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BIOECONOMIC ANALYSIS OF THE FLYINGFISH FISHERY IN BARBADOS

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ABSTRACT

The flyingfish is synonymous with Barbados *('land of the flyingfish')*, its heritage, and its culture, and is by far the most valued fish species harvested by Barbadian fishermen. In 2007 the fishery had an estimated ex-vessel value of $3.6 m BDS and an estimated overall value of $37.5 m BDS. This rather short lived species is available for harvest for only about seven months of the year during which time fishers must make full use of their time and efforts to reap maximum economic benefits from the fishery. The flyingfish is part of a shared Eastern Caribbean stock and as such there are no management systems in place either nationally or regionally for this fish stock. In order that Barbadians continue to enjoy the benefits derived from this fishery there must be an understanding as to the economic yield potential of the fishery and a strategy to manage it in a sustainable manner. This study uses a simple bioeconomic model to aid with the analysis of the fishery and recommends that specific management objectives for the flyingfish fishery be outlined in the Fisheries Management Plan with respect to research, management options for the harvest sector and continuous training and education of fishers, all geared towards achieving maximum economic benefits through a well-managed fishery.

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1 INTRODUCTION

The harvesting of flyingfish in Barbados has been an on-going activity for many years. The establishment of a Fisheries Department in the early 1940s placed much emphasis on the training and development of fishery workers and the introduction of new technology. With these newly acquired skills and fishing techniques came improvements in fish catches, this created several commercial opportunities for persons in this small but viable fishing industry. Over the last 70 years several changes took place in the fisheries sector that saw the industry develop from an artisanal fishery to one of greater industrial activity. The fishing fleet evolved from one using sail boats where safety and time spent sailing to and from fishing grounds were major issues to a more modern fleet which boasts vessels that stay at sea in excess of seven days and are better equipped for harvesting the flyingfish many miles offshore and preserving the catch. The flyingfish fishery in Barbados is unique in the region in that the target species is not only used as bait fish, but it is primarily processed for consumption and sold on the local market. It is important for current and future generations of Barbadians that the heritage and the cultural link associated with the traditions of fishing and the processing of flyingfish are preserved (Appendix 1a). In order to accomplish this, the fishery has to be economically viable. An economically viable fishery would also provide a measure of food security, reduce the import cost of fishery products and continue to provide a high quality fish product for local consumption.

The topic selected for this project embraces some aspects of the goals related to the national fisheries policy as well as the stated goals for the fisheries sector which include an increase in quantity of fish harvested by fishers to enhance their livelihood while assuring sustainable management and development of the fisheries resource (Government of Barbados, Ministry of Agriculture 2010).

In order to be able to manage the flyingfish fishery there must be a greater awareness and understanding by resource users as to how to improve their economic efficiency while maximizing their economic yield and a plan as to how to sustain the benefits to be derived from the resource for future uses through efficient, effective and sustainable management measures.

The aim of this study is to assess the flyingfish fishery of Barbados relative to the Eastern Caribbean stock and suggest ways to manage the fishery to maximize economic yield within the EEZ of Barbados.
More specifically the research will:

1. Model the flyingfish fishery in Barbados and the Lesser Antilles area (Southern Caribbean).
2. Use the information obtained from the model to assess:
    a. The maximum economic yield for the Barbados fishery;
3. Recommend management options for sustainable management of the fishery.

Chapter two of this paper looks briefly at the relative location of Barbados to its regional neighbours and the Barbadian fishing industry of which the flyingfish is an important species to the local market.
Chapter three describes the model used in this paper to examine and analyse the areas for discussion as it relates to the flyingfish fishery.

Chapter four looks at the outcomes of the analysis from the modelling of the fishery as it relates to maximization of economic yield, sustainable fishing effort and social welfare benefits considering the fishers, the consumers and the overall benefit to society.

The discussion arising from the outcome of the model and general overview is covered in chapter five.

A summary conclusion of the report is at chapter six.

Chapter seven looks at some recommendations for consideration in the further development of the flyingfish fishery.

2 BARBADOS FISHERIES

Barbados is a small island state and a former colony of Britain and part of the British West Indies Overseas Territories, independent since 1966. Located at latitude 13º 10'N of the equator and longitude 059º 35'W of the Greenwich Meridian, it is the most easterly of the Caribbean islands (Figure 1).

Figure 1: Barbados’s location in the Caribbean (http://www.google.is/images).

Barbados has a total maritime space of approximately 48,800 km^2 of ocean. The mainly low relief coralline island has a total land area of about 432 km^2 and a coastline 95 km long. The continental shelf is small, only 320 km^2, and deep water is found close to shore.

The Territorial Waters (TW) sea limit of 12 nautical miles (NM) is enforced by local Coast Guard and Marine Police. It is within these waters where artisanal fishing is done. Coastal pelagics and reef fish are harvested using a combination of nets, hand lines and fish traps.
The maritime space of the EEZ is determined by the mid-point between the neighbouring territories except on the eastern side where it extends the full 200 NM (Figure 2). This area is yet to be fully exploited by local fishermen.

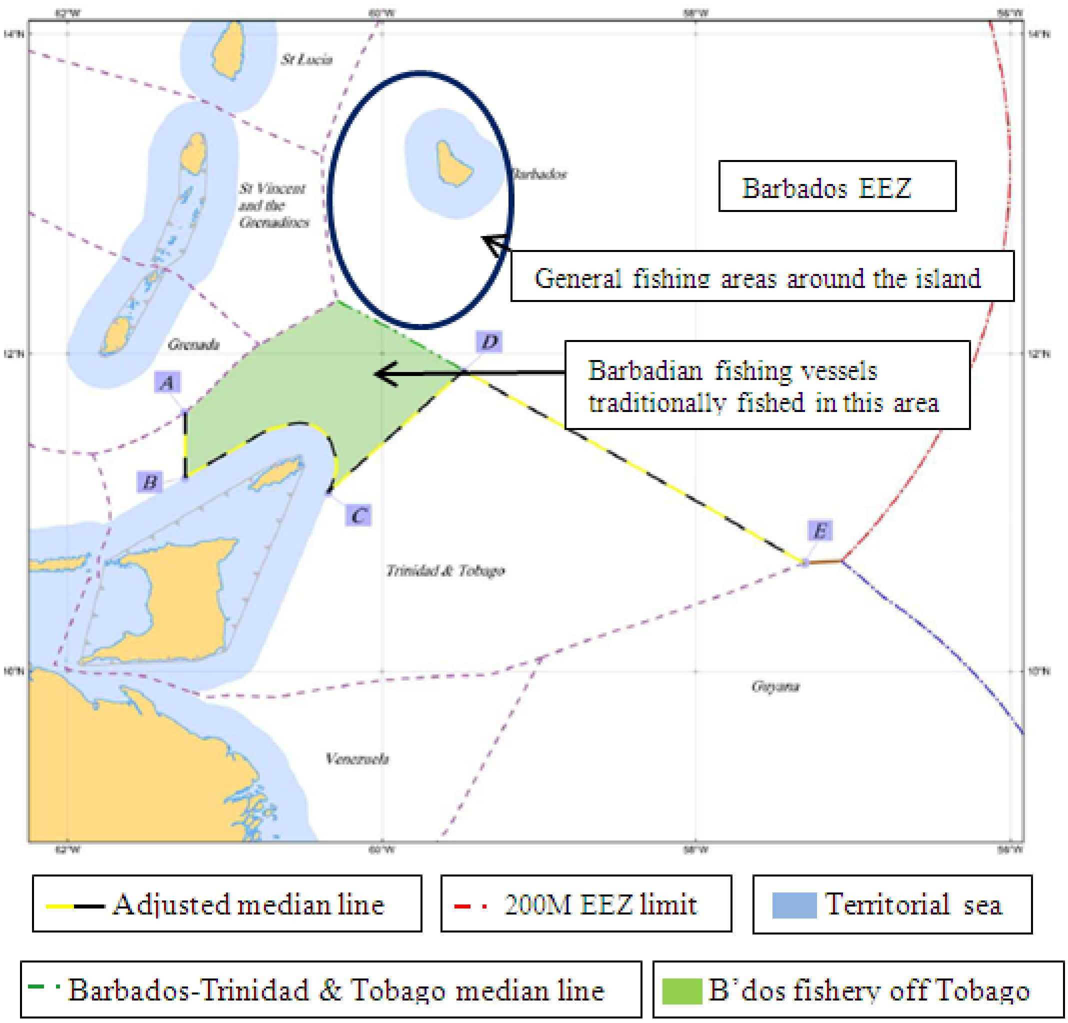

Figure 2: Barbados's EEZ and relative fishing areas (final award of the Arbitral Tribunal Barbados *vs.* Republic of Trinidad and Tobago 2006 – Map 1).

