who mention that they are **not that ready** mention that the changes are very drastic, that appear to be timeless and thus, they are not prepared.

How concerned are you about climate impacts?

***"We depend directly on the climatic conditions to work at sea"* Pescador (fisher) Isabela Island**

Most fishers (62%) mention that they were **very concerned** about climate impacts. Fishers mention that they are concerned because it could affect future generations and also because they see that the consequences would affect the livelihoods of their families. Other fishers mentioned that they are concerned because they depend on climatic conditions to work at sea.

12% of fishers mentioned that they are **moderately concerned** about climate impacts. After all they were not aware if global warming is a temporal thing or if it will affect the future. Some simply do not care as they will only be concerned at the moment that the event occurs. Finally, the remaining 12% of fishers are **not very worried because** they consider that "*we will automatically overcome it*"; and, 4% of fishers did not answer the question (See Annex 7).

4.3.3 Proposals for actions to address climate change in artisanal fisheries in Galapagos

"Strategies to address climate change must first care for people first and foremost through education and by building equity. With this education, we can guarantee conservation and confront climate change" **Pescador (fisher), San Cristóbal Island.**

Who are the key actors to support the Galapagos Fisheries Sector in tackling Climate Change and what should they do?

"These types of dialogue should be held with the national authorities so that they can take action on the effects of climate change on the fishing sector" **Pescador (fisher), San Cristóbal Island.**

The fishers identified ten institutions as key actors to support the fishing sector (Annex 8). Of these institutions, four have jurisdiction at the local level and six at the national level. Figure 1 shows the first row institutions as those overseeing or regulating at the national, regional and local levels, including the Directorate of the Galapagos National Park (DGNP), the Special Regime Council of the Galapagos Government (CREGG), the Ministry of Production, Foreign Trade, Innovation and Fisheries (MPCEIP) and the Decentralized Autonomous Governments (GADs).

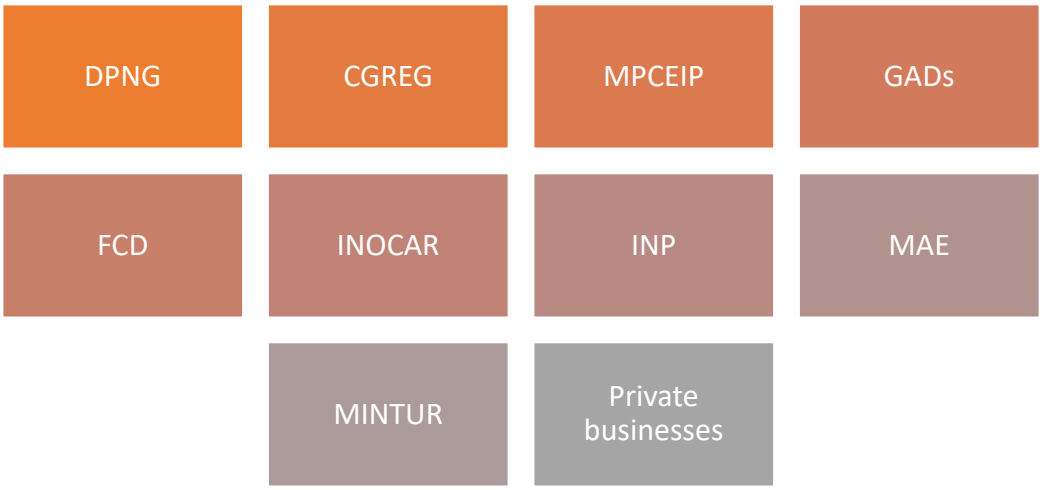


Figure 1.- Key actors to support the Galapagos fishing sector in confronting climate change. Initials for institutions stand as follows: DGNP: Galapagos National Park; CREGG: the Special Regime Council of the Galapagos Government; the MPCEIP: Ministry of Production, Foreign Trade, Innovation and Fisheries; GADs: the Decentralized Autonomous Governments. CDF: Charles Darwin Foundation, INOCAR: the Navy Oceanographic Institute of Ecuador; INP: National Fisheries Institute; MAE: Ministry of Environment; and, MINTUR: Ministry of Tourism.

Fishers attribute fisheries research and advice to the Charles Darwin Foundation (CDF), the Navy Oceanographic Institute (INOCAR), and the National Fisheries Institute (INP). On the other hand, the Ministry of Environment (MAE) as well as the Ministry of Tourism (MINTUR) are considered institutions that should provide funding or financing to the fishing sector. In addition, private companies were mentioned as potential buyers of raw materials.

Based on the key actors and proposed activities, seven key actions required by the Galapagos Fisheries Sector to address Climate Change were identified (Fig. 2).

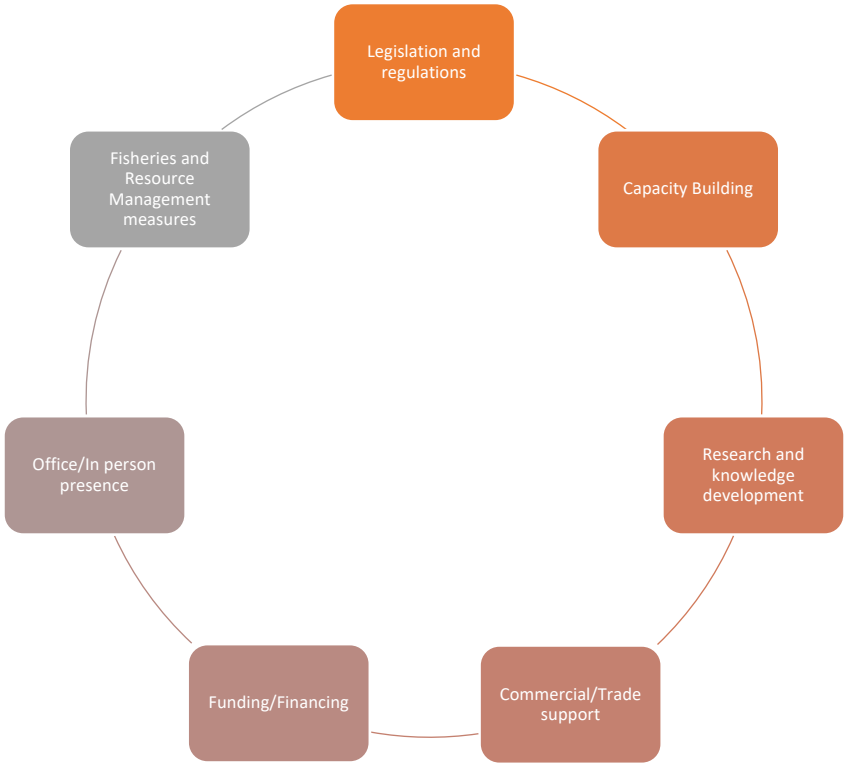


Figure 2.- Identified key actions required by the Galapagos Fishing Sector to face Climate Change.

The key actions identified are legislation and regulations, capacity building, research and knowledge generation, marketing support, financing, physical office and in person presence in Galapagos, as well as specific fisheries and resource management measures.

4.3.4 What is needed for successful stakeholder collaboration?

Fishers identified several ways in which collaboration among actors for adaptation to climate change can be successful. They were grouped into four main themes: participation, dialogue, and identification of fishing sector problems, support for sector initiatives and the creation of an inter-institutional roundtable on climate change (See Fig. 3).

Figure 3.- Mechanisms for collaboration between actors for successful adaptation to climate change

The fishers identify **participation** as a central mechanism, mentioning that each institution must fulfill a role and its competencies; they also state that institutions should have honesty and ethics. Another collaboration mechanism identified is **dialogue**, in which fishers mentioned the need for permanent communication among institutions, in addition to maintaining proposals and firm actions over time.

Another mechanism of collaboration that fishers mentioned is the **support to the initiatives of the fishing sector**, as they consider that the general problems should be identified first, and then to look for alternatives for the fishing sector. Finally, they identified the creation of an inter-institutional climate change roundtable as a collaborative mechanism. In this way, they comment, *"competition and redundancy among institutions are avoided*".

4.3.5 What issues should be investigated so that the Galapagos Fishing Sector has a better knowledge of how to face Climate Change?

The fishers identified several research topics to be developed so that the fishing sector has a greater knowledge of how to face climate change. They have been grouped into four main themes: biological-fishing themes on commercial species, physical, climatic and atmospheric aspects, socio-economic and nature and conservation issues (Fig. 4).

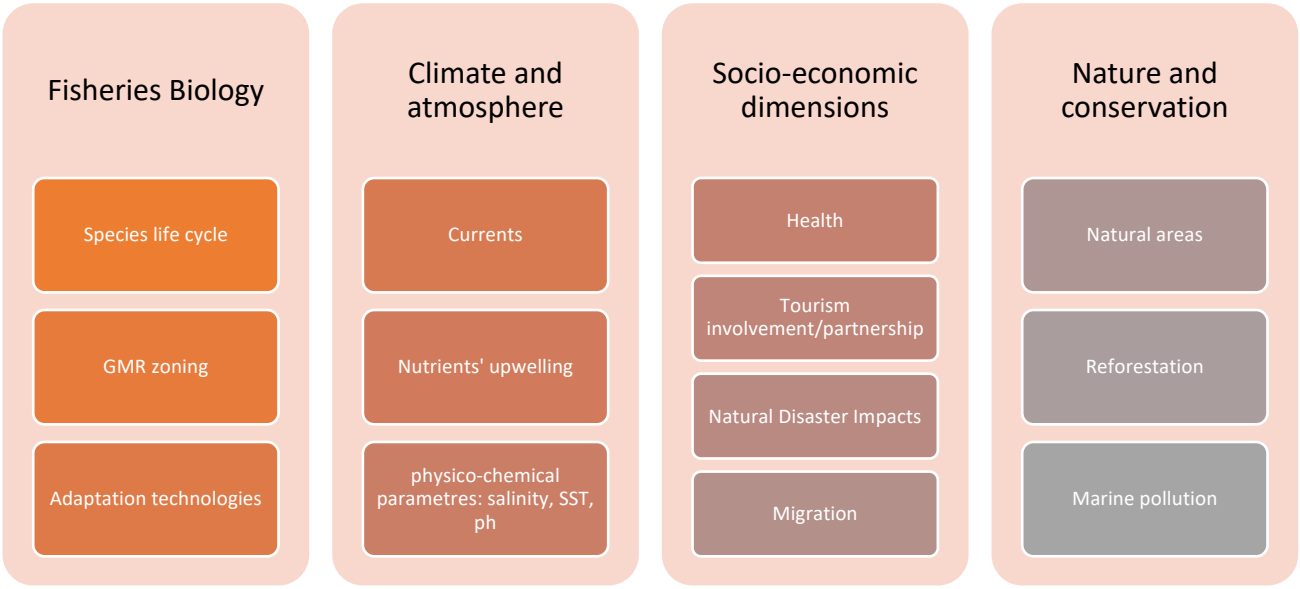


Figure n°4.- Research topics proposed by the fisheries sector to increase its knowledge of how to deal with climate change

The biological-fishing issues that fishers suggest to investigate include the life cycles of commercial fish species/fisheries considering migrations, migration depths, spawning stages, and possible impacts by tides and surges (spring tides). They are also interested in knowing the effects on fishing by the new zoning (2016) of the Galapagos Marine Reserve (GMR). In addition, the identification of technologies within fisheries for adaptation to climate change.

Regarding **climatic and atmospheric** research topics, fishers are interested in knowing about currents, their displacement and location. The location of major nutrient upwellings and the currents that produce them. On the other hand, they would like to know about physical-chemical parameters such as salinity and pH.

Among the socio-economic research topics that fishers are interested in, the following ones were listed: identifying the cause and effect of the incidence of the sun on the fishers' health, the migration of people to the islands and their impacts, the flow of tourism toward the islands, and affectations. Another issue to consider is how natural disasters affect the Galapagos Fishing Sector.

In terms of **nature and conservation**, they consider it important to know about marine pollution and the creation of natural areas to combat climate change and reforestation. It is worth mentioning that fishers identify the importance of studying the consequences of climate change in the artisanal fisheries sector, but also they express the need to permanently socialize research results with the fishing community sector.

4.3.6 What should the Galapagos Fishing Sector do to adapt to the impacts of Climate Change?

***"We must adapt, evolve, change, create a new culture in the face of climate change because it affects productivity in the fishery and affects our own lives"* Pescador (fisher) Santa Cruz Island**

With the aim to adapt to the impacts of climate change, the fisheries sector identified several adaptation measures, which were grouped into four main themes: the creation of a new culture in the face of climate change, alternative economic incomes for fishers (both fishermen and fisherwomen), the implementation of technologies and the use of effective fishing gear and equipment, as well as the commercialization of seafood products (Figure 5).

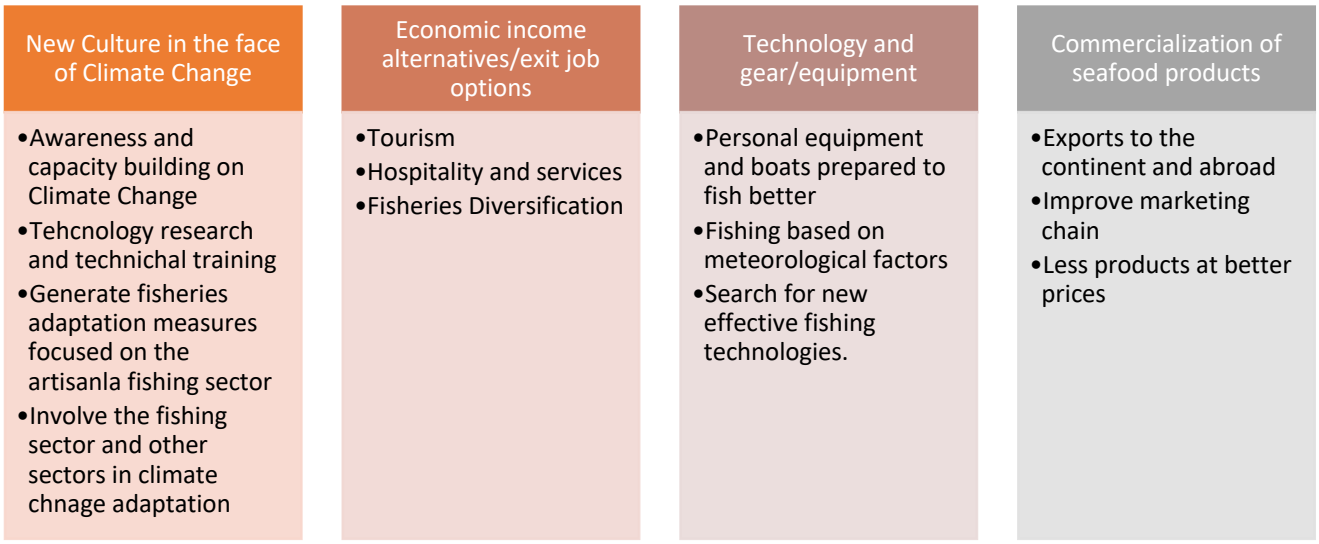


Figure 5.- Adaptation measures to the impacts of climate change on artisanal fisheries

The **creation of a new culture in the face of climate change** includes two perspectives: firstly, one focused *directly on the fishing sector* and the other involving *other sectors*. The creation of a culture of adaptation to climate change in the fisheries sector should first include awareness raising and training of fishers on Climate Change issues. They also consider that it is of paramount importance to research and educate the fishing sector about adaptive technologies. To transmit this knowledge and train the sector, fishers consider that it is essential that the communication should be assertive to approach the fisher.

The fishers also identified that the fishing sector should consider other sectors involved, including the tourism sector and community involvement, in what they call a "change of mentality" on conservation. Together with these new actors, they identified ways to adapt to climate change such as reforestation in the terrestrial environment, as well as mangroves reforestation at sea. The need to control overpopulation in order to control climate change was also mentioned.

The **search for other alternatives of economic income** is another of the measures of adaptation to climate change. Fishers mention the need for training in local-based tourism and hospitality, which could sustain the family needs. It is worth mentioning that this also includes the need to diversify fisheries.

With respect to the **use of** appropriate **technologies and gears,** fishers identified the following as measures: appealing to the implementation of personal equipment and vessels to be better prepared, seeking adaptation techniques through fishing technologies, and considering meteorological factors in order to fish better.

Finally, another general adaptation measure is the promotion of the **marketing of seafood products.** Fishers identify as a key emphasis on the marketing of added value-products. This would mean less fishing effort and better economic return. They mentioned that the strategy should be implemented through the support of the DGNP, Undersecretary of Fisheries and NGOs.

What do we propose to do with artisanal fishing in Ecuador to adapt to and mitigate Climate Change?

***"As Fishing Sector we will give a grain of sand to not to pollute the environment, although Galapagos is not meant to be the main responsible for this problem"* Pescador (fishers) Santa Cruz Island**

Fishers identified some proposals for adaptation and mitigation to climate change in artisanal fisheries in Ecuador (Fig. 6).

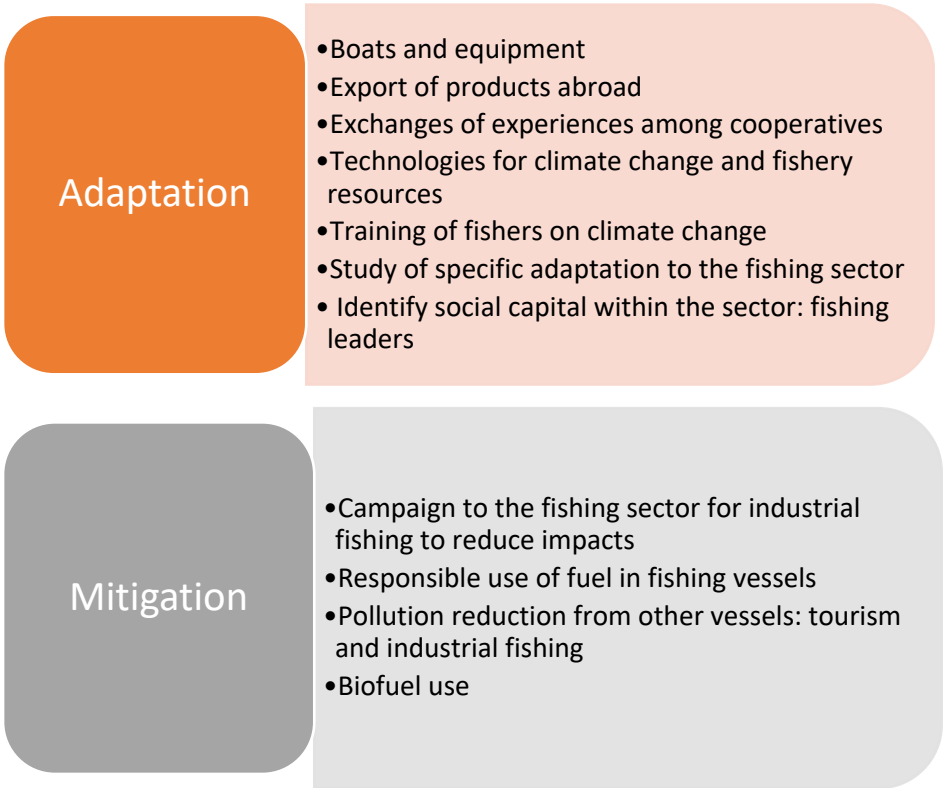


Figure 6.- Proposals for adaptation and mitigation to climate change in the artisanal fishing sector in Ecuador

The proposals for climate change **adaptation** identified by fishers include strategies such as the improvement of boats and their equipment to be better prepared for sea conditions, the commercialization of products abroad, and technologies for fishers allowing them to detect changes in the climate and availability of the fishing resource. On the other hand, they mentioned training for fishers on climate change and exchanges between local and national cooperatives to share the ways of life and adaptation. They also propose that specific adaptations to the fisheries sector be investigated.

Finally, they propose to identify community leaders within the fishing sector who are a link between researchers/scientists and the fishing community.

The climate change **mitigation** proposals identified by fishers include those within the fisheries sector and others that should be implemented by other sectors. Mitigation proposals *within the fisheries sector* include the responsible use of fuel in vessels, avoiding dumping waste at sea, and contributing to the removal of monofilament meshes from the sea. Another mitigation proposal by the fishing sector is the use of biofuels.

Regarding mitigation proposals to be implemented by *other sectors*, fishers identify the industrial fishing sector as the most aggressive towards the marine resources, so they suggest creating awareness campaigns with that sector. Likewise, they request the tourism and artisanal fishing sector to reduce environmental and marine pollution.

4.3.7 What can be done to ensure the sustainability of seafood products and ensure food sovereignty in general?

"We are concerned about the denigration of the fisherman and because he is not valued for his contribution to food and conservation" **Pescador (fisher) San Cristóbal Island**

Fishers determined actions to ensure the sustainability of seafood products and food sovereignty. They were grouped into six main themes: specific measures for the fisheries resource management, legislation and regulations of the GMR, information, equipment and technologies, participation in decision-making process, measures for the exercise of sustainable fisheries and support for the fisheries marketing (Fig. n°7).

Figure 7.- Proposals to ensure the sustainability of seafood products and in general to ensure food sovereignty

Specific fisheries resource management measures include a controlled fishing system with closures based on studies. It should implement and maintain closures according to the type of fisheries, the search for nursing sites, provide alternatives to fishing zones, maintain control and regulated fishing zones.

The **laws and regulations of the GMR** should include the adoption of laws and the application of sanctions that preserve the GMR. This refers to industrial fishing that could put artisanal fishing at risk. For example, laws to prevent the presence of illicit and illegal fishing aggregation devices (FADs) deployed by industrial boats in the GMR and to sanction and remove those fishing illegally in the GMR.

In terms of **information, equipment and technologies**, it is important to have access to information on climate change and its possible impacts, and to have adequate equipment both on a personal level and in terms of the capacity of vessels to develop better fishing operations and activities. This includes technologies to know the location of FADs and potential fisheries and seabed maps with information on fishing zones on banks. On the other hand, the need for equipment for fishing cooperatives is mentioned to guarantee the sustainability of fishery products.

Regarding **participation in decision-making**, fishers consider that it is key to integrate the fisheries sector into decision-making. Conversely, considering the zoning of the GMR, some fishers proposed the extension of the Marine Reserve, however, not all agreed. They stated that there is still a control deficit in the current Reserve, which would be even more complex to manage if it were expanded. In addition, they would require larger boats to access to distant sites.

With regard to **measures for the exercise of sustainable fisheries**, fishers propose access to the inheritance of the "fisherman" so that their sons and daughters can continue to exercise sustainable fishing. They also propose **support for marketing**, the creation of certifications for value added to the product with institutional support and training on appropriate equipment and marketing strategies for national and international markets.

4.4 Discussion

The discussion section includes three sections: the conjectural factors, what do we know about climate change and how to adapt to climate change. First, the conjectural factors refer to those themes frequently brought to debate by the artisanal fishers in Galapagos. It is estimated that around 40% of the debates and questions refer to these issues. It is a prerequisite to recognizing the local issues and conjectural factors that have to be considered for the viability of climate change adaptation projects.

The second section includes what we know about climate change, the factors that science has currently identified and what artisanal fishers have noticed over time. Finally, the section reviews some necessary adaptation mechanisms based mainly on the incorporation of fishers' knowledge.

4.4.1 Conjectural and external factors

Adaptation strategies to climate change in artisanal fisheries generally mention factors linked to impacts and adaptation mechanisms directly related to the sector. However, it is important to consider that there are other *conjectural* factors (important or urgent) in the daily life of Galapagos fishers (both fishermen and fisherwomen). These factors have to be considered as *external factors* influencing the final results of the research and are important issues to resolve and / or have to be taken into account before formulating adaptation strategies.

This is the case of the effects perceived by the fisheries over time (2009-2017). The effects of climate are minimal in comparison with the current situation. This should be considered by the institutions in

charge of climate change adaptation measures in Galapagos to ensure the viability of their implementation.

Within the topics discussed with Galapagos fishers, factors mentioned repeatedly throughout the workshops were noticed. These factors, known as *conjectural factors,* are those external factors which, although not directly affected by climate change, affect fisheries:

Tourism and fisheries

For fishers it seems that the tourism sector has advantages over the use of marine resources and less regulation of activities. Fishers identify the tourism sector as a key actor, specifically tourist boats. Fishers believe that this sector as responsible along with the fishing sector for influencing the GMR; therefore, they consider the tourism sector to be key for the decision-making and implementation of adaptation and mitigation actions to climate change in Galapagos.

Non-take zones

Another frequently mentioned topic is the Darwin and Wolf Marine Sanctuary declared as such in 2016. This zoning is perceived as *unfair because* it reduces their fishing grounds. Therefore, it has an impact on the responses to the effects on the resources available for fishing. On the other hand, the "new" zoning of the GMR elaborated in the year 2016 is another topic mentioned among Galapagos fishers since it impacts fishing by definition of non-take zones.

Markets and marketing

Another current issue is the dynamics of the market and commercialization of fish in Galapagos. If there is overfishing, prices fall; if there is a lack of traders, there is no one to sell the product or in other cases there are monopolies. It is not only the availability of the resource that has an impact, but other actors in the marketing chain are key to ensuring the sustainability of fishery products.

Quality of life

Throughout the workshops, it was mentioned that there are poor and deficient conditions in the quality of life: *It is important that the children of the fishermen have a quality education. In this way, they will be able to carry out other activities other than fishing, as well as contributing to conservation*" (Pescador (fishers) from Santa Cruz Island). Some of these conditions are frequently mentioned and identified as Unsatisfied Basic Needs (UBN) such as perceived low quality of education, low levels of health care, poor waste management, poor water quality and lack of drinking water. These considerations are key when implementing strategies for adaptation to climate change considering that "...If basic needs are not met, any intervention that doesn´t address them is unlikely to be successful" (Tarling, 2006:60).

Types of fisheries

There are also differences in fishing techniques. The first fishery for sea cucumber was authorized until 2015; thereafter and until now this specific resource is closed. It should also be taken into account that the entire lobster (*Panulirus* spp.) has only been marketed since 2009, as in the past it was previously marketed *as lobster tails*. This has an impact on economic benefits for fishers, as well as other forms of consumption for the local population. Another variable that affects the analysis of this period of time is the new zoning of the Darwin and Wolf Marine Sanctuary in 2016. Fishers consider it as a measure that reduces their fishing spaces.

Fishing Alternatives

Experiential fishing ("*pesca vivencial*"), a combination of fishing and tourism was incorporated as an alternative activity to fishing since 2012 but it is currently conceived as unfair competition with fishers. Fishers mention: "Those who have the experiential fishing patent only do snorkeling and not fishing." We wonder where the economic alternatives to fishing should reach out, and also how to create a monitor mechanism or alternatives and adaptive mechanisms.

Alternatives to fishing not only include other socio-economic activities but also fishing for other species. The diversification of fisheries and alternatives for economic sources of resources reduces the pressure on the traditional Galapagos fisheries (cod, lobster and sea cucumber). Some species, such as dorado and "la vieja" were mentioned as alternatives by the fishers.

Specialization of fishers

Another influencing factor referred by fishers is the specialization that emerged between *divers* and *deep-sea fishers*, which they consider since 2011 as an advantage in the time of marketing of fishery products.

