ISSN: 1995 –1132

CRFM Technical & Advisory Document Series
Number 2019 / 06

VARIABLE IMPACTS ASSESSMENT REPORT – EASTERN CARIBBEAN FLYINGFISH FISHERIES

Technical Support to Facilitate Long-term Enhancement of Livelihoods and Human Well-being for Eastern Caribbean Flyingfish Fisheries

CRFM Secretariat
2019

CRFM Technical & Advisory Document - Number 2019 / 06

Variable Impacts Assessment Report - Eastern Caribbean Flyingfish Fisheries

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CRFM Secretariat
Belize, 2019

CRFM TECHNICAL & ADVISORY DOCUMENT – Number 2019 / 06

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Correct Citation:
CRFM. 2019. Variable Impacts Assessment Report - Eastern Caribbean Flyingfish Fisheries. *CRFM Technical & Advisory Document*, No. 2019 / 06**.** 34p.

ISSN: 1995-1132
ISBN: 978-976-8257-97-0

Published by the Caribbean Regional Fisheries Mechanism Secretariat,
Belize and St. Vincent and the Grenadines.

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SECTION I: INTRODUCTION

There are a variety of factors that can contribute to the overall health, abundance and marketability of a fishery stock. It is important to assess these environmental, social, political and economic factors in order to effectively implement management measures that will ensure the overall sustainability of the fishery, in this case flyingfish.

The easiest and most common activity is to define what is known, however, if the current environmental (social, economic and political) future of the flyingfish fishery is to be understood we have to determine what is unknown. As a result, variable impact analysis has to be necessarily broad and examine seemingly unconnected factors. The following variable impact assessment report provides valuable information on factors and their associated known and unknown impacts on the flyingfish fishery.

OVERVIEW

A variable is known as a characteristic, number or quantity that may decrease or increase over time. Two basic types of variables are (1) independent variable: these variables can take different values and can cause corresponding changes in other variables; and (2) dependent variable: these variables can take different values only in response to an independent variable[1].

The following summarizes other types of common variables[2].

- Categorical Variable
  - Variables that can be put into categories
- Continuous Variable
  - Variables within infinite number of values, like 'time' or 'weight'
- Measurement Variable
  - Variable has a number associated with it. It's an 'amount' of something, or a 'number' of something
- Qualitative Variable
  - A broad category for any variable that can't be counted (has no numerical value)
- Quantitative Variable
  - A broad category that includes any variable that can be counted, or has a numerical value associated with it

For the purposes of this report the main types of variables that were used in the assessment of impacts on the flyingfish fishery were categorical and qualitative.

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1 WebFinance Inc. (2018). Business Dictionary – Variable Definition. http://www.businessdictionary.com/definition/variable.html]. Accessed on 30 May 2018.

2 Statistics How To. (2018). Types of Variables in Statistics and Research: A list of Common and Uncommon Types of Variables. [http://www.statisticshowto.com/types-variables/] Accessed on 30 May 2018.

IDENTIFIED VARIABLE IMPACT THEMES

Based on a 'blue sky' exercise the following six[3] broad variable impact themes and their associated sub-themes were identified for this report:

1. Climate Change
   a) Temperature
   b) Currents
   c) Migration of Species
   d) Natural Disasters
   e) Infrastructure
2. Market
   a) Global Markets
   b) Local Markets
   c) Capital
   d) Environment & Energy
   e) Human Resources
3. Political Environment
   a) Local
   b) International
   c) Policy & Legislation
4. Fishery Pressures
   a) Fishing Pressures
   b) Changes in Abundance
5. Social
   a) Inter-generational Transition
6. Technology

[3] The 6 variable impacts identified above are categorical variables.

SECTION II: VARIABLE IMPACT ANALYSIS

Identifying and assessing variable impacts is a useful fisheries management tool in order to better understand how a fishery is vulnerable to environmental, economic, political and social indicators. In the case of the flyingfish fishery, there are a number of impacts that fluctuate over time due to a variety of circumstances (i.e. changes in global markets, changes in water temperature, changes in politics, etc.) that can impact the effectiveness of a fisheries management plan if they are not properly understood. As a result, the following section identifies key variable impacts that have a potential of effecting the Eastern Caribbean flyingfish fishery. It is important to note that these impacts are subject to change in scale and intensity and are often interconnected.

CLIMATE CHANGE VARIABLE IMPACTS

Climate change is a critical environmental phenomenon that can have a significant and variable impact on the flyingfish fishery. Climate change is known to impact biotic and abiotic processes including abundance, species distribution and ecosystems' interactions[4]. Local and global climatic shifts can impact the time of seasonal life cycles, alter range of distribution, deteriorate habitats, disrupt tropic chain and food webs and also increase the risk of diseases for some fish species (*ibid*). Studies conducted by the FAO have also indicated that climate change is a known impact for directly affecting the international trade of fishery products (*ibid*).

Climate change has varying impacts around the world. For example, there are recent predictions that there will be a 30 - 70% increase in fish catch potential in high latitudes and a 40% drop in the tropical regions, including the Caribbean[5]. This is highly problematic for developing countries in tropical regions who have a greater economic and nutritional dependence on marine resources, such as fish, and generally have a lack of capital to invest in climate adaptation (*ibid*).

According to Pardo, "the effect of climate change in aquatic ecosystems produces variations not only in the water temperature, but also increases the thermal stratification, alters the flux of nutrients and ocean productivity, triggers the rise of sea levels, modifies the precipitation patterns, and boots water acidification – all of which have significant impacts on fish populations and directly affects the abundance of habitat-forming species"[6]. In summary, climate change impacts multiple aspects of an ecosystem, such as fisheries, at varying scales, with no identifiable time sequence or patterns, with largely unpredictable effects that change from year to year.

[4] Pardo, F. (2014). Effects of Climate Change and Fisheries on the Distribution of Marine Fish in the Caribbean Colombian Sea Based on Traditional Artisanal Fishing Knowledge. *Major Paper for Faculty of Environmental Studies, York University.* Toronto, On.

[5] Barange, M., Merino, G., Blanchard, J.L., Scholtens, J., Harle, J., Allison, E.H., Allen, J.I, Holt, J. & Jennings, S. (2014). *Impacts of climate change on marine ecosystem production in societies dependent on fisheries.* Nature Climate Change. Doi:10.1038/NCLIMATE2119

[6] Pardo, 2014, 1.

Most of the research that focuses on the impacts of climate change on fisheries has been conducted outside of the Caribbean and generally examines the impacts of one or two stressors in short-term ex situ experiments[7]. As indicated in Oxenford and Monnereau's paper, it is unlikely that these types of studies accurately reflect the true complexity of the long-term impacts of climate change in the Caribbean region (*ibid*). This emphasizes the importance of examining the direct and indirect effects of climate change stressors on both individual fisheries and the marine ecosystem as a whole.

The following table provides an overview of identified climate change variable impacts that have been considered when assessing the Eastern Caribbean flyingfish fishery.

Table 1: Climate Change Variable Impacts on the Flyingfish Fishery

Climate Change					
	Temperature	**Natural Disasters**	**Currents**	**Infrastructure**	**Migration of Species**
Social		Loss of fishing infrastructure and vessels • May result in people leaving the fishery completely/ income diversification • Adds additional total costs to the fishing operations Loss of homes, security • May leave the fishery completely		With global warming Infrastructure, such as processing and market facilities, may require modification to workspace (shelter from extreme weather events and heat) Need to adapt / migrate coastal facilities to meet changes in environmental conditions (i.e. sea level rise)	If fishing costs are too high because of distances to harvest areas may result in migration out of the fishery

[7] Oxenford, H. & Monnereau, I. (2017). Impacts of Climate Change on Fish and Shellfish in the Coastal and Marine Environments of Caribbean Small Island Developing States. *Commonwealth Marine Economies Programme.* Science Review. 83 - 114.

Climate Change					
	Temperature	**Natural Disasters**	**Currents**	**Infrastructure**	**Migration of Species**
Economic	Altered seasonality, heat stress, cooling costs, changes in fisheries populations and distribution range	Direct links between economy and loss of infrastructure / and ability to fish to generate income Vulnerability of small vessels to hurricanes Increased insurance costs / loss of insurability Business interruption costs		Cost of infrastructure adaptation may put additional economic burden on the fishing industry	Species moving forward from existing fishing areas will increase the cost of fishing
Environm-ental	Change in temperature may change conditions for spawning and egg survival	Increased frequency and intensity of extreme storms damage to climate-sensitive ecosystems Potential loss of spawning habitat? Could create more spawning habitat?	Changes in currents may result from sea surface temperature and wind forcing caused by climate change	See above	
Gender		Reduction in landings has a direct impact on women working in marketing and processing Income diversification needed			

Other		Governance • Attention of government is drawn away from fisheries management and management staff may be focused on reconstruction rather than fisheries management Need for funds for reconstruction may take away from day to day management		Governance • Climate change adaptation of infrastructure may put additional burdens on planning and operations in fisheries divisions	

Temperature

According to CMEP (2017) the seasonal variability of sea temperature in the Caribbean is low, which means it only takes a small increase in temperature for a change to be identified compared to the normal sea temperature trend that exists in the region[8].