2.1 The Fishing Industry

The Barbados fishery is best described as a multi-species, multi-gear, open access fishery. Barbados has a long record and well documented flyingfish fishery with good records of harvest over the past 60 years (Mohammed *et al.* 2003, Figure 3). During this time the fleet evolved from a sail boat fishery to one of the more modern advanced small mechanized fleets in the region (Willoughby and Cecil 2001, Appendix 1b). Today, the commercial fishing fleet comprises four types of vessels constructed of wood, glass reinforced plastic (GRP) or a combination of both. Day boats and ice boats are used in the fishery for flyingfish and its associated predator, the dolphinfish (Table 1). Over time the number of ice boats has been increasing while at the same time the number of day boats declining (Figure 4). Even so, day boats are still a very common feature in this fishery. The fishing areas exploited by the vessels engaged in harvesting flyingfish vary with the time of year. Most of the activity is generally concentrated to the West and South-west of the island and is consistent with the movement of the flyingfish as part of its migration process as the fishing season progresses from November to July (Figure 2).

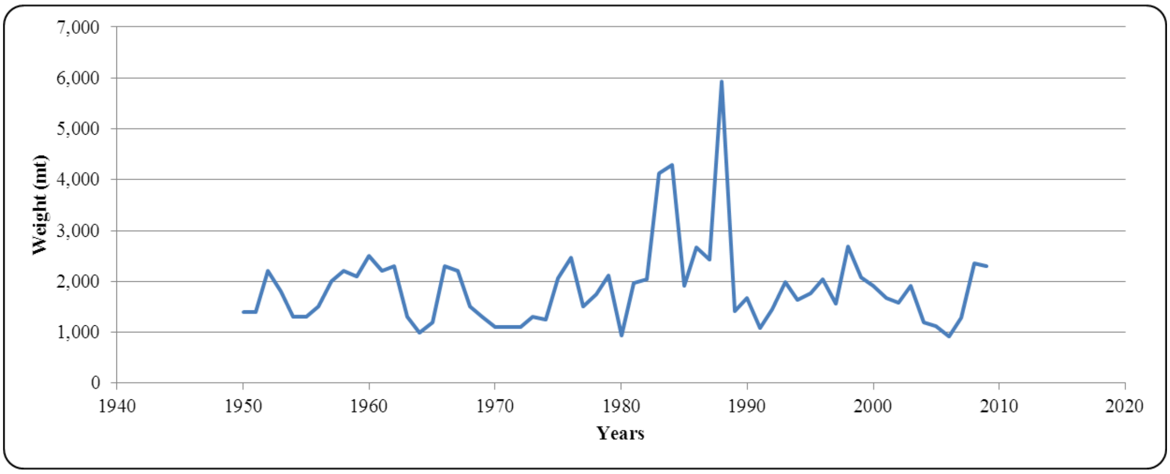

Figure 3: Barbados flyingfish landings 1950-2009 (Fisheries Division, Ministry of Agriculture 2010).

Table 1: Summary of the commercial fishing fleet by type, associated gear and propulsion used (Government of Barbados, Ministry of Agriculture 2010).

Vessel Type	**Length**	**Propulsion**	**Species Targeted**	**Gear Used**	**Fishing Area**
Moses	< 6 m	5-40 hp outboard motors or oars	Reef fish	Traps, hand lines, trolling lines, cast nets	Coastal <5 NM
Day boat	6-12 m	10-180 hp inboard diesel and some carry 60-150 hp outboard motors	Flyingfish and Dolphinfish	Gill nets, hand lines, trolling lines & few use seine nets	Coastal/Offshore Up to 25 NM
Ice boat	>12 m	150 hp >	Flyingfish and Dolphinfish	Gill nets, hand lines, trolling lines	Offshore > 25 NM
Long liner	>12 m	Up to 650 hp inboard diesel motors	Large pelagics- tunas, swordfish, bill fishes	Long line	Oceanic >150 NM

The fishing fleet has grown steadily in size since 1954 after the fleet was destroyed by hurricane Janet. The period 1978-1992 saw a rapid expansion of the Barbados fishing fleet with the addition of the ice boat. Landings of flyingfish were practically doubled as the ice boats were better equipped than the day boats, had a longer range and a greater capacity for storing the flyingfish on ice and therefore could remain at sea for much longer periods of time. The noticeable change in numbers of day boats *vs.* the rise in numbers of ice boats between 1997 and 2009 was attributed to some owners converting from one type of fishing activity to another (Figure 4). The changes in the design, construction and some modifications made to earlier designs of vessels that characterised the Barbadian fishing fleet over the years influenced the development of social and economic activity associated with fishing. There were improvements in both the quantity and quality of fish landed; these improvements were a result of the improved capability, capacity and durability of the vessels now operating in the fleet coupled with the application of fish handling skills acquired by some of the fishing vessel crews through training. Other areas in which there were notable changes during the period 1940–2009 were:

1. The improvements to infrastructure at public fish markets and fish landing sites in Barbados (e.g. Oistins and Bridgetown Fishing Complex) – this offered an improved work environment for the fishery workers in the post-harvest sector who are directly involved in the processing of flyingfish (scaling and boning).
2. The emergence of private fish processing plants – this added another dimension in the value chain of flyingfish production in Barbados (Government of Barbados, Fisheries Division 2010).

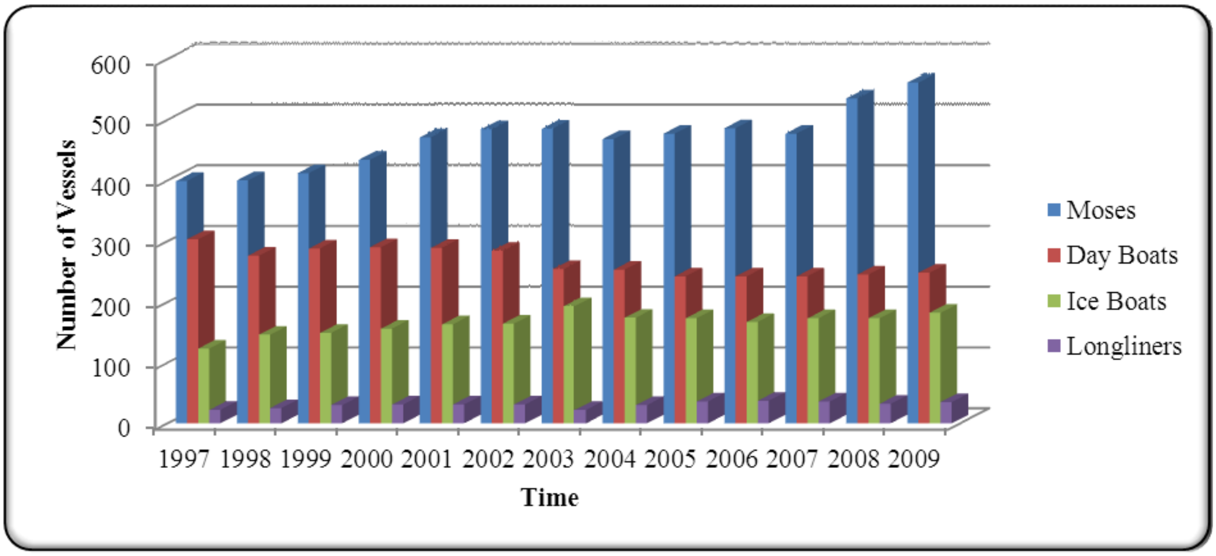

Figure 4: Composition of the fishing fleet in Barbados 1997-2009 (Government of Barbados,, Ministry of Agriculture 2010).

2.1.1 Biology of the flyingfish

The four-winged flyingfish *(Hirundichtuys affinis)* is one of 13 species of flyingfish found in the Eastern Caribbean and is one of three known to be exploited, accounting for about 90% of all flyingfish landed. This is a short-lived single stock species and grows to full size in 12 months (maximum length ~25 cm). The diet of the flyingfish comprises mainly zooplankton and nekton. They are the prey of many large oceanic pelagics such as dolphinfish, wahoo, billfishes and large tunas and as such are an important bait fish for targeting these species. Flyingfish may live for 1-5 years but rarely live beyond the first spawning (Oxenford 1994). Spawning takes place twice a year in May/June towards the end of the peak fishing season and at the end of November; but may take place throughout the year (Lewis *et al*. 1962). Floating objects, debris or if available any fish aggregating device once present in the water are used primarily as spawning substrate by mature flyingfish ready to spawn. Flyingfish is mainly available for exploitation between November and July and supports fishers in the Eastern Caribbean, Curacao and off the North-east Brazilian coast. The preferred spawning area in the Southern Caribbean is the shelf area off the North-west coast of Tobago (Oxenford 1994). The habitat of the flyingfish is generally the open ocean (Appendix 2). Information from other studies estimates that the annual natural mortality rate of the flyingfish is between 83% and 99%, but this estimate may include migration as well as mortality (FAO 2010).

2.1.2 The value and relative importance of the fisheries sector to Barbados

Flyingfish landings account for approximately 62% of annual fish landings with an ex-vessel value of $3.6 m BDS. As the fish move from point to point through the value chain and along various pathways to the consumer there is a great deal of value added to the final product, with a realized economic value estimated at $37.5 m BDS, approximately 10 times more than the ex-vessel value (Mahon *et al.* 2007). Over 6,000 persons find employment with the harvesting and other activities related to the flyingfish fishery (Table 2). Apart from direct employment and job creation in the fisheries sector there are many other ways and benefits, tangible and intangible, that the fishery has made its impact on the socio-economic landscape of Barbados, e.g. in relation to tourism, support services to the fishing industry, culture and heritage.