Fishing measures

Another frequently mentioned mechanism is the fishing license (PARMA). Related to this heritage for the fisher's children they mention "We proposed to give priority to the fishers children to have the access to fish as a legacy". This also includes what fishers mentioned as "limitations of labor access" in reference to the contractual needs of labor for the fishing sector.

4.4.2 What do we know?

Effects of climate change

Projections of climate change in the Pacific Tropical Northeast region are uncertain compared to other regions at high latitudes. Although small-scale fisheries can adapt to available resources, they are highly vulnerable to habitat degradation (FAO, 2018).

Fishers notice climate changes and see their consequences in the fishing operations, directly associated with the reduction of the fisheries resource and variations in the marine food chain. Likewise, these changes in fishing and marketing activities affect their quality of life due to the reduction of their economic income, implying what they call "negative effects on their wellbeing".

The overall result of the fishers is that they are not ready to adapt to climate change, but they are concerned about it. While most fishers express they are not ready, at the same time and although apparently contradictory, they mention that they will be able to react when they have to face the situation and that they will eventually discover mechanisms to overcome the challenges.

Management of fishery resources

The management of marine and fisheries resources is identified as an adaptive strategy for climate change in developing countries (FAO, 2018). Fishers recognize that good fishing practices are effective; in this sense, they respect the closures and temporal management of fishing resources. They can

recognize when resources are affected by variations of catch dynamics (e.g. the red spiny lobster, *Panulirus penicillatus*).

These good practices denote the successful management of a fishery. This good practice generates resilience of the fishing resource in the Galapagos in the face of climate change effects. It has been officially implemented in Galapagos since the creation of the Marine Reserve. This implies that sustainable management is only possible through adaptive management over time.

It is also important to consider the generation of adaptive fisheries resource management measures in other fisheries. Currently, only lobster (*Panulirus* spp.) and sea cucumber (*Isostichopus fuscus*) seems to be effectively managed. There are new studies on some species, such as the Galapagos grouper (*Mycteroperca olfax*), white-spotted sand bass (*Paralabrax albomaculatus*), Mottled Scorpionfish, (*Pontinus clemensi*) (Usseglio et al. 2015; Salinas-de-León et al. 2017; Marin Jarrín et al. 2018). However, it is important to include the sustainable management of other resources, mainly commercial species of the Galapagos.

4.4.3 How to adapt?

Climate change adaptation mechanisms for the sector include the following: improved research, management, planning and the establishment of a framework of technical, administrative, adaptive capacity and communication policies (FAO, 2018). It is worth highlighting the importance of incorporating local ecological knowledge of fishers as part of research for a sustainable use of fisheries resources.

The importance of the knowledge of fishermen and fisherwomen

The fishers' local knowledge is an important input for developing sustainability in fisheries management. Several studies demonstrate the importance of considering the local knowledge of fishers, including, the so-called "ecological and technological knowledge" (Grant & Berkes, 2007); the "fishers ecological knowledge FEK (Johannes et al. 2000) or/and the local ecological knowledge-LEK (Silvano & Valbo-Jørgensen, 2008).

LEK, for example, is considered to have the potential to improve fisheries management, provide new information about the ecology, behaviour and abundance patterns of fish or aquatic animals, reproduction, migration, and ecological relationship between fish and predators (Silvano & Valbo-Jørgensen, 2008; Bender et al. 2014). Others, such as Figus (2018) demonstrate the use of local knowledge of fishers in the management of commercial fisheries and Wong (2016) the use of LEK on IUCN endangered species identification:

***"For species that have not been described on a scale that is relevant (or large enough) for Red Listing, local resource users and people who interact with the resource might be the only source of ecological and biological information"* (Page. 6)**

Through the analysis of climate change impacts on artisanal fisheries in Galapagos, several issues were identified:

Knowledge of fishers (fishermen and fisherwomen)	Provision/ availability of the resource
	Resource reduction
	Habitat change of commercial species
	Incidence of habitat change in the availability of the resource
	Fishing pressure on the resource (possible overexploitation)
	Resource life cycles
	Climate change indicator species
	Trophic chain variations/changes due to changes in climate (predatory fish)
	Temperature changes and species' life cycle changes

Figure n°8.- Knowledge of fishermen and fishermen (LEK) on fisheries in Galapagos

Castrejón (2011) mentions that after years of RMG co-management, the expected results on resources management were not achieved. He believes that fishers were only integrated in the decision-making process and not directly in more comprehensive processes such as planning, research and implementation processes. For example, FAO (2018) incorporates the local knowledge of fishers for planning management and decision making advice into the portfolio of climate change adaptation tools.

This research is an exercise in collecting the local ecological knowledge of Galapagos fishers (fishermen and fisherwomen). Although Figure 8 mentions some pieces of knowledge/facts, it still needs a more exhaustive analysis with the use of other qualitative methodologies that analyses the data by types of knowledge, by fishery, by function and by the level of contribution in the management and management of resources.

Adaptation mechanisms

The search for **alternatives to fishing** has been conceived as a mechanism for adaptation to climate change. Experiential fishing, for example, which allows the combination of fishing and tourism is not currently considered by fishers as an effective measure. They see some fishers taking advantage of a double activity. Thus, they propose other mechanisms such as the collection of garbage on the high seas as a mechanism for economic income (e.g., incentives) and a conservation measure for the GMR.

Although small-scale fisheries are considered to be the most sensitive to climate change impacts because these fisheries are associated with areas harboring threatened ecosystems such as mangroves and coral reefs (FAO, 2018), Galapagos could be considered an advantage of adaptation to climate change due to its protection and management conditions as a Protected Marine Reserve.

As another adaptation mechanism, fishers also propose the **use of new gears** such as "the modified oceanic-pelagic longlining fishing system" ("el empate oceánico modificado") and **new fisheries**,

emphasizing deep-sea fishing. They also propose sea cucumber farming as a socio-economic alternative. However, caution should be considered concerning longline fishing projects in the GMR because of the direct and indirect impacts on sharks, manta rays, marine mammals, turtles, and seabirds (Cerutti-Pereyra et al. 2019). Another frequently mentioned mechanism is to guarantee the **fishing license** (PARMA) for the children of fishers (fishermen and fisherwomen). In general, climate change adaptation mechanisms should consider the existing regulations of the Galapagos National Park concerning the fishing sector to ensure the sustainability of fishing activities. The analysis of governance is fundamental and should include all actors involved in the sector.

Implications for food security and sovereignty

The resilience of a socio-ecological system depends on the current state of its local populations since it influences the potential range of adaptation (FAO, 2018). Reducing poverty and providing a population with basic living conditions are a guarantee of better adaptation. As evidenced by the results, Galapagos fishers are aware of climate change and its importance in affecting their resources. However, there is still much to be done to warrant and ensure better living conditions (i.e. health, education, sanitary conditions, and basic services) that will in turn increase their level of resilience.

Other strategies included by fishers to ensure the sustainability of seafood products and food sovereignty are as follows: specific resource management measures, legislation and regulations within the GMR, access to information, fishing equipment/gear and technologies, participation in decision-making, measures to ensure sustainable fishing and marketing support.

Management and risk reduction for resilience

Although FAO (2018) mentions the *reduction of risks and disasters for resilience* within climate change adaptation strategies, this topic was scarcely addressed by the fishers in the workshops. Only the need to know more about natural disasters and possible impacts was identified in the first place; and, reforestation or rehabilitation of marine and terrestrial ecosystems was proposed as an adaptation mechanism.

4.5 Scope and Limitations

- It is necessary to consider that the number of fishers participating (26) in the workshops represent about 7% of total active fishers.
- There was a high involvement of the representatives of the Galapagos fishing cooperatives.
- Results were mapped differentiating fishers origin, there are differences in results between inhabited islands.
- The following variables were not considered as a factor that affects the knowledge / perception level about climate change among this research:
    - Fishers age
    - Differences between active, retired and boat owners (armadores).
    - Fishing gear, the vessels type and fishing effort of each fisher.
    - Fishers number by type of fishery.
    - The “changing baseline” (Castrejón, 2011) of fishers.
    - These and other factors should be considered in the following researches.
- Currently there are ontological, epistemological and applicability challenges for linking local knowledge and scientific knowledge (Raymond et al. 2010). It is suggested to deepen this type of research and to diversify qualitative methodologies that allow significant contributions to the integration of local knowledge with other types of knowledge.

4.6 Conclusions

A great amount of local ecological knowledge from fishers was identified during the workshops. The artisanal fishers of Galapagos identified mechanisms for adaptation and mitigation to climate change; they identified key actors and key actions to carry out. In addition, they generated adaptation strategies to ensure the sustainability of seafood products and food sovereignty.

To increase knowledge about climate change, fishers have defined and prioritized topics on which they need to be trained. Also, they called on institutions that generate research on climate change to socialize, inform and permanently train the sector to strengthen its capacities and build resilience.

As proposed in the workshops, emphasis should be placed on the creation of an inter-intuitional committee on climate change. It should define roles, clear responsibilities and mechanisms for inter-institutional collaboration. This research also proposes to develop an adaptation plan to climate change in artisanal fisheries with emphasis on sustainability and food sovereignty in Galapagos. It is considered pertinent to incorporate a topic that was poorly addressed, but a key issue, which is disaster risk management as a mechanism for adaptation to climate change.

This is the first research about fishers' knowledge in Galápagos to generate mechanisms for adaptation to climate change in the artisanal fisheries sector. It is important to deepen the analysis and collect more comprehensive information that should be subsequently integrated into management and administration of fisheries resources.

Acknowledgments

The authors would like to thank the fishers who participated and contributed their knowledge to this workshop. Special thanks to Astrid Freire, Paulina Cepa and Eduardo Franco for their voluntary collaboration during the workshop on April 5, 2019, Ricardo Castillo for COPESAN facilities for the workshop on August 15, 2019 and Geovanny Pachay for the facilities of Oasis for the September 7 workshop. We also thanks Lea Monnier (Agrocampus Ouest) and Nikita Gaibor (Instituto Nacional de Pesca, INP) for attending and providing input in the first workshop. This work was partially funded by the Dr. Gerald "Jerry" Wellington Marine Climate Change Project and the Gordon and Betty Moore Foundation and carried out under DGNP Research Permit No. PC-37-19 "Socioecology, assessment and management of fisheries: steps towards sustainability".

4.7 References of Chapter 4

Castrejón, M. (2011). Co-fishing management in the Galapagos Marine Reserve: trends, challenges and prospects for change. *Charles Darwin Foundation/Kanankil/Plaza-Valdés, Mexico*.

Cerutti-Pereyra, F., Moity, N., Dureuil, M., Ramírez-González, J., Reyes, H., Budd, K., Jarrín, J.M. and Salinas-de-León, P. (2019) Artisanal longline fishing the Galapagos Islands–effects on vulnerable megafauna in a UNESCO World Heritage site. *Ocean & Coastal Management*, p.104995.

FAO. 2018. Impact of climate change on fisheries and aquaculture. Food and Agriculture Organization. http://www.fao.org/3/I9705EN/i9705en.pdf

Figus, E. C. (2018). *Using local knowledge to inform commercial fisheries science and management in Poland and Alaska*. University of Alaska Fairbanks.

Grant, S., & Berkes, F. (2007). Fisher knowledge as expert system: A case from the longline fishery of Grenada, the Eastern Caribbean. *Fisheries Research*, *84*(2), 162-170.

Johannes, R. E., Freeman, M. M., & Hamilton, R. J. (2000). Ignore fishers' knowledge and miss the boat. *Fish and Fisheries*, *1*, 257-271.

Marín-Jarrín, J.R., Andrade-Vera, S., Reyes-Ojedis, C. & Salinas-de-León, P. (2018). Life History of the Mottled Scorpionfish, *Pontinus clemensi*, in the Galapagos Marine Reserve. *Copeia*. No.3:515-523.

Raymond, C. M., Fazey, I., Reed, M. S., Stringer, L. C., Robinson, G. M., & Evely, A. C. (2010). Integrating local and scientific knowledge for environmental management. *Journal of environmental management*, *91*(8), 1766-1777.

Salinas-de-León, P., Bertolotti, A., Chong-Montenegro, C., Gomes-Do-Régo, M. & Preziosi, R.F. (2017). Reproductive biology of the endangered white-spotted sand bass *Paralabrax albomaculatus* endemic to the Galapagos Islands. *Endangered Species Research*. Vol 34:301-309.

Silvano, R. A., & Valbo-Jørgensen, J. (2008). Beyond fishermen's tales: contributions of fishers' local ecological knowledge to fish ecology and fisheries management. *Environment, Development and Sustainability*, *10*(5), 657.

Stern, M. J. (2018). *Social science theory for environmental sustainability: A practical guide*. Oxford University Press.

Usseglio, P., Friedlander, A.M., Koike, H., Zimmerhackel, J., Schuhbauer, A., Eddy, T. & Salinas-de-León, P. (2016). So Long and Thanks for All the Fish: Overexploitation of the Regionally Endemic Galapagos Grouper Mycteroperca olfax (Jenyns, 1840). *PLoS ONE*. 11(10): e0165167. https://doi.org/10.1371/journal.pone.0165167

Wong, P. (2016). Traditional Ecological Knowledge and Practice and Red List Assessments: Guidelines and Considerations for Integration. Guidelines and Considerations for Integration. Working Paper 3. The Social Science for Conservation Fellowship Programme, Working Paper Series. IUCN. Washington-USA.

4.8 Annexes of Chapter 4

Annex 2-I: Workshop agenda

Workshop Agenda April 5, 2019

Time	Activities
8:00	Opening and welcome of the workshop Objectives, agenda and rules of coexistence Presentation of participants Presentation and feedback on progress of CDF fisheries research projects Effects of climate change on artisanal fisheries in Galapagos
13:30-14:30	**Lunch**
18:00	Proposals for actions to address climate change in artisanal fisheries in Galapagos Next steps Acknowledgement and closing

Agenda for workshops 12 July, 15 August and 7 September.

Time	Activities
9h00	Opening and agenda of the day
	Objectives and rules of coexistence
9h10	Presentation round of participants
9h20	Results of the workshop "Impacts of climate change on artisanal fisheries in Galapagos: traditional knowledge of fishermen and fisherwomen".
10h00	Agreements and next steps
10h30	Closing

Annex 2-II: List of participants

Workshop participants April 5, 2019

No.	Name and surname	Institution	Provenance
1.	Léa Monnier	Agrocampus Ouest	France
2.	Geovanny Briones	COPAHISA	Isabela
3.	Geovanny Pachay	COPAHISA	Isabela
4.	Henry Segovia	COPAHISA	Isabela
5.	Luis Bonilla	COPROPAG	Santa Cruz
6.	Oscar Intriago	COPAHISA	Isabela
7.	Daisy Vera Moreno	COPESAN	
8.	Noemi Calderon	COPESAN	Saint Kitts and Nevis
9.	Ricardo Castillo García	COPESAN	Saint Kitts and Nevis
10.	Dionicio Zapata	COPROPAG	Santa Cruz
11.	Julian Quimi	COPROPAG	Santa Cruz
12.	Fausto Villaroel G.	COPROPAG	Santa Cruz
13.	Leopoldo Ayala Cruz	COPROPAG, Helmsman	Santa Cruz
14.	Javier Chafla Neira	DPNG-CUEM	Santa Cruz
15.	Sergio Larrea	Facilitator, Consultant	Quito
16.	José Pontón Cevallos	Charles Darwin Foundation	Quito
17.	Astrid Freire	Charles Darwin Foundation	Santa Cruz
18.	Eduardo Franco Fuentes	Charles Darwin Foundation	Santa Cruz
19.	Jorge Ramirez	Charles Darwin Foundation	Santa Cruz
20.	Juan Manuel García	Charles Darwin Foundation	Santa Cruz
21.	María José Barragán	Charles Darwin Foundation	Santa Cruz
22.	Paulina Cepa	Charles Darwin Foundation	Santa Cruz
23.	Solange Andrade	Charles Darwin Foundation	Santa Cruz
24.	Nikita Gaibor	National Institute of Fisheries	Guayaquil
25.	Philipp Kanstinger	WWF Germany	Germany
26.	Franklin Garcia	COPESAN	Saint Kitts and Nevis

Participants in workshops Santa Cruz, San Cristóbal and Isabela

No.	Name and surname	Institution	Date
1.	Jaime Asencio	COPROPAG	July 12, 2019
2.	Julio Jaya	COPROPAG	
3.	Celso Villaroel	COPROPAG	
4.	Daisy Vera Moreno	COPESAN	August 15, 2019
5.	Ricardo Castillo García	COPESAN	
6.	Oscar Intriago	COPAHISA	7 September 2019
7.	Geovanny Briones	COPAHISA	
8.	Geovanny Pachay	COPAHISA	
9.	Francisco Ortuño	COPAHISA	
10.	Yangarlo Fariño	COPAHISA	

Annex 1-III: Methodological script

Workshop "Impacts of Climate Change on Galapagos Artisanal Fisheries: traditional knowledge of fishermen and fisherwomen".

Time	Duration	Activity	Method	Material	Mounting
7:45	30 min.	Registration of participants	• As they arrive, the participants are registered. • Each participant receives a white sticker in which he registers his name with a black marker.	• 1 Registration of participants • Table • 3 Spheres • 40 white and rectangular stickers • 3 black markers	• Table at the entrance of the room with the necessary materials
8:15	5 min.	Openness and objectives	• Words of welcome • the objectives of the event are presented and in what context it is being done. The targets are displayed. • the facilitator introduces himself	Visualized Objectives	30 chairs in double semicircle Slate or wall in front
8:20	10 min.	Presentation of agenda and rules of coexistence	• Visualized presentation of agenda and rules of coexistence. • The rules of coexistence are: to ask for the floor, to be brief and concise in interventions, to be respectful of ideas and people, punctuality, cell phones in vibrating mode. • Permission is requested to take photographs/video and to record the audio of the interventions. • It is announced that a film crew will do interviews. The interviews are voluntary. • It is announced that a record will be distributed after the event. • The plenary is asked if there are any doubts, comments or suggestions.	Agenda and visualized rules of coexistence	30 chairs in double semicircle Slate or wall in front
8:30	20 min.	Presentation of participants	• There will be a sociogram that consists of the participants being grouped according to the criteria that are raised. • The criteria are: age, years of experience in fishing in Galapagos, fishery to which I mostly dedicate myself, island in which I live, cooperative to which I belong, place of birth, position or function that I occupy in the cooperative. • The statistics are displayed	Criteria displayed on cards. Flipchart paper with distribution of criteria.	In an open space A slate on the side

Time	Duration	Activity	Method	Material	Mounting
				Markers. Slate	
8:50	30 min.	Workshop context and key definitions	• Brief presentation of the context in ppt (10 min.). • Definitions of key terms are presented: climate, climate change, climate change adaptation, climate change mitigation, management responses, climate variability, livelihoods. (10 min.) • These definitions are displayed on cards to serve as a reference for subsequent work. • Questions and comments are received (10 min.).	Projector Screen Extensions Definitions written on cards	30 chairs in double semicircle Front screen or wall

9:20	70 min.	Presentation and feedback on progress of CDF fisheries research projects	• Explanation of the presentation method (3 min.)
			• 4 presentations of 5 min. each. The presentations of results (20 min.):
			  ○ Interviews on changes in abundance and fishing activity related to climate variability.
			  ○ Sampling of larvae with light traps.
			  ○ Fishing trips in Fish Aggregating Devices.
			  ○ Sampling of fish at the Pelikan Bay pier and on board of fishing fibers at different points of the Galapagos Marine Reserve.
			• The presentations are displayed on posters.
			• After the presentations, the plenary is divided into 4 groups that will rotate through the 4 presentations. Each group will have 10 minutes to ask questions and make comments at each station (40 min.). Rotation time 2 min. between rotations, 6 min. total time between rotations.
			• There will be one CDF person at each station. This person will respond to the questions and comments, as well as record the fishermen's contributions on flipchart paper.
				5 posters
				16 sheets of flipchart paper
				Bookmarks
				Masking tape
					4 stations in the 4 corners of the hall (1 station has two posters)

10:30	**30 min.**	**Refreshments**			
11:00	125 min.	How does climate change affect artisanal fisheries in	• Explanation of the task and possibility to answer questions (5 min.) • The plenary is divided into groups. The criterion was groups by island to which the fishermen belong. (5 min.). • Each group will fill in a matrix. The matrix will have 10 columns from 2009 to 2018	5 historical diagrams Bookmarks	5 spaces for group work

Time	Duration	Activity	Method	Material	Mounting
		Galapagos, historical diagram	and four rows with the following themes: climate (ambient temperature, sea temperature, winds, tides/water, currents); fishing (catches: e.g. species, size, quantity, shape, location); marketing of fishery products and; quality of life of fishing families. • Each group will fill in the matrix with the information. At the end of the writing, the group should check the matrix again and draw 3 conclusions on three cards. • The CDF facilitator and staff will accompany the groups. • In plenary, each group will present its work emphasizing its conclusions. The plenary may make additional contributions. 10 min. per group, total 55 min. maximum.	Cards	
13:05	25 min.	How prepared is the Fishing Sector for climate change?	• Explanation of the task (5 min.) • After making the historical diagram, the participants are asked to answer the following questions on two scales (15 min.): • Do you think the artisanal fishing sector is ready to adapt to climate change? The scale will be: it is not ready, it is not ready enough, it is moderately ready, it is ready. Each participant will have a card that will be placed in a scale box inside an envelope to maintain the privacy of the vote. On that card you will record the reason why you think you are in that position. • On a scale of 1 to 10 (where 1 is not concerned at all and 10 is very concerned), how concerned are you about climate impacts? Each participant will put a card inside an envelope on the scale. The card will explain why you are in that position. • The votes will be counted, in addition to putting up the cards of the visible reasons. • Trends in scales and reasons given are reviewed. • This is an input for the next part.	2 scales displayed 40 green cards 40 celestial cards 40 black markers 3 masking tape 3 sheets of flipchart paper	30 chairs in double semicircle Front ladders
13:30	**60 min.**	**Lunch**			
14:30	85 min.	Proposals for actions to address climate change in artisanal fisheries in Galapagos	• Explanation of the task (5 min.) • Stations are set up with the following questions: ○ Who are the key actors to support the Galapagos Artisanal Fishing Sector in tackling climate change and what should they do? Kraft will be divided into actors from the State, Civil Society, Academy. ○ What issues should be researched so that the Galapagos Fishing Sector has a better understanding of how to deal with climate change? ○ What should the Galapagos Artisanal Fisheries Sector do to adapt to the impacts of climate change?	Questions displayed on cards 4 sheets of 3 kraft papers each, 40 markers 40 cards	Kraft papers on the walls.

Time	Duration	Activity	Method	Material	Mounting
			○ What do we propose to do to adapt and mitigate artisanal fisheries to climate change in Ecuador? ○ What is needed for successful collaboration among identified actors? • Each station will have three large sheets of flipchart paper glued to a wall. • Participants will be able to rotate freely at each station to propose answers to each of these questions (40 min.). At each station, there will be one person who will write down the participants' contributions on cards. • A group will be assigned to each question that will be in charge of systematizing the contributions of the participants in a visualized way. (40 min.). The systematization must incorporate in an orderly and creative way all the contributions, even if there are some on which the group does not agree. The plenary will be responsible for analysing the relevance of the proposals. If new ideas emerge from the group during the systematization, they can be incorporated showing that they are new contributions from the group. In each group there will be a person assigned to support the systematization work.	40 markers	
15:55	20 min.	**Refreshments**			
16:15	90 min.	Analysis of proposed actions to address change in artisanal fisheries in Galapagos	• In rotary plenary, each group presents in 5 min. the systematization carried out. The plenary will have a maximum time of 15 min. to feedback the presentation. • The feedback will be done through the traffic light technique which consists of having three types of circular stickers to ask, congratulate and comment. • At the end of each presentation all the participants will have the possibility to stick the stickers in any point of the presentation.	Traffic light stickers Group systematizations 16 flipchart paper Bookmarks	The work place of each group is visited.
17:45	10 min.	Next steps	• The following steps are considered. • The recording delivery date is remembered.	Displaying Next Steps	30 chairs in double semicircle Slate or wall in front
17:55	20 min.	Evaluation of the event	• Each fisherman is asked to record on one card what he liked about the workshop and on another what could be improved. • Each fisher is given the opportunity to read his cards and stick them on the wall.	Visualized questions Two-color cards	30 chairs in double semicircle

Time	Duration	Activity	Method	Material	Mounting
					Slate or wall in front
18:15	5 min.	Acknowledgement and closing	• The active participation is appreciated, and the event is closed.	None	30 chairs in double semicircle Slate or wall in front

Annex 2-IV: How does Climate Change affect artisanal fisheries in Galapagos?

Below are the historical diagrams prepared by each group of fishermen and fisherwomen for each of the islands in Galapagos:

Saint Kitts and Nevis

Topics	2009	2010	2011	2012	2013	2014	2015	2016
Weather	Aguaje, strong currents, quite a bit of wind.	Aguaje, strong currents, quite a bit of wind.	Aguaje, strong currents, quite a bit of wind.	Aguaje, strong currents, quite a bit of wind.	Aguaje, strong currents, quite a bit of wind.	Aguaje, strong currents, quite a bit of wind.	Extreme sun, more intense. Colder. Mar bravo.	

Topics	2009	2010	2011	2012	2013	2014	2015	2016
Fishing	Larger catches of lobster, cod, grouper, little camotillo. Catches of 130-140 quintals PNG had knowledge of fishing sites and resource quantities. There was restriction and closure of sites. Good fishing catch (Darwin & Wolf for cod, Isabela and northern islands, especially Pinta, for grouper). The capture of sea cucumber was good in Isabela, but not so good in Cristobal.	Less cod Catching more species. Dry-salty.					Sea cucumber fishing. Greater intensity in deep-sea fishing (tuna).	Closure of fishing sites at Darwin & Wolf.

Topics	2009	2010	2011	2012	2013	2014	2015	2016
Commercialization	There were no fixed merchants of Dry-salted (e.g. Cod and other species). Internal and external commercialization. Incalculable value of lobster. They were not satisfied because only the glue was marketed. There was no regulated handling or marketing of sea cucumbers. The merchants didn't pay him everything and they owed the fisherman. There were regulations that affected the capture and commercialization of the resources (e.g. Lisa).	It was kept from regular to good. Lack of marketing over time. Zoning by PNG/Regulations affecting commercialization. From this year onwards, the catches of certain species (e.g. mullet) decreased.					Good on Christopher, bad on Isabela. Cucumber: at the beginning $4.00; at the end $ 2.00.	Just tail.