There are a variety of impacts associated to the rise and fall of sea surface temperatures which can impact local fisheries. These may include changes in species distribution, changes in biodiversity and impacts on the conditions for fish spawning and egg survival. "With regard to sea surface temperature (SST) there is measured evidence across the entire Caribbean Sea (albeit spatially variable) during the latter part of the last century and the early part of this century of an overall increase in SST; an increase in the frequency of occurrence of anomalous 'hotspots' (greater than 1 degree C above mean monthly maximum SST); an increase in the occurrence of periods of deleterious 'heating stress' (greater than 8 degree heating weeks); and an increase in the frequency of category 4 and 5 hurricanes" (*ibid*). Additionally, surface temperature can have an economic impact as it makes the preservation of catch more difficult, which results in a need for upgraded equipment (ice boats) or shortened fishing time.

Changes in seawater temperature can coincide with observed changes in the distribution of fish populations. In an analysis of 50 fish species native to the waters of the Northeast Atlantic, 70 % had responded to temperature increase by changing distribution and abundance. Strong El Niño events along the west coast of the Americas have resulted in deeper thermocline and declines in yellowfin tuna catches – fish are able to spread out in the water column beyond the reach of commercial fisheries[9]

[8] CMEP (2017). Caribbean Marine Climate Change Report Card 2017. (Eds. Paul Buckley, Bryony Townhill, Ulric Trotz, Keith Nichols, Peter A. Murray, Chantalle Clarke-Samuels, Ann Gordon, Michael Taylor). Commonwealth Marine Economies Programme, 12pp.

[9] Pinnegar, John K., Georg H. Engelhard, Miranda C. Jones, William W.L. Cheung, Myron A. Peck, Adriaan D. Rijnsdorp, and Keith M. Brander. "Socio-Economic Impacts—Fisheries." In *North Sea Region Climate Change Assessment*, edited by Markus Quante and Franciscus Colijn, 375–95. Cham: Springer International Publishing, 2016. https://doi.org/10.1007/978-3-319-39745-0_12.

Currents

Climate change has also been attributed to changing wind and current patterns[10]. Changes in the speed and direction of the dominant patterns for currents and winds, which pushes surface waters, will affect the distribution of larval fish as they develop and may impact the survival of young fish[11]. Changes in currents may result from sea surface temperatures and wind forcing caused by climate change. Additionally, changes in currents can be directly linked to changes in distribution of species (i.e. at the non-mobile stage of growth eggs and larval are susceptible to changes in currents).

There is strong evidence that the Atlantic Meridional overturning circulation is already at a weakened state, which will likely have significant biophysical impact in the waters of the Eastern Caribbean[12]. Particularly, those of Barbados, Trinidad and Tobago, Grenada, Saint Vincent and Saint Lucia. As a result, there is a likely impact on the distribution of harvestable flyingfish in the Eastern Caribbean.

Migration of Species

Climate change and the impacts these changes have on water temperature and ocean currents is known to influence the distribution of pelagic species. These effects are complex, however, recent literature[13] suggests they can be modelled[14]. Analysis of various models on distributional impacts on climate change are deterministic and can be predicted, however, there will be likely significant impacts on livelihoods and the local economy. For example, if a fisher is required to travel further to catch their target species there is a direct increase in cost to their operation, which could impact their bottom line and constrain their economic viability. Additionally, if fishers find that the costs of fishing are too high and it is not profitable, they may leave the fishery altogether.

Natural Disasters

Since the early 1990s there has been an increase in the number of extreme weather events, such as hurricanes, both in terms of strength and frequency[15]. These natural disasters have had traumatic consequences on local fisheries, including the flyingfish fishery. This is demonstrated through a loss of fishing infrastructure (i.e. damage to processing plants, destruction of homes, damage to local restaurants) or the loss or damage of fishing vessels. Additionally, with the increased frequency and intensity of storms there is likely an increase in the cost of insurance or loss of insurability[16]. Natural disasters have more than just an impact on society through social and economic impacts, but also have environmental impacts through the damage of coral reefs, which act as natural sea defenses[17].

[10] Miller, J.L. (2017). Ocean currents respond to climate change in unexpected ways. *American Institute of Physics. Physics Today.* 70 (1), 17.
[11] Chapman, E. (n.d.). Climate Change & Fish Populations. *University of New Hampshire.* Publication #: UNHMP-IS-SG-10-09. [http://nsgl.gso.uri.edu/nhu/nhug10001.pdf]
[12] Praetorius, S.K. (2018). North Atlantic Circulation Slows Down. *Nature.* 556; 180-181.
[13] Baugrand, G. (2018). How do marine pelagic species respond to climate change? Theories and Observations. *Annual Review of Marine Science.* 10; 169-197.
[14] Valladares, F. (2014). The effects of phenotypic plasticity and local adaptation on forecast of species range shifts under climate change. *Ecological Letters.* 17; 1351-1364.
[15] CMEP (2017). Caribbean Marine Climate Change Report Card 2017. (Eds. Paul Buckley, Bryony Townhill, Ulric Trotz, Keith Nichols, Peter A. Murray, Chantalle Clarke-Samuels, Ann Gordon, Michael Taylor). Commonwealth Marine Economies Programme, 12pp.
[16] Simpson, M., Scott, D., & Trotz, U. (2011). Climate Change's Impact on the Caribbean's Ability to Sustain Tourism, Natural Assets and Livelihoods. *Inter-American Development Bank – Environmental Safeguards Unit.* No. IDB-TN-238.
[17] CMEP, 2017 (See footnote 9)

The impacts associated with these types of weather events are as follows:

- The loss of fishery infrastructure may result in people leaving the fishery in search other sources of income as their ability to harvest, sell and process fish has been compromised.
- If there is a reduction in landings there is a direct impact on women working in marketing and processing and their ability to generate an income (i.e. less fish in marketplace means decrease in income opportunity for those that sell fish).
- The costs associated with repairing damages will add additional financial burden on the overall total costs to fishing operations.
- Natural disasters have been known to destroy but also create spawning habitat.
- Attention of government is drawn away from fisheries management and focused on reconstruction.
- There is an increased need for funds to be directed towards reconstruction and away from day to day fisheries management activities.

Infrastructure

As mentioned in the previous section (Natural Disasters) the increase in the frequency and intensity of storms has a direct impact on coastal infrastructure caused from sea level rise, storm surge, flooding and more. Effort has been made to focus on how to best adapt and modify coastal infrastructures, particularly in the tourism sector, to withstand these changes. However, there are some indirect impacts that have not been as closely monitored. It is widely known the important that tourism plays to the economic prosperity of many small-island states contributing approximately 15% of the gross domestic product and approximately 16% of employment[18]. Climate change can deter tourists from visiting the region, which may indirectly negatively impact the local fishery (loss of local market). The decrease of tourism dollars in the local economy directly impacts other sectors that are linked to its success.

The following diagram illustrates the relationship between infrastructure, tourism and local markets. The red arrows represent loss (i.e. loss of infrastructure) and how that impacts other sectors. For example, if coastal infrastructure (i.e. beach hotels) are damaged from a storm this will result in the potential loss of tourism to the region, which in turn can create a loss in local fish markets due to a decreased demand for product.

[18] Simpson, M., Scott, D., & Trotz, U. (2011). Climate Change's Impact on the Caribbean's Ability to Sustain Tourism, Natural Assets and Livelihoods. *Inter-American Development Bank – Environmental Safeguards Unit.* No. IDB-TN-238.