Table 2: Summary valuation of five species of commercial importance to the Barbados fisheries (Mahon *et al.* 2007 and Fisheries Division, Ministry of Agriculture 2010).

Species	Est. annual Landing Range (MT)	Gear Used	Value BDS ($) Ex-vessel	Economic Importance	Other Considerations
Snapper	6-32	Fish traps, hand lines	164,300	BDS $901,300 per year. Highly priced luxury product in high demand on the local market.	Potential yield est. for Barbados shelf range from 18-80 t/yr. Requires investment in fishing equipment to increase yield.
Flyingfish	**1100-2600**	**Gill nets, hand lines & dip nets.**	**3.6 million**	**BDS $ 37.5 million.**	**Accounts for ~62% annual landings. Provided full-time employment for ~2,800 persons in the fishery sector.**
Dolphin fish	357-745	Trolling & lurk line. This fish is harvested with the flyingfish	5 million	BDS $13.5 million.	~22% of total fish landings. Fishing effort increased in both size and number of vessels. Potential yield is unknown due to lack of stock assessment. The dolphin fish is a known predator of the flyingfish.
Yellowfin tuna		Long line	1.4 million	BDS $4.7 million.	Based on crude estimates of potential yield for hypothetical EEZs, Barbados's potential annual yield for Yellowfin is ~761 t.
Reef fish	7-16	Fish traps	89,300	BDS $152,500 per year. Linked to tourism and related recreational activities.	Potential of stocks unknown. Low populations due to habitat degradation and overfishing in some areas. User conflicts with tourism and coastal recreation.

2.1.3 Issues of a shared stock – Offshore pelagics

Pelagics such as flyingfish, dolphinfish, wahoo, tunas, bill fishes etc. are not confined to waters of any one island in the Eastern Caribbean. With respect to the flyingfish the main issue rests with an unresolved agreement to harvest flyingfish in the neighbouring waters of Trinidad and Tobago as Barbadian fishing vessels have traditionally fished in a section of the Trinidad and Tobago EEZ (Figure 2). The issue of the no fishing agreement with Trinidad and Tobago has restricted fishing activity in those areas once targeted by local fishermen.
While Barbados has been vigorously pursuing the flyingfish with great success, the other islands were less efficient in their harvest efforts. Fisheries records show the disparity in catches between Barbados and the rest of the islands with flyingfish harvest accounting in most years for over 80% of the landings, as compared to the other islands in the region whose landings are less than 500 MT (Figure 5). It must be noted that flyingfish catches for Tobago (part of the archipelago with Trinidad) is not accounted for in this record, however the Tobago estimated annual flyingfish landings are approximately 16% of annual landings (Table 4).

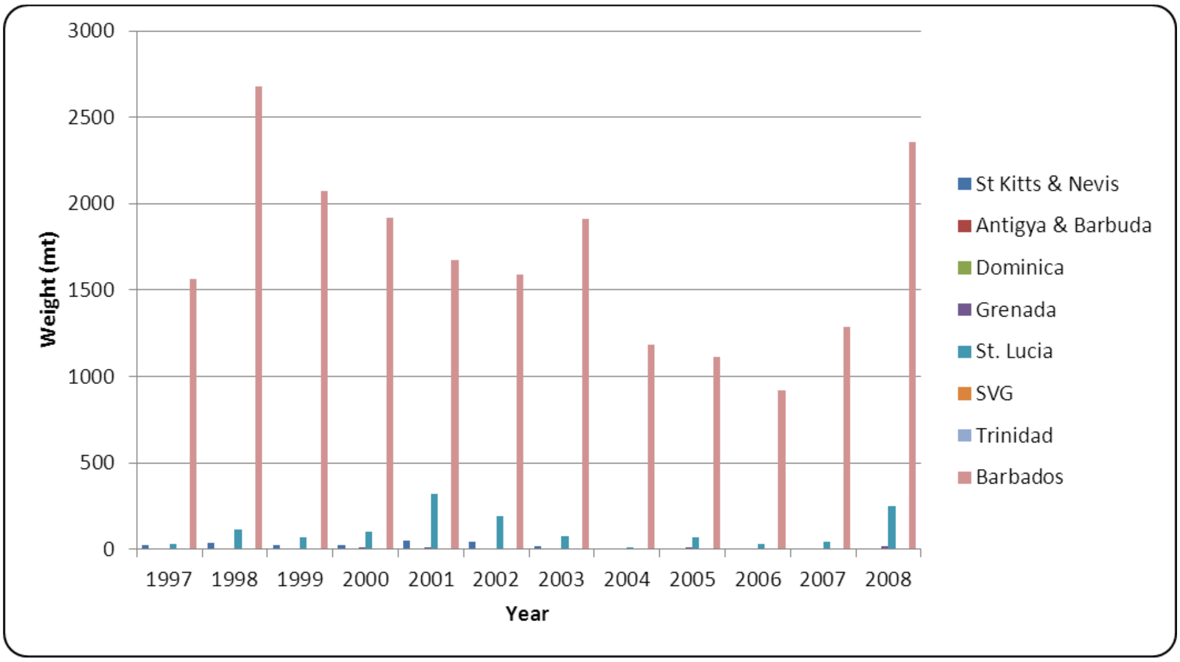

Figure 5: Flyingfish catches in the Eastern Caribbean (FAO 2009).

2.2 Fisheries management regime

2.2.1 Legislative rramework for fisheries management in Barbados

The fishing industry is regulated by several pieces of legislation, fisheries management plan, fisheries policies and international agreements to which Barbados is signatory and member to. The international instruments and organizations to which Barbados is signatory are in Appendix 3.

The fisheries sector is administered by the Fisheries Division, Ministry of Agriculture. There is a Fisheries Advisory Committee provided for in law and appointed by the Minister of Agriculture to advise the minister on all aspects of fisheries management and development.

The other key non-government stakeholder by whom fishery workers are represented is the Barbados National Union of Fisherfolk Organizations (BARNUFO). This is a non-profit organization whose members are drawn from registered fishery workers who are members of an established fisherfolk association (Appendix 4).

Fish tolls, catch and effort data and price statistics are collected at eight primary fish landing sites or markets. These markets are managed by the Markets Division, Ministry of Agriculture. Fisheries Division has part-time personnel who collect catch and effort statistics at secondary sites generally five days a week. For the tertiary sites (open beaches) data may be collected on a random basis by data collectors from the Fisheries Division (Appendix 5).

2.2.2 Enforcement

Monitoring, control and surveillance of fishing activities is carried out by the Coast Guard and Marine Police. This is primarily for compliance to requirements and not directly related to harvest efforts. However, strict control is maintained over the marine protected areas and the sea egg fishery.

The capability of the Fisheries Division to be involved in several areas of enforcement is restricted by the number of technical officers on staff. Two of the stronger areas of enforcement are the general administration and management of the fishing fleet operations and the conservation policy of the sea egg fishery. The department is also responsible for the inspection and registration of fishing vessels as well as the registration and issuing of cards for fishery workers. Provision has been made in law for the issuing of licences for vessels, fishers and fishing in specific areas. The Fisheries Division is also responsible for capturing and collating catch and effort related data. While information on fish landings is recorded at the major landing sites, other catch and effort monitoring relies heavily on self-reporting by fishermen after each trip.

2.3 Use of bioeconomic models

Bioeconomic models have been used in fisheries management to predict the impact of alternative management strategies applied to the harvesting of fish or other aquatic animals. Specifics such as population dynamics, stock assessment and recruitment, cost of implementing management policies or projects to enhance or control fishing effort and harvest are analysed.In essence, bioeconomic models are used to look at the optimal efficiency of a system.

The harp seal fishery in the North-west Atlantic (Canadian Arctic and Western Greenland) was the subject of a bioeconomic study conducted after a sustained period of harvest of the animal for over 20 years (Conrad and Bjorndal 1991). This seal was important because of the high valued seal pelts used in the garment industry in Europe at the time. The white fluffy furry coats attracted hunters for decades and it was thought that the population had been seriously depleted by the impact of hunting the harp seal. While the study was not done for an economic analysis, there were other outcomes such as population dynamics for pups and seals older than one year, the optimal herd size and the present value and revenues to be derived from the harvest of the pups and juveniles.

Iceland is well known for its great successes in fisheries management and has perhaps one of the most successful fishing industries for a small state. This makes the country a very good example of how the use of bioeconomic modelling has had a positive impact on the development of fisheries. The Icelandic demersal fisheries were the subject of a numerical model approach which involved multiple fish species (namely cod, haddock and saithe), three of the most valuable fish species to the Icelandic economy and whose annual catches earned in excess of $500 million USD (Arnason 1984).

The model took into account the complexity of multi-species, multi-fleet dynamics of the fishery. Further complexity in the model came by involving the component of the processing sector with different types of production processes. The model thus had the components of a biological part using a Beverton-Holt model, while the economic part contained the variables of the harvest and post-harvest sectors. The successes of such models can be used to compute efficient harvesting programmes and show the magnitude of benefits that can be derived from such programmes, calculate the outcome of alternative harvesting programmes and identify the productive areas for biological and economic research with the aid of using sensitivity analysis (Arnason 1984).