Topics	2009	2010	2011	2012	2013	2014	2015	2016
Quality of life	Many accidents by diving (sea cucumber) / Unprotected. Exploitation of fisheries by traders. What was paid for the lobster tail did not represent a welfare for the fishermen considering the risk posed to the fisherman by the capture of this resource.	There were no alternative activities						Closed sites affected fishermen/fewer fishing sites

Santa Cruz

Topics	2009	2010	2011	2012	2013	2014	2015	2016	2017
Weather	Coast: lowest sea temperature. More rain (downpours). Height (open sea): temperate temperature (tropical storms). Bravest sea.	Coast: lowest sea temperature. Height (open sea): temperate temperature (tropical storms). Bravest sea.	Coast: lowest sea temperature. Height (open sea): temperate temperature (tropical storms). Bravest sea.	Coast: lower sea temperature lower. More rain less downpours	Less rainfall due to deforestation.	Less rainfall due to deforestation	Warmest sea temperature in hot months and coldest in cold months. Hot open sea temperature. Sea more brave in brave months. Calmer sea in calm months. Less rainfall due to deforestation	Warmest sea temperature in hot months and coldest in cold months. Hot open sea temperature. Sea more brave in brave months. Calmer sea in calm months. Less rainfall due to deforestation	Warmest sea temperature in hot months and coldest in cold months. Hot open sea temperature. Sea more brave i brave months. Calmer sea in calm months. Less rainfall due to deforestation

Topics	2009	2010	2011	2012	2013	2014	2015	2016	2017
Fishing	Lobster good volume. The higher the temperature, the more lobster ovada (general comment not per year). Cucumber is not by pirates (general comment not by year). Climate change has affected animals on the shore (hedgehogs, slugs, corals) and so there is no cucumber (general comment, not per year). Deep-sea fish / white fish, fish migrate because of unpredictable currents of temperature (general comment, not per year).	Little sorcerer.	Little sorcerer.	Punta Cormorant has recovered coral Little sorcerer.	Little sorcerer	Little sorcerer	It increases the volume of fish because there is deep-sea fishing. Last cucumber fishery. Boom of the sorcerer (they go less fiber to catch witches than boom, because they open other fisheries like lobster)	It increases the volume of fish because there is deep-sea fishing. Boom of the sorcerer	It increases the volume of fish because there is deep-sea fishing. Six months are given to fish for lobster. The 6 months of lobste have affected the resource, should be 4 months. Boom of the sorcerer

Topics	2009	2010	2011	2012	2013	2014	2015	2016	2017
Commercialization	Lobster less price because only the tail is sold. Fish at USD 2.20 a pound of albacore.	Lobster less price because only the tail is sold. Fish at USD 2.20 a pound of albacore.	Lobster less price because only the tail is sold. Good commercializatio n of lobster because separation of divers and deep-sea fishing was allowed. All the lobster has been taken advantage of and the price increases. USD 2.20 per pound of albacore	Chinese Wo arrives to buy lobster. Good commercializatio n of lobster because separation of divers and deep-sea fishing was allowed. All the lobster has been taken advantage of and the price increases.	Good commercializatio n of lobster because separation of divers and deep-sea fishing was allowed. All the lobster has been taken advantage of and the price increases.	Good commercializatio n of lobster because separation of divers and deep-sea fishing was allowed. All the lobster has been taken advantage of and the price increases. USD 1.30/lb of albacore.	Good commercializatio n of lobster because separation of divers and deep-sea fishing was allowed. All the lobster has been taken advantage of and the price increases. The agreed price of USD4 per cucumber was not met because intermediaries put cucumber classification and lowered the price. USD 1.30 lb of albacore.	USD 1.30/lb albacore	USD 1.30/lb albacore

Topics	2009	2010	2011	2012	2013	2014	2015	2016	2017
Quality of life	There's no good hospital with good specialists. There's no drinking water. There should be good education (general comments, not by year). Good quality of life	Good quality of life	Good quality of life	Good quality of life	Good quality of life	Reduced the quality of life and now we subsist on animal shortages due to climate change.	Reduced the quality of life and now we subsist on animal shortages due to climate change. The quality of life can be increased with the alternative of deep-sea fishing.	Reduced the quality of life and now we subsist on animal shortages due to climate change.	Reduced the quality of life and now we subsist on animal shortages due to climate change.

Isabela

Topics	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Weather	Study of oceanic tie. Thermocline / water visibility. Normal" winter - rain - no torrential drizzle. Cistern to capture mist - sweet - salty. Cold. Use of motor 75HP - 20 pax (750 fiber)	It's not as cold as it used to be. Rains sometimes yes sometimes no. The climate is temperate. There are different types of waves: curly, capillary, etc. You could work two hours without a shirt. He was tanned, but not burned. You could work barefoot.		Hotter waters. Sheltered	Boats split in the wind between August and November.	Stronger, bigger waves. We must be totally covered by the strong sun. You can't work barefoot anymore.	He's coming back from FAD because he couldn't. He took a chance because he had to fish for economic necessities.	There was no summer (no waves), it was calm all year round. No heat, no wind. It started to look like more sea lions, Loberia moved to the landing site.	A little more wind. Weevils surf in waves (indicator) There were no penguins.	Food shortages, Port didn't leave. Many sea lions and sharks (predators).

Topics	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Fishing	Excellent fishing, but I didn't have anyone to sell to, about 7 miles. Albacore, wahoo, gold and weevil had good size.	Cucumber fishing Everybody wanted to be a fisherman. The PARMA license was obtained in the hope that the children would have the option of fishing.	Cucumber fishing Everybody wanted to be a fisherman. The PARMA license was obtained in the hope that the children would have the option of fishing.	Cucumber fishing Everybody wanted to be a fisherman. The PARMA license was obtained in the hope that the children would have the option of fishing. It incorporates experiential fishing as a double activity. It is considered to compete with fishermen who are exclusively engaged in fishing.	Cucumber fishing Everybody wanted to be a fisherman. The PARMA license was obtained in the hope that the children would have the option of fishing.	Pretty much everything stays the same.	Season there was no fish. Santa Cruz had to be sent to see him.	There was no fish. Fished 2553 lb albacore in one night Sword, wahoo.	There was no fish. There was no wahoo.	There was no fish for 2 months. There's no fish. You have to send fish to Santa Cruz twice a week.

Topics	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Commercialization	We had problems because there were no merchants. There were hoarders who monopolized trade.						Cucumber, (golden accompanying, no fish, need ice flakes, must be...(illegible)		There was no wahoo	The marketing monopoly is removed. The fisherman invested in marketing as well. It was a little better the price too. In 2019 USD10/lb.

Topics	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Quality of life	It was better: there was money to eat, for the children and the wife. However, there is a desire to change activity. Fish and shellfish were available for family consumption. Same traditional food. There was no access to health services and it goes on. Poor water quality. Mishandling of garbage. They charge a fine. 12 tons - $1400 junk. Continuous scrap recycling is a problem. First necessity products arrive, but to take out product... (illegible)			Sewer doesn't work.	A 40% tax is established to bring boats.		Desalinizer is installed, but does not supply. They do not connect it for the use of the whole village so there is no drinking water. Water must be sold by tanks.	Survival for a fisherman. Food is more expensive. Non-renewable energy projects don't work. The use of fossil fuel continues.	Life and work habits change: more night work is done to avoid the sun	Coffee jar $11.50. Those who have the experiential fishing patent do not just snorkel and not fish. Under current conditions, fishing cannot continue unless there is an alliance with tourism.

Annex 2-V.- Frequency of response and arguments to the question How prepared is the Galapagos Artisanal Fisheries Sector for Climate Change?

Scale	It's not ready	It's not ready	It's moderately ready.	It's ready
Frequency (number of fishers)	**8**	**4**	**0**	**2**
Arguments	• We are not ready because many fishers do not know the dangers of this phenomenon. • It's not ready for global warming and water. It affects fishing. • The fishing sector is not ready, but the fisherman has always been an empirical scientist and will discover in time the mechanism to overcome it. • It's not ready. There is no fishing because of the warming of the water. • He's not ready, but whether or not he has to continue working. • It is not ready because there are no alternatives or options for a solution. • He's not ready, but he reacts to the moment to face the situation. • Not prepared to counter climate change	• It's not ready, but the same sense of survival and common sense makes it evolve and adapt to change. Long live evolution! • He's not ready because the changes are so drastic. • He's not ready. • It appears temporarily. I'm not ready	•	• Yes, as a sector we are ready to work, although we are very concerned. • He's ready to withstand inclement weather, but not to face it.

Annex 2-VI: Frequency of responses and justifications to the question How concerned are you about climate impacts?

The following table shows the answers in categories 1 to 10, with 1 being very little concerned and 10 being very concerned

Scale	1	2	3	4	5	6	7	8	9	10
Frequency (number of fisher-men who voted)	**1**	**0**	**1**	**1**	**2**	**0**	**0**	**0**	**0**	**10**
Justifications	• I'm not worried because we'll automati cally get over it.		• Because no, I don't know if global warming will be only for this year or will continue for the rest of the years.	• Only at the time of the event	• I'll take • ..					• I'm very worried. • Very concerned about future generations. If the temperature goes up 2 degrees, what happens? • I'm concerned about climate change and nature. • I'm 100% concerned about global warming. It affects my economy and therefore the good life of my family. • I'm worried about climate change. • I'm worried because it affects future generations. • Because we depend directly on climatic conditions to work at sea. • I'm worried because it affects future generations. • Yes, very worried because I am and I feel Galapagos. • I'm very concerned about fishing and my family's livelihood. • Because there's no limit to the greed of many human beings! At last we're the ones who destroy the world. I'm chholo and don't pity me!

Annex 2-VII Key Actors and Actions to Support the Galapagos Fishing Sector in Confronting Climate Change

Key player	What should you do to support the Fishing Sector?
Ecuadorian State	• Policies in benefit of the Fishing Sector. • Provide information on climate change. • Carry out awareness campaigns on Climate Change. • Providing greater and new alternatives for the Fishing Sector • Have more openness with the Fishing Sector • To support the fishing sector's own initiatives.
DPNG	• Regulations and Zoning. • Limit the presence of large tourist boats. • Establish regulations against the entry of foreign fishing vessels. • Establish regulations for the tourism sector. • Open new fishing sites. • Allow adequate fishing seasons. • Training on other fisheries. • Consensus with the fishing sector: regulation and zoning • Modified oceanic tie would help recover bottom zone
CDF	• Work together with the Fishing Sector. • Report on your research projects. • Strengthen the relationship with the Fishing Sector through training and information delivery. • Establish a mutual commitment. • To provide information on the threats, problems, challenges and opportunities of Climate Change. • Support with propaganda, marketing about the effects of climate change and its dangers. • Produce a catalogue with fisheries information; an information bulletin could also be produced. • To provide knowledge on species of interest both commercial and endangered.
CGREG	• Support fishing cooperatives with infrastructure • Training of cooperatives in fishing technologies. • Establish regulations against the entry of foreign fishing vessels. • Establish regulations for the tourism sector.
INOCATE	• Provide more and better weather information.

Key player	What should you do to support the Fishing Sector?
Ministry of Production, Foreign Trade, Investment and Fisheries	• Facilitate and give viability to qualify cooperatives to commercialize fishing abroad. • Provide information on Galapagos fishery resources. • Change LOREG
National Institute of Fisheries	• It must have a presence in Galapagos. • You must conduct research in Galapagos. • To provide financing to the Fishing Sector.
GADs	• They must set up a fishing technical office.
Ministry of the Environment of Ecuador	• Provide financing to the Fishing Sector
Ministry of Tourism of Ecuador	• Provide financing to the Fishing Sector
Ministry of Production	• To support the Galapagos Fishing Sector in the commercialization of its products.
Private company, the Expedition for example	• Marketing of fishery products

5. CASE STUDY 3: SOUTH AFRICA

5.1 Document preparation

This section presents more detailed results of the workshops that took place in South African. This research answered the question: how does the knowledge of fishers determine strategies and mechanisms for adaptation to climate change? To answer those questions, a workshop was held in Cape Town, South Africa, in October 2019.

During the workshop, it was possible to learn about the effects of climate change on the line fishery in South Africa: how prepared the fishing sector is and are the needed actors and actions in the face climate change ready to face climate change in South Africa? Finally, some newly suggested actions to face climate change with emphasis on the sustainability of seafood products and food sovereignty were determined. A significant number of perceptions and knowledge of fishers on climate change were identified. This research is an exercise showing how perceptions and knowledge can be integrated into climate change adaptation mechanisms in the fishing sector.

This report corresponds to the results of the global project "Fish Forward 2 - It's getting hot down here - Warming Oceans and Effective Adaptation in a Changing Climate" in South Africa. Fish Forward 2 (FF2) is an international inter-institutional research initiative funded by WWF-Germany and implemented by Agrocampus Ouest (France) and the University of British Columbia (Canada) in collaboration with the National Fisheries Institute (INP) and the Charles Darwin Foundation (CDF).

FF2 aims to conduct workshops in different parts of the world (Latin America, Africa and Asia) to explore and understand the knowledge of artisanal fishers on their mechanisms of adaptation to climate change. In the case of Africa, South Africa was chosen to hold one workshop in Cape Town. In collaboration with Agrocampus Ouest, WWF South Africa led the organization of the workshop.

This project intends to know the ways of knowledge of the fishers in South Africa and has answered the following questions: 1) What is climate change and climate variability and what are the consequences for fishers? 2) What are the impacts on small-scale fisheries? and, 3) What adaptation strategies can be effectively implemented in fishing communities to address climate change? To answer these questions, one workshop was held with stakeholders from the line fishery sector in Cape Town (see Methods section).

The results of this research are a contribution in order to generate climate change adaptation measures, as well as fisheries measures management considering the knowledge, needs and perceptions of artisanal fishers in South Africa. In addition, it has the purpose to bringing a bridge between fishers' local ecological knowledge and scientific knowledge as a driver for biodiversity conservation.

5.2 Workshop structure

To carry out this research in South Africa, a workshop was held in Cape Town and attended by 4 fishers from the line fishery sector, 5 scientists, 1 person from the government (DAFF). The workshop, held on October 3rd and 4th, 2019, and called "Towards adaptation to climate change in the South African line fishery" identified knowledge, experiences and perceptions on the social, economic and environmental impacts of climate change on fisheries, from resource extraction to commercialization, as well as adaptation tools (Annex 1: list of participants).

This workshop was held in Kalk Bay, Cape Town, and brought together four artisanal fishers from the region to share their knowledge concerning the impacts of climate change on their fisheries. The number of fishers attending the workshop was low due to weather conditions that were very favourable to go fishing. Other stakeholders and partners, including facilitator as well as scientists and government, WWF Germany and Agrocampus Ouest (France) were also attending the workshop. The workshop was facilitated by Lynne Shannon. The facilitator and technicians facilitated the dialogue and provided relevant information to enrich the discussion between fishers and other participants.

5.3 Results: Workshop outcomes

5.3.1 What were the changes in the last decade in the South African line fishery?

The stakeholders identified changes in the last ten years in several aspects: climate, fishing and its marketing.

Climate changes refer to changes in sea temperatures, changes in ocean conditions (water visibility, wave levels and types) and atmospheric conditions (winds). The existence of more or less preys: there is not enough food for the fish (no more sardine).

Fishers highlighted the effects on fishing and marketing. These refer to changes in marine catches/landings (higher and lower according to species, *e.g.* a decrease in snoek availability and catch, increase in hottentot catch), level of fishing intensity/fishing effort, levels of fishing resource, volumes of fish, seasonality (*"And now we're actually starting, say from march, yes end of March, we start in Port Nolloth. We normally waited for that fish to come down but we can't do that anymore. Because our season, it ends now in June. Normally we catch snoek until end of July/August. Now we stop in June. So we can't wait. We must go one month earlier, two months earlier to catch the fish before it comes down. It's far up there.").*

5.3.2 How prepared is the South African line fishery sector for climate change?

Do you think the artisanal fishing sector is ready to adapt to climate change?

Half of the stakeholders (50%) expressed that they are not ready to adapt to climate change, mainly because too few fishers have been informed regarding the subject and its consequences. This is mainly because there is a knowledge gap between fishers, managers and scientists, and because of the low adaptive capacity of the fishery itself. Also evoked was that there are many others stressors the linefishers have to cope with/react to/adapt to. Consequently, climate change is not acknowledged in decision-making.

13% of the stakeholders said the fishery is ready to adapt but give no justification.

Finally, 38% of the stakeholders said the fishery is moderately prepared. They mentioned that it concerns a multi-species fishing sector, having already some infrastructures in place to allow for adaptation, for instance, in targeting new fish species. However, if fish would move too far out of their current range, the current boat sizes would not satisfy further fishing. Plus, the cost of travelling would outweigh the revenue fishers make from selling the catch. Others regret the fact that too few linefishers are even aware what global warming is all about.

How concerned do you feel about climate change?

All the stakeholders mentioned that they were **very concerned** about climate change. They justified this high level of concern mostly regarding their livelihood. They mentioned that fishers would not be able to make a living solely out of (line) fishing. They were also worried about the decrease in fish abundance and changes in the species' distribution, further offshore, implying changes in the fishing practices.

5.3.3 Proposals of actions addressing climate change in the South African line fishery

The table bellow synthesizes the different suggested adaptation measures identified during the workshop (the most highlighted measures are marked in red):

Objectives	Examples of adaptive measures (and main goals)	How to implement
Adapt fisheries practices/fishing activity		
At sea	Target species that are more available and resilient to climate change	• **Anticipation appears complicated** due to **uncertainty** around the effects of climate change, but chub mackerel could be valued • Possible only if the species are not too far from the coast (it would then be too costly)
	Move fishing effort further offshore (according to the decrease in abundance observed inshore)	• This would imply a (limited) increase in boat size (in order to improve on-board safety) • Adapt skippers license
On land	Increase product beneficiation to reduce the need to catch more (and avoid overfishing)	• Improve quality and thus price by introducing ice on boats • **Add value to species that are more available and resilient to climate change**, by encouraging fish processing, especially for species that are more available and resilient to climate change (e.g. chub mackerel) • **Regulate supply and demand** to get higher prices. Switch from effort to catch limit (potentially a **'per day' catch limit**)
	Diversify activities (in order to face a likely decrease in catch and fishing revenues)	• **Diversify into <u>related</u> activities** rather than use a middle man – processing, packing etc. (decrease dependence to downstream sectors)

Adapt fisheries management

Efficient management	Enforce effective monitoring, control and surveillance (A TOP PRIORITY before any changes can be made in the SA linefisherie).	• Reinforce the control agency and tools dedicated to the surveillance from harbour to inspectors to reporting • Enhance inspector expertise on sustainable fishing and efficiency surveillance • Inform and educate fishers regarding the importance of compliance to the regulation
	Introduce TACs in order to improve efficiency and effectiveness of a sustainable stock management	• **Set TAC limits for entire fishery** rather than on the basis of fishing method. E.g. Global Snoek TAC for all sectors, demersal trawl & hake longline, line fishery, midwater trawl, and pole and line fishery.
	Integrate permit allocation and management	• **Avoid overlap and** in some cases **duplication of permits** between small scale, interim relief and commercial line fishers. • **Eliminate 'paper quotas'** and focus on genuine fishers (a significant number of permit holders do not use their permit). Too many fishers have quota but no boats etc.
	Implement seasonal closures in order to improve stocks status and thus resilience	• **Study species specific biological factors** where appropriate. E.g where a species has a very specific breeding season and/or area
	Improve MPAs	• Provide resilient areas for fish • Switch from no take to controlled zones for fishing
Adaptive management	Change from effort limit to catch limits in order to adjust exploitation rates to changing (and unstable) catch potentials	• **Regulate supply and demand** to get higher prices. Switch from effort to catch limit (potentially a **'per day' catch limit**)
	Broaden target resource base (introduce a basket of species instead of limiting it to linefish)	• Allow harvesting of species compatible with fishing vessel, equipment and seasons such as redbait, white mussel, alikreukel, etc.
	Take into account all the effect of climate change in the scientific advice	• Develop stock assessment method taking into account adapted to climate change • Consider uncertainty ling to climate variability in scientific advices
	Define management measures needed to reach targets of sustainable management on a yearly basis involving all stakeholders (cf. participative management)	
	Inform and educate fishers	• **Share scientific information appropriately with all stakeholders** Enhance stakeholder engagement on the ground with active fishers
Participative / collaborative management	Change the fisheries governance structures	• **Set up or develop more participative structures,** such as management committees organized at the fishery and regional levels, and involving all stakeholders • **Have all the stakeholders involved** in the thresholds to aim at, and the values
	Inform all stakeholders on scientific knowledge and results	• **Package and communicate useful and relevant information** appropriately for the various stakeholders (scientists, fishers, buyers, consumers). Video seen as a good tool

		for feedback. • Involve all stakeholders in the research that is being done, notably with government setting up training and resources for fishers to engage
	Involve fishers in MPA's governance	• **Co-create knowledge** streams, flowing together to shape policy
	Reinforce stock assessments and the scientific advices system	• Analyse the completeness of the current system in charge to provide diagnoses and scientific advices for management (Main stocks should be regularly assessed, as well as depleted or threatened stocks) • **Avoid duplication of work** by scientists, working in isolation
Science-based management	Develop ecosystem approach to fisheries management (EAFM)	• Make a structural and institutional shift within Department of Agriculture, Forestry and Fisheries to truly embrace an ecosystem based approach • **Use fleet-based management as an operational tool to move towards EAFM** (assessing all ecosystem impacts but also socio-economic performances per fleet segment) • **Bring in the social component** so that the system is balanced
	Develop research on fisheries adaptation to climate change	• **Make quasi-realistic scenario planning** - integrating various factors and information from all stakeholders to develop a range of potential scenarios • **Accept the need for sometimes difficult trade-offs** when incorporating social and behaviour aspects into natural sciences. Potential for conflict can be high, thus this approach is often viewed as taboo. • Strengthen functional relationship between the resource and the management plan in ecosystems approach • Include indigenous knowledge
	Change the targets of fishery management to a more precautionary approach	• **Address the weakness of the precautionary approach in the demersal sector**, especially when it comes to bycatch (due to the current, highly depleted nature of the line fishery, the approach is already very precautionary)
Precautionary management	Increase minimum landing size limits or mesh size in order to reduce the fishing impact on fish stocks	• **Ask scientists** to systematically provide an assessment regarding the impact of selectivity on fish stock abundance and landings • **Educate fishers** on the potential benefits of large mesh sizes or large minimum landing size, on the medium term • **Initiate concertation between stakeholders** in order to set up an optimal fish stock management (of fishing pressure and selectivity)
	Level the playing field for linefishers	• **Increase the boat size limit to 15 meters:** • to allow fishers to go further out to sea for longer periods and target the fish where they are. • to make things safer for the more extreme weather which is predicted as a result of

		climate change • **Develop mechanisms to reduce bycatch of key linefish** species by demersal trawlers. • **Make monitoring, control and surveillance effective**, including harbour management (It is currently almost completely dysfunctional).
Social management	Favor small scale fisheries using differential access rights by fishery	• **Give more rights** to small scale fishers (possibly based on the fleet-based approach including the assessment of ecological and socio-ecological performances per fleet segment) • **Communicate to consumers on the origins of food and encourage the labelling of small scale local fisheries**

5.4 Discussion

The discussion section includes two parts: a) the conjectural factors, b) how to adapt to climate change. The conjectural factors refer to themes that do not directly refer to climate change, although there can be existing interactions. These conjectural factors must be considered for the viability of climate change adaptation projects.

The second part includes all factors impacted by climate change that have been identified by scientists or by the artisanal fishers themselves.

Conjectural and external factors

Adaptation strategies to climate change in artisanal fisheries generally mention factors linked to impacts and adaptation mechanisms directly related to the sector. However, it is important to consider that there are other conjectural factors (important or urgent) in the daily life of the fishers (both fishermen and fisherwomen), which are considered as external factors. They influence the final results of the research and are important issues to resolve or ask questions before formulating adaptation strategies.

Within the topics discussed with fishers, factors mentioned repeatedly throughout the workshops were identified. These factors, known as conjectural factors, are those external factors which, although not directly affected by climate change, affect fisheries and are within the imagination of fishers.

Types of fisheries

Interactions with the industrial sector, consisting mostly of trawlers targeting hake species (*Merluccius merluccius* and *Merluccius capensis*) are pointed. Snoek, the main species of the line fishery, is considered as a bycatch of the industrial sector.

Product quality, diversification and value-adding

As evoked with the stakeholders during the workshop, there is a need to change the way they market their products. This involves, first, to be able to maintain a good quality of fish until it is

sold. A proposal was made to have ice on boats and ice at landing sites. This was already launched locally, and should be expanded.

"The problem with the ice is that it's being implemented in a few places, but not across. Many boats cannot land in some places because there is no ice. But to me it seems like it's not very difficult to implement. You need to have some land-based facilities. So you can pick up your ice in this place before you go at sea. You see results immediately. You get more money and price is not expensive. So that's an obvious easy thing to do."

However, this was qualified by the fact that landing sites are very numerous and might be brought to switch from one area to another with the changes in fish distribution. Therefore, scenarios should be explored to be able to predict areas of interest in the future.

In many cases, it will no longer be profitable just to sell fresh fish. The value of the catch can be increased by cost-effectively developing new value-added products which satisfy consumer demand for quality, variety and sustainability. In the latter regard, eco-labeling and certification may become more important, even in small-scale fisheries.

Augustyn *et al.* (2017) explain the change in distribution of subtropical line fish species to take advantage of increasing temperatures further south allow opportunities to replace existing species with others, and these could potentially be faster growing species and therefore be more productive. Better protecting small boat harbours and developing additional harbours will provide more protection at landing facilities and to boats. This is in line with South Africa's Small Scale Fisheries Policy (2012) which aims to develop small-scale fisheries infrastructure and establish cooperatives and processing facilities to increase the value of landings through further development of products. Maintaining viable quotas will play an important role in ensuring that rightholders are not impoverished, leading to illegal fishing and overfishing.

Non-take zones

Non-take zones within MPAs are seen as unjustified and fishers are asking for more involvement in the definition of MPAs. Fishers regret they were not asked what the important areas for them are before closing them.

Fishing alternatives

Alternatives to fishing not only include other socio-economic activities, but also fishing of other species. This fishing diversification might reduce the pressure on the traditional species targeted by the line fishery. Some species, such as chub mackerel, were mentioned as an alternative by the stakeholders. Chub mackerel is already caught by fishers but not sold, as it has a low value. Here again, improving the quality of sold fish (i.e. freshness through the availability of ice on boats) appears to be the first step.

"We don't get money for it. Because it's badly conserved. But if we could put some ice on it immediately, we would get money for it."

The importance of the knowledge of fishermen and fisherwomen

The fishers' local knowledge is an input for sustainability in fisheries management. Several studies demonstrate the importance of considering the local knowledge of fishers, including, the so-called "ecological and technological knowledge" (Grant & Berkes 2007); the "fishers ecological

knowledge FEK (Johannes et al. 2000) or/and the local ecological knowledge-LEK (Silvano & Valbo-Jørgensen, 2008).

LEK, for example, is considered to have potential to improve fisheries management, provide new information about the ecology, behaviour and abundance patterns of fish or aquatic animals, reproduction, migration, and ecological relationship between fish and predators (Silvano & Valbo-Jørgensen 2008; Bender et al. 2014). Others, such as Figus (2018) demonstrate the use of local knowledge of fishers in the management of commercial fisheries and Wong (2016) the use of LEK on IUCN endangered species identification.