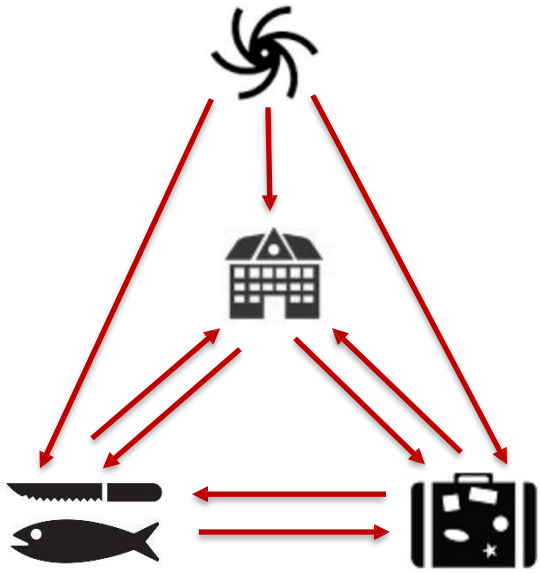

Figure 1: Impact Relationship that Exists between Weather Events, Infrastructure, Tourism and Local Markets

Fisheries' vulnerability to climate change depends upon four key elements:

- Exposure to physical effects
- Sensitivity of the natural resource
- Dependence of the national economy on the fishing sector
- The extent to which these potential impacts can be offset

An assessment of climate change impacts on UK fisheries looked at examples of adaptation by the sector in response to changes (or potential changes) in species distribution and population. The key adaptation actions identified included:

- Travelling further to fish for current species.
- Diversifying livelihoods of port communities – e.g. recreational / sport fishing angling species that have become more abundant.
- Increasing vessel capacity if stocks of currently fished species increase.
- Changing or adapting gear to fish different species if new or more profitable opportunities emerge.
- Developing export markets to match the changes in catch supplied.
- Stimulating domestic demand for a broader range of species through marketing and promotion campaigns.

The estimated annual cost of adaptation to climate change was in Europe was USD 0.03 - 0.15 billion, and USD 1.05 - 1.70 billion) in East Asia and the Pacific[19].

[19] Pinnegar et a Pinnegar, John K., Georg H. Engelhard, Miranda C. Jones, William W.L. Cheung, Myron A. Peck, Adriaan D. Rijnsdorp, and Keith M. Brander. "Socio-Economic Impacts—Fisheries." In North Sea Region Climate Change Assessment, edited by Markus Quante and Franciscus Colijn, 375–95. Cham: Springer International Publishing, 2016. https://doi.org/10.1007/978-3-319-39745-0_12.

The following infrastructure impacts are important to consider when assessing how to respond and prepare to climate change:

- Modifications to workspace to adapt to climate change impacts (i.e. shelter from extreme heat or weather events).
- Need to adapt coastal fisheries facilities, marinas and ports to meet changes in environmental conditions (i.e. sea level rise, storm surge)
- Cost of infrastructure adaptation as a result of climate change may put additional economic burden on the fishing industry and local governments (less allocation of funds to fishery support program).
- Damage to local tourism attractions (i.e. hotels, beaches) can have an indirect impact on the local fisheries sector (i.e. decline in demand for fish in markets / restaurants).

MARKET VARIABLE IMPACTS

Local, national and international markets can greatly impact the demand for fish species. Markets are continuously changing due to trade relationships (free trade agreements, protectionist tariffs, and changing geo-political alliances) and changing consumer preferences. The increased awareness of the importance of fish in a healthy diet have opened up markets for fish products to local and international consumers. Furthermore, international migration of peoples who have traditionally consumed fish create new market opportunities for Caribbean fish products in North American, Western European and Asian markets.

These market impacts are non-linear and can be complicated by changes in local vs. international demand, which provide competition for traditional uses of flyingfish. The following table provides an overview of the variable impacts that markets have on the Eastern Caribbean flyingfish fishery.

Table 2: Market Variable Impacts on the Flyingfish Fishery

	Markets				
	Global Markets	**Local Markets**	**Capital**	**Environment & Energy**	**Human Resource**
Social	Increasing global markets may decrease availability of traditional food in local markets	Developing local markets for flyingfish may support tourism Support for or promotion of local markets has a positive social impact (sense of wellbeing, culture valued) locally	Lack of capital constrains opportunity to diversify in the fishery and forces diversification to other non-fishing income sources – (lack of capital prevents the development of local market for FF in countries where it is only caught for bait)	Movement for eat local may promote better health by eating locally caught FF Eco-certification creates a sense of social well-being – environmental stewardship	Demographic and cultural changes impact labour availability
Economic	Development of niche markets where ex-patriate West Indian will pay premium price can have a positive economic impact on FF Drive innovation in processing	Development of export markets can reduce the supply in local markets and undermine the overall fishery (reduce supply and increase price)	Lack of access to capital limits opportunity and ability to expand and grow	Eco-certification schemes have a potential to increase prices which increases economic return to fishers Additional burden to become certified which can only be met by larger fishing enterprises Global market prices for fuel can have a significant negative impact on flyingfish harvesting	Professionalization in the harvesting FF and in marketing can increase economic return and draw people to the fishery (if seen as a profession instead of a job of last resort) Skills specific to flyingfish process (cutting) – fewer people are able to cut FF efficiently Economic opportunities increase for people who are trained

Markets					
	Global Markets	Local Markets	Capital	Environment & Energy	Human Resource
				returns	
Environm-ental	Global marketing runs counter to environmental movement to buy local eat local Most eco-certification systems are global marketing systems therefore, to be a part of these schemes local fishers must have access to global markets	Promotion of local markets supports the eat local movement – potential to increase prices which in turn increases economic return	Over capitalization of the fishery has been known to result in over harvesting (increase in industrial capacity, increase in harvesting capacity and increase in incentive to pay off loans) Lack of access to capital delays investment in more up-to-date environmentally appropriate technologies		
Gender		Increasing local markets creates opportunity for women who have been traditionally involved in this sector	Gender differences in access to capital Microloan movement Movement to support women's role in fishery – international scale		Professionalization creates opportunity for women in the fishery, particularly in processing and marketing

Global Markets

With the increase of demand for predatory species, like tuna, in the global market there is a potential impact on the flyingfish fishery. In some regions, flyingfish is used as bait, which may decrease its availability as a traditional food in local markets. There are high-value commercial fisheries for large pelagic fish that operate in the waters around Barbados, Trinidad and Tobago, and Grenada. Yellowfin tuna, skipjack, swordfish, billfish, wahoo, dolphinfish, blackfin tuna and mackerel are pursued by commercial fishermen in the wider Caribbean region. Global and regional market demand for these products has increased steadily over the past few decades. Global imported value of frozen skipjack and yellowfin tuna has increased 277% and 161% respectively since 2001 (Figure 1)[20].

[20] International Trade Centre, UN COMTRADE

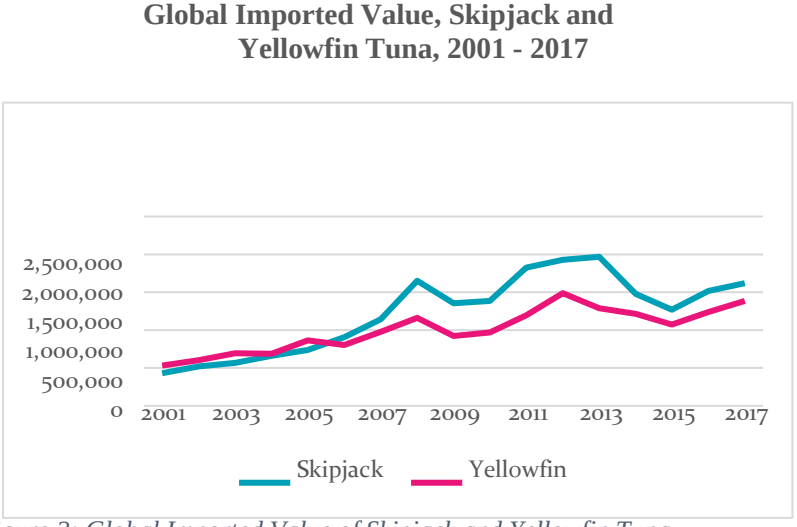

Figure 2: Global Imported Value of Skipjack and Yellowfin Tuna

These target species' diet consists primarily of smaller pelagics, such as mackerel and flyingfish. The relative importance of flyingfish has declined as the value of these larger pelagic species has increased, particularly in Grenada and Trinidad and Tobago, where local demand for a flyingfish food fishery is minimal[21]. Over time, this has shifted the utilization of flyingfish as a food or export commodity to use as bait in higher-value fisheries, such as tuna. Demand for flyingfish as a local seafood product is still strong in Barbados, however this could change with increased global demand for higher-value species (tuna) in the face of stable or declining demand for flyingfish locally. The shift in use of a species, such as flyingfish, from food / export fishery to commercial bait fishery has a number of potentially negative effects on subsistence fisheries and local food security[22]. These include:

- Bait fishing operations can potentially deplete the common stock of locally important food fish, such as flyingfish, thereby reducing food security for local fishing communities (*ibid*).
- Flyingfish stocks can be further impacted through the by-catch of juveniles during bait fishing, as harvesters' primary aim is the targeting of more valuable species rather than the health of the bait stock. The harvesting of juveniles can deplete stock that would have become valued food fish and contributes to the overfishing of the species used for bait (*ibid*).