The successes of the development of the Icelandic fishery over the past 65 years serve as a good example and have many learning curves which small states can adapt to their own national fisheries development programmes.

3 DATA AND MODEL OF FISHERY

3.1 Data used

Data on flyingfish landings and fishing effort for Barbados during the period 1997-2009 were used in this study. The catch and effort data was collected at all primary and secondary fish landing sites around the island. The information on fish landings includes the landed catch (Table 3), the name and registration number of the vessel associated with the catch provided the relevant information on the type of vessel used. The ice boat is the principal vessel used to target the flyingfish but because there are other types of vessels operating in the same fishery it was necessary to use a scaling factor to equate the effort of all other vessels harvesting flyingfish to the effort of the ice boat (Appendix 6). The adjusted fishing effort, i.e. number of vessels, is provided (Table 3). The wet weight measure of the flyingfish was used in determining the number of individuals (flyingfish) per tonne. The Barbados data was obtained from Fisheries Division, Ministry of Agriculture.

Table 3: Recorded flyingfish landings and fishing effort in Barbados 1997-2009.

Year	**Landed weight (MT)**	**Effort (No. of vessels)**
1997	1,566	269
1998	2,680	243
1999	2,075	220
2000	1,916	216
2001	1,673	215
2002	1,590	206
2003	1,912	221
2004	1,186	219
2005	1,112	182
2006	922	190
2007	1,288	201
2008	2,354	169
2009	2,292	179

Price data for flyingfish (Figure 6) and the Retail Price Index (RPI) for Barbados were obtained from the Barbados Statistical Service. The price of flyingfish varies at each stage in the path from ex-vessel price (where the fish is sold by volume – price per hundred fish) to the value added product where it is sold by the price per kg of flyingfish. The data on fish imports from Guyana and Trinidad and Tobago as a substitute for flyingfish was obtained from the Agricultural Planning Unit, Ministry of Agriculture (Appendix 7). An average of 27 tonnes of fish was imported at an estimated $1.1 million (BDS) during the period 1997-2009. The data was used to analyse the impact on a substitute for flyingfish shortages as a result of demand.

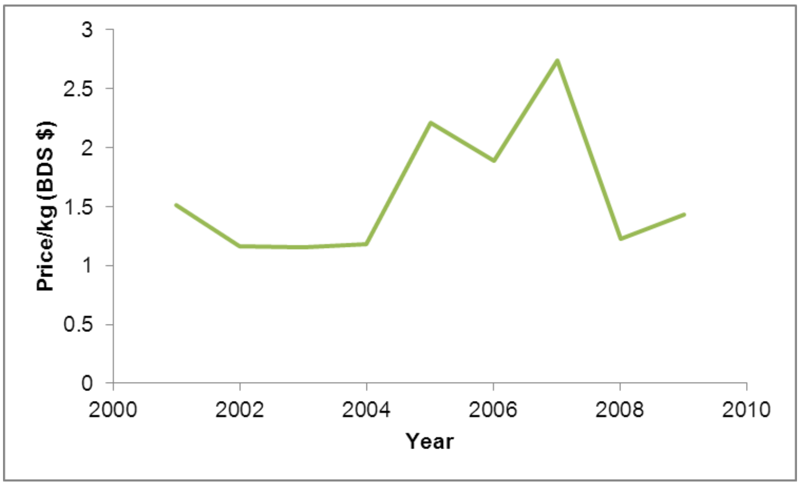

Figure 6: Price per kg of flyingfish from 2001-2009 (Barbados Statistical Service 2010).

Data on flyingfish landings for the islands in the Eastern Caribbean was obtained from the FAO database and FAO 2010 report including information on the Tobago flyingfish fishery. The estimated landings for the other islands in the region have been grouped as one because of the low volume of landings. The estimated biomass is based on the number of individuals in the stock at time t_{+1} and is based on stock analysis data (Table 4).

Table 4: Flyingfish landings and estimated biomass in metric tonnes for the Eastern Caribbean 1997 -2009.

Year	Barbados	T & T (est.)	Others Islands	Total Landings (est.)	Biomass
1997	1,566	503	58	2,127	20000
1998	2,680	566	155	3,401	22534
1999	2,075	585	90	2,750	22421
2000	1,916	517	135	2,568	22984
2001	1,673	570	381	2,624	23347
2002	1,590	605	240	2,435	23717
2003	1,912	639	99	2,650	23927
2004	1,186	466	14	1,666	23677
2005	1,112	229	81	1,422	24318
2006	922	191	33	1,146	24607
2007	1,288	183	47	1,518	26351
2008	2,354	210	264	2,828	25063
2009	2,292	n/a	n/a	2,292	23605

The information is being used in this study for comparison and to highlight the importance of flyingfish to Barbados against the rest of the islands in the region based on the volume of fish landed. The best available information for value and price for national fleet sectors in the Lesser Antilles was sourced from the report prepared by Mohammed *et al.* (2003) pages 18-21 and 31.

3.2 Development of the model

The objective of fisheries management is to make the fishery as profitable a venture as possible with a long term view of:

1. Efficiency in the management of the fishery,

2. Maximisation of fisheries' economic yield and
3. Identifying an optimum point at which (a) and (b) above can be achieved.

Predictive models of the fishery are used by fisheries managers to have a snapshot of the fishery and make decisions relative to the likely impact of fishing effort on the resource. These models include biological and economic information.

3.2.1 Biological part of the model

The flyingfish of the Eastern Caribbean region has been the subject of various studies. The most recent study by the WEACAFC Ad Hoc Fisheries working group is from 2008 (FAO 2010). The Beverton and Holt model was used to conduct a stock assessment of this fish species. The choice of this model for the study was based on the available data and the simplification of fitting the data to the model. The growth model used which is adapted from the study is:

(1) $$S_{t+1} = \frac{N_\infty R_0 S_t}{N_\infty + (R_0 - 1) S_t} \qquad N_{t+1} = \frac{N_\infty R_0 N_t}{N_\infty + (R_0 - 1) N_t}$$

where N_∞ is the number of individuals or the carrying capacity of the unexploited stock, S_t is flyingfish stock less harvest from the previous period at time t, S_{t+1} is the growth of the stock in the current time period t_{+1} and R_0 is the population rate increase factor, based on the parameters used in the stock assessment report. $N_{(t+1)}$ is total number of fish in the cohort at time t_{+1}. The number of individuals is derived by using the wet weight factor of the flyingfish which is given in this paper as ⅙ kg.

Calculating the stock level or any change taking place in the stock takes into account the growth (recruitment) of the flyingfish taking place in the cohort in the time period; this also takes into consideration the total mortality component (through fishing, predation and natural mortality ~97%) which is part of the resulting change in the number of individuals *(N)* within the population. The total flyingfish stock in time period S_t is comprised of new recruits from spawning, given the two peak spawning points during the active fishing season and also at which time the fast growing juveniles reach maturity. The flyingfish spawning stock is represented in the model where *x* denotes the spawning biomass.

(2) $$S_t = x = N_{t+1} - w * y(E_t)$$

The volume of harvest is dependent on fishing effort and the size of the biomass to which the effort is applied. Fishing effort *(E)* is measured as the number of vessels since the flyingfish is harvested by a range of vessels applying the same method but with a varying number of fishing days per trip. All vessels fish for approximately 125 fishing days per year, however the number of trips made by the ice boats are fewer with their average length per trip being seven days. The fishing effort per unit is based on a scaled ice boat equivalent number of vessels engaged in the fishery (Appendix 5). Harvest function is based on the Surplus Production model (Schaefer 1954), and is used to estimate harvest (yield) as a function of effort to determine MSY and MEY:

(3) $$y(E) = aE_t + bE_t^{\,2} \qquad y/E = a + bE_t$$

where *y* is harvest at time *t*, *E* is the fishing effort at time *t* and *a* and *b* are the parameters estimated from the historical data of the fishery. The estimation is based on the fishing effort and the catch per unit effort data for the period 1997-2009.

3.2.2 Economic part of the model

Flyingfish is a Barbadian delicacy and all fish caught is exclusively for local consumption. It is necessary to take into account that the supply of flyingfish affects its retail price. With any increases in supply the price falls; when there are shortages there is a corresponding increase of price, the only other exception being the religious holiday (Easter) where because of a high demand for fish there is also a high price for fish. Not taking this factor into consideration may lead to an incorrect model result. Flyingfish is almost exclusively supplied by local fishermen to the local market. There is some variability in catches and this is as a result of variations of the flyingfish stock (FAO 2010). An assumption can be made that the price of flyingfish is determined by the demand for it given the available supply. The demand for flyingfish can be estimated as an inverse demand. A Cobb-Douglas inverse demand functional form is used in this paper to estimate the inverse demand relationship. It relates the real price of flyingfish to the quantity supplied (inflation adjusted). The function has the following form:

(4) $$\ln(P(y_t)) = ln\left[\frac{P}{RPI_t}\right] = \alpha_0 + \alpha_1 \ln(y_t)$$

where *P* is the price at time *t*, *RPI* is the Retail Price Index for Barbados at time *t*, *y* is the supply at time *t* and α_0 and α_1 are the parameters to be estimated based on the available data.
There was very little available economic data for the Barbados flyingfish fishery hence a simplified cost structure was adopted.