Through the analysis of climate change impacts on the line fishery in South Africa, several of these were identified below:

CLIMATIC CONDITIONS
Increase in **temperature**
Ocean currents (exaggerated **high tides**)
Strength of **winds** increased
ECOLOGY AND BIOLOGY OF MARINE RESOURCES
Decrease in fish **abundance**
Change in the **distribution** of fish
Changes in species assemblages and trophic relationships
Change in seasonality/species life cycle
FISHING PRACTICES
Increase in fishing **pressure on the resource** (possible overexploitation)
Increase in **distance to the shore** for fishing
Reduced fishing yields
Reduced **areas** to fish
Reduced number of suitable fishing days

For example, the FAO (2018) incorporates the local knowledge of fishers for planning management and decision-making advice into the portfolio of climate change adaptation tools.

Implications for food security and sovereignty

The resilience of a socio-ecological system depends on the current state of its local populations since its range of adaptation will be greater (FAO 2018). Reducing poverty and providing a population with basic living conditions are a guarantee for better adaptation. As evidenced by the results, South African line fishers are aware of climate change and its importance in affecting their resources. However, there is still much to be done to warrant and ensure better living conditions (i.e. health, education, sanitary conditions, and basic services) that will in turn increase their level of resilience.

Other strategies included by fishers to ensure the sustainability of seafood products and food sovereignty are as follows: specific resource management measures, legislation and regulations, access to information, fishing equipment/gear and technologies, participation in decision-making, measures to ensure sustainable fishing and marketing support.

Management and risk reduction for resilience

Although the FAO (2018) mentions the reduction of risks and disasters for resilience within climate change adaptation strategies, this topic was scarcely addressed by the fishers in the workshops. Only the need to know more about natural disasters and possible impacts was identified in the first place; and, reforestation or rehabilitation of marine and terrestrial ecosystems was proposed as an adaptation mechanism.

5.5 Scope and Limitations

- It is necessary to consider that the number of fishers participating (4) in the workshops was very low, due to good weather conditions leading fishers to go out at sea.
- There was a high involvement of local scientists.
- Due to the low number of fishers, the covered area was limited, and there could be differences in results between the different regions.
- The following variables were not considered as a factor that affects the knowledge / perception level about climate change among this research:
- Age (of fisherman)
- Differences between active, retired and boat owners.
- These and other factors should be considered in the following researches.
- Currently there are ontological, epistemological and applicability challenges for linking local knowledge and scientific knowledge (Raymond et al. 2010). It is suggested to deepen this type of research and the diversification of qualitative methodologies that guarantee and allow significant contributions to the integration of local knowledge with other types of knowledge.

5.6 Conclusions

Complementary workshops should be organized to share with the fishers the findings and to validate them. These socialization workshops should also be participatory, to receive feedback and record new information.

Acknowledgements

The authors would like to thank the fishers who participated and contributed with their knowledge to this workshop. Special thanks to Monica Stassen (WWF SA) who did a lot in the workshop organization, as well as the members of WWF South Africa who gave their voluntary collaboration during the workshop on October 3rd-4th, 2019. Thanks to Lynne Shannon for facilitating the workshop, and to Philipp Kanstinger (WWF Germany) to have participated to the workshop.

5.7 References of Chapter 5

Augustyn, J., Cockcroft, A., Kerwath, S., Lamberth, S., Githaiga-Mwicigi, J., Pitcher, G., Auerswald, L. 2017. *South Africa. Climate Change Impacts on Fisheries and Aquaculture, 479–522*. doi:10.1002/9781119154051.ch15

Bender, M.G., Machado, G.R., Silva PJdA, Floeter, S.R., Monteiro-Netto, C., Luiz, O.J. et al. 2014. Local ecological knowledge and scientific data reveal overexploitation by multigear artisanal fisheries in the Southwestern Atlantic. PLoS ONE 9(10): e110332.

FAO, 2018. Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge, adaptation and mitigation options. In: Barange, M., Bahri, T., Beveridge, M.C.M., Cochrane, K.L., Funge-Smith, S. & Poulain, F. (eds). FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp.

Figus, E.C. 2018. Using local knowledge to inform commercial fisheries science and management in Poland and Alaska. Thesis, University of Alaska Fairbanks. (Available at: https://scholarworks.alaska.edu)

Grant, S. & Berkes, F. 2007. Fisher knowledge as expert system: a case from the longline fishery of Grenada, the Eastern Caribbean. Fisheries Research 84(2): 162-170.

Raymond, C. M., Fazey, I., Reed, M. S., Stringer, L. C., Robinson, G. M., & Evely, A. C. (2010). Integrating local and scientific knowledge for environmental management. *Journal of environmental management*, *91*(8), 1766-1777.

Silvano, R.A. & Valbo-Jørgensen, J. 2008. Beyond fishermen's tales: contributions of fishers' local ecological knowledge to fish ecology and fisheries management. Environment, Development and Sustainability 10(5): 657.

Wong, P. 2016. Traditional ecological knowledge and practice and Red List assessments: guidelines and considerations for integration. Working Paper 3: the social science for conservation fellowship programme, Working Paper Series. IUCN. Washington-USA.

5.8 Annexes of Chapter 5

Annex 3-I: Workshop agenda

"TOWARDS CLIMATE CHANGE ADAPTATION IN THE LINE FISHERY IN SOUTH AFRICA", A FISHFORWARD 2 PROJECT

Workshop held in Kalk Bay, Cape Town, South Africa, on the 2nd and 3rd of October, 2019.

Wednesday, 2nd of October 2019		
09:30	Arrival, workshop registration and tea	
10:00	Welcome and project context Round of participants	Monica Stassen (WWF SA)
10:30	Project introduction	Léa Monnier (Agrocampus Ouest, France)
10:50	Objectives, order of the day and general housekeeping	Lynne Shannon
11:00	Session 1: group work on changers observed by the stakeholders in the linefishery Deliverables: filled template per group, each group to agree on their top 3 changes and top 3 drivers of the observed changes	
12:30-	Lunch	
13:15	Session 2: group work to elicit fishers' knowledge of climate change (scientific stakeholders to observe) Deliverable: filled template per group	
14:15	Presentation on climate change	Didier Gascuel (Agrocampus Ouest, France)
15:00	Distribution of Fish Forward Climate Change, Oceans and Fisheries pamphlets Closure of day 1	WWF SA

Thursday, 3rd of October 2019		
09:30	Arrival, workshop registration and tea	
10:00	Climate Change and fisheries in South Africa	Carl van der Lingen (DAFF), Kelly Ortega-Cisneros (NMU), Léa Monnier (Agrocampus Ouest, France)
11:00	Session 3: group work on stakeholder concerns around climate change Deliverable: filled template per group	
12:00	Session 4.1: group work on tools for adaptation of the line fishery to climate change	
13:00	Lunch	
13:45	Session 4.2: onwards – group work Deliverable: filled table on adaptation measures per group, Top 3 adaptation measures to be proposed by each group	
14:45	Where to next?	
15:00	Workshop closure	

Annex 3-II: List of participants

Name	Designation/ Organization	Number of pax		Day 1	Day 2
		Male	Female		
FISHERS					
1. Eugene	Linefisher	1		Yes	Yes
2.	Linefisher	1		Yes	Yes
3.	Linefisher	1		No	Yes
4.	Linefisher	1		No	Yes
SCIENTISTS					
5. Kelly Ortega Cisneros	Rhodes University		1	No	Yes
6. Louise Gammage	UCT		1	No	Yes
7. Clara	UCT		1	Yes	Yes
8. Marieke	UCT		1		
9. Astrid Jarre	UCT		1	No	Yes
AUTHORITIES					
10. Carl van der Lingen	DAFF	1		No	Yes
ORGANIZERS/GUESTS					
11. Monica Betts	WWF South Africa		1	Yes	Yes
12. Craig Smith	WWF South Africa	1		Yes	Yes
13. Philipp Kanstinger	WWF Germany	1		Yes	Yes
14. Lynne Shannon	Amethyst Independent Facilitation		1	Yes	Yes
15. Didier Gascuel	Agrocampus Ouest	1		Yes	Yes
16. Léa Monnier	Agrocampus Ouest		1	Yes	Yes

Annex 3-III: Template for conducting the workshop

Group Exercise 1: Aim: obtain the changes they observe and see if they associate any of these changes with climate change

Group Number: _____ *Scribe*_____

1.1 History of the fisherman / scientists

1.1.1 What do the catch mainly? _____

1.1.2 Are the commercial or interim relief fishers? _____

1.2 What changes have the fishermen observed since the beginning of their career? How have they adapted to the changes?

Catch (species, size/ length of species, quality, prices, seasonality, price, costs?)
Changes:
Adaptations:
Environmental: (E.G. time at sea, fishing area, amount caught, weather, temperatures, clarity, wind)
Changes:
Adaptations:
What do you think are the main drivers for all the changes? Do you think its fishery related or external?

Rank your top 3 changes that you have seen and top 3 drivers.

Rank your top 3 changes that you are expecting in the future and top 3 drivers.

Group Exercise 2: Stakeholder knowledge of climate change

2.1: Ask group if the know what climate change is (note number of yes / no)?
2.2: If yes, what do they understand it to be (Note the various interpretations)?
2.3: What do the stakeholders know about risks linked to climate change? (separated groups)
What do you think will be the changes in the coming years due to climate change and what are the main risks for fish, fishers and marine ecosystems?
Do you think climate change could have impacts on seafood markets, prices? Or broader aspects of your life?
Have some of these impacts of climate change already occurred? If so, have you already changed something in your fishing activities in order to adapt?
Full group: In your opinion what are the main risks for fishers in the coming decades? Score the different risks, from the most important to the less important.

Group Exercise 3: Introducing climate change to stakeholders

3. 1: Presentation by climate change scientists

Intro – Didier Gascuel

Day 2 - Change in SA – Carl Van der Lingen

Work so far - Kelly Ortega / Lea Monnier

Note any questions from stakeholders

Exercise to determine how worried stakeholders are about CC and why? (same exercise as in Galapagos with argued vote on a scale from 1 to 10, every paper is then read out loud by the facilitator)

Group Exercise 4: Adaptations measures and how to implement them?

4.1 Are they aware of measures to address climate change? If so what are they? Has it worked? Show list of measures suggested by FAO ask if any of those measures have been used?
4.2. Who should be a part of the adaptation process?
4.3 What areas do fishers/ scientists think need to be focused on more?
4.4 Do you as government, scientists, fishers have any suggestions that could assist in adapting to climate change?
4.5 What needs to be done to maintain food security and long term sustainability of the seafood?
4.6. Do you think the fishery is ready to adapt for climate change?

What are your top 3 adaptation measures / suggestions for the fishery?

Annex 3-IV: Transcription of the workshop

Transcription - SESSION 1 – GROUP 1

WWF member: As a fisher, how would you respond if you want to prove your adaptation to climate change? Would you consier changing target species a good way to adapt to climate change? For example, if you were fishing snoek and snoek is no longer gonna be an option, and yellowtail for example is an option, doyou think that changing your species that you target is a good way to adapt?

Fisher: yes.

WWF member: and is it possible to adapt to change?

Fisher: Yellowtail is more seasonal also. (…) The snoek was here the all time before that it gives the rights to the trawlers to stop them. We are forced now to leave this and fish hottentot or go for the yellowtail.

WWF member: so you are already displying some adaptability in targeting different species, depending on the seasons, what's available... And how does that work out for you because if you had an option, what would you prefer to fish? If it was always available, what would you prefer to target?

Fisher: there is more value in yellowtail. But then it depends on the season.

Facilitator: I guess that is alsothe issue in terms of unpredictability in systems with climate change. As a linefisher, how do you adapt to unpredictability? Snoek is constant throughout the year, hottentot is constant throughout the year, but yellowtail is seasonal. And with change in water currents, temperatures, that could have other impacts which makes things difficult to predict when they will be around, and where they will be.

Fisher: Yes.

Scientist: I think what we have noticed in the southern cape as well was that it's not so much the actual driver of change that is problematic but the patterns that have changed. And also I think that also sees with the predictability of target species. All of a sudden you're catching kob from January to june. So the predictability makes it very difficult to make adaptation decisions. So the snoek you would expect the whole year but you don't catch snoek the whole year. I haven't had a snoek this whole year so I'm thinking about snoek all of a sudden! Personally as a fish consumer I can see the changes in what is available so imagine if you want to catch that.

Facilitator: So aren't that snoeks being available, I mean, in the linefishery. Typically the tradition is you would follow where the snoek is migrating. So if snoek is present at lambertsbaai, you'll take your boat to lambertsbaai. So if it pops up being in False bay, you come to fish in false bay. That sort of adaptability would help you being more resilient to the changes in those fish populations. You are already a fishery that moves as the fish migrates. So there is already some sort of resilience in the fishery, as long as the fish don't move too far, out of your core area.

Scientist: How far do you go?

Facilitator: That's quite a distance of movement, almost to the border of Namibia. So typically the linefishery does move like that, particularly for snoek and yellowtail. They follow those migrations. But if the fish moves outside of that area...

Scientist: Too expensive to travel at distance. The cost outweighs the amount that you are going to get from catching the fish.

Fisher: Yes.

Facilitator: And also, though moving you only guarantee that you will spend that amount of money.

Scientist: If you catch your fish, processed fish comes down and then all of a sudden you're being paid fewer

rands. So it's a fine balance.

Facilitator: There is some inherent resilience that the linefishery has built up in terms of targeting multiple species, particularly though the seasonality and so it should help them in terms of adaptability to climate change as long as the distribution shift is not too severe, too large, they could possibly cope with that. But that's just distribution. The issue of predictability is something additional.

Scientist: If you use to have fish in x, y, z places when the wind is like this and this is like this. And you get there and you spend money but they are not there, it's a huge loss that you can't avoid because you are not guaranteed of anything either.

Facilitator: So first point, there is some adaptability and that's because, you're talking about seasons and about targeting multi species already. So it's not like you're targeting one species and you have to shift to a new species. So the fishery has already learnt to adapt to seasonal shifts, to distribution shifts. It's just that with climate change that shouldn't be too severe otherwise it's going to cause problems and the predictability that is a big question mark.
So if the fisher indeed go further offshore, just in terms of regulation you'll need a boat that is safe. So typically, larger vessels, motor capacity, more safety and also stuff to be seen. So these are all additional requirements that is going to become important of you want to go fish further offshore. Also your skeppiers license would need to be upgraded to be able to fish further offshore. So all of those things would have implications. But an issue of a bigger vessel may be something that you need to access if the fish is moving further offshore. Would you agree to that?

Fisher: I agree to that, yes.

Scientist: The question whether it's viable in terms of adaptation is also can we move offshore? It could solve the problem of fishing effort but there are other structural problems of making the change: buying a bigger boat means having a lot of money to buy the bigger boat. So then in terms of adaptation, is it really a good option to suggest, because can we make it happen? Probably not as it means a lot of investment for someone somewhere.

Facilitator: so yes, all of that matters, in terms of investments, upgrading certificates for fishers, larger vessels... But also, once you go further offshore, you start to catch in other fishing areas which has to see with inherent conflicts between fishing sectors.

Scientist: you could be competing with trawlers then, when you go further out.

Facilitator: Probably not directly, but certainly it's a matter of space, to be fishing in the same. Trawlers coming through and you are a small...

Scientist (Kelly): If you want a bigger boat, can you apply for finance?
Scientist: Say you get everything in place to move further offshore, do a lot of problems that we have, issues with fishing pressure, as opposed to the climate at the moment, so is it really wise to increase fishing pressure offshore as well, don't we run the risk of running just the same. Aren't we maybe then delaying an inevitable decision for next couple years.

Facilitator: So that's almost as if we open the door to go fishing further offshore, you kid of adjust a buffer that you have.

Scientist: Yes, aren't we just putting later the problem? And when we get there we still haven't figured out how to deal with it?

Scientist (Kelly): For me, they don't have much bycatch, so they are fishing with sustainable methods. So you can kind of find a compromise between them.

Sc: But trawling is catching linefish as bycatch often. So the linefishery is really struggling in terms of catch.

Sc (Kelly): Then they have to think about the management together

Sc: That's a management discussion... (laughs)

Facilitator: So that is exactly the part of rational a part of it. Limit the fishers so that they cannot go too far and so the area is still considered more “pristine” for the stocks. So now if you get bigger this is basically opening the entire continental shelf to exploitation. I'll put a question mark so that it's not as straight as saying “invest in bigger vessels”.

Facilitator: So the next one is “reduce fishing impacts on the ecosystems”. So I think for the linefishery it has not a big impact on ecosystems as in other than the linefishery. It is a pretty clean fishery in many aspects. If you're targeting snoek, you're very much almost catching snoek, with yellowtail. The ecosystem impacts probably in terms of other fisheries than line fishery. For example, the trawl fishery is catching bycatch of a lot of linefish species, including snoek, carp, and it has to be mitigated or reduced. I think this is a big issue, a contentious issue for many years now. The trawlers reducing their impacts on the species. There are also the purse seiners having impacts on the play of a lot of … And looking at that interaction, to increase resilience for the linefishery.

Scientist: I have something to add to that, if you look at impacts further down the food chain, so like when I was doing my master on the movement of the west coast rock lobster southwards, one of the things that has been suggested is that the rock lobster could kind of establish themselves so well on the south coast where they've previously been quite rare. They've been there but they weren't there in abundance. It's that a lot of reef fish had been fished out of that ecosystem, which would normally feed on the rock lobster. Because they had no large predators, they were able to completely flourish. And because of that they then caused a regime shift in those ecosystems, completely changing the ecosystem. So it has an effect all the way down the food chain.

Facilitator: So yes, obviously the linefish species are part of the ecosystem.

Scientist: You need to look at ecosystems as a whole because for linefishery, other fisheries are almost having a bigger impact on the ecosystem than the linefishery for instance. I don't know how the linefishery reduces its impact.

Facilitator: For me it becomes more and more competitive, and MPAs are somethings that need to be fostered. So that you don't put more pressure on ecosystem, that climate change is already going to bring. So it's also a good opportunity to adapt to climate change.

Scientist: Yes I think they have seen that near MPAs you have a positive effect on the areas around the protected area, where people find more fish than they used to.

Facilitator: I think that would be more of a management response. Shall we go ot the next one “Increase product value”, so that's in the value chain. So for me I think that's kind of a key thing in terms of climate adaptation, increasing revenue. If you have a better income, you are more likely to adapt to climate change than if you don't have increased revenue. How do we increase value for linefish? Do you have some ideas?

Fisher: if we catch fish, there is a company that buys all the fish. So there will be more control in the price. Today they buy us 15Rands and tomorrow they buy us 30Rands.

Facilitator: Would it be some value in saying that instead of selling to a factory, because a factory is basically going to take your product and is going to pay you 15rand-30rand, has a pretty huge mark upon that product. And so the person who is making the money is not you, that's the factory. And the linefishery needs people closer to the market directly so that... You should be cutting the middlemen, but just so that you can actually realize more value for your product. So that you don't need to go for volume but you can actually fish for this, but for each fish you're catching because you got a direct channel in the market, you can get more for your product.

WWF member: They want to have, to decentralize the system. They want to have a hub also,
where there culd be all livelihoods, with job opportunities. Some people to clean, some people to process the fish... That is sort of a hub that would bring up the livelihood to develop, improve the economy.

Facilitator: That's an other good suggestion. One is to bring your closer to the market. And the other is to be part of the value chain, in processing. So instead of just selling your fish for example as a whole fish, you actually are cutting, you are filleting, you are potentially making smoked products or whatever... These are opportunities to actually get more value for all fishers. So I think being included in the value chain is a critical step.

Fisher: we should catch the fish and then sell it because now the middleman is getting more. And because we work so hard to get this fish. The middleman is gonna take it and sell it.

So... If you go to hub, then it makes more sense taking straight to the...
Scientist: It's almost like you must become the middleman because the middleman problem is a problem across all our food systems. If you know what a farmer gets for edible lettuce and what the buyer makes you pay... 99cts if we're lucky. So you must actually become the middleman to be able to slot into the way the economy works and that you derive the value from.

So it has a lot to do with communication and how you introduce an hike and gage and these tools now that have become available using technology, like ABALOBI. These tools that are now there that will help fishers to actually be able to engage.

That's a very important adaptation strategy, because as soon as you're making the money yourself, you're able then to diversify in related activities, which means that you can put plans in place. If fishing is bad, you can do x, y and z. So it builds capacity for other, not just in the fishery, but in other things. It is going to be really important in terms of climate change and adaptability.

Certainly, that issue touches to the other next one which is “diversify activities”. So I think that talks very strong to that basically. I think seeing the climate change impacts only on fishing for your income is probably not going to help you to survive. You need to broaden your activities. So some of those are basic examples. All of a sudden bring fish market in a community now starts to bring people and tourists A fish shop, you can sell recipes or whatever that you make with your fish products... But also in terms of arts and crafts with one of the shellfish, you can use a fish market idea, you can also diversify, because you already have a vessel, you already have a knowledge of the sea, link to ecotourism, take some people out for photography, whale watching, for recreational fishing. There are possibilities because you have the infrastructures. But how do you make them all work together?

Imagine you're at kalk bay harbor, and everything that was in kalk bay harbor was owned by the fishermen of kalk bay and all the activities on kalk bay harbor was for kalkies. And everything goes for... Imagine the money was going back to the fishermen of Kalk Bay. Fishermen of Kalk Bay would be in a very different position than they are now. So it now becomes a fantastic snowball effect of possibilities which is probably where you ideally would like to go. In my mind at least!

WWF member: I think we certainly agree that diversification and adding value to products are key things that actually can practically be done but how and who? because you probably can't take a fish and say “ok we do this”... Somebody needs upskills, somebody needs to train on, somebody needs to mentor and who is fulfilling that role? Is government doing that? Are NGOs doing that?

Scientist: Yes, I think it comes back to that management discussion that we have postponed. But yes that's where it becomes very tricky.

WWF member: So some great ideas. How do we get to real life examples? Because I think there are certainly options but you just need champions.

Scientist: It means a very concerted effort. I wrote a whole PhD (laughs).

WWF member: And it can vary from community to community.

Scientist: The context is important, you have to take it into account. It works for Kalk's bay, but not for Port Nolloth...

WWF member: How would you feel as a fisher if you were presented a different type of life, linked to the sea but you're no longer fishing? But you're making an income from, let's say for example, you train up as an ecorange or something that's able to take people out on the boat to show them false bay, the whales, penguins... Would that be something fishers have interest for in the community or they only want fishing?

Fisher: it would be nice to take them out and show them where you fish. Maybe put a line down.

WWF member: Ok, so you would say something like that can be considered. What do you think can be an obstacle for you, a barrier now? What is preventing you from doing that?

Fisher: Government should get other people to do that stuff. If we can do that then it would be an income for us
So you're interested in doing something like that but you need the necessary support to help you to access that opportunity. Like other people are doing currently.

Fisher: yes.

Scientist: Isn't that what small-scale fisheries policy is supposed to aiming to do?

WWF member: It's supposed to broaden at a more holistic idea of having a basket of species as opposed to single species, building resilience, getting competitive, to get supplementary livelihoods...So certainly it was heading in that direction and the government still continues to push in that direction.

Scientist: Yes that's the essence behind, so I guess we did the thinking of it and I guess comes that "how?" question again on how to implement.

Transcription SESSION 2 – GROUP 1

Scientist: I like the idea of having a responsive management. You kind of respond to what is happening. If management was easy, then we wouldn't have management discussion.

Facilitator (Craig): we heard that fish stocks are going to decrease by possibly up to 40% in the worst case, less in some places, but the message is that the biomass is going to decline and that's just in terms of nothing else changes (business as usual scenario). Reduce the number of people, of vessels, fishing seasons, boat size? How would you adapt?

Scientist: How do the people attached to that resource, what do they do? I've always thought it would be much easier if you can tell 'you cannot catch as much as you used to but to make up for that this is what we can do to help you make up for the money." for instance.

Facilitator: If you combine that comment with what we did in the previous session, if you look at the value chain. We need to reduce the effort, so instead of removing participants we are saying that actually you are catching less. And we help you to get more value for your products.

Scientist: If somebody would come and say "you're not allowed to catch as much, but that won't affect your money, because you're maybe getting more for the fish or you're given access to a shop to run, or..." would that be an acceptable choice? Would it be something that fishermen would be interested in? If they don't lose financially.

Fisher: It would be fine if we get good price for the fish.

Facilitator: So I think what we have to say for that point is we'll have to reduce the fishing effort but we must take into consideration the social impacts. And these social impacts need to be part of tradeoffs. Either value people in the value chain, or improve diversity of activities, get access to other species as well, as part of a basket.

Scientist: it links very strongly to the diversifying statement.

Facilitator: Favor seasonal closures is the next one. To me it is not automatic that because you have climate change you'll have to jump to seasonal closures. You need to have a biological reason for a seasonal closure, that's my perspective. Either that you've got the spawning behavior of a species is strange and you have to consider it or?

Scientist: Yes, it's always been for biological reasons.

Facilitator: lots of fishers are saying that Rock Lobster, especially in Northern Cape, that they've noticed the lobster gone to baby a lot earlier. So that doesn't mean we are sitting at one point in time, that it will stay the same. We need to reassess.

Lynne: So we need to review the seasonal closure in the light of phenology.

Scientist: But a species that doesn't require a seasonal closure now is not going to require one under climate change necessarily.

Facilitator: So then we have TAC.

Scientist: TAC or TAE?

Facilitator: Some species have bag limits. So do you want a total of catch. And who is verifying those quotas?

Scientist: We have already said the ecosystem impact of the linefishery is very low. The amount of fish you can really catch is limited.

Facilitator: I guess these are two systems playing. Do you go TAC or TAE?

Scientist: I don't think it's necessary in the linefishery to have TAC. Because they can't catch as much. They are not an industrial bunch of fishers.

Facilitator: You've already limited them in terms of vessel size, number of crew members, so it seems to become easy to manage in that sense. A TAC is very different and would require a lot more, not only enforcement, but also stock assessment. Stock assessment that says basically what is the outtake that you can have for each species, it's gonna be crazy. And what I like with the TAE for species that are depleted there's always there is always an option to climb down on bag limits, size limit, that you can implement with any TAE. But I think going to TAC for a multispecies fishery...

Scientist: It's a mess, yes. Like for the kob a few years ago, they increased the size of the kob that is allowed to be caught. There are species that are very endangered that are not allowed to be landed at all.

Facilitator: Except for recreational sector, but that's another story

Scientist: I feel like TAE is sufficient.

Facilitator: The issue of marine protected areas. If we have more vows I think we can provide more resilience to resources. You can reduce the other impacts of climate change. Fishing pressure, mining, degradation, pollution, take those pressures off so you create a safe refugee for life. So a network of MPAs would be something that, in my mind, would be an adaptive management strategy, as opposed to TAC approach, or seasonal closures.

Scientist: Yes, hat's a very strict type of management. There's a lot of new MPAs. There was this nice pristine spot and now that it's gonna be closed, it stays pristine. Which is good for the rest of the fishery in that area, I imagine.

Facilitator: Can we get from a fisher point of view, what is your opinion on marine protected areas? Because as much as we said, it's something that is very useful, a useful tool. But a lot of times, there is a lot of animosity between fishers and MPAs because everybody see their use but just not in my backyard.

Fisher: Areas where we dd fish, now they close them for us. Because the fish don't come to eat anywhere. Just come certain places. And then the government comes and they close. Then we must go far now, that is our problem.