There is small but steady demand for processed flyingfish products in a number of countries with populations of Eastern Caribbean origin (i.e. emigrants, expatriate, etc.). Seafood processors in Barbados and Trinidad and Tobago export frozen whole and filleted flyingfish products to the US, Canada, and EU. Market development initiatives aimed at increasing awareness of and demand for flyingfish products could have a positive impact on livelihoods for participants along the flyingfish value chain. Sea fish, a UK organization working with the UK seafood industry to promote the sustainable production and consumption of seafood, identified a similar need in the development of export markets for their pelagic fisheries. Their *Seafood Strategic Outlook 2016* identified UK expatriate populations in other countries as targets for seafood product market development. Strategic actions to address this need included offering higher quality products and attending relevant seafood shows to increase demand[23].

[21] NEXUS industry consultation: Grenada, Trinidad and Tobago (October 2017).
[22] International Pole & Line Foundation (IPLF). (2015). Annual Report: Ensuring Sustainability of Livebait Fish. Retrieved from [http://ipnlf.org/perch/resources/ipnlf-annual-report-2015low-res.pdf]
[23] Garret, Dr. A. (2016). *Trade Developments: An initial review of developments, implications and practical responses from industry and Seafish.* Seafood Strategic Outlook. Retrieved from [http://www.seafish.org/media/1673384/trade_developments_lr_v2.pdf]

Finally, the increase in global demand for seafood products and the concomitant growth of online retail sales channels are creating new opportunities for seafood producers. Although processing capacity in the Eastern Caribbean is generally limited in its ability to supply ever- increasing global demand for seafood, small pockets of innovation have developed. One state-of-the-art processing facility operating in Barbados has developed a wide range of innovative value-added products, marketed locally and abroad. Opportunity exists for processors to develop markets for direct-to-consumer seafood sales, as well as logistics and packaging processes that facilitate entry into these markets. These markets have the potential to allow processors to retain more of the final value of product by bypassing brokers and retailers. This increase in global demand, while potentially beneficial to processors and distributors, increases the risks associated with increased fishing pressure on targeted species (see Targeted Harvesting Variable Impacts).

Local Markets

There are a number of variable impacts that developing the local market for flyingfish products can have including growth in tourism, employment and opportunities for women to participate in the fishery.

For example, the World Tourism Organization (UNWTO) stated in their 2012 *Global Report on Food Tourism* that: "In recent years, food Tourism has grown considerably and has become one of the most dynamic and creative segments of tourism. Both destinations and tourism companies are aware of the importance of gastronomy in order to diversify tourism and stimulate local, regional and national economic development. Furthermore, Food Tourism includes in its discourse ethical and sustainable values based on the territory, the landscape, the sea, local culture, local products, authenticity, which is something it has in common with current trends of cultural consumption"[24]. An international survey of UNWTO members on the importance of food tourism found the following:

- 87% believe that gastronomy is a distinctive and strategic element in defining the image and brand of their destination.
- 70% have already targeted gastronomy tourists as a market segment.
- The potential of gastronomy to enhance the livelihood of the local community has been valued at 8.5 points out of 10 with 80.5% of destinations rating its potential with 8, 9 and 10 points.

There is potential to further develop local markets for flyingfish and market flyingfish food products as a key component of a broader gastronomic experience to the ever-increasing numbers of international tourists engaged specifically in food tourism. Promotion of local markets supports the 'eat local' movement – potential to increase prices which in turn increases economic return.

Changes in the use of fisheries resources due to the impact of factors such as global markets and climate change can impact the social wellbeing and sense of community identity of traditional fishing communities and cultures[25]. Support for local fishing industries can be provided in ways that include investment in infrastructure, legislative / regulatory change, research and development, market development, and facilitating access to markets. Providing this support demonstrates that the broader community values fishing industries and the people that work in them. This is turn can help attract and retain workers in the industry and help prevent fisheries from becoming vulnerable to labour volatility and shortage.

[24] UNWTO (World Tourism Organization). (2012). *Global Report on Food Tourism*. AM Reports: Volume four. Retrieved from [http://cf.cdn.unwto.org/sites/all/files/docpdf/amreports4-foodtourism.pdf]

[25] Khakzad, S. & Griffith, D. (2016). The role of fishing material culture in communities' sense of place as an added value in management of coastal areas. Journal of Marine and Island

It is estimated that roughly half of all global seafood industry workers are female. Female workers who enter the fisheries workforce often occupy jobs in pre- and post-harvest activities, although on a global scale increasing numbers work in primary harvesting. Women also perform important non-market support functions in fisheries, including equipment repair, food preparation, financial management, etc. Despite their nearly equal representation in the global fishing industry as a whole, women earn only 70% of the income of their male counterparts[26]. Support for local fisheries and markets can provide more opportunities for women to earn income and diversify their livelihoods through employment in the industry. Frocklin et al (2013) offer a comprehensive analysis of women roles in a Zanzibar fishery with several similarities to flyingfish fisheries in the Eastern Caribbean[27]. This includes:

- The fish value chain in Zanzibar is much like that of the flyingfish value chain in Barbados. Most of the sector is artisanal making use of traditional gear and equipment. Fish are landed at government landing monitored by fisheries department staff who report the number of fish landed, weight and price. Fish are mostly sold to traders at local open construction fish who then sell the fish, processed (salted, sun-dried, or smoked) or fresh (whole or filleted), to local customers, hotels, and restaurants.
- Interview research conducted by the study's investigators found:
  - the number of women entering local fish markets has increased over the last years due to the lack of alternative economic activities.
  - Although men and women fish traders spent an equal amount of time in markets, women's additional responsibility for household duties resulted in much longer workdays.
  - the three main sources of financial capital required to enter the industry included microcredit, savings, and loans. 86% of the women fish traders used borrowed money to start-up their business.
  - the majority of the respondents reported high levels of job satisfaction.

  According to the respondents, society perceives fish trading and marketing as more prestigious and of greater economic status than being a harvester. Another central factor was income, and the majority of the interviewees said that fish trading has improved their living standards.
  - Research findings indicated that women shared less access to profitable markets, financial capital, contacts, organizations, and tuna species.

Capital

A lack of access to investment capital is a constant challenge facing participants in small- to medium-scale fisheries around the world. The volatility and uncertainty of fish stocks and highly competitive and increasingly global seafood markets have contributed to the fishing industry being classified as high risk with governments and financial institutions limiting their investment and debt exposure to the sector. Furthermore, capital invested in fishing vessels and processing plants and equipment are often highly illiquid, offering financial institutions little opportunity to recoup investments in the event of business failure.[28]

[26] Monfort, M.C. (2015). The role of women in the seafood industry. Food and Agriculture organization of the United Nations: Globefish Research Programme. Volume 119. Retrieved from [http://www.fao.org/3/a-bc014e.pdf].

[27] Frocklin, S., de la Torre-Castro, M. Lindstrom, L. & Jiddawi, N.S. (2013). Fish Traders as Key Actors in Fisheries: Gender and Adaptive Management. Ambrio: 42(8); 951-962.

[28] National Indigenous Fisheries Institute (2017) http://indigenousfisheries.ca/en/discussion-materials/

Lack of access to investment capital prevents the development of local markets for flyingfish in countries where it is only caught for bait. Industry interviews conducted by the consultants in Grenada and Trinidad and Tobago revealed the common perception that a lack of access to capital impacts both harvesters and processors. Harvesters are unable to upgrade equipment or invest in larger vessels needed to pursue higher-value species and increase revenue / income. Processors who have difficulties accessing capital are limited in their ability to invest in new innovative, energy efficient equipment that can diversify their product line and help gain access to new markets. Lack of an ability to invest in growth and innovation may have the effect of constraining income potential and requiring harvesters to seek income earning and livelihood opportunities outside the fishery.

The other side of lack of access to capital are the risks inherent in overcapitalization as has been experienced in many industrial fisheries around the world. Greater investment results in larger debt obligations and the requirement to generate revenue to cover operating and debt servicing costs. This increased obligation can drive harvesters and enterprise owners to value productivity over conservation and species / size selectivity. Although the scale of fisheries in the US is incomparable to that of any fishery in the Eastern Caribbean, the impact various contributing factors had on the emergence of overcapitalization in US provides cautionary insight.