(5) $$C(e) = \gamma * E_t$$

where γ is the marginal effort cost estimated as the average revenue per unit effort in a period where landings were poor. If the profitability is poor then an assumption can be made that revenue is close to or equal to cost. The cost parameter was an estimate based on the revenue and effort data for the period 2001-2009.

The profits are derived from the revenues from harvest based on current prices minus the cost of effort. The profit function in the model is:

(6) $$\pi = P\big(y(E_t)\big) - C(E_t)$$

where π is profit *P(y(e))* is from the inverse demand equation at (4) based on predicted catches from the harvest function. The effort level is the decision variable for the model.
Any reduction in the quantities of flyingfish supplied affects the welfare of the consumers. This needs to be addressed in the analysis of the welfare effect of the changes of fishing effort which has some effect on the flyingfish supply. The welfare loss to consumers is approximated using the change in consumer surplus from the current supply and the regulated supply associated with the reduced effort level and catch. The Social Cost (SC) model is represented as:

(7) $$SC = \int_{y_1}^{y^0} e^{\alpha 0}\, y^{\alpha 1} dy$$

where y^0 is the harvest today, y^1 is predicted future harvest that is determined by the harvest equation and the reduced effort level applied.

Based on the current investment climate in Barbados the discount rate used in the paper represents a moderate interest rate to be applied to projected cash flow benefits to be derived from the fishery taking into account such risks as variation of catch and/or regulated fishing effort over time. The net benefits from the fishery in the model is the difference between the net present value and the welfare loss to consumers.

$$SNB = \pi - SC \quad (8)$$

3.2.2 Key estimates and parameters of information and some results of this model

The data used to determine the estimates were obtained by regression analysis method, the parameters a and b in equation (3) were results of CPUE and data on fishing effort. The data used for the estimates α^0 and α^1 equation (4) and (7) are based on linear price and quantity based on the best available for pricing information data including the other cost of living factors in Barbados between 2001-2009.

Table 5: Key estimates and parameters used in the model in equations (3), (4) and (7).

Parameter	Estimate	SD	Remark
R_0	3.40		From FAO SLC/R929 (En) 2010 report
Unexploited biomass (MT)	26,351		From FAO SLC/R929 (En) 2010 report
Biomass 2007 (MT)	25,919		From FAO SLC/R929 (En) 2010 report
$\acute{w}$ (wet weight of flyingfish)	⅙ kg		Fisheries Division, Ministry of Agriculture
a	15.263	12.453	Own estimate based on data
b	-0.033	0.414	Own estimate based on data
γ	0.008		Own estimate based on data
α^0	0.863	2.097	Own estimate based on data
α^1	-0.646	0.943	Own estimate based on data

4 RESULTS

The flyingfish is a short-lived species. The total annual mortality of the flyingfish population is about 97%. Recruitment occurs during the fishing season when mature fish spawn in November at the start of the season and again in May/June towards the end of the season. Due to its fast growth the flyingfish stock rebuilds rather quickly as flyingfish reach maturity at around five months. Assuming population growth before the 2007 stock assessment, the rate of flyingfish population increase from 2007 to 2018 based on the model can be seen below in Figure 7.

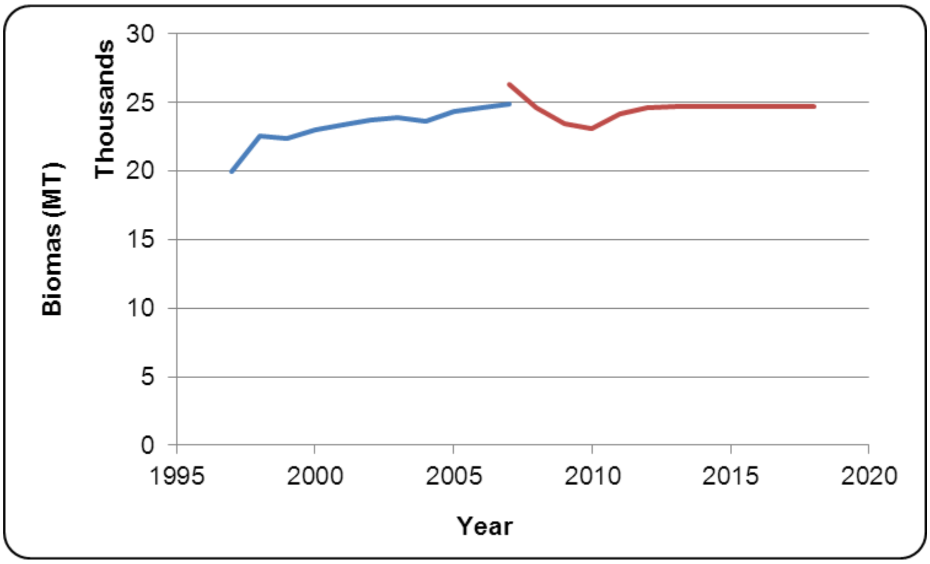

Figure 7: Flyingfish population increase assumed before 2007 from the model until 2018 when $R_0 > 1$ (FAO 2010).

This estimated number of individuals occurring in the stock before 2007 with the assumption of biomass of 20,000 MT in 1997 can be seen in Figure 8. The peak in 2007 indicates where base data from stock assessment fixed the biomass at 25,919 MT. Stock size reaches steady state at ~24,752 MT.

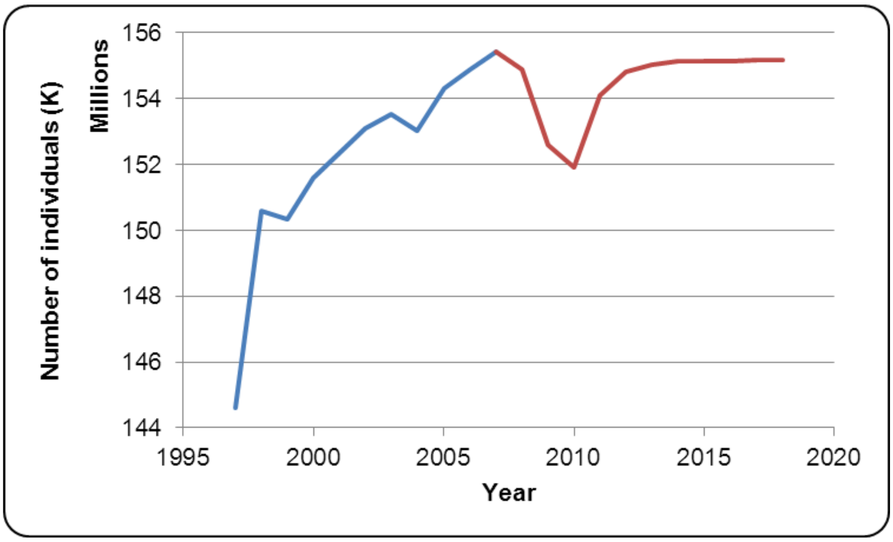

Figure 8: Estimated number of individuals (K) occurring annually in the flyingfish stock until 2018 based on the model before and after the stock assessment in 2007.

Available information on flyingfish harvest from Barbados and the other islands in the study indicate that there is no risk of overexploitation and that harvest levels were significantly less than the 2007 MSY figure of 7,897 tonnes. This means that the resource has not been heavily fished despite the volume of catches reported for the Barbados fishery. The impact of annual harvest of flyingfish in Barbados is plotted with the estimated flyingfish stock in the Southern Caribbean region (Figure 9). The estimated total annual flyingfish landings from all islands in the region have not exceeded 3,000 MT annually in the last 13 years (Table 3).

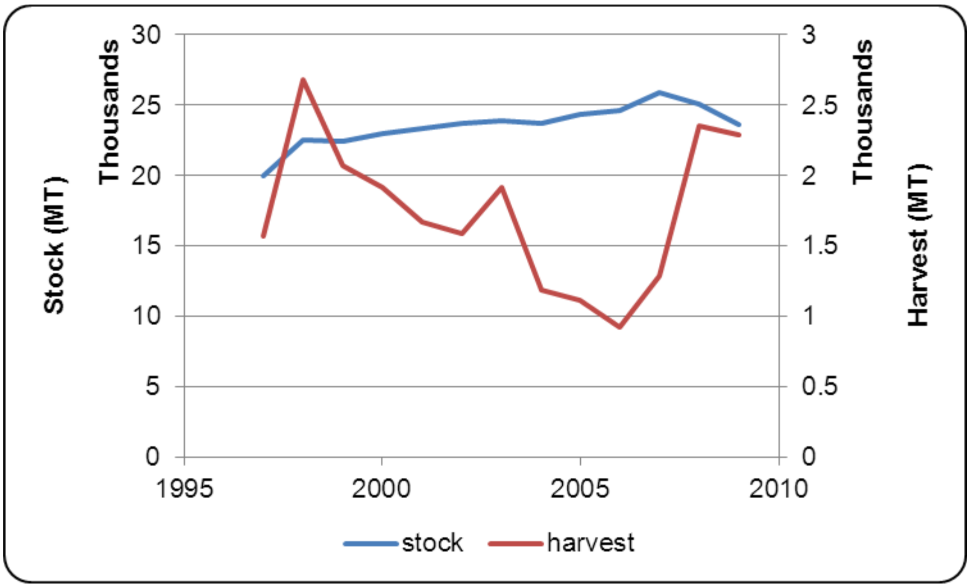

Figure 9: Impact of Barbados's harvest plotted with available stock in the region 1997-2009.