Facilitator: So, I am fully aware of that, I am just thinking that what MPAs promulgation needs to be done in a way with close consultation with the fishing sector to see what sort of compromises can be found. For example, snoek is the main species you target. You class an area, but you may allow just that sector to fish snoek, because it's a migrating species.

Scientist: It goes to types of MPAs. In Brazil, I know it doesn't work as well at the moment, because that's more a government failure, but they have different zones, some are take zones for specific communities maybe, controlled zones... They have labels of zonation for protected areas and maybe this is something we can look at here.

Facilitator: For example, a trawl vessel would not be allowed in that area

Lynne: Because, maybe, it's destroying some of the habitat.

Scientist: Yes, but the linefishers can catch a couple of snoek, it's not gonna make... Especially a migratory species like snoek. It's not like a reef fish that lives on a spot, so it's gonna swim into the MPA and swim out again.

Fisher: The fish is moving and we are moving also.

Scientist: maybe we also need to reconsider how we do public participation and who we are speaking to in public participation. I don't where we are (scientists).

Facilitator: Can we talk about that when it's "include fishers in the MPA governance"?

Scientist: and fishermen being the primary resource users, have infinitely with them a lot of how to fish. So they would be the first to ask where to fish or not fish. It's a bit of a shortcut actually.

Facilitator: Public participation sounds an easy way. Until you actually get into it. How do you actually engage, where you engage, in terms of time... It's very complicated. How do you get the inputs and how do you get an agreement on them?

Scientist: That often takes a lot more energy and effort and time, than the consultants doing these consultations are willing to give.

Facilitator: So the government has to look at it, because if it's well done, then there are more chances that it will be implemented, and sustainably implemented.

Scientist: if fishermen say we have been with you closing this area but not this area. The fishermen will more likely stick to that agreement.

Fisher: Yes. For Eastern, if you close that area and then you say you can't go catch this but you can catch snoek...

Facilitator: So yes, you consider that you still have a livelihood, you still have a dependence to fish, but you're limited in terms of what species you can target. You can't go fish the reef fish, but you can go for yellowtail and snoek because that has no impact.

Scientist: Exactly. That goes back to management.

Facilitator: Yes, but that comes with good consultation. You are actually willing to listen to what fishers have got to say. And they become part of a joined solution to reach purposes.

Scientist: And it's also a failure to acknowledge, that the knowledge people hold as an expert in the system, like a fisherman is an expert in the system as well, as much as a scientist is an expert. And you need to find ways to synthesize everyone's knowledge, and take everyone's knowledge into account when looking for a solution. That's bottom up we are talking about. Instead of government is the knowledge.

Facilitator: Move to co-management would also be more participative. Share decision making. Then there is one question on fishers information and education. From the scientists or the managers to the communities, to fishers, it doesn't happen that well.

Scientist: Even between academics, scientists, and government, the communication is a big issue.

Facilitator: Yes, and I think it's a vital point. Internally, within a sector, but also between government and other departments and fishers themselves. Especially in the context of climate change. How to adapt has a lot to do with information sharing.

Scientist: you have to put systems and structures and methods in place to facilitate good flow of information between the national, the local, as well as up and down. And I on't think we've done that very well at all. That

doesn't work.

Facilitator: most of the population has an access to smartphone and the government has to use that technology. Even a simple thing like SMS is a way of communicating. Important information on your fisheries, important decisions, important things that you need to keep input on.

Scientist: There is also tools and techniques that if set up properly, one can use to bring different stakeholders closer together and dialogue, and when you have dialogue you facilitate the flow of information. But once again it's public participation and it takes long. I think what a very practical idea is in smaller scales, fisheries management has been nationally. If you can evolve in terms of responsibility, even give it to local government, you're bringing decision makers closer to users and other stakeholders because the gap needs to be reduced. And then you can have committees, you can have groups and then you start bringing things like technology.

Facilitator: There is a disconnection between scientists and fishers. I think a lot of that disconnect is coming from science. Scientists are looking at peer review, publications, to be recognized as a scientist, but what is a scientist doing to make his information a lot more accessible to the fishers? So what Carl is doing here, he's making that information. Management is supposed to connect indirectly but unfortunately managers are more working with working groups because that's the easiest thing, already structured, there are associations. But basically, you're working with the industry in that because they can afford to have structures. But smaller fisheries, community-based fisheries are not gonna have those structures. They can't afford to send someone from Port Nolloth or whatever to come to Cape Town for the working group.

Lynne: Just observing today, I would say that someone like Kelly, Carl, Emma... Do like a small short information session for the scientist to come to the fishers in a community on a bad fishing day. To say “This is what we are finding on our side”. Because then there would be that information.

Facilitator: I think this is a very good practical suggestion. Even before giving feedback, government could use information provided by fishers to make assessment. Collect data from the fishers, tell fishers what they are doing, how they plan to use it and provide the feedback, so they feel they are part of the process.

Scientist: Even how we do research. We have to gather with NGO so that we don't duplicate and waste resources, waste time. You are doing that, you are doing that. Working groups are a good start. And scientist have to be trained on how they communicate on their results.

Monica: Communication is the key. I see with the workshops I was doing with fishers... You have to make it relatable, so to translate it into a language that is understandable. Some misunderstandings are just because people don't explain things. Take time to communicate, not just give a flyer.

Facilitator: Should we talk about science-based management. And the ecosystem approach. So we've been focusing on single species, changing target, TAE, TAC, but what about ecosystem approach?

Scientist: We spoke about complexity of human systems and I guess it's the same when we talk about species management, about ecosystems. You can't take one thing and not think about something else. I'm a geographer so i'm specifically looking at human environmental interactions and if you say ecosystem to me, I include people. We have to be very careful about how we define the ecosystem.

Facilitator: We need to agree that when we are talking about ecosystems, we are talking about ecological, the socio-economic and governance.

Scientist: I remember a few years ago, there was this model and then there was this box on the side “social” and that's always in my mind when I think about the problem.

Facilitator: And I think I have to take it a little step further because even look at how fisheries are imagined in South Africa, it's very much ecological, and governments, and the middle one which is socio economics is almost not existent

Scientist: OR a very narrow definition of what is socio economics. Because DAFF does socio-economic assessments for fisheries, I got templates, I found it on the website. But it's a very narrow definition constitutes social and economic. But it's actually economic.

Facilitator: You just count the number of fishers. If you want an ecosystem approach, there should be an effort made to bring socio economics in management.

Scientist: We wouldn't be sitting talking about problems of our management if they had been taking fishers into account when making management decisions. This conversation is the result of a failure.

Facilitator: There is a question “Develop research on?”. What do you think of? Something not listed...

Scientist: I think we've got a lot of research, we are just not putting it together nicely. We have the puzzle pieces but now we have to think of how we put them together.

Facilitator: We keep talking about integrating indigenous knowledge but there is not a working model of how do we do that.

Scientist: How do we take LEK and integrate it into models? To improve decision making.

Facilitator: From a fisher perspective, how important is science to manage fisheries? Do you value science or do you think science is working against you?

Fisher: Before there was no rule, we did fish, and the scientist came in and bring the rules, stop us on doing this, stop us on from catching that,

Facilitator: So you look at scientists as only bringing new rules that limit you in terms of what you can do. So you don't have a high regard for scientists. This comes back to fishers and scientists need to be talking more.

Scientist: There has been very much a shift away from doing research like that. I mean, that's a very old way of doing research. all my research for example was based on that, talking with fishermen and asking them what do you think about this. And when you get insight on what people think, how they view it, you have a very different view on what you can do with it. Because it forms you as a person as well. But it's also the way we do participation, you know the scientist comes and “oh there's an MPA now and you didn't say whether there should be an MPA”. I don't blame fishers that they don't like scientist very much.

Facilitator: I think the issue is mainly communication, dialogue. Let's move to precautionary management. Typical fisheries are managed according to MSY. SO here is an example, to move from MSY to MEY which means that you are fishing so that you get the maximum value. That's one option. MSY is difficult to stick to. MSY is criticized.

Scientist: I don't know, does MSY speak to Ecosystem based management?

Facilitator: It goes back to single stocks.

Scientist: MEY, that sounds like a bad idea. Just sounds like, let's fish everything until there's nothing left.

Facilitator: I think, more importantly than MSY or MEY, it's more to have well established harvest control rules in place. Your stock needs a certain level, if it goes below it provokes a reaction. That a responsive management approach.
Ok, Social management: favor small scale fisheries in access rights. If you have for example two different fisheries having impacts on the same stock, so you've got trawl that's catching snoek and you got the linefish sector that's catching snoek. Social management says that we should actually maybe prioritize SSF and favor them so if the stock is in trouble, it's the trawler that has to reduce its impact, if we take social considerations.

Fisher: If there is fish there then we catch there but when the trawler comes then they trawl there also, take the food, trawl the snoek. Tomorrow we come then there is no more work for us.

Scientist: I guess the big companies are able to, because of the capital that they hold... Their workers are also often from small communities, so there is not no social impact for trawlers. So do we say then that big companies have the responsibility towards their workers?

Facilitator: I think you rise a valid point, that before you make that drastic decision, that needs to be underpinned by social, socio-economic data, so you understand what are the implications in big industries of having those

limitations, what are the impacts on the small-scale sector. You understand what are the impacts both sides and what trade off can be considered. So generally speaking we think that big industries have more diversification, they have more options available.
Ok, so let's take a round, now, what would be the top one adaptation?

Fisher: Stop the trawlers, so fish can get in and we can go work. For our fishery then we don't have to go far because the fish is coming along the coast.

Facilitator: so you would reduce the impact by other fisheries on your resource?

Fisher: Yes.

Facilitator: Is there any other that you think is important?

Fisher: I don't think there is others because if we get the snoek then we don't have to go for other species.

Scientist2: Definitely holistic management, ecosystem management. I think I'm also biased because that's my earlier studies. Ecosystem taking people into account, not just ecosystems.

Scientist: I would also say holistic management and I think the consideration of livelihood is very important, it must be considered very seriously. We're going to have to change, at some point, all of us, in the next time, we are going to be forced to change.

Transcription Session 2 – Group 2

DEFF: we already spoke a little bit about some management this morning. We discussed already the potential of changing from effort limit to catch limit. Problem is for example if you catch 300 snoeks because you can and it's 5 bucks each but with catch limitation you could catch fewer fish and get a better price for them. So that would answer « Fix fishing effort limits and favor introduction of a TAC » as in my opinion you were keen on that.

Fisher: Yes, definitely on the snoek yes. But on all other fish species as well. Kilo price should remain the same. Why would you spend all your expenses, all your effort, your people, your gear. Why would you work a day for 1000Rand if you can work half a day for 1500 Rands.

Didier:I think that's a very good point, but here the idea is a bit different. With climate change, we will observe huge variability from one year to the other. Some stocks are going to increase, and then decrease, and then you have to adapt the fishing regime each year according to abundance of fish stock and then the idea is that you are not only managing fisheries using limit on the number of boats because you cannot change the number of boat from a year to another, so how can you have more adaptive management in order to change the fishing pressure or the exploitation rate from one year to the other? And that's the idea, that maybe it's easier using TAC, I don't know, what do you think of that? Maybe changing the number of days fishing? How can you adapt from one year to the other?

WWF member: At the moment, you can fish every day? Ift the fish is there and the weather is ok?

Fisher: Yes, but other thing is what I said, we are line fishermen, and we only rely on linefish and that is where, to come back to small scale and interim relief when they want to work on a basket system, that is actually gonna work for all fishermen because now you don't have to just target on snoek, you can get white mussels that is something you can eat easily, it's not costing a lot of money, and you can sell it. I think they must actually give us more trap to make a living of, than just concentrating on the linefish, because global warming is probably going to have effect on, as we said, on linefish. Some of the fish as you said, if the water gets warmer... Say snoek it's going to get least, and silver fish, carpenter, it's also going to decrease, how do we know that? Maybe it's gonna be more fish, I don't know, like silverfish, is global warming gonna have the same effect on all species?

WWF member: no, exactly.

Fisher: So, if it's going to have an impact on snoek, maybe it's not going to have an impact on white mussel. Then we can make a living out of that.

Didier: But maybe we have to limit the catch of the snoek?

Fisher: yes, limit, but not leave the species.

DEFF: We don't have abundance timeseries for our linefish. The only insight we've got is CPUE data. We got stock assessment. So I'm completely with you in the fact that having a limited effort in linefishery doesn't actually take into account the dynamic of the resource. So that seems on the paper to be a good idea, because this is gonna track the resource dynamic better. But a lot of linefish are in a seriously depleted state already, so even the most optimistic scenarios would give low limits...

Astrid Jarre – *talking about interaction with large scale fishery, and how this should be regulated, but hardly audible*

Didier: Yes, a TAC would allow to share the catch between large and small scale, that's why it would be the perfect tool.

Fisher: I would say, they have a bycatch, and their bycatch is actually our fish that we are supposed to make a living of. There is a lot of money involved for that bycatch. What I say is that bycatch, yes, but he knows what he is catching. If I know my boat and I?, then I know what is under my boat, just according to echo sound. Trawler, according to the color, he knows what he is trawling snoek, so it's not a bycatch anymore, it's targeted. I have a guy, he's actually on my boat now, he worked for them and they trawled, and he said tome, when the net is coming up, they cut the net, and snoek is drifting behind their boat, for as far as you can see. They are not allowed to catch that abund, so they let it. Said "Why? Bring that fish and let it go to the line fishers. Yes, give them an amount for expenses for the trip, but bring them, don't waste it." And that's to come back to south African linefish association. That's for the line fishers, and divided between the line fishers. They don't trawl it for the bycatch, they trawl it because they make money out of it. For me, to go out for tuna, it costs me let's say 5000Rand fuel, I don't catch anything, I can't eat.

DEFF: we should have the data in he snoek catch in the demersal trawling sector. Sometimes they are quite big. What about seasonal closures?

Fisher: That's gonna be difficult, because we don't the normal seasons that we had. I don't think it's gonna work.

DEFF: What about closures during the short reproductive seasons?

Eugene: Yes, we could do that!

DEFF: But what do you think the linefishery would say? So, for example, let's imagine we close linefishery on carp from September to December because they then have their maximum reproductive time. Would it be something the linefishery would be frustrated of? Do you really think it's going to increase biomass?

Clearly coming out here, a key thing for fisheries management, is there has to be some enforcement.

Fisher: If you go to mussel bay, I've seen it because I often go to mussel bay. I can go to mussel bay and I can buy myself 50kilos of fish, and that's what they do. Then they take that and they buy this undersized fish that recreational fishermen and some commercial fishermen catch. They sell it, it's undersized but they got it. They changed the size. They made it smaller for them, only for them. If you catch geelbeck, a cape salmon here, then . So how are you going to regulate something if one rule applies for this area. They can catch undersized carp, they can catch undersized geelbeck, but I must respect the rules and I must catch bigger fish.

DEFF: I don't think that conception is that problematic, because if you've got a fish that has got different life stages distributed in various places, especially the small scale cannot go fish up here... The critical thing is to make sure that this type of fishing is sustainable. So from that perspective di don't see a problem having different regulations in different areas.

Fisher: Yes, but what's gonna stop me? What's gonna stop him to catch undersized fish in my area?

DEFF: yes, no, well again a lack of enforcement. The enforcement would stop him.

Fisher: Because somewhere East they catch undersized fish, and that fish is in the market. There is undersized fish that can be sold.

DEFF: But then it goes back to a point I just made, the primary thing about fisheries management is enforcement. I think that's the critical thing about the management.

Fisher: Sometimes we need to bring the logbook to get it signed, but there is nobody. They are having fish and chips...

DEFF: But at least they are eating the right kind of stuff!

AJ: 27' Over the whole western cape, their work has been made impossible by disturbances, by stuff that is coming from Pretoria, by working conditions... Not being at the top of the motivation... Again it's complexity, but the point is that enforcing is so not happening that it's really tripping out the sustainability of the fisheries.

DEFF: So the next point is about participative management. This can include

WWF member: And they were talking about exempting. Could you de-proclaim the MPAs? No no, that's a big mission, but could you make exemptions. Because there is for example a 16miles beach that is apparently completely irrelevant for some reason...

DEFF: So the new MPAs were selected based on, trying to protect habitats, species, and to also take into account where marine activities were. I don't know whether the old existing MPAs were fitted into that. The new ones are the offshore ones. What would the intention be or how would fishers get involved in MPAs governance?

WWF member: I think from what Eugene said yesterday, it's about getting input and information from them. They were talking about how certain fish species move through an MPA, so you're allowed to catch them here, but once they cross the line, you're not allowed to catch them, even though they are not the real reason the MPA was declared.

Fisher: Yes, we are only catching the snoek, we are not catching bottom fish. Maybe Hottentot. But I think there should be more input from the fishers. Or actually go to see how it's done. Because I don't think they know actually what fishing methods are used.

DEFF: so you are talking about more nuanced delimitations. But to me that's not governance. The final result is governance but what you're saying that it's these insights you've got that can be used to have better governance.

Fisher: Yes, but they said to us, they are THINKING about doing this, and then, later, listen, this has been done. Not a workshop in Kalk Bay, fishermen come here, other places, fishermen come here, what do you think?

DEFF: That was a limited process. I mean, there were lots of consultations, I don't know how many have been done. But again, because there is a lot of offshore, all the stakeholders were the offshore sector. But yes, I think what we want to say in this, is increase fishers conslultation, especially in making MPAs.

AJ: I would go a step further and say go away from the word consultation. Co-creation of knowledge would be better.

Didier: do you have councils managing the MPAs?

DEFF: supposedly, each MPA has management objectives and? But there is no plan, so it's not well done. But I think the process for the offshore ones was a lot better, there was an intention and there was a plan to make specific management objectives. Again, how well it can be done when we have no enforcement... Then we reach number 3, science-based management, first one is informed stakeholders on scientific knowledge and results. Kind of a corollary, when you ask for collaboration. But also inform about climate change impacts. We were talking about cocreation of knowledge, what do you fishers think about that? Would you be keen, do you think

there is value in that kind of engagement?

Fisher: Yes, definitely.

DEFF: I think one of the tricks would be in doing so, would be to formalize it to a certain degree. We have particular ways of doing things that we do. We do things always the same way and... So the first thing is what kind of knowledge do we get from fishers? Can we put it into functional categories and how do we incorporate it? It's a long road... To me there is great value, particularly in the short-term temporal approach, because we do things not so often. Some have one survey every three years. But you guys are on water much more regularly. This seems to me to be very complementary. But you cannot just take everybody's opinion, things have to be categorized.

AJ: … we could actually get this kind of dialogue going and see that it goes somewhere. But we can also now say things are changing, even if it's very subtill.

DEFF: The next point is "develop ecosystem approaches" and it concerns linefishery or other sectors that might impact linefishery. One of the key sectors having an impact on linefishery is small pelagic fishery. And at this date, we don't have any explicit linefish consideration in our ecosystem approach. The only thing we've got and it's a matter for broad debate is a relationship between penguins' survival on Robben island and sardine biomass western cape aghulas. When there are fewer sardines, I think below a threshold, then the penguin mortality increases. And pengouins are endangered. Recently I've been working with linefish and see if we can find a relationship between some small pelagics and linefish species. There is one that is scary for geelbeck. There apparently is one with geelbeck and sardine. It's better than experimental when you cross correlation mapping. It's too good to be true I think, but.. So we are trying to do that.
To a less or greater degree, some of the other sectors that impact the linefishery are supposes to be implementing EAF, but in reality, nothing happens, so... Again, it comes down to enforcement. It's on the paper, but no one is enforcing it.

AJ: Sorry Carl, we're not on the same page here. No doubt that enforcement has defaults. It's the big problem. But in the stock assessment groups, the scientific working groups, As soon as it's realistic, it's picked out. You've got some people looking at bycatch, but as soon as it lands in the scientific working groups, there is no talk about this approach.

DEFF: I disagree that there's no talk. On the small pelagics, you know that there has been talks. The key problem that we face when we want to implement that is to come up with a very strong and defensive functional relationship between the two things. Exploitation rate or whatever it is compared to whether or not it's exploited. That's where the critical point is. Penguins to start. How does the model work, what does it mean? And then what do we implement? Because the people say "hang on, so now we don't take enough fish because we want to keep the penguins alive?". Yes... But there is also a lot of money in penguins with tourism. So you have opposing camps. It's very difficult to bring an agreement. But I agree, we have done a bad job in implementing the EAF.

AJ: The constraint is on how DAFF operated. So there's modelling and that's work for a few years time but, even though it's difficult, there has to be people working on that.

DEFF: Yes, there were working groups. It didn't go anyway. Problem is because it wasn't an EAF management group, it just led nowhere.

AJ: That's what I say. So the mindset of the stock assessment people was not on EAF.

DEFF: Institutionally, we have failed to embrace it.

Didier: So it's not only a question of enforcement, it's a question of organization of the management because, we have the same in Europe, we have a lot of evidence regarding relationship between species and fisheries effects on ecosystems, but in fact the fisheries management is still based on single species. And the enforcement is another question.

DEFF: There needs to be heartfelt and meaningful incorporation of EAF.

AJ: That's a very good one.

DEFF: So now it comes to “develop research on?” I think one of the things we really like here is quasi realistic scenario planning. This is a page we have for many years. In kelly's presentation you've seen that SST increase, and it's bad news for everyone. We know that SST is gonna increase, and we also know that winds are going to increase, and probably productivity is going to increase on the west coast. So you have to make a model that has both an increase in SST, and increase in productivity. And that's a realistic scenario.

AJ: This is what they do in Emma's paper.

DEFF: we now have 2 scenarios: one where ocean gets warmer, and nothing else happens, which is very far from being realistic. And we have another scenario where water gets cooler which is also not realistic.

AJ: I really agree on scenario planning, but please could you add “with all stakeholders included”. People from the small pelagic fishery committee keep telling me that they only need to talk to Safia because it's 80% of the project. For Heaven's sake, it's not. We agree, I know, but that's a kind of things that keeps being thrown around to make sure that the people whose livelihood is going to be affected the most are being kept out because it's actually more difficult to have them included. With the particular history of this country, it's going to be a difficult process. Never mind, we have to do it.

DEFF: okay, so that's a big plus.

AJ: Can I do one more thing of research? Because research shows difficult trade-offs. There are some like keep the commercial fishery alive because that you can kind of convert into money. But then there are taboo tradeoffs. Having to trade off stuff when you can express one with money but not the other one. For example, if you're struggling with a budget and you put save the life of one child or buy a new coffee machine for the entire floor. What do you do? The number of jobs in the fishing industry is never going to be traded worth against penguin conservation. That's exactly the point. Because at the moment we cannot convert the ecotourism into money because we don't have the data but there is a completely different dimension to that and that is the value of having diverse species in the ocean because that's going to keep the ecosystem function as a whole.

WWF member: Is it not actually where climate change is our friend? Because we all know what is the most important part in mitigating climate change is in ecosystem restoration, etc.

AJ: Back to trade off. I'm talking about something you cannot really put a price on. And then there is a third category that is even worse which is if you have to trade off two things that are basically non-value things. 2 children and one kidney. That's a tragic trade off. To bring back to fisheries, how do you decide wether A or B is going to have a certain amount of geelbeck? The mean thing about what I'm saying is that has to be forced to take social science and behavioral science on board in addition.

DEFF: So next is “Favor SSF access to rights”, how do you do that? What mechanisms might there be to improve the lot of linefishery in face of big companies. What ways would you suggest to level the playing field?

Fisher: As I said, the small scale is not gonna work well, because these people in there they are actually not fighting for the fishermen, they are fighting for themselves, for the money. So that's why I say keep the linefishery as it was now, we are let's say commercial.

DEFF: Yes I think what Didier means with “small scale” is the linefishery. It's the commercial linefishery against commercial trawl fishery.

Fisher: First of all, they must take the limitation of the size of the boats. Because we can't go where offshore people is going now with their boats. We can't do that with boats under 10meters.

DEFF: That's also positive from a climate change perspective because we are saying, anticipating more extreme weather, so for safety at sea you need bigger boats...

Fisher: If you see a storm coming and you have a small boat, then you have to go back to shore. But if you have a bigger boat you can stay there, you have your food, your accommodation... you can stay behind the storm. Until you can start fishing again. We have to get bigger to get closer to the bigger companies. Because you cannot get to their level with a vespa scooter.

WWF member: And the amount trawlers catch needs to be reduced.

Fisher: for snoek, yes. Just give them enough to cover their expenses for the trip. If they don't catch anything else. Global warming is not only going to affect us, line fishers.

DEFF: Can we capture that by saying “reduce the level of bycatch species which are important to the linefishery”? Because that's exactly the issue. Specifically, for species that they shouldn't be targeting, and that are targeted legitimately by the linefishery.

Fisher: And also what I said yesterday, the information that you use from the blue books. That's not what you want. Because we have to pay a fee. Let's say from 1 ton to 2 tons it's 500 rands, 2 to 5 tons it's say 1000 rands, 30 tons and more, no matter how much more, it's 6000rands. So most of the fishermen don't want to spend 6000rands a year, so they say they only caught 2 tons of fish and that's why you can't trust the blue books. There are people who want to make money but they don't want to give money out.

DEFF: Hopefully that will change with the new minister. She had a good briefing. So let's move forward with “switch to a more precautionary approach”. Management of the linefishery is highly precautionary at the moment because of the badly depleted state. whether there is on other fisheries that are catching linefish as a bycatch, mute point. It's quite clear that it's a feeling that it's not properly precautious. Increase minimum size limits. That's the second point here in precautionary management. I would argue in fact that you want to increase, you want to limit the size of really big fish, I mean you want to limit the catch of really big fish.

Fisher: But for us now in False bay, we call it also a silver fish, but you call it a dolphin. It's a carpenter, but you call it a dolphin. It only gets that size. So the size for a silver fish, carpenter, was 25cm. Then they changed it to 30, and then to 35. Then, these people here, they normally caught that and made a living out of it. They sold it because you don't get a silver fish in False Bay. The silver fish is in the deeper water.

DEFF: this is what I was saying earlier. This is now perhaps the nursery area.

Fisher: 35, it's a big fish, but you catch it. But here they are actually stopping people from making a living because these people don't have boats to travel. They made a living out of that.

AJ: … *(not audible)*

DEFF: So let's talk about the top adaptations. Your one was “co-creation of knowledge”

AJ: Proper participation and that includes co-creation of knowledge. MCS (Monitoring, Control, Surveillance) (*not audible)*.

Fisher: Increase product value/beneficiation.

DEFF: quasi-realistic scenario, enforcement. There was also broaden the species to target (white mussels).

6. CASE STUDY 4: THE PHILIPPINES

6.1 Document preparation

This report presents more detailed results of climate change impacts on the Filipino tuna handline fishery. This research answers the question: how does the knowledge of fishers determine strategies and mechanisms for adaptation to climate change? To carry out these results, a workshop was held in Legazpi, Philippines, in October 2019. It gathered stakeholders from two different areas: Lagonoy Gulf and Mindoro Strait.