Many traditional fisheries around the world are now nearly or completely depleted as a result of increased global demand for seafood products and expansion of fishing fleets. The number of operating fishing vessels and size of the harvesting workforce have increased 40% and 60% respectively since 1976 leading, in part, to an increase of 50% in landed volume. This growth – a response to increasing consumer demand, government support and assistance, and technological innovation - has incented the US fleet to invest heavily to increase capacity. Capital invested in this expansion failed, for the most part, to yield expected returns and let to a crisis whereby 65 of a total 231 US marine fish stocks were classified as overfished placing the livelihood of US harvesters at substantial risk[29].

Environment and Energy

There is growing pressure from consumers for seafood products to be certified "sustainable". Eco-certification schemes are believed to have the potential to increase prices of seafood products, thereby increasing economic returns to harvesters. Currently, there is no evidence that eco-certification of fisheries results in price premiums that benefit harvesters. There is some evidence that large producers have their fisheries eco-certified in order to gain access to specific consumer markets (i.e. higher-end retail and food service outlets) rather than to garner any significant price premium[30].

The non-governmental organization (NGO) community has been successful at increasing consumer demand for eco-certified seafood products and creating pressure for fisheries to comply and maintain access to markets. This has resulted in increased cost for the fishing industries that buy-in and barriers to access for those that do not. Eco-certification involves costly assessment and reporting requirements that can often only be met by large industrial fisheries. The costs associated with the acquisition and maintenance of certification can be quite expensive. Full fishery assessment can range from $10,000 - $250,000 US depending on the size and complexity of the fishery. Additional costs borne by industry would be associated with harvesting and management practices that may need to be changed or followed in order to maintain certification[31].

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[29] Buck, E. & Preziosi, D.V. (1995). Overcapitlization of the U.S. Commerial Fishing Industry. ResearchGate.

[30] Organization for Economic Co-operation and Development (OECD)/FAO Round table on ecolabelling and certification in the fisheries sector (2009).

[31] *Evolution of Seafood Sustainability Certification Standards: Key Trends & Considerations*, Bonnell (2012).

Flyingfish fisheries in the Eastern Caribbean would most likely be considered too small and local to warrant eco-certification, however access to global markets may be limited should consumer demand for certified products increase.

Another variable impact that can have significant negative effects on harvesting returns and on the economic sustainability of the flyingfish fishery is the global market prices for fuel. Aggregate average retail gasoline prices rose 74% from 1998 to 2016 (Figure 2)[32] in Barbados, Grenada, and Trinidad and Tobago, while the landed price of flyingfish has essentially remained stable over the same period of time. For harvesters targeting mostly flyingfish (dayboats) to sell at market (Barbados and Tobago), rising fuel costs could have a negative impact on the profitability of their fishing enterprises, as operating costs rise while flyingfish revenues remain relatively stable. Larger boats may have the ability to offset rising fuel costs by diversifying their catch and targeting higher-value species that have seen increasing market prices relative to flyingfish.

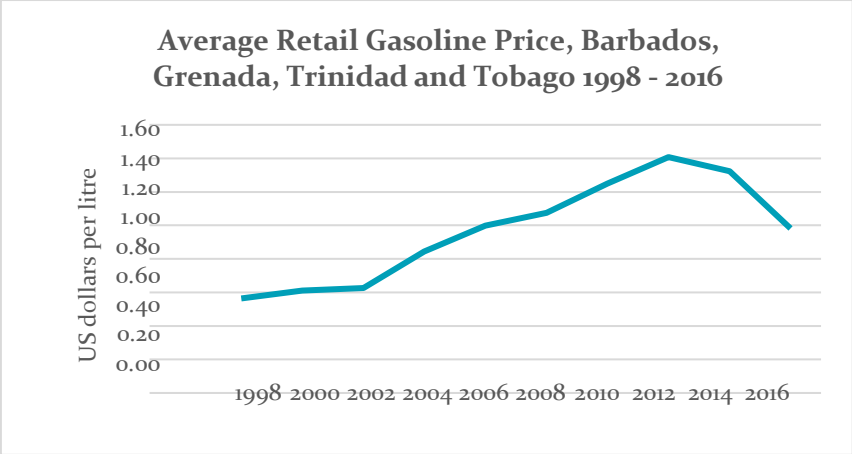

Figure 3: Average Retail Gasoline Price

Human Resources

There are a number of human resource factors (demographic and cultural changes) that can impact labour availability for the flyingfish fishery. The working age population in Barbados, Grenada, and Trinidad and Tobago increased 30% on average between 1960 and 2016 (Figure 3)[33]. Increases in this demographic are a positive indicator of potential labour availability to all sectors of the economy.

[32] World Development Indicators, the World Bank (2018).
[33] World Development Indicators, the World Bank (2018).

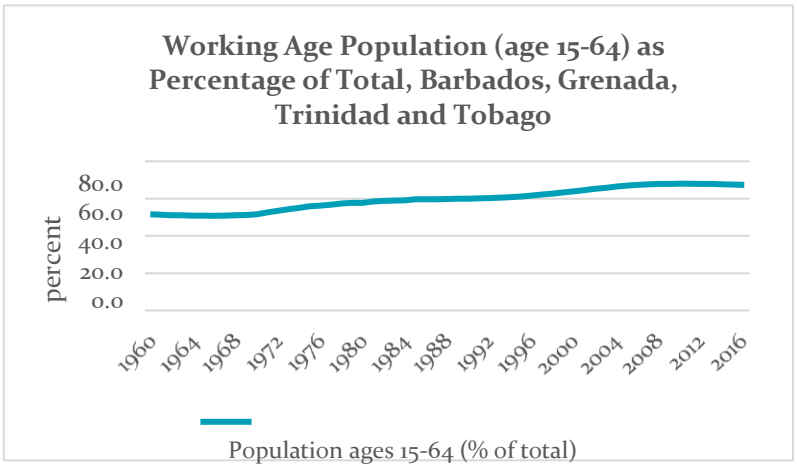

Figure 4: Work Age Population

Educational attainment has dramatically increased in all countries in the Eastern Caribbean over the past few decades. Trinidad and Tobago, for example, has seen a massive increase in the percentage of the population that has completed post-secondary education – from 1.2% in 1970 to 44% in 2009. Completion of lower secondary (middle school) education has risen 292% over the same time period (Figure 4)[34].

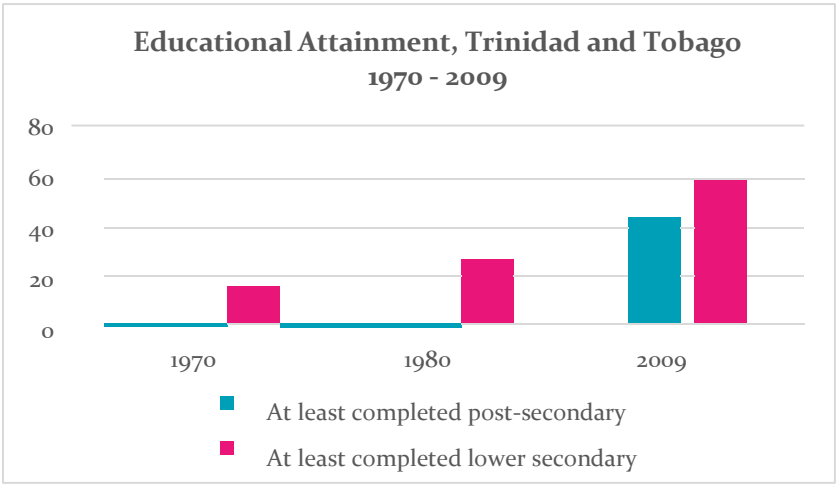

Figure 5: Educational Attainment

A shift in the education of a population into higher levels of attainment can have the effect of decreasing the percentage of the workforce willing to seek employment in primary sectors such as fishing. Industry interviews conducted by the consultants in all three countries highlighted that it is becoming increasingly difficult to find people willing to work in the fisheries, and that skills specific to flyingfish process (i.e. cutting) are not being handed down to younger generations. Professionalization (i.e. developing licensing certification and training) of the fishery has the potential to attract higher skilled and educated workers.

[34] World Development Indicators, the World Bank (2018).

POLITICAL ENVIRONMENT VARIABLE IMPACTS

There are often interconnections between the fishing industry and the natural resource that are not directly the result of biophysical and economic relationships. Socio-political influences can often have significant impacts on fisheries even though these influences are not focused on fishery issues. For example, changing political relationships between Nation States can have direct impacts on the accessibility of fishers to resources or markets that influence livelihood viability. The following table provides a summary overview of the key political environmental variable impacts related to the flyingfish fishery.