The average CPUE over the period was 8.4 tonnes per vessel. Based on data and results in years of low harvest (2004-2007), CPUE averaged < 6 tonnes per vessel with the exception in 1997 where more than 260 vessels (ice boat equivalent) were operating in the fishery. For all other years where between 180 and 220 vessels were operating average CPUE was greater than 7.5 tonnes per vessel (Figure 10).

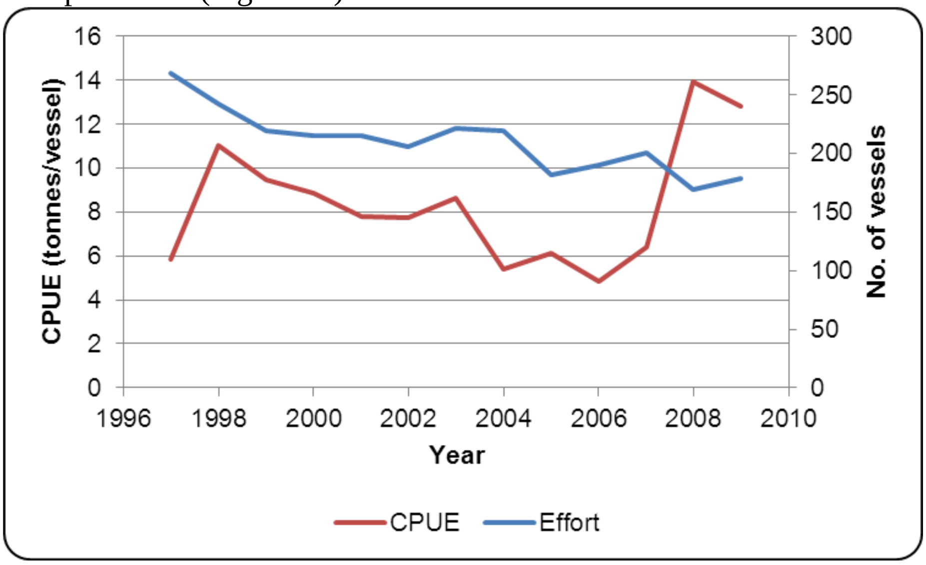

Figure 10: CPUE of fishing vessels operating during the period 1997–2009.

The sustainable yield curve shows the estimated yield that will be produced for varying effort levels applied showing E_{MEY} 1,108 tonnes from 90 vessels and E_{MSY} of 1,749 tonnes from effort level of 233 vessels (Figure 11).

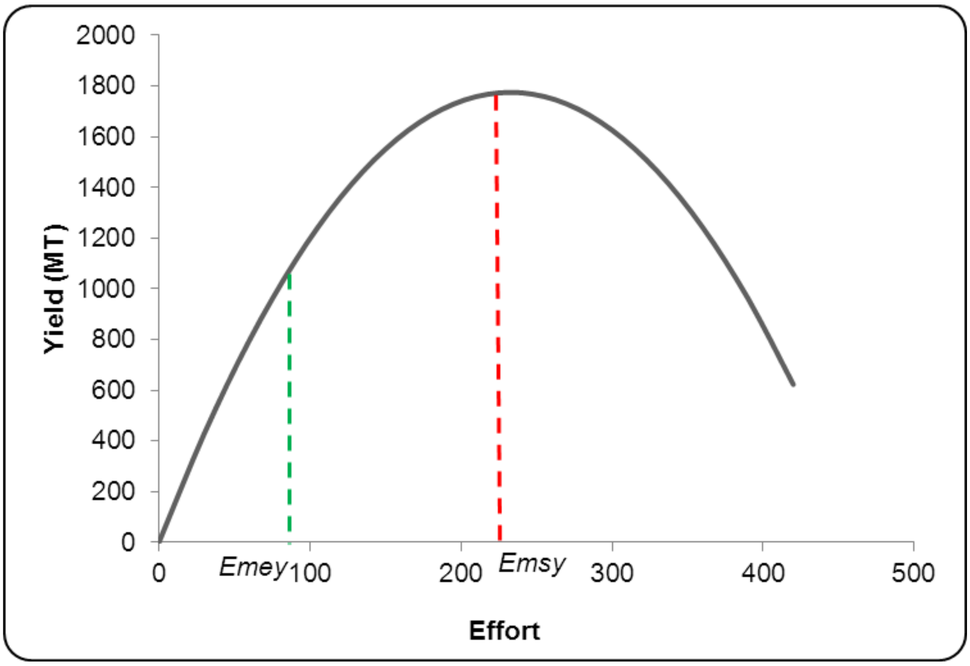

Figure 11: Sustainable yield curve for the Barbados flyingfish fishery.

Fishing effort at E^* is an alternative position that would provide an option of reduced private benefits as well as those benefits to consumers. It would also require a reduction of effort level below open access and MSY levels but not as low as that which would provide maximum benefits to be derived from an effort level of 90 vessels (Figures 12 and 13).

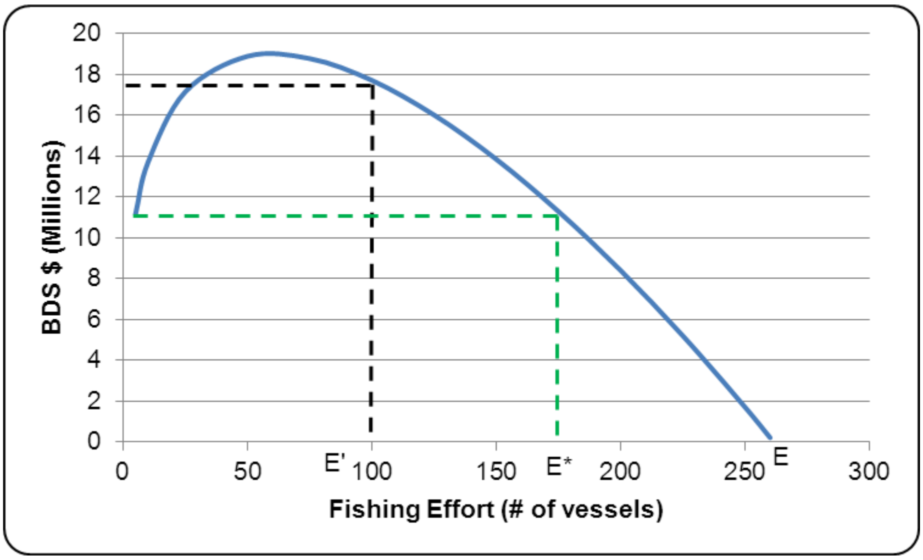

Figure 12: E' and E^* where the change in welfare costs is shown with the reduction of fishing effort.

Fishing effort at E' where it indicates the best economic position where MEY and private benefits can be derived from effort reduction to 90 vessels and harvest of 1,108 tonnes. This would have an effect on the increase in the price of fish which would be reflected in an increase in revenue and profit and a reduction in consumer surplus (Figure 14 and 15).

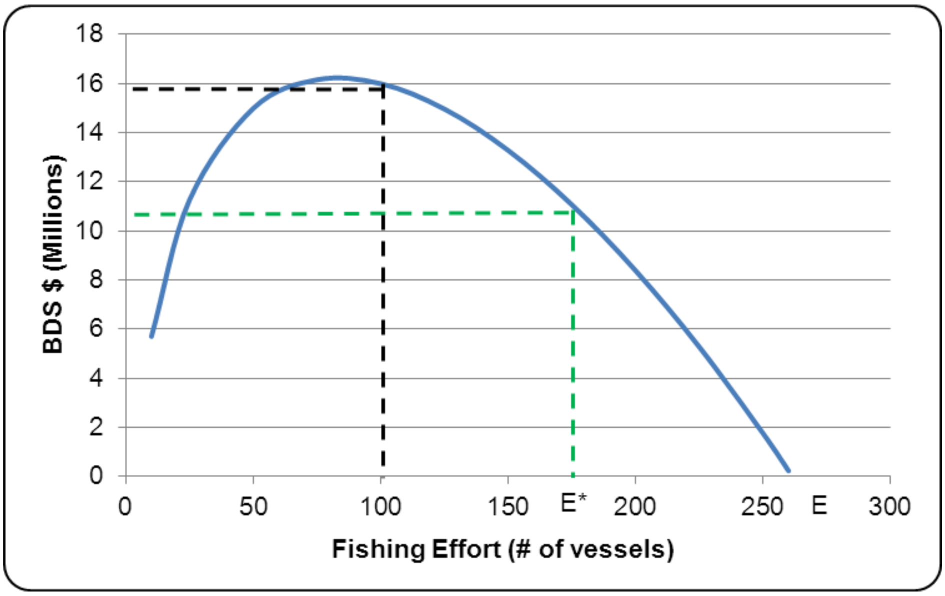

Figure 13: *E'* and *E** where the change in welfare costs is shown with the reduction of fishing effort.