During the workshop, it was possible to learn about the effects of climate change on the tuna handline fishery in the Philippines: how prepared the fishing sector is and are the needed actors and actions in the face climate change ready to face climate change in the Philippines? Finally, some newly suggested actions to face climate change with emphasis on the sustainability of seafood products and food sovereignty were determined. A significant number of perceptions and knowledge of fishers on climate change were identified. This research is an exercise showing how perceptions and knowledge can be integrated into climate change adaptation mechanisms in the fishing sector.

This project intends to know the ways of knowledge of the fishers in the Philippines and has answered the following questions: 1) What is climate change and climate variability and what are the consequences for fishers? 2) What are the impacts on small-scale fisheries? and, 3) What adaptation strategies can be effectively implemented in fishing communities to address climate change? To answer these questions, a workshop was held with stakeholders from the line fishery sector in Legazpi (see Methods section).

The results of this research are a contribution in order to generate climate change adaptation measures, as well as fisheries measures management considering the knowledge, needs and perceptions of artisanal fishers in the Philippines. In addition, it has the purpose to bringing a bridge between fishers' local ecological knowledge and scientific knowledge as a driver for biodiversity conservation.

6.2 Workshop structure

To carry out this research in the Philippines (Legazpi), a workshop was held and attended by 21 fishers from the tuna handline fishery sector, 5 scientists and 1 person from the government (DAFF). The workshop, held on October 9th and 10th, 2019, and called "Towards adaptation to climate change in the Filipino tuna handline fishery" identified knowledge, experiences and perceptions on the social, economic and environmental impacts of climate change on fisheries, from resource extraction to commercialization, as well as different adaptation tools (Annex 1: list of participants).

This workshop was held by 21 artisanal fishers from the Lagonoy Gulf and Mindoro Strait to share their knowledge concerning the impacts of climate change on their fisheries. Other stakeholders attending the workshop included: a facilitator, scientists, the government, WWF Germany and Agrocampus Ouest (France). The workshop was facilitated by Anabele Barillo, and assisted by Gregg Yan. The facilitator and technicians facilitated the dialogue and provided relevant information to enrich the discussion between fishers and other participants. This report analyses the results of this workshop.

6.3 Results: workshop outcomes

At a general level, the workshops could determine: 1) the current effects of climate change on artisanal fisheries in the Philippines (with a focus on the Lagonoy Gulf and Mindoro Strait), 2) the preparedness of the artisanal fishing sector in adapting to climate change, 3) the needed actors and actions to face climate change, and finally, 4) the role and importance of sustainable fishing practices to adapt to climate change. Each of the questions developed in the workshops is developed below:

6.3.1 What were the changes in the last decade in the Filipino tuna handline fishery?

The stakeholders identified changes in the last ten years in several aspects: climate, fishing and its marketing.

Climate changes refer to changes in sea temperatures, changes in ocean conditions and atmospheric conditions (winds).

The fishers said that fish have become smaller and moved deeper into the seas and corals have been turning whiter (coral bleaching). With regard to the cost of fishing, they said that it now requires more capital since their catch became less. They also have to go further at sea to catch the same quantity of fish as compared to the past. Because of this, some fishers started borrowing money to banks and spend longer times fishing to earn enough money.

6.3.2 How prepared is the Filipino Tuna handline fishery Sector for Climate Change?

Do you think the artisanal fishing sector is ready to adapt to climate change?

Most of the stakeholders (89%) mentioned that **they are ready** to adapt to climate change. The main reasons invoked are that they are knowledgeable. They also highlight that people in the Philippines can adapt well to such novel situations.

How concerned do you feel about climate change?

Most of the stakeholders (41%) mentioned that they were **very concerned** about climate change. The reasons they evoked for being very concerned are linked with the impacts of climate change on the environment, the decrease in abundance and distribution of fish (going deeper and further), the impacts on the livelihood of their family, the lack of knowledge on the reasons of climate change, the lack of control on climate change, the intensity of extreme events.

Only 19% of the stakeholders mentioned they were **not very worried**. To support this vote, they mention climate change is already here so there is no reason to worry. Others mentioned they believe climate change could be stopped.

Finally, 40% of the participants were **moderately concerned** about climate change. They mentioned that they were prepared for it through Information, Education and Communication (IEC) and the Local Climate Change Adaptation Plans (LCCAP). Others evoked that they were badly informed about the issues of climate change, giving them a weak opinion on the issue. Some others believed all changes could be overcome.

Fishers identified huge waves and stronger typhoons, food scarcity and hunger, further economic inequality through the widening of the gap between the rich and the poor, and lack of income and poverty as main risks brought to them by climate change.

6.4 PROPOSALS FOR ACTIONS TO ADDRESS CLIMATE CHANGE IN THE TUNA HANDLINE FISHERY IN THE PHILIPPINES

Objectives	Examples of adaptive measures (and main goals)	How to implement?
Adapt fisheries practices/fishing activity		
At sea	Target species that are more available and resilient to climate change	• **Identify** types of fish species with a high adaptive capacity regarding the impacts of climate change
	Move fishing effort further offshore (according to the decrease in abundance observed inshore)	
On land	Increase product beneficiation to reduce the need to catch more (and avoid overfishing)	• **Improve quality and thus price** by introducing ice on boats • **Add value to species that are more available and resilient to climate change**, by encouraging fish processing, especially for species that are more available and resilient to climate change • **Regulate supply and demand** to get higher prices.
	Diversify activities (in order to face a likely decrease in catch and fishing revenues)	• **Diversify into <u>related</u> activities** rather than use a middle man – processing, packing etc. (decrease dependence to downstream sectors) • Develop climate-smart and climate-resilient **aquaculture** technologies
	Protect the infrastructures	• **Identify safety docking areas** • **Construct seawalls**
Adapt fisheries management		
Efficient management	**Enforce effective monitoring, control and surveillance**	• Reinforce the control agency and tools dedicated to the surveillance from harbor to inspectors to reporting • **Strict enforcement against Illegal, Unreported and Unregulated Fishing (IUUF)** • Enhance inspector expertise on sustainable fishing and efficiency surveillance • **Inform and educate fishers** about the importance of compliance to the regulation

	Implement seasonal closures in order to improve stocks status and thus resilience	• **Study species-specific biological factors** where appropriate. (*e.g.* when a species has a very specific breeding season and/or area)
Adaptive management	Change from effort limit to catch limits in order to adjust exploitation rates to changing (and unstable) catch potentials	• **Regulate supply and demand** to get higher prices. Switch from effort to catch limit (potentially a **'per day' catch limit**)
	Take into account all the effect of climate change in the scientific advice	• Develop stock assessment method taking into account adapted to climate change • Consider uncertainty linked to climate variability in scientific advices
	Define management measures needed to reach targets of sustainable management on a yearly basis involving all stakeholders (cf. Participative management)	
	Inform and educate fishers and Filipinos in general	• **Share scientific information appropriately with all stakeholders Enhance stakeholder** engagement on the ground with active fishers • **Intensify IEC campaigns** on climate change adaptation • Create programs **to strengthen the adaptive capacity of communities** • The academe should integrate climate change-related subjects in class for primary, secondary and tertiary levels – (*e.g.* develop school videos and climate change communication training aids for students)
Participative/ collaborative management	Change the fisheries governance structures	• **Set up or develop more participative structures,** such as management committees organized at the fishery and regional levels, and involving all stakeholders • **Have all the stakeholders involved** in the thresholds to aim at, and their values
	Inform all stakeholders on scientific knowledge and results	• **Package and communicate useful and relevant information** appropriately for the various stakeholders (scientists, fishers, buyers, consumers). Video seen as a good tool for feedback. • **Involve all stakeholders** in the research that is being done, notably **with government setting up training and resources for fishers to engage**
	Reinforce stock assessments and the scientific advices system	• Analyze the completeness of the current system in charge to provide diagnoses and scientific advices for management (Main stocks should be regularly assessed, as well as depleted or threatened stocks) • Establish a tuna, bonito and mackerel center in Bicol for conservation and sustainable development purposes
Science-based management	Develop ecosystem approach to fisheries management (EAFM)	• **Use fleet-based management as an operational tool to move towards EAFM** (assessing all ecosystem impacts but also socio-economic performances per fleet segment) • **Bring in the social component** so that the system is balanced

	Develop research on fisheries adaptation to climate change	• **Accept the need for sometimes difficult trade-offs** when incorporating social and behavior aspects into natural sciences. Potential for conflict can be high, thus this approach is often viewed as taboo. • **Strengthen functional relationship between the resource and the management plan** in ecosystems approach • **Focus on local people's knowledge about the biology and habitat of tunas and how to best manage them.** • **Implement science-based policies**
Precautionary management	Increase minimum landing size limits or mesh size in order to reduce the fishing impact on fish stocks	• **Educate fishers** on the potential benefits of large mesh sizes or large minimum landing size, on the medium term • **Initiate concertation between stakeholders** in order to set up an optimal fish stock management (of fishing pressure and selectivity)
	Level the playing field for fishers	• **Change in boat materials** (wood to fiberglass): • to make things safer for the more extreme weather which is predicted as a result of climate change
	Secure the fishing activity	• Develop early warning systems
Social management	Favour small scale fisheries using differential access rights by fishery	• **Give more rights** to small scale fishers (possibly based on the fleet-based approach including the assessment of ecological and socio-ecological performances per fleet segment) • Apply available insurance from PCIC for severe weather conditions such as extreme weather events which prevent fishing activities and decrease the number of fishing days • Provide financial assistance

Fishers recommend to revisit the local climate change adaptation plans (LCCAP). They recommend LCCAP to be implemented by LGUs through a FARMC resolution. This LCCAP should contain a part on information dissemination. Indeed, stakeholders insisted on the high importance of IEC.

6.5 Discussion

The discussion section includes two sections: a) the conjectural factors, b) how to adapt to climate change. The conjectural factors refer to themes that do not directly refer to climate change, although there can be interactions. These conjectural factors must be considered for the viability of climate change adaptation projects.

Second section includes what we know about climate change, the factors that science has currently identified are determined, as well as what artisanal fishers have recognized all over time.

Conjectural and external factors

Adaptation strategies to climate change in artisanal fisheries generally mention factors linked to impacts and adaptation mechanisms directly related to the sector. However, it is important to consider that there are other conjectural factors (important or urgent) in the daily life of the fishers (both fishermen and fisherwomen), which are considered as external factors. They influence the final results of the research and are important issues to resolve or ask questions before formulating adaptation strategies.

Within the topics discussed with the linefishers, factors mentioned repeatedly throughout the workshops were identified. These factors, known as conjectural factors, are those external factors which, although not directly affected by climate change, affect fisheries and are within the imagination of fishers:

Types of fisheries

Interactions with the industrial sector, consisting mostly of trawlers targeting hake species (*Merluccius merluccius* and *Merluccius capensis*) are pointed. Snoek, the main species of the linefishery, is considered as a by-catch by the industrial sector.

Product Quality, Diversification and Value-Adding

As evoked with the stakeholders during the workshop, there is a need to change the way they market their products. This involves, first, to be able to maintain a good quality of fish until it is sold. A proposal was made to have ice on boats and ice at landing sites. This was already launched locally, and should be expanded.

"The problem with the ice is that it's being implemented in a few places, but not across. Many boats cannot land in some places because there is no ice. But to me it seems like it's not very difficult to implement. You need to have some land-based facilities. So you can pick up your ice in this place before you go at sea. You see results immediately. You get more money and price is not expensive. So that's an obvious easy thing to do."

However, this was qualified by the fact that landing sites are very numerous and might be brought to switch from an area to an other with the changes in fish distribution. Therefore, scenarios should be explored to be able to predict areas of interest in the future.

In many cases, it will no longer be profitable just to sell fresh fish. The value of the catch can be increased by cost-effectively developing new value-added products which satisfy consumer demand for quality, variety and sustainability. In the latter regard, eco-labeling and certification may become more important, even in small-scale fisheries.

Fishing Alternatives

In the Philippines, fishers have other livelihoods (rice farming, abaca…) Alternatives to fishing not only include other socio-economic activities, but also fishing of other species. The diversification of fisheries and alternatives for economic sources of resources, reduces the pressure on the traditional species targeted by the linefishery. Some species, such as chub

mackerel, were mentioned as an alternative by the stakeholders. Chub mackerel is already caught by the linefishers but not sold, as it has a low value. Here again, improving the quality of fish appears to be the first step.

How to adapt?

The overall result of the fishers is that they are not ready to adapt to climate change, but they are concerned about it.

Management of fishery resources

The management of marine and fisheries resources is identified as an adaptive strategy to climate change in developing countries (FAO, 2018). All the stakeholders insisted on the fact that effective monitoring, control and surveillance have to be enforced, as a priority. It is expected that good governance generates resilience of the fishing resource in the face of the effects of climate change. This implies that sustainable management is only possible through adaptive management over time.

Climate change adaptation mechanisms for the sector include the following: improved research, management, planning and the establishment of a framework of technical, administrative, adaptive capacity and communication policies (FAO, 2018). It is worth mentioning the importance of incorporating local ecological knowledge of fishers as part of research for a sustainable use of fisheries resources.

The importance of the knowledge of fishermen and fisherwomen

The fishers' local knowledge is an input for sustainability in fisheries management. Several studies demonstrate the importance of considering the local knowledge of fishers, including, the so-called "ecological and technological knowledge" (Grant & Berkes, 2007); the "fishers ecological knowledge FEK (Johannes et al. 2000) or/and the local ecological knowledge-LEK (Silvano & Valbo-Jørgensen, 2008).

LEK, for example, is considered to have potential to improve fisheries management, provide new information about the ecology, behaviour and abundance patterns of fish or aquatic animals, reproduction, migration, and ecological relationship between fish and predators (Silvano & ValboJørgensen, 2008; Bender et al. 2014). Others, such as Figus (2018) demonstrate the use of local knowledge of fishers in the management of commercial fisheries and Wong (2016) the use of LEK on IUCN endangered species identification:

Through the analysis of climate change impacts on the tuna handline fishery in the Philippines, several of these were identified below:

CLIMATIC CONDITIONS
Increase in **temperature**
Increase in randomness of the climatic conditions
ECOLOGY AND BIOLOGY OF MARINE RESOURCES
Decrease in fish **abundance**
Change in the **distribution** of fish
Change in seasonality/species life cycle
Change in **size** of fish and invertebrates
FISHING PRACTICES
Increase in fishing **pressure on the resource** (possible overexploitation)
Increase in **distance to the shore** for fishing
Reduced fishing yields
Increase in the time spent in fishing
Increase in the number of fishers

Adaptation mechanisms

Implications for food security and sovereignty

The resilience of a socio-ecological system depends on the current state of its local populations since its range of adaptation will be greater (FAO, 2018). Reducing poverty and providing a population with basic living conditions are a guarantee of better adaptation. As evidenced by the results, Filipino linefishers are aware of climate change and its importance in affecting their resources. However, there is still much to be done to warrant and ensure better living conditions (i.e. health, education, sanitary conditions, and basic services) that will in turn increase their level of resilience.

Other strategies included by fishers to ensure the sustainability of seafood products and food sovereignty are as follows: specific resource management measures, legislation and regulations, access to information, fishing equipment/gear and technologies, participation in decision-making, measures to ensure sustainable fishing and marketing support.

Management and risk reduction for resilience

Although FAO (2018) mentions the reduction of risks and disasters for resilience within climate change adaptation strategies, this topic was scarcely addressed by the fishers in the workshops. Only the need to know more about natural disasters and possible impacts was identified in the first place; and, reforestation or rehabilitation of marine and terrestrial ecosystems was proposed as an adaptation mechanism.

6.6 Scope and Limitations

- It is necessary to consider that the number of fishers participating (4) in the workshops was very low, due to good weather conditions for fishing, which had the fishers going fishing.
- There was a high involvement of local scientists.
- Due to the low number of fishers, the area covered is limited, and there could be differences in results between the different regions.
- The following variables were not considered as a factor that affects the knowledge / perception level about climate change among this research:
- Fishers age
- Differences between active, retired and boat owners.
- These and other factors should be considered in the following researches.
- Currently there are ontological, epistemological and applicability challenges for linking local knowledge and scientific knowledge (Raymond et al. 2010). It is suggested to deepen this type of research and the diversification of qualitative methodologies that guarantee and allow significant contributions to the integration of local knowledge with other types of knowledge.

6.7 Conclusions

Complementary workshops should be organized to share with the fishers the findings and to validate them. These socialization workshops should also be participatory, to receive feedback and record new information.

Acknowledgements

The authors would like to thank all the stakeholders who participated and contributed with their knowledge to this workshop. Special thanks to Raisa Pandan and Joann Binondo (WWF PH) who did a lot in the workshop organization, as well as the members of WWF Philippines who gave their voluntary collaboration during the workshop on October 9th-10th, 2019. Thanks to Anabele Barillo and Gregg Yan for facilitating and documenting the workshop.

6.8 Annexes

Annex 3-I: Workshop agenda

Workshop held in Oriental Hotel, Legazpi, Philippines, on the 9th and 10th of October, 2019.

Day 1 – October 9, 2019		
Time	*Activity*	*Point Person*
INTRODUCTION OF THE WORKSHOP		
9:00 AM	Arrival of Participants and Registration	WWF Staff
9:00 – 9:15 AM	Acknowledgement/ Introduction of Participants	WWF Staff/Facilitator/Participants
9:15 – 9:30 AM	Opening Remarks/Rationale of the Project	Léa Monnier, Lydia Teh
9:30 – 9:45 AM	FF2 Presentation	WWF Staff
9:45 – 10:00 AM	Setting of Expectations/Guidelines	Facilitator
STAKEHOLDERS EXPERIENCES; CHANGES OBSERVED		
10:00 – 11:00 AM	First Exercise: Knowledge Gathering of Stakeholder Experiences	Facilitator/Participants
11:00 – 11:30 AM	Reporting of Exercise Results	Participants
11:30 – 12:00 NN	Discussion of Exercise Results	Facilitator/Participants
12:00 – 1:00 PM	Lunch	
MAPPING EXERCISE FOR KNOWLEDGE ON CLIMATE CHANGE		
1:30 – 2:30 PM	Second Exercise: Knowledge Gathering on Climate Change (Possibly a Mapping Exercise on Effects of Climate Change)	Facilitator/Participants
2:30 – 3:00 PM	Reporting of Exercise Results	
3:00 – 3:30 PM	Discussion of Exercise Results	Facilitator/Participants
3:30-4:30 PM	First Presentation from Scientist (Focus on Effects on Fisheries)	Dr. Ronnel Dioneda (Bicol University)
4:30 – 6:00 PM	Dinner	

Day 2 – October 10, 2019		
Time	*Activity*	*Point Person*
9:00 – 9:30 AM	Recap of First Day	Facilitator
GATHERING KNOWLEDGE AND INFORMING ABOUT CLIMATE CHANGE		
9:30 – 10:30 AM	Game: Resilience Game from UP MSI (Card Game about Climate Change and Natural Resource Management)	Facilitator/Participants
10:30 – 11:00 AM	Discussion of Game	Facilitator/Participants
11:00 – 12:00 NN	Presentation: Effects of Climate Change on Oceans	Gregg Yan
12:00 – 1:00 PM	Lunch	
1:00 PM – 2:00 PM	Third Exercise – Level of Alarm/Worry Re: Climate Change	Anabele Barillo/Participants
REACTION TO CLIMATE CHANGE		
2:00 – 3:00 PM	Presentation: Climate Change Adaptation Measures	Anabele Barillo
3:00 – 4:00 PM	Fourth Exercise: Group Discussion on Climate Change Adaptation	Anabele Barillo/Participants
4:00 – 5:00 PM	Recap of Workshop	Anabele Barillo
5:00 – 5:30 PM	Open Forum/Feedback	Anabele Barillo/Participants
5:30 – 5:45 PM	Fifth Exercise/Final thoughts: How ready is the fisheries sector to adapt?	Anabele Barillo/Participants
5:30 – 7:00 PM	Dinner	

Annex 3-II: List of participants

Name	Designation/ Organization	Number of pax		Day 1	Day 2
		Male	Female		
TUNA FISHERS ASSOCIATION (TFA)					
1. Atenogenes B. Reaso	Pres. – Malilipot TFA/GLTFF Inc	1		Yes	yes
2. Ramiro Bertumen	President – Bacacay	1		Yes	yes
3. Lodegario Bendal	President – Rapu-Rapu	1		Yes	yes
4. Edgardo De Vera	President - Tabaco	1		Yes	yes
5. Joel Bingkingki	President – Malinao	1		Yes	yes
6. Elizaldy Boboyo	President – Tiwi	1		Yes	yes
7. Marcelo Pano Jr.	President – San Jose	1		Yes	yes
8. Suzette VIllano	Sec. – Sagnay TFA & MFARMC		1	Yes	yes
9. Eden Pacamarra	Secretary – TFARCT/MFARMC		1	Yes	yes
10. Arnel Bitome	President – San Andres	1		Yes	yes
11. Jose Nelmar Pante	- Virac	1		Yes	yes
12. Rufino Apostolero	President - Bato	1		Yes	yes
13. Vicente Nazareno	President – Lagonoy	1		Yes	yes
14. Reynaldo Baturiano	President – Presentacion	1		Yes	yes
15. Luis Santellices	President – Caramoan	1		Yes	yes
16. Nestor V. Murillo	President – Calintaan	1		Yes	yes
17. Alberto Herera	President - Sablayan	1		Yes	yes
18. Jesus M. Casuncad	President – Sta. Cruz	1		Yes	yes
19. Bernard Mayo	Sec – Mamburao /IFARMC Chair	1		Yes	yes
20. Dante Macatol	VP – Paluan	1		Yes	yes
21. Conchita Roldan	President – Rizal FEFAR/MFARMC		1	Yes	yes
GUESTS/ORGANIZERS					
22. Joann Binondo	WWF Philippines		1	Yes	Yes
23. Marietta Calacal	WWF Philippines		1	Yes	yes
24. Cara Gene Batan	WWF Philippines		1	Yes	yes
25. Leah Benosa	WWF Philippines		1	Yes	yes
26. Honey Grace Anonuevo	WWF Philippines		1	Yes	yes
27. Raisa Pandan	WWF Philippines		1	Yes	yes

28. David David	WWF Philippines	1		Yes	yes
29. Alo Lantin	WWF Philippines		1	Yes	yes
30. Léa Monnier	Agrocampus Ouest	1		Yes	yes
31. Lydia Teh	UBC		1	Yes	yes
32. Jimmy Masagca	Catandanuas State University	1		Yes	yes
33. Ronnel Dioneda	Bicol University	1		Yes	No
34. Nonie P. Enolva	BFAR		1	Yes	yes

7. TRANSCRIPTION OF THE WORKSHOP

SEC. 1: SETTING OF EXPECTATIONS

After a quick round of introductions, participants were asked to think of a catchphrase or 'hugot line' to describe themselves and their values. Color-coded metacards were thereafter distributed to gauge the audience's expectations for the two-day event, based on three distinct criteria (1. Topic and Content, 2. Resource Speakers and Facilitators, 3. Co-Participants). The participants' answers are listed below.

1. Topic and Content – Effects of climate change on fishing. Reasons for climate change. Effects not only on nature but on us individuals. Knowledge on climate change. Comprehensible and localized adaptation plans for fishers. Cause and effect of climate change on the environment and fisheries. Impacts of climate change, both favorable and unfavorable.

2. Resource Speakers and Facilitators – Participative and cooperative. Speak clearly and slowly. Have some humor. Clear pronunciations. Creativity. Approachable and friendly. Mentally stimulating. Concise and understandable. Accommodating.

3. Co-Participants – Keen observers. Lovable. Cooperative. Attentive. Participative. Broad-mindedness. Consciencous. Open-minded.

Expectation Metacards were arranged according to color.

Organizers and participants had to think on their toes, concocting 'hugot lines' instantly.

SEC. 2: FISH FORWARD 2 by Ms. Joann Binondo

Fish Forward 2 promotes responsible seafood consumption for the benefit of the planet's oceans, people and climate. It is implemented in 17 countries, 11 of them based in Europe. It is a pan-European project raising awareness about the social and environmental impacts of fish consumption.

Fish is a crucial source of food, nutrition and income for more than 800 million people, many living in developing countries. The EU is the biggest market and importer of seafood in the world, with more consumption of seafood supplied through products imported from non-EU countries rather than through EU catches or aquaculture production. European consumers, corporates and authorities can make a global difference.

WWF and EJF teamed-up with partners in Europe and the developing world – to drive the European market and global fisheries in a more sustainable direction. A responsible choice of seafood in Europe is a global driver for change.

The EU co-funded Fish Forward Project raises awareness of sustainable seafood consumption. Fish Forward aims to achieve behaviour change of consumers and corporates in Europe based on an increased awareness and knowledge of the implications of seafood consumption and sourcing on people and oceans in the developing countries, but also in Europe.

Overfishing, illegal fishing and climate change mostly affect people living in developing countries, where most of the fish we eat is coming from. Choosing and sourcing sustainable seafood benefit both people and nature around the globe. The project's objectives are as follows:

By 2020, consumers and the corporate sector in Europe are taking responsibility by choosing sustainable seafood as active contributors to the Sustainable Development Goals, climate change mitigation and adaptation. Authorities are promoting sustainable fisheries management and interlinkage with climate change and SDGs for better implementation of existing legal frameworks.

Producers and local authorities in five developing countries will be involved in stakeholder engagement processes and seafood sustainability assessments. The project runs from 2018 to 2020. The end goal is to strike a balance between economy and ecology. The project should benefit people through livelihood, income and empowerment, plus nature through fish stock and natural capital recovery. The presentation ended after approximately 30 minutes.

SEC. 3: CLIMATE CHANGE AND FISHERIES by Dr. Ronnel Dioneda Sr.

Climate change induced changes to fisheries systems can be analyzed according to physical, ecological and overall (fisheries) productivity – everything from turbidity to salinity and the availability of nutrients are interconnected and affect each other.

The impact pathways of climate change shall vary widely. There will be physical changes in oceans, rivers, lakes and other habitats. There will be impacts on fish populations and aquatic ecosystems. Effects will trickle down to fishers and their livelihoods, trade, the wider economy, plus all of society.

Effects on fish will vary, but spawning grounds will be affected. Primary production (phytoplankton), secondary production (zooplankton), distribution of fish (migration), the abundance of fish, timing of natural phenomenon, plus food web impacts will all change or be affected in time.

To prepare, communities must understand climate sensitivity, exposure, impacts, vulnerability and adaptive capacity, which is dependent on health, education, governance and economy size. The Philippines is part of the Coral Triangle and is thus highly dependent on fisheries. This country is very vulnerable to climate change effects, plus it has heavily-exploited marine systems. Storm systems continuously batter the eastern side of the country and do much damage to coral reefs, making it harder and less profitable to fish. Diseases and algal blooms shall become more commonplace because of heightened sea surface temperatures and coral bleaching.

El Nino, acidification, coral bleaching and other phenomenon will reduce the productivity of oceans. Approximately 25% to 30% of global fish production comes from coral reefs. About 60% of coral reef nations are considered as developing countries, with 25% included in the world's least-developed countries. Lastly, the populations of what are called coral reef indicator species have been plunging. These include butterflyfish, cleaner wrasses, parrotfish and so forth.