Table 3: Political Environment Variable Impacts on the Flyingfish Fishery

Political Environment			
	Local	**International**	**Policy & Legislation**
Socio-economic	Changes in regulation can modify the ability for some people to participate in the fishery and this in turn can undermine or promote support for the local government	Harmonization of flyingfish fishery regulations amongst CRFM Member States can impact the cost of fishing (changes in gear, changes in location of fishing) some groups within the fishery International fisheries management arrangements (ICCAT) can impact the harvesting of local tunas, therefore, impact flyingfish used as bait	Introduction of species-specific harvesting licenses can have a social and economic impact on fishermen (increase cost of fishing and sense of control of their own livelihood), and removes the opportunity for people to informally fish commercially on a needs basis
Environmental		Marine protected areas in the Eastern Caribbean may reduce areas where flyingfish fishing can occur	Promoting environmental well-being / environmental stewardship may result in reducing effort in the flyingfish fishery in some areas (protection of foraging fish populations, promoting large pelagic fishery viability, reducing overharvesting in stressed areas Eco-certification

Political Environment			
	Local	**International**	**Policy & Legislation**
Gender		Global movement to increase the role of women in fisheries Increased levels of education amongst women increases participation of women in fisheries governance	

Local

As in many situations the introduction of new management measures by governments has a direct impact on accessibility to the fishery by local residents. These measures may be necessary to protect the long-term viability of the fishery (i.e. sustainability), however, they do create short-term issues that can impact livelihoods. Furthermore, changing regulatory requirements for fishers may result in changes to fisher's perceptions of their industry (i.e. reporting requirements, licensing requirements, minimum vessel standards, etc. can strain relations between fisheries managers and fishers). There is an increasing pressure to implement these types of regulatory requirements in order to avoid the over-exploitation of marine life. However, the data and catch reports shared to international organizations, such as the FAO, are often incorrect and only report commercial catches that will be exported[35]. This puts additional pressure on local governments to develop new legislation to reduce misreporting and promote more sustainable use of fisheries. Changes in regulation can modify the ability for some people to participate in the fishery and this in turn can undermine or promote support for the local government.

A common explanation for fisheries management failing to achieve sustainability and conservation goals is rule-breaking by resource users. Solutions to increasing compliance to create sustainable marine resource management remain generally elusive. Complex laws coupled with heavy punishment can create confusion and resentment and often lead to increased rule-breaking among fishers. Because fishermen are unlikely to inform on their rule-breaking colleagues, there is a general lack of self– enforcement of rules among fishing communities. A study of coastal villages in the United Republic of Tanzania revealed that many fishers believe that the health of the marine resource is declining despite most participants being aware of rules controlling fishing activity. Nearly half of those interviewed believe high levels of rule-breaking exist. The authors found that "while some targeted enforcement may be effective this can only be carried out if the underlying socio- economic factors determining fishers' decisions to comply are understood and addressed." This study recommended that increasing awareness of the linkages between marine health and fisheries rule compliance, combined with promoting social environmental responsibility, should be part of long-term fisheries management strategies aimed at supporting sustainable use of marine resources[36].

International

Changes in political relationships between Nation Sates can have significant direct and indirect impacts on a local fishery, for example international trade agreements can open markets to locally caught fish, which

[35] Science Daily (2016). *Under-reporting of fisheries catches threatens Caribbean marine life.* Science News. Frontiers. Retrieved from [https://www.sciencedaily.com/releases/2016/08/160805115011.htm]

[36] Slater, Matthew J., Yunus D. Mgaya, and Selina M. Stead. "Perceptions of Rule-Breaking Related to Marine Ecosystem Health." PLoS ONE 9, no. 2 (27 February 2014). https://doi.org/10.1371/journal.pone.00891

in turn, can stimulate directed harvesting. Similarly, creation of trade barriers can undermine fisher's livelihoods if harvests are subject to new tariffs in traditional markets.

In some instances, international discourse on emerging global priorities (i.e. fair trade, human rights, environmental sustainability, etc.) can have an impact on harvest practices within local fisheries. These impacts can be the result of changing market relationships, or new environmental protection measures, such as marine protected areas being implemented to meet new international standards. This can have both positive and negative impacts on local livelihoods, particularly if local fisheries are already meeting new international environmental and labour market standards. However, if they are not, then the adjustments may impact some fishers negatively.

While increased trade can improve food security and promote economic prosperity in general, it can also have negative impacts on the welfare of particular communities and groups of people. Negative impacts can include:

- Reduced fish supply for household consumption decreasing food security in areas with few other available options / agricultural resources.
- Higher local prices of fish due to excess demand.
- Competition from artificially low-priced imports due to subsidies in exporting countries.
- Environmental degradation from aquaculture or harmful fishing practices.

Fish production for export can also divert investment away from harvesting and processing fish for domestic markets, which can displace fish workers from their traditional livelihoods. Trade-induced changes in technology and infrastructure can also impact the livelihoods of small-scale fishers and other fishing industry workers. Women who work in fisheries are often most vulnerable to changes that result from trade liberalization, particularly those engaged in the processing and trading of fish who can be displaced due to shorter, export- oriented supply chains[37].

In summary, the following political impacts may be important for consideration in the management of the flyingfish fishery:

- Harmonization of flyingfish fishery regulations amongst CRFM Member States can impact the cost of fishing (i.e. changes in gear, changes in location of fishing) for some groups within the fishery.
- International fisheries management arrangements (ICCAT) can impact the harvesting of local tunas, therefore, impact flyingfish used as bait.
- Marine protected areas in the Eastern Caribbean may reduce areas where flyingfish fishing can occur.
- Global movement to increase the role of women in fisheries.
- Increased levels of education amongst women increases participation of women in fisheries governance.

Policy and Legislation

As a result of changes in fisheries management necessary to promote sustainability governments often need to introduce additional policies and regulatory instruments. These measures are related to the local and international political processes mentioned above, however, the specific impacts of policy and regulatory changes are focused more directly on the fisheries which are the subject of the new policies and regulations. Impacts resulting from changes in policy and regulations that may be experienced in the flyingfish fishery include:

[37] Trollvik, T. (2002). The impact of WTO agreement on fish trade. FAO Fisheries circular No. 977, Rome, Italy.

- Introduction of species-specific harvesting licenses can have a social and economic impact on fishermen (increase cost of fishing and sense of control of their own livelihood) and removes the opportunity for people to informally fish commercially on a needs basis.
- Promoting environmental well-being/ environmental stewardship may result in reducing effort in the flyingfish fishery in some areas (i.e. protection of foraging fish populations, promoting large pelagic fishery viability, reducing overharvesting in stressed areas, etc.).
- Eco-certification of the harvest places additional burdens on the industry regarding monitoring and reporting (i.e. gear type and use, location of fishing, time of fishing, stock status, etc.), which can put additional financial burden and training requirements on fishers.

TARGETED HARVESTING VARIABLE IMPACTS

Humans are a component of the marine ecosystem. Sustainable fisheries is one in which human caused mortality of fish through harvesting is in balance with other ecosystem activities and functions. When fishers target flyingfish and the fishing pressure exceeds that which is in balance with other ecosystem functions (production and other causes of fish mortality – predation, etc.) then there can be direct impacts on the fishing industry. The following table highlights some of the potential impacts that excessive targeting of flyingfish can have on the fishery.

Table 4: Targeted Harvesting Variable Impacts on the Flyingfish Fishery

Targeted Harvesting		
	Fishing Pressures	**Changes in Abundance**
Social	One causes the other (fishing pressure impacts the abundance of a species – more you fish the less fish there are) If fishing pressure exceeds sustainable levels there can be conflict between harvesters	In periods of low abundance targeted fishing can create conflict between fishers
Economic	Standard fisheries economic – as the return on effort goes down there is greater competition, resulting in price going up, which in turn increases pressures, ultimately leading to economic collapse	Decrease in abundance of fish stock directly impacts local economy through decrease in access to resource, decrease employment opportunity, etc.
Environmental	High fishing pressure can alter the ecosystem relationship between the foraging fish and other higher tropic species (i.e. tuna).	Changes in abundance can alter ecosystem integrity and undermine sustainability

Fishing Pressures

There are a number of fishing pressure factors that can impact a fishery, including the flyingfish fishery. Fishing pressure is defined as the anthropogenic impact that fishing activities have on the natural resource. This can be represented through a number of fishing pressure indicators such as (1) capacity – number of vessels, (2) fishing effort – days at sea, (3) frequency an area is fished and (4) annual fishing mortality[38].

Anthropocentric activities such as industrial fisheries and overfishing can impact ocean productivity, marine ecosystems, ecological processes and fish population distribution[39]. Fishing pressures have a direct impact on fish species by reducing their abundance, affecting life history (growth, maturation, spawning and recruitment), structure, sex ratio and species composition of the community (*ibid*). Furthermore, in developing countries, which are dominated largely by artisanal fisheries that are characterized by large numbers of small boats, the level of fishing effort is more difficult due to the lack of data[40]. The following map (Figure 5) illustrates the fishing effort densities in the wider Caribbean. It is important to note the limitations of the data used when referring to this map as it is directly influenced by the accuracy of the spatial data obtained for each fishery; the more accurate the data, the more intense the fishing appears to be (*ibid*).