The result for comparison of social cost benefits are based on NPV, revenue, costs and profit. The effort level applied is 90 with an open access effort of 261 vessels. A reduced effort to 90 vessels would create a loss of employment for some fishermen. The impact of substitute flyingfish imports was added to the model to see what impact this would have on profitability and social net benefits but was found to have no significant effect on the results and is not included in the table (Table 6).

Table 6: Results from the model of social welfare benefits based on outputs in BDS $ (million) .

Effort	Harvest (tonnes)	Revenue	Cost	Profit ($)mil	Welfare Loss	Social Net Benefit	Imports
90	1108	$2.5	0.99	$1.5	-0.17	1.3	0
261	1749	$2.9	2.88	$0	0	0	0

Results of Social Benefits 5% Discount rate		
$18.24		Private Benefits
-$2.05		Social Cost
$16.18		Social Benefit

The analysis (Figure 14) looks at how sensitive the results are in relation to changes in assumptions on the price, cost and catchability as it relates to flyingfish production. The sensitivity in relation to cost and price are similar in that they are both sensitive to increases based on supply and amount of effort. With regard to catchability, the data shows that there is a relatively small harvest of flyingfish in relation to the stock size depicted in the model. Assuming data from earlier stock assessment of MSY, there is no immediate prospect of overexploitation of the stock. The market and demand for flyingfish in Barbados and the region are small and are also limited to only to a small number of users. The low price indicated that with present technology used in the fishery it may be less profitable to harvest closer to MSY. It appears more favourable that future investment in the industry is more likely to be driven in the post-harvest sector where there can be opportunities through product development of the flyingfish product rather than through the acquisition of new fishing technology which would serve only to increase the investment and operation cost of the fishing fleet.

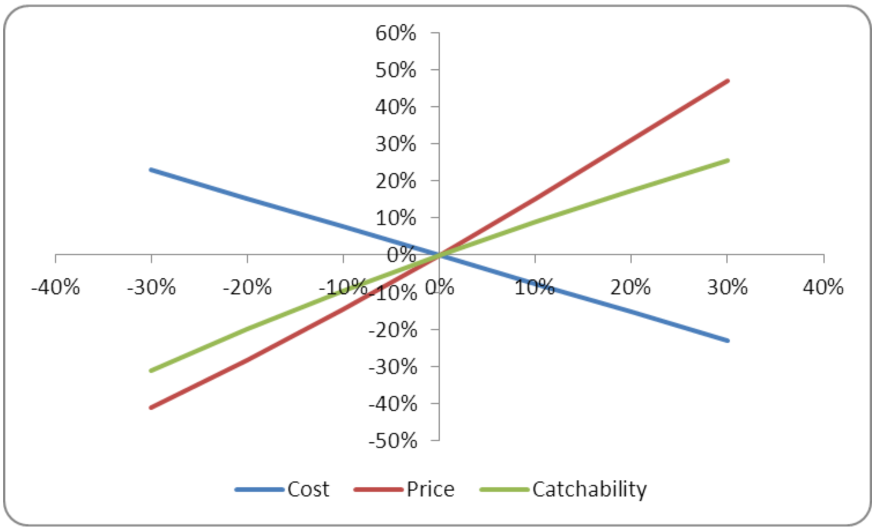

Figure 14: Analysis based on assumed discount rate of 10%, E_{MEY} 90 vessels and net social benefit of $15.7 m (BDS).

5 DISCUSSION

The Eastern Caribbean flyingfish stock, despite suffering almost 100% mortality annually, replaces the biomass through recruitment by the following fishing season. Neither the individual nor the collective harvest from the various territories within the Eastern Caribbean region has had any significant impact on the stock. These results did not point to a situation of overexploitation of the flyingfish. However, a recommended 'trigger' point of 5,000 MT was suggested, i.e. sustained harvest should not exceed this point to eliminate any risk of overfishing (FAO 2010).

In looking at the Barbados flyingfish fishery, the basis for stock recruitment and biomass was results of previous studies of the Eastern Caribbean flyingfish stock as the flyingfish is a common stock shared by individual territories in the Caribbean region. The total harvest for the Eastern Caribbean from this stock over the last 15 years has not exceeded 3,500 MT. The only island harvesting the flyingfish as a primary target species is the Barbados fishery, accounting for greater than 53% of the annual average harvest. Data for the Barbados flyingfish fishery has been used independently to that of the other islands to assess the status of the Barbados fishery and to make some recommendations that could lead to achieving maximum economic benefit from the fishery while applying a strategy to manage this fishery in an economically optimal manner.

5.1 Fishing effort

Results from the model suggest that fishing effort in the flyingfish fishery should be reduced from open access levels to 90 vessels, the point at which MEY is achieved assuming that only vessels categorized as ice boats are operating in the fishery. Not only do these vessels have a longer operational range but their added capacity gives them an advantage over other smaller vessel types targeting the same species. Ice boats spend more time on the fishing grounds, potentially improving current CPUE of about 8.4 tonnes per vessel. The reason for this measure is not related to overexploitation of the flyingfish from a biological perspective as the impact of harvest on the stock is low, but rather that it will induce higher operating cost and not necessarily improve benefits to the fishery as only a small market is being serviced by this fishery. With low prices and catchability it appears to be more profitable to harvest less and demand a price that would improve profitability despite the small welfare loss to consumers considered. Fishing effort at MSY would require an effort level of 233 vessels but would provide a reduction in private benefits without any significant effects on welfare loss to consumers.

Other information from the study indicates that over 400 vessels of varying types access this fishery (Appendix 5). This has implications for the quality of fish landed and the cost. While a marginal cost per unit effort was used in the study, there will be varying operating costs associated with each type of vessel, impacting the revenue and profit margin for each unit. The owners and crews would tend to spend much time and effort on fishing operations while receiving reduced benefits.

Effort restrictions if properly implemented should help improve yield and revenue of individual units. Reduced number of vessels operating in the fishery could lead to more efficient fishing operations by vessels actually focusing on fishing rather than on competing to return quickly to port to discharge their catch in order to fetch 'a good price' for the fish.

During the period under review it can be seen that about 49% of the vessels operating in the fishery had cold storage capacity (whether insulated ice boxes or refrigerated compartments) and accounted for more than 70% of the flyingfish landed (Appendix 5). What is important however would be the turnaround time between fishing trips of the ice boats.

5.2 Barbados flyingfish harvest

The history of flyingfish landings over time shows some consistency with effort. The periods of high landings were synonymous with improved technology and/or increased fishing effort in some periods. The effect or impact of some environmental factors on harvest of the flyingfish cannot be discounted as in the case of 2006 the total harvest was only 922 MT from the landings of 190 vessels. The average annual number of vessels operating over that period of time was 210 with an average annual landing figure of 1,736 MT. The figures projected by the model are in keeping with historical data and trends.

From a regional perspective Barbados is still the leader in flyingfish production primarily for its domestic market, while Tobago export their flyingfish catch. As to whether any consideration for Barbados to harvest flyingfish exclusively in the region should be undertaken at present, current information does not suggest that Barbados should seek to harvest the flyingfish exclusively as a primary focus. Given the indicators of profitability, costs and price associated with local flyingfish production and fish substitute imports, it best serves the Barbadian interest to maintain an annual harvest within the scope of the modelled result, between the point at which MEY and MSY can be achieved, and continue to add imports of substitutes for flyingfish as has been done in the past. This would provide some balance between cost of flyingfish production to the consumer and revenue and profits that can be made by the fishing sector under a managed fishery rather than the open access fishery.

5.3 Economic benefits

The effort level from which the largest economic benefits can be derived by the fishers is an effort level of 90 vessels with a harvest of 1,108 MT. Based on the projections from the model this would have an impact on the increased price per/kg of fish which would be of lesser benefit to consumer. The fishers in the long run would realize improvements in profitability and substantial private benefits as a result of reduced harvest and reduced effort. This analysis is based on *E'* (Figures 12 and 13), the position where maximum economic benefits may be achieved. The challenges of this position would be the impact of job losses in the harvest sector to fishermen as average crew per ice boat is three persons. This appears to be a more favourable position since the prospects of increasing effort beyond 260 units and harvest beyond 1,749 MT would result in greater cost per unit effort for projected harvest estimates that would decrease over the long run (Figure 12). The price of flyingfish is sensitive to quantity supplied to the local market. For long term investment in the fishery it would appear to be of greater benefit to have a reduction of cost while sustaining an effort level and harvest aimed at generating increased profitability. Further profitability for the industry is more likely to come in the form of an improved value added flyingfish product as opposed to extracting greater harvest from the fishery and pushing beyond the suggested ‘trigger’ point of 5,000 MT without sound regular stock assessment data and updated analysis of MSY. As for seeking revenue from regional and extra-regional exports, greater economic benefits can be further derived from continuous research and development of greater utilisation of all components of flyingfish. In addition, greater economic benefits can be derived from looking for innovative ways of making the flyingfish product more easily accepted in markets outside of Barbados whether by canning or whichever marketing strategy can best sell the flyingfish as a competitive fish product.