To assess climate change vulnerability, consider climate exposure and sensitivity. These two should be considered to ascertain potential impacts. An area or people's adaptive capacity is its ability to cope with climate change related changes.

There are two solutions – climate change mitigation and adaptation, but for today's talk, we should concentrate on climate change adaptation, which takes many forms and will be further discussed in tomorrow's presentation. The talk ended after approximately 70 minutes.

SEC. 4: CLIMATE CHANGE EFFECTS ON OCEANS by Mr. Gregg Yan

The presentation started with a warm-up exercise called *Fish Fu*, wherein participants massaged each other using different Fish Fu techniques. The group chose two fish – the Rabbitfish and Shark. The exercise ended with the introduction of the concept of ecological balance, which is the central concept of the talk.

Approximately, 71 % of the Earth is covered with water. Ninety-seven percent (97 %) of this form its oceans while 2.4 % is locked as polar ice and 0.6 % form bodies of freshwater. Ninety-four (94 %) of all life is aquatic. For these reasons, Earth should instead be called Oceania. Earth harbors life because it is the exact size and distance from its nearest star. By comparison, Venus and Mars are too hot and cold, respectively.

In Japan, a single 278-kilogram Pacific Bluefin Tuna was sold for P155 million this 2019. The fish is an apex or top predator and would have eaten over 5500 kilograms of other fish, but its value at P155 million was far greater than 5500 kilograms of other fish, probably worth around P1.3 million, because humanity has commodified certain types of seafood, most especially tuna.

The human population is growing and now stands at 7.2 billion. All these people require resources, the most basic being food. Humanity has fed its population through agriculture and hunting. Agriculture now covers 11% of the planet's terrestrial surface and produces about 70 billion farm animals yearly, but our oceans provide large amounts of food, hosting an estimated 3.5 trillion fish.

In 2015, fish accounted for 17% of animal protein consumed by the global population. Fish provided 3.2 billion people with almost 20% of their yearly protein requirements. The Coral Triangle is where the Philippines is situated, rich in marine life because of its many islands and the conflux of two large bodies of water, the Indian and Pacific Oceans. There are about 3000 species of fish in the Philippines and 200 are commercially-valuable.

Trophic Level production means that one kilogram of apex predators is worth 10 kilograms of secondary consumers, 100 kilograms of primary consumers and 1000 kilograms of primary producers. Peak fish was reached in 1996, leading to stagnation of wild-capture fisheries.

Climate Change is a natural phenomenon but is being exacerbated by human action and resource consumption, such as overfishing. The world's atmosphere is thickening and it is caused by fossil fuel emissions, clearing of forests and highly-intensive agricultural practices.

The world has reached 1.5-degrees above pre-industrial levels, leading to the beginning of systemic changes in our planet's natural systems. Projected effects include the extinction of less adaptable plant and animal species, such as the seven species of sea turtle. Another is coral bleaching, which halved the live coral cover of the planet's largest reef, the Great Barrier Reef in Australia, which suffered massive die-offs in 2014 and 2015.

Twilight or Mesophotic coral reefs can prove to be a gene bank for shallow and midwater marine life. The country's most well-known mesophotic reef is Benham Bank, east of Aurora and accessible from Catanduandes. Fishers from the Bicol region have known about and have accessed Benham Bank for years. The area is rich in fish and has 100% live coral cover.

Oceanic acidification makes it harder for all animals and plants to utilize calcium, leading to the demise of many animal groups. What will be left are jellyfish and more adaptable species.

nthropogenic stressors accelerate the magnitude of damage caused by climate effects. These include overfishing, improver docking and anchorage, destructive fishing practices and so forth. Cold water fish will follow cold waters while warm water fish will expand their ranges. Main takeaways are that fish composition will vary: some stocks and species will increase, some will decrease. Warm water fish will increase their ranges. Tuna fishing grounds will move further east.

Shallow water species like skipjack will move to cooler waters while deepwater species like yellowfin will be more stable. Wild fish will become more expensive. Aquacultured seafood will take a larger share. Coral composition will vary. Mesophotic coral reefs will survive longer. Coastal communities will be hit by rising sea levels and storm surges. Many fishers will need to shift to other sources of livelihood.

Climate Change has two solutions – mitigation and adaptation. Mitigation is more of a sectoral decision but individuals can reduce their personal climate impacts by cutting their carbon footprints. A more apt strategy for the Philippines would be to adapt to changes instead.

Examples of how adaptable species have replaced native life include the maya bird of Eurasia, tilapia of Africa and cane toad from South America. These are now invasive but they are adaptable. Charles Darwin once said that “It is not the strongest or smartest species that survive. It is the most adaptable.” Humans are the most adaptable of species so we will definitely survive the coming millennia in some form.

The presentation ended with a question and answer portion. Answers are that some coral groups like branching corals have proven resilient to rising sea surface temperatures and that deepwater or cold water fish will migrate polewards (North, South plus East) to colder waters from the period 2050 to 2100. The best course of action for fisherfolk would be to practice responsible fishing and to keep an eye on changes happening in their coasts and offshore fishing sites. The presentation ended after about 60 minutes.

SEC. 5: CLIMATE CHANGE ADAPTATION by Ms. Anabele Barillo

Climate change adaptation depends on how well people understand potential risks and work to mitigate their effects. Key concepts include Disaster Risk Reduction (DRR) and Climate Change Adaptation (CCA) – both of which reduce people's vulnerability to hazards by improving their ability to anticipate, cope with and recover from the impacts of climate change. The common goal is to secure resilience. However, not all disaster hazards are climate change related.

The Philippines has a national framework strategy on climate change from 2010 to 2022. Local climate change action plans are also covered in Republic Act 9729 section 14, encompassing DRR. Climate change mitigation measures include reducing fossil fuel consumption, energy efficiency, promoting sustainable transport and waste management – all to minimize the continued emissions of stored fossil fuels.

Climate change adaptation measures include building flood and coastal defenses, using early warning systems, shifting to climate change resistant crops and redesigning systems and policies – all to moderate harm or even exploit beneficial opportunities brought about by a changing environment.

There are many levels to adaptation, including addressing the adaptation deficit, adapting to incremental changes and adapting to qualitative changes. These take the form of building or bolstering resilience, climate proofing communities and inducing transformational change.

Mitigation in fisheries might not be too significant, but industry greenhouse gas emissions can still be reduced through fuel efficiency and better fishing practices for fishing vessels and flotillas. Mangrove planting and restoration can also help both mitigation and adaptation as aside from absorbing carbon, mangrove forests act as a buffer against storm surges and coastal erosion.

Safer vessels, harbors and ports, plus better safety-at-sea (SOLAS) and early-warning systems must be considered when crafting and mainstreaming CCA and DRR for the fisheries sector. This should be bolstered by regular capacity building, training and IEC modules. All of these should be interlinked within national, local and regional policies and programs. The presentation ended after approximately 30 minutes.

SEC. 6: MAPS OF FISHING AREAS (Workshop Outputs)

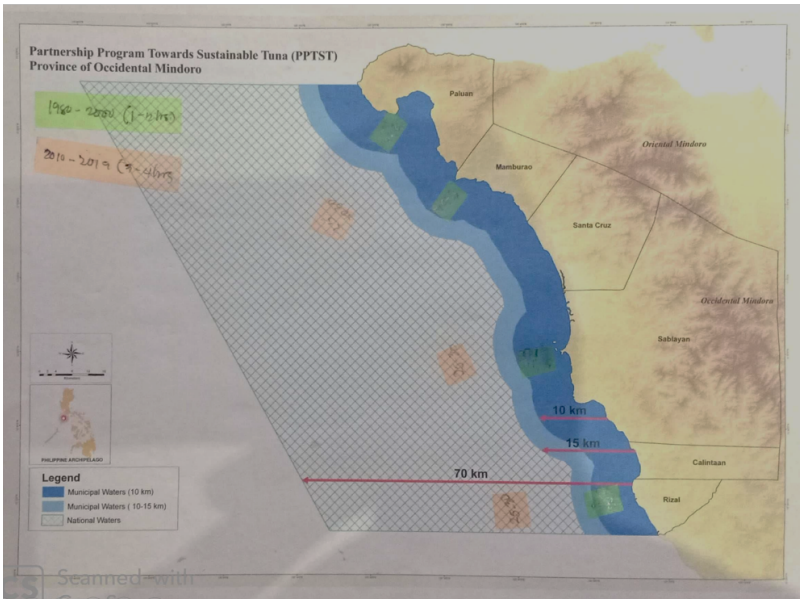


Fig 1. *Mindoro Strait fishing areas from 1980 to the present day*

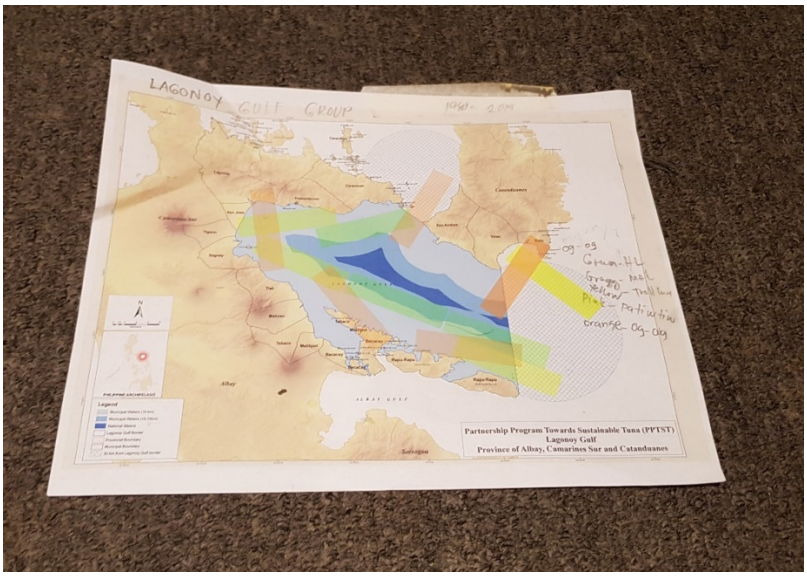


Fig 2. *Lagonoy Gulf fishing areas showing the various optimal sites per gear type*

SEC. 7: HOW WORRIED ARE YOU ABOUT CLIMATE CHANGE?

This question was posed at the start of the workshop to gauge the understanding and levels of apprehension and worry of participants. A second question on the participants' readiness to adapt to climate change was administered at the end of the workshop. Top responses for the first question are **10** (10 responses), **5** (9 responses) and **8** and **4** (4 responses each). All answers are from fisherfolk unless otherwise indicated by a parenthesis (LGU or Academe).

Worry Level 10 – 10 responses.

Reasons – We can't control climate change because of so much human intervention. It is triggered by human activities like fishing which are exhausting our oceans. Because of the decreasing amount of fish and destroyed coral reefs. Because it can affect our environment, especially our coral reefs. I am more worried nowadays about the tremendous effects of climate change and global warming, which is why even some institutions and line agencies have a concerted effort on disaster risk reduction and climate change adaptation literacy. More often than not however, they are reluctant to acknowledge the issues. Sad to say they mostly just wait and see what will happen next. Fish are declining and coral reefs are dying. Climate change might affect us for a long time.

Worry Level 9 – 3 responses.

Reasons – We should prepare for climate change because no one can stop it and it will affect future generations. To become more prepared for the worst case to come like tsunami and the 'big' one.

Worry Level 8 – 4 responses.

Reasons – Nothing to worry about but rather, adapt and do what should be done. Because the oceans are getting hotter and fish are decreasing. I worry about the livelihood of my family. We need to understand the reasons behind climate change. Because of global warming, the migratory fish, specifically yellowfin tuna are going deeper and further.

Worry Level 7 – 3 responses.

Reasons – We can overcome all changes.

Worry Level 6 – 1 response.

Reasons – Because of human activities.

Worry Level 5 – 9 responses.

Reasons – Conservation, save forests, waste management, observe cleanliness, protect mangroves, support the livelihoods of fishers, inform others of proper ways of fishing, conservation of fish products. Because I did not know the potential effects of climate change. Our livelihoods will crash, the climate will change, our fishing areas will be pushed farther out, costs will rise, plus the environment is being destroyed. We are not sure of what climate disturbances we might encounter. We will not be so heavily affected by climate change if we do not abuse nature. Ignorance is bliss. If you don't understand an issue, you don't care about it (LGU).

Worry Level 4 – 4 responses.

Reasons – Our area is prepared for adaptation through IEC and LCCAP. Bigger and more violent waves are inbound to affect the lives and livelihoods of fishers. Coral reefs are being destroyed. The world is becoming a hotter place. Many people are looking for solutions.

Worry Level 3 – 3 responses.

Reasons – Instead of worrying, we should just adapt. It is already there. It's not so dangerous because we still have a chance of stopping climate change.

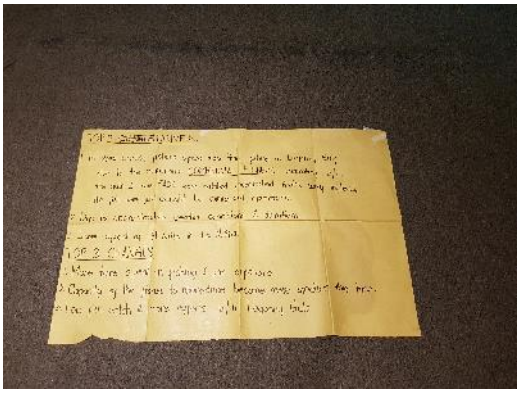
Worry Level 2 – 2 responses.

Reasons – Because it's already here. The effects of climate change on us fishers will be severe.

Worry Level 1 – 3 responses.

Reasons – We can't change fate.

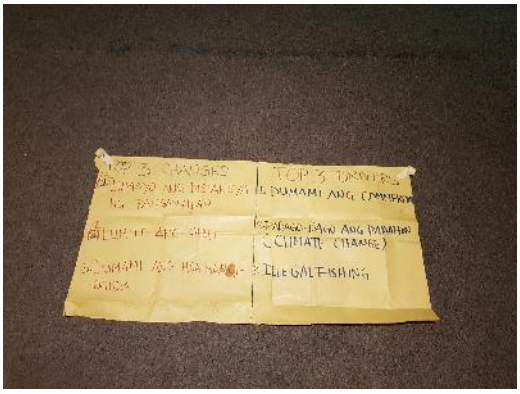
SEC. 8: TOP 3 CLIMATE CHANGE DRIVERS



For Lagonoy Gulf Fishers

In some areas, fishers spend more time fishing in the Lagonoy Gulf die to numerous commercial fishers operating within the gulf and more FADs were installed without proper management. The fish were instead caught by commercial fishing operators instead of artisanal fisherfolk.

1. Unpredictable weather conditions and duration per condition.
2. Severe effects of El Nino and La Nina.



For Mindoro Strait Fishers

We noticed an increase in the number of commercial fishing vessels.

1. The climactic conditions are now far more random than they used to be when we fish.
2. There are now more cases of illegal fishing.

SEC. 9: TOP 3 CLIMATE CHANGE EFFECTS OBSERVED

By Lagonoy Gulf Fishers

1. More time spent in fishing and fisheries pushed farther offshore.
2. Reduced capacity of fish to reproduce.
3. Reduced fish yields even with higher fishing effort within the Lagonoy Gulf.

By Mindoro Strait Fishers

1. Our fishing grounds were pushed further out to sea.
2. Our catches decreased, both in the volume and individual sizes of fish and invertebrates.
3. There are now more fisherfolk.

SEC. 10: TOP 10 SPECIES AND PRICES FROM 2010 TO 2015

As Reported for the Lagonoy Gulf

1. Yellow Fin Tuna (YFT) – P100
2. Skipjack – P80
3. Albacore – P85
4. Bulangawan – P100
5. Lamadang – P65
6. Matambaka – P70
7. Tanigue – P150
8. Langkoy – P40
9. Pusit – P60
10. Manabang – P65

As Reported for the Mindoro Strait

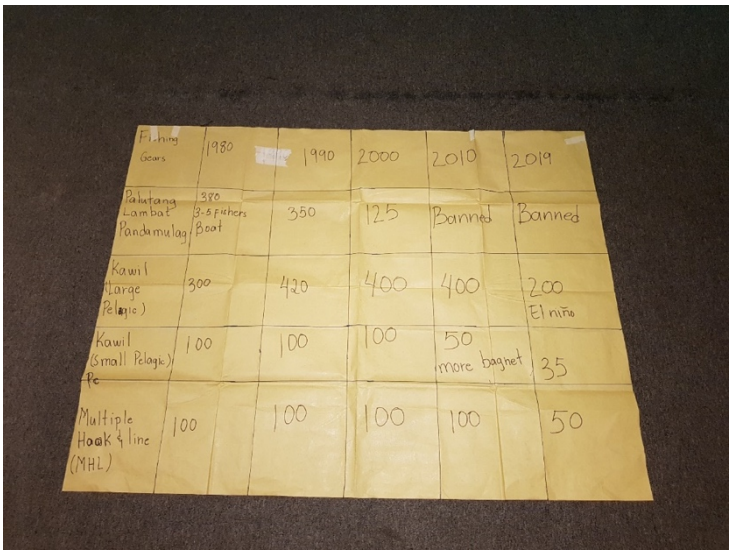
1. YFT – 60 to P220
2. Blue Marlin – P200
3. Tulingan Bilog – P25
4. Matambaka – P30
5. Dorado – P30
6. Swordfish – P150
7. Wahoo – P80
8. Skipjack Tuna – P50 to P60
9. Aloy – P10 to P20
10. Alumahan – P30 to P50

SEC. 11: TOP 10 LANDED SPECIES AND PRICES FROM 2015 TO 2019

As Reported for the Lagonoy Gulf

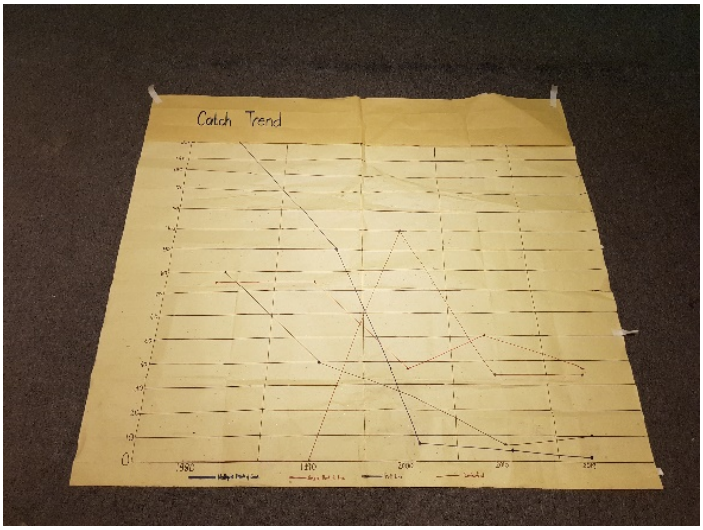
1. YFT – P125
2. Skipjack – P90
3. Albacore – P80
4. Bulangawon – P100
5. Lamadang – P100
6. Matambaka – P120
7. Tanigue – P180
8. Langkoy – P50
9. Pusit – P100
10. Manabang – P95

As Reported for the Mindoro Strait



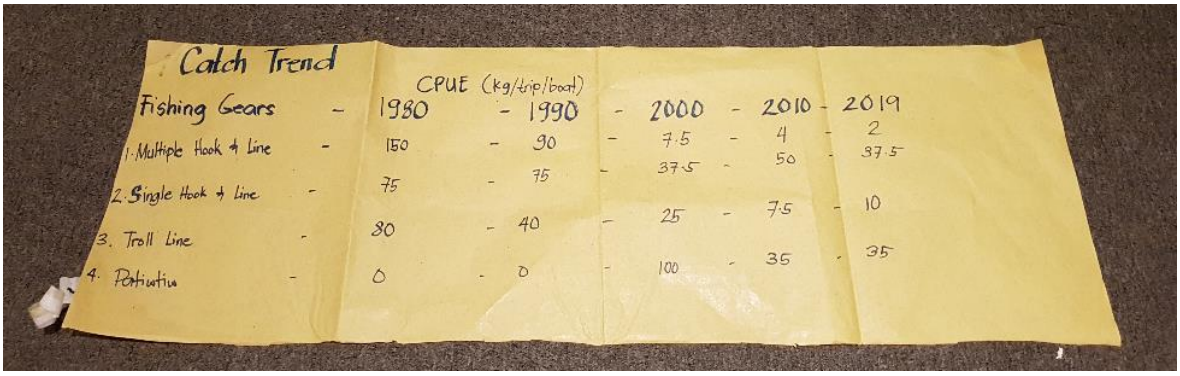
1. YFT – P120 to P350
2. Blue Marlin – P200 P60 to P100
3. Matambaka – P80 to P100
4. Dorado – P60 to P70
5. Swordfish – P200
6. Wahoo – P150
7. Skipjack Tuna – P35 to P60
8. Aloy – P60 to P80
9. Alumahan – P60 to P80

SEC. 14: CATCH TRENDS FROM 1980 TO 2019



Lagonoy Gulf A – Catch trends in the Lagonoy Gulf clearly show a dramatic decrease from the 1980s to the present day. The fishers attribute the decline to various factors, detailed in the sections above.

Lagonoy Gulf B – All catches can be seen in decline, with the biggest drop being Multiple Hook and Line yields, which plummeted from a high of 15 kilograms per trip per boat in the 1980s to 2 kilograms per trip per boat in 2019.



Mindoro Strait A – All catches have historically declined, the most dramatic being a 65% decline in the yields of small pelagic fish caught using kawil gear. Yields from other gear declined by an average of 50% from the 1980s to the present day.

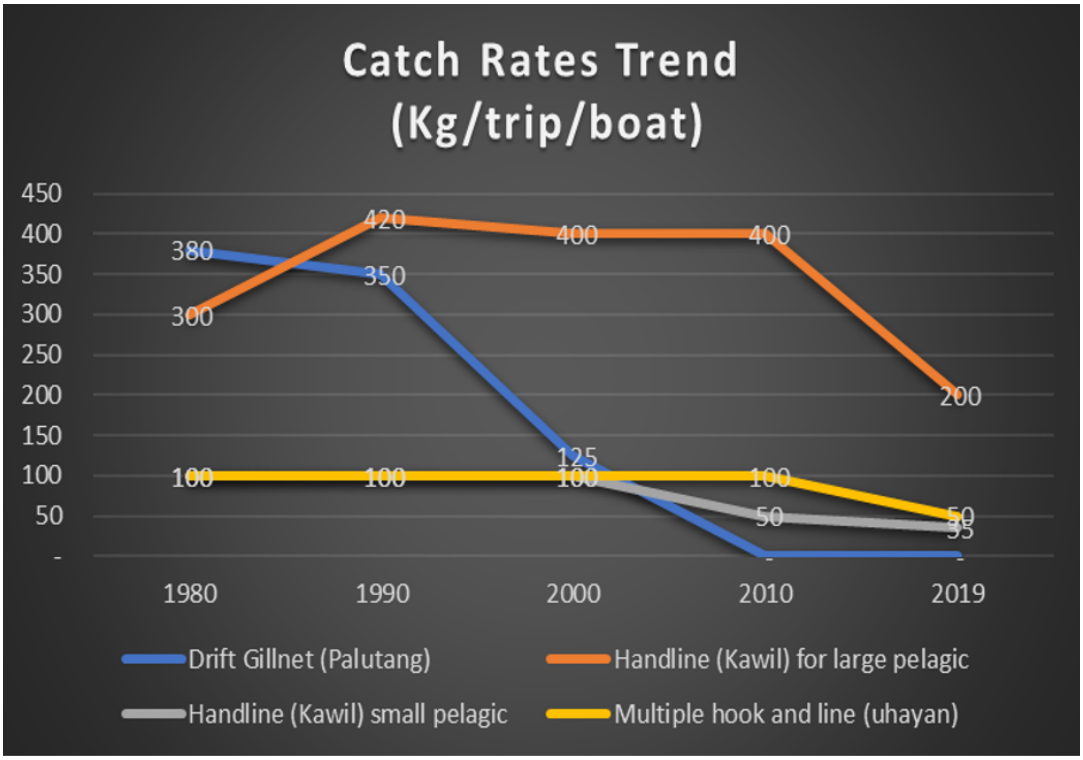
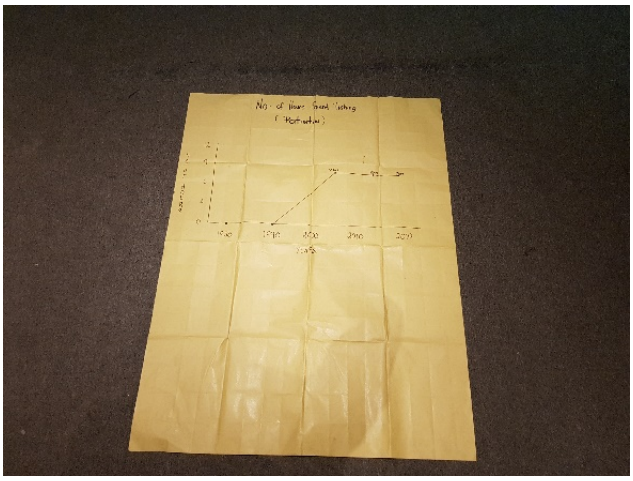
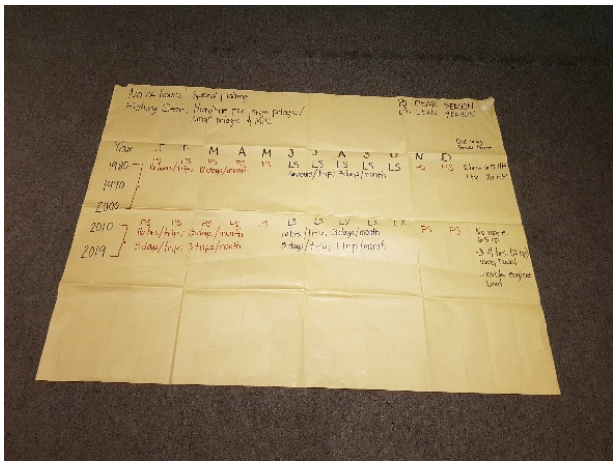


***Fig. 3. Mindoro Strait B** – Graph illustrating overall decline in fish catch rates, regardless of gear*

SEC. 13: NUMBER OF HOURS SPENT FISHING

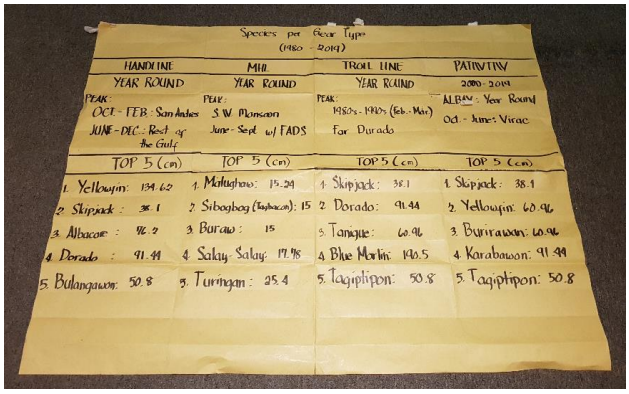


For Lagonoy Gulf Fishers – Fishing hours have remained constant for the Lagonoy Gulf's fishers, ranging from 8 to 12 hours per trip, depending on the type of gear used.