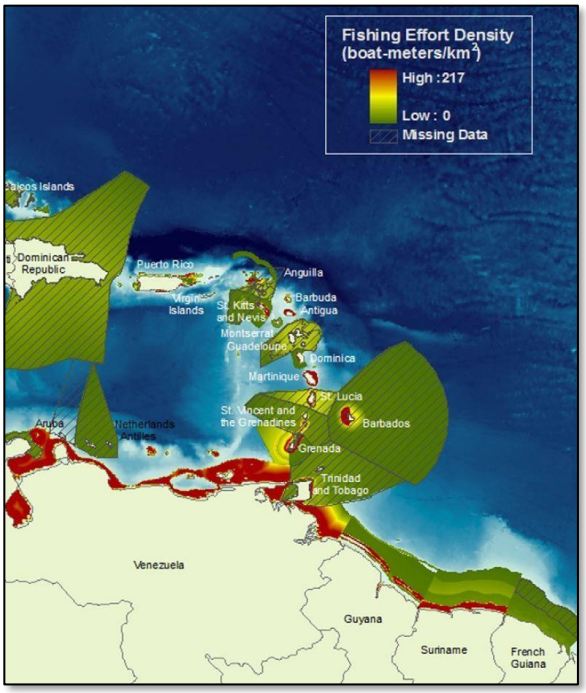

Figure 6: Aggregated coastal fishing effort in boat-meters across all gears and development levels in the wider Caribbean[41].

[38] Piet, G.J., Quirijns, F.J., Robinson, L. & Greenstreet, S.P.R. (2007). Potential Pressure Indicators for Fishing, and their Data Requirements. *ICES Journal of Marine Science.* 64:110-121.

[39] Pardo, F. (2014). Effects of Climate Change and Fisheries on the Distribution of Marine Fish in the Caribbean Colombian Sea Based on Traditional Artisanal Fishing Knowledge. *Major Paper for Faculty of Environmental Studies, York University.* Toronto, On.

[40] I., & Halpin, P.N. (2010). A regional analysis of coastal and domestic fishing effort in the wider Caribbean. Fisheries Research 102; 60-68.

[41] Dunn, D.C., Stewart, K., Bjorkland, R.H., Haughton, M., Singh-Renton, S., Lewison, R., Thorne, I., & Halpin, P.N. (2010). A regional analysis of coastal and domestic fishing effort in the wider Caribbean. Fisheries Research 102; 60-68.

Changes in Abundance

There may be multiple factors that impact the abundance of flyingfish (see climate change section above, etc.), however, targeted fishing of flyingfish can directly impact the abundance of the resource, particularly if the level of effort exceeds that which the resource can sustain. As a result, during periods of time when there is low stock abundance there is a potential for conflict amongst harvesters for access to the resource, pricing, repairs, etc. Finally, changes in abundance can alter ecosystem integrity and undermine sustainability.

High fishing intensity as a result of increased demand (i.e. from consumer markets, tourism, fish meal for aquaculture, etc.) has been identified repeatedly as the primary driver of global overfishing. Zhoue et al point out, however, that the low overall fishing mortality rate at an ecosystem level and the limited proportion of globally overfished stocks suggest that fishing pressure alone is only a part of the problem. The root of the problem, they suggest, is selectively catching too many fish of a certain type, size, or sex, either within a species or a community[42].

TECHNOLOGY VARIABLE IMPACTS

There is a growing awareness of the need to apply new technologies to the fishing industry in order to meet local, national and international obligations for sustainable fisheries management. These technologies apply to all stages of the value chain, including harvesting, fish handling, vessel operation, monitoring, processing, and marketing. The introduction of new technologies can have a direct impact on the flyingfish fishery, including those listed in the table below.

Table 5: Technology Variable Impacts on Flyingfish Fishery

	Technology
Social	Technology based industries are competing for youth in the labour market – therefore fewer young people entering into the fishery As advanced education becomes more accessible to residents of coastal communities fewer youth seek direct employment in resource-based industries, such as fishing
	Technology
Economic	As requirements change for the use of new technologies in order to access the fishery or fish markets change (gear, monitoring/reporting, etc.) there can be a greater economic burden on existing and new entrance to the fishery

[42] Zhou Shijie, Smith Anthony DM, and Knudsen E Eric. "Ending Overfishing While Catching More Fish." *Fish and Fisheries* 16, no. 4 (February 3, 2014): 716–22. https://doi.org/10.1111/faf.12077.

Technology based industries are competing for youth in the labour market, therefore, there are fewer young people entering into the fishery. However, some of the new technologies involved in monitoring and data processing are more easily understood and used by youth. As advanced education becomes more accessible to residents of coastal communities, fewer youth seek direct employment in resource-based industries, such as fishing[43]. As a result, there are labour market changes resulting from the application of new technologies in the fishery.

As requirements change for the use of new technologies in order to access the fishery or fish markets change (gear, monitoring / reporting, etc.) there can be a greater economic burden on existing and new entrance to the fishery.

Electronic Monitoring

To promote the conservation and sustainability of fisheries resources, fisheries divisions require accessible, dependable, and timely data. Fisheries management relies on scientific advice based primarily from stock assessments that utilize numerous forms, sources, and types of data, including but not limited to, catch data, spatial data, temporal data, and type of gear used and level of effort. Internationally, some of these key data have been collected through at-sea fisheries monitoring programs. At-sea fisheries observers are placed on commercial vessels to collect biological data on catches, monitor compliance to fisheries regulation, and provide technical reports on their findings to government fisheries departments.

In many cases, fisheries monitoring can enhance a country's ability to meet its fishery management obligations, including obligations to international species management, and support the continued development of and eco-certification programs in fisheries.

Increasingly, electronic monitoring programs are being introduced to replace, or augment at-sea observer programs. Electronic monitoring is most commonly based on the use of multiple cameras recording deck spaces from which fishing activity occurs. The video of fishing activity is recorded then analyzed to determine amount and size of fish caught, number of discards and presence of endangered or prohibited species in the catch. In some instances, electronic monitoring may also include electronic flow scales that record the weight of fish caught.

Electronic monitoring can impact human behavior. If the video recordings become property of the government, fishers can perceive electronic monitoring as a statement that the government does not trust them, creating animosity between fishers and government. As a result, fisher may avoid efforts to collect data at all. Furthermore, in situations where buyers are actively engaged in the sale of unsanctioned or illegal catch (IUU fisheries), buyers may find more ways to have fishers covertly target desired species outside the electronic monitoring program. Buyers may also actively campaign against electronic monitoring. In these instances, this can have a significant impact of the social and emotional well-being (mental health) of the fishers and their communities.

[43] Tam, J., K. Chan, T. Scatterfield, G. Singh, & S. Gelcich. (2018). Gone fishing? Inter-generational cultural shifts can undermine common property co-managed fisheries. *Marine Policy.* 90; 1-5.

SECTION III: VARIABLE IMPACTS MATRIX

The following table provides an overview of all of the categorical variable impacts discussed in Section II that may impact the overall health, demand, marketability, accessibility, and sustainability of the flyingfish fishery.

Table 6: Categorical Variable Impacts Matrix on the Flyingfish Fishery

	Climate Change	Markets	Political Environment	Targeted Harvesting	Social Variables	Technology
Climate Change		Climate change effects on Caribbean do not directly affect Global Markets Food production impaired in other region, creates demand for Caribbean products. Climate change affects infrastructure in Caribbean, decline tourism. Influx and widespread distribution of Sargassum in	Influx and widespread distribution of Sargassum in Eastern Caribbean has created frustration within the fishing industry, which translates into political frustration.	Changes in distribution due to climate change - result in over harvesting where abundance diminished, or creates opportunity where abundance increased. Conditions may be improved in other places for other flyingfish. Influx and widespread distribution of Sargassum in Eastern Caribbean reduces the area in which	Climate change displacing people from other industries end up moving into fishery. Fishing as last resort Climate change can pull people out of fishery into restoration projects.	