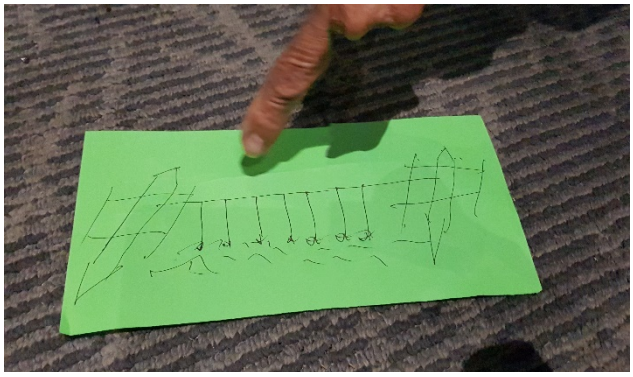


For Mindoro Strait Fishers – Fishing expeditions in Mindoro average 16 hours per day. The number of days depends on the month, with about 50% less fishing days during the Southwest Monsoon season, owing to rougher conditions at sea.

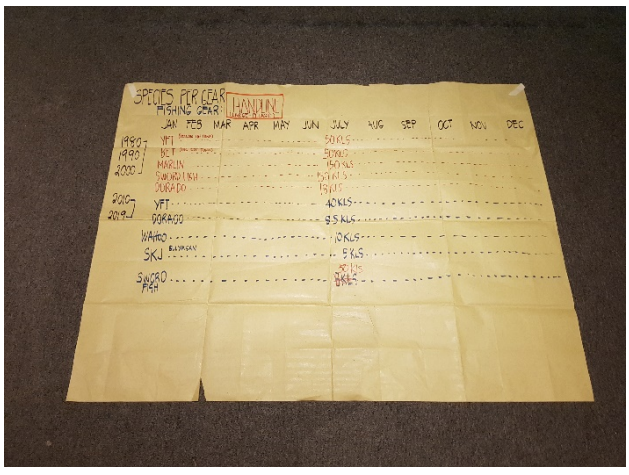
SEC. 14: LANDED SPECIES PER GEAR TYPE



For Lagonoy Gulf Fishers – Top species for handline fishers include yellowfin tuna, skipjack, albacore, dorado and bulangawon. A special gear used in the Lagonoy Gulf is the 'Patiwtiw', able to land skipjack tuna, yellowfin tuna, burirawan, karabanson and tagiptipon.

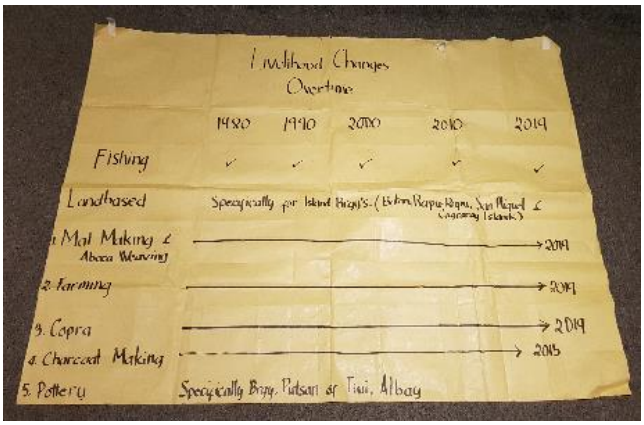


'Patiwtiw' Illustration – Reportedly a unique fishing method from the Bicol Region, Patiwtiw uses a 30 or so meter line between two small vessels. Numerous hooks are trolled, attracting droves of pelagic fish such as skipjack tuna.

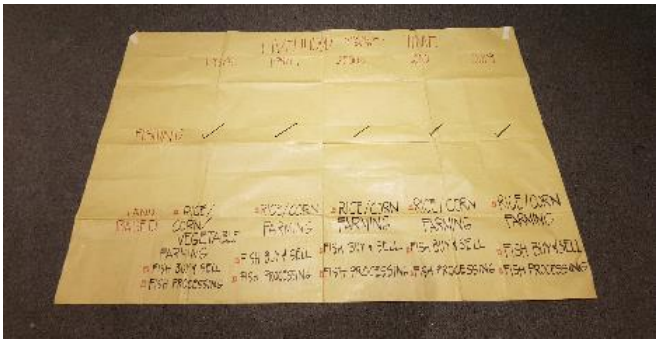


For Mindoro Strait Fishers – Top species for handline fishers include yellowfin tuna, bigeye tuna, marlin, swordfish, dorado, wahoo and skipjack tuna.

SEC. 15: LIVELIHOOD CHANGES OVER TIME

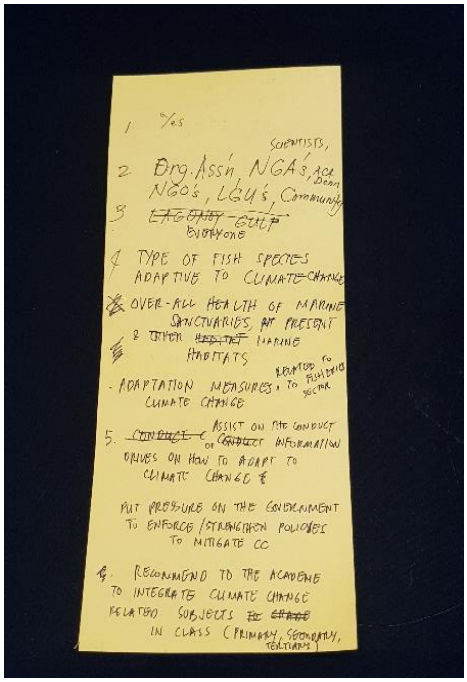


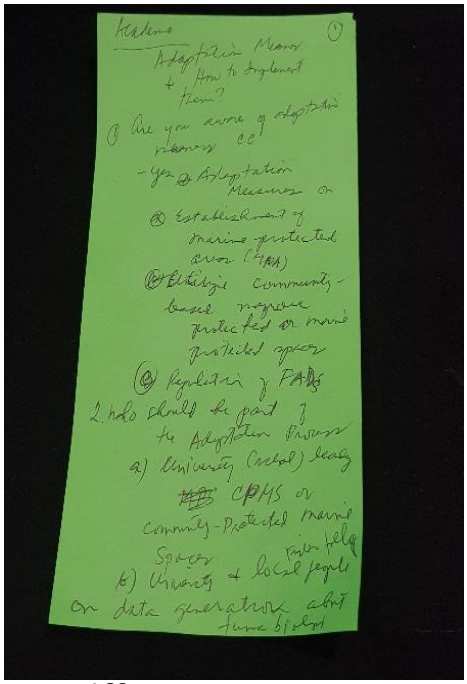
For People in the Lagonoy Gulf – Fishing can be seen to have remained constant from the 1980s to the present day. Additional livelihood sources include mat making and abaca weaving, farming, copra production, pottery and charcoal making. All these activities have been continuous except for charcoal making, which was halted in 2015.



For People in the Mindoro Strait – All sources of livelihood have continued unabated since the 1980s. Fisheries tops the list, followed by the farming of rice, corn and other vegetables, buying and selling fish and fish products and fish processing.

SEC. 16: ADAPTATION MEASURES AND HOW TO IMPLEMENT THEM





HOW TO IMPLEMENT THEM

ARE YOU AWARE OF ADAPTATION MEASURES TO CLIMATE CHANGE?

Mindoro Strait Fishers – Yes we are.

Lagonoy Gulf Fishers – Yes we are.

National Government Agencies – Yes we are aware.

Academe – Yes we are.

WHO SHOULD BE PART OF THE ADAPTATION PROCESS?

Mindoro Strait Fishers – Municipal fisheries.

Lagonoy Gulf Fishers – Organizations and associations, national government agencies, scientists, the academe, nonprofits, local governments and communities.

National Government Agencies – The approach should involve many stakeholders: NGAs, provincial and municipal LGUs, the academe, NGOs, local communities and so forth.

Academe – University or school or community-protected marine habitats and spaces. University and local people on data generation about tuna biology. Local government units and fisherfolk communities. Department of education and commission on higher education.

WHAT AREAS MUST BE FOCUSED ON?

Mindoro Strait Fishers – Fishers, LGU, academe and local communities.

Lagonoy Gulf Fishers – Everyone. No one will be spared.

National Government Agencies – Strengthen the adaptive capacity of the government and community. Sensitivity and exposure are already here.

Academe – Basic information on the breeding populations and biology of tuna, bonitos and mackerels in various habitats. Focus on local people's knowledge about the biology and habitat of tunas and how to best manage them.

DOES YOUR GROUP HAVE SUGGESTIONS TO BETTER ADAPT TO CLIMATE CHANGE?

Mindoro Strait Fishers – Yes.

Lagonoy Gulf Fishers – Yes. Identify types of fish species adaptive to climate change. Gauge the overall health of marine sanctuaries and other marine habitats. Identify climate change adaptation measures related to the fisheries sector.

National Government Agencies – Intensify IEC campaigns on climate change adaptation. Develop climate-smart and climate-resilient aquaculture technologies. Create programs to strengthen the adaptive capacity of communities. Conduct research, development and extensions highlighting climate adaptation.

Academe – Strengthen the partnership between fisheries and the academe. Develop school videos and climate change communication training aids for students. Establish a tuna, bonito and mackerel center in Bicol for conservation and sustainable development purposes.

WHAT NEEDS TO BE DONE TO MAINTAIN FOOD SECURITY AND MAINTAIN LONG-TERM SUSTAINABILITY OF SEAFOOD?

Mindoro Strait Fishers – Properly implement fisheries-related laws. Strengthen campaigns and efforts on sustainable practices. Fishers should submit their fish catch reports to determine the real status of their respective fisheries.

Lagonoy Gulf Fishers – Assist in conducting information drives on how to adapt to climate change. Pressure the government to enforce and strengthen policies to mitigate climate change. Recommend that the academe integrate climate change-related subjects for primary, secondary and tertiary levels. Strict enforcement against Illegal, Unreported and Unregulated Fishing (IUUF). Rehabilitate marine habitats back to their original state and practice good fisheries techniques.

National Government Agencies – We should bank on aquaculture. We should establish more MPAs and resilient networks. We should minimize local threats. We should better implement fisheries management measures.

Academe – Universities should engage in sustainable tuna and seafood resilience plus sustainability measures. Establish TBM marine aquaculture technology center for conservation. Enhance mangrove river system studies and conservation programmes.

WHAT ARE THE TOP 3 ADAPTATION MEASURES PER FISHERY?

Mindoro Strait Fishers – Conduct IEC. Formulate and properly allocate a budget to implement the climate change development plan. Strict implementation of RA-10654 or the Amended Fisheries Code, plus municipal ordinances.

Lagonoy Gulf Fishers – Restore the ecological health of the environment. Science-based policies should be implemented. Climate change resilient actions and decisions must be preferred. Fisherfolk should be a good model to the community through mangrove rehabilitation, clean-up drives, reforestation and so forth.

National Government Agencies – Mangrove reversion, rehabilitation and management. We should establish more protection measures for coastal areas through MPAs and MPA networks. We should invest in good aquaculture practices. LCCAP. We need better IEC, research and development.

Academe – Technology integration in tuna fisheries are adjusted for conservation. FADs are well-monitored and controlled. Promulgation of community-based climate change communication.

SEC. 17: WHAT ADAPTATION MEASURES WERE ALREADY IMPLEMENTED?

Mindoro Strait Fishers – *Temperature and SLR*: Mangrove planting (DENR), build strong seawall (LGU, MENRO), resettlement of fisherfolk (LGU). *Coral bleaching*: Regulate fishing activity (LGU), strictly implement RA-10654 (LGU and BFAR). *Migration of fish species*: Installation of more Payaw or fish aggregation devices (LGU and BFAR). *Storm surge*: Convert wooden boats to fibreglass. Identify safety docking areas (LGU), early warning systems (LGU, FARMC). Apply available insurance from PCIC for severe weather conditions such as extreme weather events which prevent fishing activities and decrease the number of fishing days, look for alternative livelihoods (LGU / farms), request financial assistance from LGUs and other agencies.

Lagonoy Gulf Fishers – *Temperature and SLR*: Use of solar energy and other renewable energy sources. *Coral bleaching*: Fishing activity in the evening. Plant mangrove trees. *Migration of fish species*: Practice energy efficiency. *Storm surge*: Early warning systems during storms surge events. Construct a seawall. Plant more mangroves. Protect seagrass habitats. *Severe weather*: Alternative livelihoods. Displacement fund from government (DRRMC). Except for the displacement fund, all of these are to be led by fishers and the local community. Trainings were already held, including modules for WASAR, CPR, rappelling, resolutions on proper garbage disposal, segregation, plus water potability training – these have helped a lot in increasing capacity.

National Government Agencies – Already developed climate-resilient aquaculture technologies (seaweed farming, polyculture, aquasilviculture, etc.), mangrove rehabilitation activities, assistance to LGUs in establishing MPAs and MPA networks.

Academe – Catanduanes State University (CSU) established the center for climate change solutions for the Asia-Pacific Region. 'Biobelts' and 'bioarmor' – good understanding of mangrove systems in Catanduanes. Production of brochures and other communication materials on climate change. Practice climate-smart agriculture. *Temperature and SLR*: Put-up and plant more mangroves. *Storm surge:* Construct more biobelts and bioarmor. *Severe Weather Conditions:* Operate the weather station of the university to inform local fishers. Conduct studies on weather history on the typhoon history of the Bicol Region.

SEC. 18: CONCRETE ACTION POINTS AFTER THE WORKSHOP

Mindoro Strait Fishers – Revisit local climate change adaptation plan. Recommend LCCAP to be implemented by LGUs through a FARMC resolution. Information dissemination by LCCAP.

Lagonoy Gulf Fishers – Re-echo learnings to all members. Establish alternative livelihoods for families. Meet with the association and MFARMC to prepare resolutions for the local government units regarding climate change mitigation plans. Reforestation, fish catch monitoring, spread out to our designated communities.

National Government Agencies – Mainstream climate change adaptation in programs, projects and activities. Share knowledge to LGUs and other partners through capacity-building activities. Prepare communications plan on climate change adaptation. Continue implementation of climate-smart aquaculture technology. Conduct research and development.

Academe – Conduct similar workshops with CSU faculty and staff, plus agriculture students. Launch the center of climate change solutions at CSU on 19 October 2019. Hold a national event on climate change and fisheries at CSU.

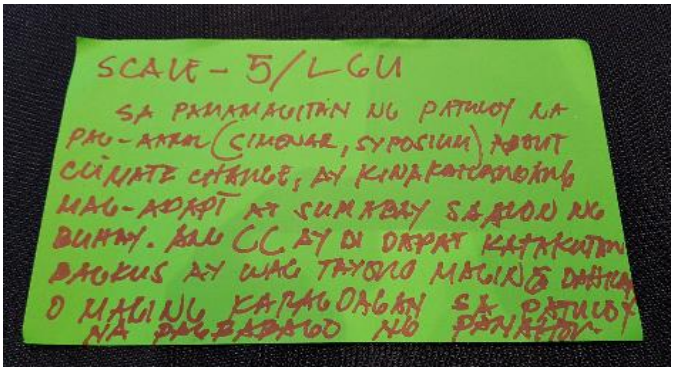
SEC. 19: RESILIENCE GAME DISCUSSION AND LEARNINGS

The participants were divided into two groups and played 'Resilience' – a roleplaying card game created by the University of the Philippines Marine Science Institute (UP-MSI) to illustrate how development affects natural capital and how investments in natural capital can pave the way for truly sustainable, triple-bottomline development. The participants played the game for 60 minutes and discussed and shared their experiences for another 60 minutes. Results of the two games are detailed below.

Mindoro Strait Fishers – The group scored a total of 50 resilience points and was able to stake a claim to the ideal outcome. Their in-game groups shall live prosperous lives within a bountiful and healthy environment. They did this by making numerous sustainable investments, such as forest and mangrove plots, protected areas and low-impact business ventures like mudcrab farms. The group made responsible investments, ensuring that all business investments were counterbalanced with investments to protect natural capital – particularly for coral reefs and mangrove forests. "We're fishers after all," beamed a participant.

Lagonoy Gulf Fishers – In contrast to the Mindoro group, the Bicol-based second team scored a paltry 33 resilience points. This is because they concentrated on developing high-yield developments and investments at great cost to their natural capital. In the end their in-game communities suffered from a poor overall quality of life within a heavily-degraded and unproductive environment. They now face the challenge of rising up without the environmental resources they first had at the start of the game. "Easy profit comes at a price. We realized we shouldn't wipe out natural resources because short-term gains will be offset by what will come in the future. We shouldn't think purely of profit, so long as our basic needs like food are met. Everyone will be affected because we're all part of a greater whole."

SEC. 20: ARE THE PARTICIPANTS READY TO ADAPT?



This question was posed at the end of the workshop to check if the modules positively or negatively affected their perceived capacity to adapt to climate change. Top responses are **10** (13 responses), **8** (6 responses) and **8** (5 responses). Not all participants answered this second question. All answers are from fisherfolk unless otherwise indicated by a parenthesis (LGU or Academe).

Readiness Level 10 – 13 responses.

Reasons – We now have a lot of knowledge. Because fisherfolk are prepared for any eventuality. I now have the knowhow about climate change. Yes, we are ready to adapt through massive IEC, to our members and within our area. IEC for implementation on how to adapt to climate change. I now have a better understanding of what climate adaptation is. Because adaptation is needed for sustainable livelihoods of fisherfolk and people. Yes, we are ready. IEC for fisherfolk to deal with climate change. Planting mangroves to reduce climate change. Sustainable IRRs for local ordinances. Involvement of the LGU for recommending ordinances in climate change adaptation.

Readiness Level 9 – 5 responses.

Reasons – Because we were informed about climate change, so we now know what to do. We are ready (Academe). People can adapt well.

Readiness Level 8 – 6 responses.

Reasons – We have to know what to do to prepare for the coming effects of climate change so that we can continue to work as fisherfolk and derive our livelihoods from the sea. We have to adapt. What else are we to do? We now understand more reasons behind climate change and possible solutions to deal with it. People caused climate change, so we are sure people can also solve it.

Readiness Level 7 – 1 response.

Reasons – We are prepared for change.

Readiness Level 6 – 0 responses.

Reasons – N/A.

Readiness Level 5 – 1 response.

Reasons – With continuous study and understanding through seminars and symposia about climate change, we can maximize the chances of riding safe and unscathed through the waves of life. We should not add to the problem of the degradation of the environment to contribute to climate change (LGU).

Readiness Level 4 – 0 responses.

Reasons – N/A.

Readiness Level 3 – 0 responses.

Reasons – N/A.

Readiness Level 2 – 0 responses.

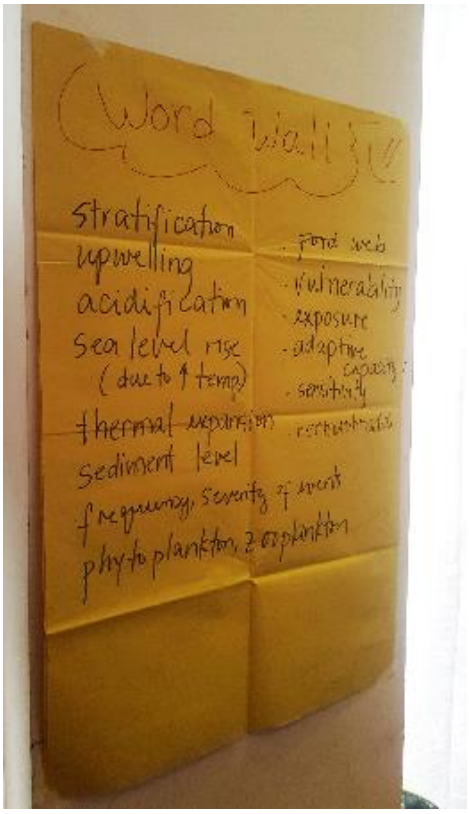
Reasons – N/A.

Readiness Level 1 – 1

Reasons – No notes provided in answer sheet.

SEC. 21: WORD WALL

A 'Word Wall' to highlight unique and technical terms was set-up near the stage to pique the interest of participants. The words are listed in order below. All terms were defined and covered by the four main presentations.



Stratification

Upwelling

Acidification

Sea Level Rise (Due to Rising Temperatures)

Thermal Expansion

Sediment Level

Frequency and Severity of Events

Phytoplankton

Zooplankton

Food Web

Vulnerability

Exposure

Adaptive Capacity

Sensitivity

Hermaphrodite

Glossary

Adaptation.- "The process to adjustment to the actual or expected climate impacts and its effects" (IPCC 2014). "In *human systems*, the process of adjustment to actual or expected *climate* and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects" (IPCC 2018)

Climate Change.- Climate change refers to a change in the state of the *climate* that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external *forcings* such as modulations of the solar cycles, volcanic eruptions and persistent *anthropogenic* changes in the composition of the *atmosphere* or in *land use (IPCC 2018)*.

Climate Change Impacts.- Effects of extreme weather and climate events and climate change on natural and human systems of. The fifth report of the IPCC defines "impacts" as "effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services and infrastructures due to the interaction of climate changes or dangerous climatic events that occur over a period of specific time and the vulnerability of the society or systems exposed to them ". The consequences of realized *risks* on natural and *human systems*, where risks result from the interactions of climate-related *hazards* (including *extreme weather and climate events*), *exposure*, and *vulnerability*. Impacts generally refer to effects on lives; *livelihoods*; health and *well-being*; *ecosystems* and species; economic, social and cultural assets; services (including *ecosystem services*); and infrastructure. Impacts may be referred to as consequences or outcomes, and can be adverse or beneficial (IPCC 2018).

El Niño.- The term El Niño was initially used to describe a warm-water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. It has since become identified with warming of the tropical Pacific Ocean east of the dateline (IPCC 2018). This oceanic event is associated with a fluctuation of a global-scale tropical and subtropical surface pressure pattern called the Southern Oscillation. This coupled atmosphere–ocean phenomenon, with preferred time scales of two to about seven years, is known as the El Niño-Southern Oscillation (ENSO). It is often measured by the surface pressure anomaly difference between Tahiti and Darwin and/or the *sea surface temperatures* in the central and eastern equatorial Pacific (IPCC 2018).. During an ENSO event, the prevailing trade winds weaken, reducing upwelling and altering ocean currents such that the sea surface temperatures warm, further weakening the trade winds (IPCC 2018). This phenomenon has a great impact on the wind, sea surface temperature and precipitation patterns in the tropical Pacific. It has climatic effects throughout the Pacific region and in many other parts of the world, through global teleconnections. The cold phase of ENSO is called La Niña (IPCC 2018).

Small-scale fisheries.- A fishing sector that includes relevant socio-economic characteristics, generating high levels of employment that generally involve the whole family of the fisherman. It is an activity based on local communities, attached to fishing traditions and ancestral knowledge and in many cases seen as the main nutritional and income source for the families involved.

Climate variability.- Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the *climate* on all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the *climate system* (internal variability), or to variations in natural or *anthropogenic* external *forcing* (external variability) (IPCC 2018). Climate variability can be greater at the regional or local level than at the hemispheric or global level (ENCC-Ecuador).

Réalisation, mise en page: Pôle halieutique AGROCAMPUS OUEST

ISSN 2116-8753 (en ligne)

ISSN 2260-0922 (papier)

Crédit photos: AGROCAMPUS OUEST

This report presents the results of the study conducted in France by the Pôle halieutique—AGROCAMPUS OUEST and in Canada with the University of British Colombia (UBC) in collaboration with the Ecuadorian National Fisheries Institute and the Charles Darwin Foundation, in the framework of the project FISH FORWARD 2— « It's getting hot down there ».

AUTHORS (**AGROCAMPUS OUEST**)

Léa MONNIER
Didier GASCUEL

With the contribution of Juan José Alava, Maria José Baragan and William Cheung.

Ce rapport a été produit par l'équipe de la Cellule Etudes et Transfert, Pôle halieutique AGROCAMPUS OUEST avec l'appui de NORMAPECHE BRETAGNE et le soutien financier de la Région Bretagne, de FranceAgriMer et du Fonds Européen pour la Pêche.

Pôle halieutique
Fisheries and Aquatic Sciences Centre
CELLULE ÉTUDES & TRANSFERT

CONTACTS

• **AGROCAMPUS OUEST**

Didier GASCUEL : didier.gascuel@agrocampus-ouest.fr

Cellule Études et Transfert
Pôle halieutique
AGROCAMPUS OUEST

65 rue de Saint Brieuc
CS 84215 • 35 042 Rennes Cedex

http://halieutique.agrocampus-ouest.fr/

ISSN 2116-8752 (en ligne)
ISSN 2260-0922 (papier)

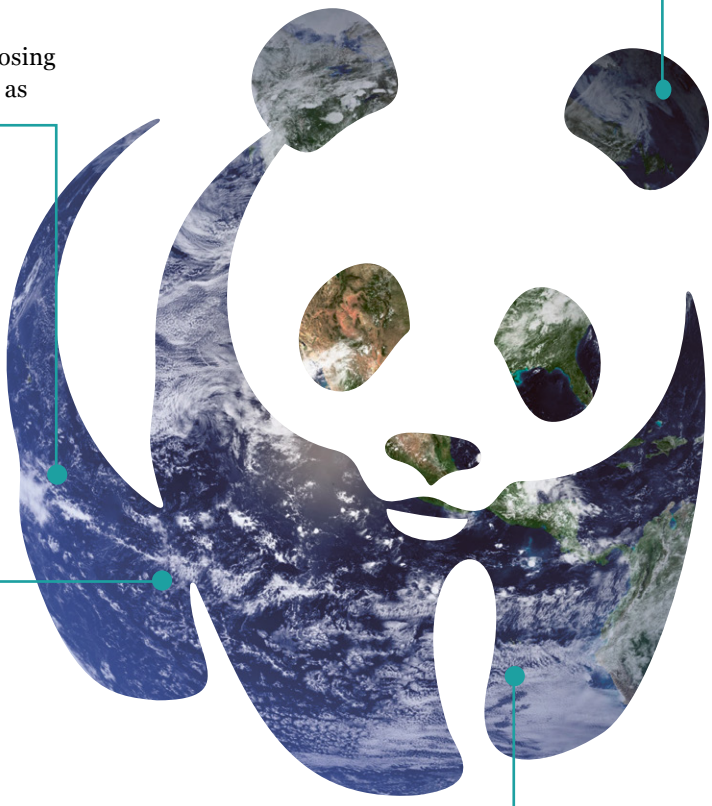
THE CLIMATE CRISIS IN A WARMING OCEAN IN NUMBERS

50%

As the ocean warms developing countries face a 50% potential reduction in annual catches

70%

Small island states and developing countries risk losing up to 70% of their revenue as their catches diminish



3MM PER YEAR

Sea level rise 25cm over last 140 years, but 3mm per year since the 1990s

10 TIMES FASTER

Warming oceans are changing oceans: #climatechange pushes aquatic animals to migrate about 10 times faster than their terrestrial counterparts

WWF

THIS PROJECT IS CO-FUNDED BY THE EUROPEAN UNION