	Climate Change	Markets	Political Environment	Targeted Harvesting	Social Variables	Technology
		Eastern Caribbean results in decrease landings which directly impacts the availability of flyingfish in the marketplace		flyingfish fishing can be targeted.		
Markets		Potential to create market for flyingfish with increase in tourism in Caribbean. Globally marketed foods displacing flyingfish as a culturally relevant local food Increased demand for fresh tuna (large pelagics) in the tourism industry makes flyingfish more attractive to be used as bait	Pressure on local government to create relationship with external markets. Fishermen have a lot of political power and care about their ability to sell fish – pressure on government to create opportunity to sell fish – increasing the value of the catch – get more for their catch –finance market infrastructure	Increased markets - increased demand - increased pressure on fishery. If harvesting over optimal yield, they need to reduce fishing pressure (displace market with other product). Eco- marketing/ fair trade can put public scrutiny on fishing pressure (eco certification movement)	Improved markets can improve social conditions amongst fishing families Creating more corporate marketing structures can displace local family structures Increased income can negative social consequences (drug/ alcohol use, domestic problems, poor spending habits	Improved markets – afford better technology – if flyingfish are really valuable fisher might move from day boat to ice boat – impact on intensity of fishing Higher value drives innovation – technology advancement

	Climate Change	Markets	Political Environment	Targeted Harvesting	Social Variables	Technology
					Declining markets creates economic hardship on families and communities – forces people out of fishing – potential to lose the social memory, heritage, skills	
Political Environment		Changes in trade agreements / creation of trading blocs impact market access for Caribbean fish products, preferred tourism destinations. Lack of political will have a negative impact on market development (i.e. Barbados vs. Tobago)	Conflict over transboundary management (control and access of flyingfish) between Caribbean States Enforcement – States fishing within other State's waters – prevent IUU Lack of local commitment to regional processes and lack of connection between	Political uncertainty related to undermining the control of fishing pressure Lack of political will to reduce effort in the fishery / impose new regulations/policy	Social impacts of all to the left (ex. Too much fishing going on that eventually affects sustainable livelihoods).	Lack of political will to use technologies that could be helpful in management (information technology for data acquisition and analysis) Demand for support in new technologies

	Climate Change	Markets	Political Environment	Targeted Harvesting	Social Variables	Technology
		Government needs to support flyingfish industry and they don't (Grenada) – Government could help – policy could help increase market opportunities Finance restrictions on getting loans (lack of access to capital)	regional processes and local realities			
Targeted Harvesting		The harder you fish the more you land – brings price down Increased effort leads to increased landing which leads to decreased value Increased pressure increases the 'pressure' to land fish fast that can impact quality that can impact price	More fishermen more votes Disproportionate effort between States can lead to animosity		Decreased landings can create economic hardship for fishing families Displacement – loss of access to resource (because of climate change) can lead to people having to exit the fishery to	The further people have to fish the more they have to rely on increased technology. Day boats to ice boats – longer at sea duration – use of ice holds – this could be increased by climate change

	Climate Change	Markets	Political Environment	Targeted Harvesting	Social Variables	Technology
					seek alternative employment If there is an increase in fishing activity, then people can migrate into it from other sectors Decline in flyingfish landings or revenues from flyingfish can lead to livelihood diversification (ex. Tourism – boat rides)	Finding other ways of harvesting in sargassum rich areas Using At-Sea Observers or Video to monitor fishers' activities and catch
Social Variables		Eco-certified and fair trade – global social initiatives Inundation of external cultures (advertising/TV/ American mono-culture) decreasing demand for local	Pressure by fishermen for government to do more – invest – provide more government support (program support)	Healthy eating – movement to eat fish – increased consumption Less socially/ economically desirable to be a fisherman		Use of social media amongst fishermen to communicate areas of fishing activity is high Greater comfort to adopt technology use

	Climate Change	Markets	Political Environment	Targeted Harvesting	Social Variables	Technology
		cuisine and increased demand for imported foods (fast food) which displace flyingfish in local markets		Increasingly harder to find crew to fish		Social media used for marketing
Technology		Social media used as a tool to market Cell phones used to market Streamline processing to get fresher product to market Processing technology - Creating new products new markets	Social media interaction with political – increased ability to communicate and put pressure.	Improved technology increases fishing efficiencies / landings.	Social media changes / could change public awareness of issues around FF. Potential to use tech / social media in education, training,	

SECTION IV: CONCLUSION

Desktop review of relevant literature and the 'blue sky' exercise show that there are complex relationships between different types of impacts on the Eastern Caribbean flyingfish fishery. These impacts are not independent but are interrelated and indeterminate. As a result, it is difficult to fully assess the overall effects of the multiple variable impacts on the flyingfish fishery without extensive research.

The overall impacts of the multiple variables on the flyingfish fishery has a high level of uncertainty. There is considerable literature on processes to deal with uncertainty in biophysical assessments of fisheries resources. As a result of this work, the precautionary principle was introduced for management decision making to protect resources from over- harvesting. The assessment of variable impacts further highlights the need to deal with uncertainty with respect to climate change, changing geo-political and socio-economic conditions in the fishery. The following figure illustrates the complex relationship that exits between the multiple variables that can impact the fishery, including health of the fishery resource, social condition of fishing industry, and the economic viability of communities who are dependent on fishery resources.

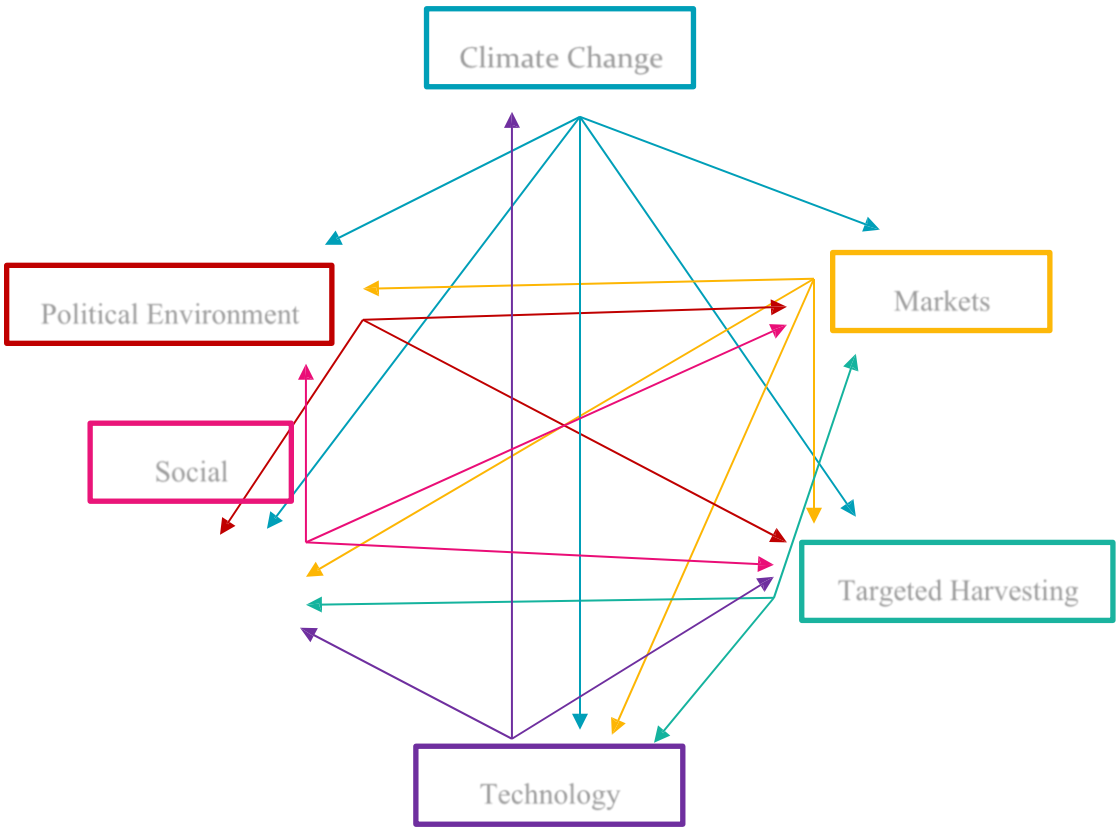

Figure 7: Inter-relationships between Categorical Variables

To address the uncertainty national governments and regional organizations should collaborate in sharing information related to the multiple variables and not just catch and landing statistics to determine stocks abundance. The enhanced understanding of local effects on climate, changing market relationships within domestic markets, changing demographics of the fishing industry, changing international marketing opportunities, introduction of new technologies (FADs, gear, vessels, electronic monitoring, etc.) and changes in directed effort on flyingfish stocks will improve the overall understanding of the fishery upon which each of the Member States depend.

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The CRFM is an inter-governmental organization whose mission is to "Promote and facilitate the responsible utilization of the region's fisheries and other aquatic resources for the economic and social benefits of the current and future population of the region". The CRFM consists of three bodies – the Ministerial Council, the Caribbean Fisheries Forum and the CRFM Secretariat.

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