5.4 Management of the flyingfish fishery

The results from the model suggest that this fishery needs to be managed to ensure that fishers and consumers can continue to enjoy the full benefits derived from efficient and economic harvest of the flyingfish. From the results some limitations could be placed on the number and type of vessels that could be allowed to operate in the fishery. A second measure would be the implementation of an allowable catch or quota per vessel per annum. This would have further implications for issuing licences to participate in the flyingfish fishery.
Oxenford *et al.* (2007)[1] have recommended some management options that could be adapted for the management of the flyingfish fishery either from a regional management perspective or for an individual territory. Some of the options suggested (closed season or area, TAC or limited effort, gear restriction) would have some socioeconomic implications on the effect of cost of fishing operations which would impact the price and supply of fish to the vendors, processors and consumers.

With respect to a regional management position and a Common Fisheries Policy (CFP) for the shared fish stocks, there is sufficient information from the LAPE project 2008, CLME project 2007 and the various studies of the flyingfish and dolphinfish that all indicate the need for the establishment of a Regional Management unit and CFP for the Eastern Caribbean area. The LAPE area (Appendix 6) is very small compared with other areas where countries with adjoining maritime boundaries and shared fish stocks have agreed and implemented such agreements as to joint management policies to regulate the harvesting and protection of fish stocks. This is not new ground as there are good examples of Regional Fisheries Management of pelagic, demersal and other fish species in the North Atlantic where the North East Atlantic Fisheries Commission (NEAFC) with members from the European Union was formally created in 1983 but had its roots set in 1970. The CFP is revisited from time to time to address areas of concern or make amendments as deemed necessary as a result of social, environmental or economic changes[2]. Two other examples of note are the British Columbia Fisheries Action Plan[3] which features the regional management of fisheries along the North-west Canadian and Alaskan coastal areas and the Western and Central Pacific Commission (WCPC)[4] whose focus is on addressing the problems in the management of high seas fisheries with unregulated fishing, the over-capitalization of fisheries, excessive fleet capacity, the re-flagging of vessel to escape controls, insufficiency in the selection of gear, unreliable databases and insufficient multilateral cooperation with respect to conservation and management of migratory fish stocks in the region. WCPC also recognises the need for developing states to have a Regional Fisheries Management Organization (RFMO) whose respective areas of competence should overlap with the WCPFC and reflect the unique geo-political environment in which the Commission operates.

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[1] Chapter 25 (p. 260-262)- Overview of options for management of eastern Caribbean flyingfish fisheries
[2] European Union Common Fisheries Policy - 2009
[3] British Columbia First Nations Fisheries Action Plan - 2006
[4] Western and Central Pacific Fisheries Commission (WCPFC) - 2004

6 CONCLUSION

In the study of the bioeconomic analysis of the Barbados flyingfish fishery the following conclusions were reached:

1. While the flyingfish stock is not independent to that of the Eastern Caribbean region, quantities harvested by Barbadian fishing vessels have no impact on the regional stock level and there is no risk of biological overexploitation.
2. Maximization of economic benefits and economic yield can be achieved through the reduction of fishing effort to about 90 vessels and catches of around 1,108 tonnes by employing only ice boats which have greater capacity and a longer fishing range and are capable of providing a better quality fish for the market. At present maintaining current fishing technology would not have a great cost impact on operations as the present gear (gill net) has proved quite effective in the capture of flyingfish. The flyingfish is more attracted to this gear as it is targeted between the two peak spawning periods which occur during the time that the flyingfish is available for harvest.
3. Other management options available to streamline the types of vessels that access the fishery and ensure that only the ice boats harvest the flying fish commercially would be to implement a licencing programme to be managed by government.

7 RECOMMENDATIONS

Subject to the results of the study there are some recommendations on how the maximum economic yield and benefits from the flyingfish fishery can be achieved for the benefit of the fishers and the society as a whole. It must be noted however that for any success to be achieved from the implementation of one management measure, it must be supported by other management options identified, and requires the involvement and full participation of government and the main stakeholders in the fishing industry which includes both fishery workers and private investors.

1. Reduction of fishing effort as indicated to achieve maximum economic benefits based on the E_{MEY} indicator.

2. The present Fisheries Management Plan to make provisions for the implementation of management regulations and policies that would lead to sustainable management of this fishery from which future economic benefits are expected to be derived.

3. Continuous training, education and capacity building for fishery workers coupled with stakeholder participation in strategizing the future product development of flyingfish value added products to maximize economic benefit from flyingfish production.

4. Review the design, equipping and construction of the Barbadian fishing vessel that would make it more suited for flyingfish operations in the EEZ.

ACKNOWLEDGEMENTS

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Data was an important component in the study and so I am indebted to the efforts made by Mercille and Joyce in particular and the staff of the Fisheries Division in general, and the staff at the Statistical Department who were very helpful in my data collection quest.

Without a guiding light the obstacles in the path would have been more difficult to see; in this regard I offer my sincerest thanks and appreciation to my supervisor Dadi whose guidance can be likened to the work of a chisel used to shape rude matter to a polished finish.

To the staff at UNU-FTP and the UNU-FTP Fellows 2010, my thanks and appreciation to you are no less warm. To your future endeavours I bid you *'Fair winds and following seas.'*

All praises and glory belong to the **CREATOR**, for it is through him that all things are possible. It was by his will that I stood the test of time amidst the several challenges faced in pursuit of **Excellence** here in Iceland.

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APPENDIX 1a The capture and processing of the flyingfish[5]

Four-wing flyingfish (in flight)
(Hirundichtuys affinis)

Surface gill net used in the harvest of the flyingfish

Fish vendor processing the flyingfish. Below the finished product is seen– de-boned and filleted.

[5] Sources: FAO 2010, Google Images, Fisheries Division

APPENDIX 1b The Barbadian fishing vessel from the use of sail power to the modern mechanized ice boat[6]

Old Sail Boat

Old sail boat used before 1954, fishing range 3-5 miles, major SOLAS issues with high incidence of loss of life at sea.

Day Boat

The day boat was the first stage of the evolution process with the added dimension of an inboard diesel engine and a small cabin house forward. The vessel is steered by a tiller stick connected to the rudder affixed outboard of the transom. This vessel still exists in the fleet today.

Ice Boat (Wood with detachable ice box)

Ice Boat (GRP with integrated ice hold)

The Ice Boat appeared in the fleet in the late 1970s and was an integral part of several changes which took place in the fishing industry in general and the flyingfish fishery in particular. The vessel is fitted with modern electronic navigational aids, hydraulic steering systems and some auxiliary equipment.

A
Sea [7]

[6] Source: Fisheries Division 2010
[7] Source: FAO 2010


90
80
70
60
50
30
20
10

APPENDIX 3 International Instruments and Organisations[8]
This appendix lists and highlights aspects of the international fisheries instruments and organisations to which Barbados is signatory or affiliated.

Code of conduct for responsible fisheries

The Code of Conduct for Responsible Fisheries occupies a position of prominence among international fisheries instruments. The Code promotes the adoption of practices for the sustainable use, management, development, and conservation of all fisheries and aquaculture through the voluntary compliance of governments, fishing industries, non-governmental organisations and other entities associated with fisheries. Article 6 of the Code sets out general principles that are summarised below and serve as the guidelines for fisheries management in Barbados.

- Maintain biodiversity and use ecosystem approaches to management;
- Manage fishing capacity and fishing methods to facilitate resource sustainability;
- Use precautionary approaches to sustainable use, management and exploitation;
- Protect and rehabilitate critical fisheries habitats and the environment generally;
- Use post-harvest practices that maintain nutritional value and quality of products;
- Include fisheries interests in all aspects of management planning and development;
- Establish effective mechanisms for monitoring, control and surveillance;
- Collect and provide data including sharing, pooling and information exchange;
- Ensure that fisheries decision-making processes are transparent and that all stakeholders have the opportunity to participate;
- Conduct trade in fish and fishery products according to applicable agreements;
- Cooperate with States in order to prevent disputes or resolve them in a peaceful manner;
- Promote awareness of responsible fishing through education and training;
- Ensure safe, healthy and fair working and living conditions for fishery workers;
- Recognise the contribution of small-scale fisheries to employment, income and food security;
- Promote aquaculture as a means for diversification of income and diet.
- Integrate fisheries into coastal area management to ensure that the needs of coastal communities are met without harming fragile coastal ecosystems.

[8] Source: Fisheries Division 2010

Other international instruments

The Code reflects the provisions of several fisheries-related international instruments including the:

- 1982 United Nations Convention on the Law of the Sea (UNCLOS)
- Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (i.e. 1995 UN Fish Stocks Agreement).
- Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (i.e. 1993 FAO Compliance Agreement).
- The 1992 Rio Declaration on Environment and Development; Chapter 17 in Agenda 21 of the United Nations Conference on Environment and Development (UNCED).

Barbados became party to the following international instruments and organisations to properly manage the resources in the EEZ and to apply appropriate leverage in international circles to secure equitable shares of resource allocations through provisions that recognise the special circumstances of small-island developing states (SIDS).

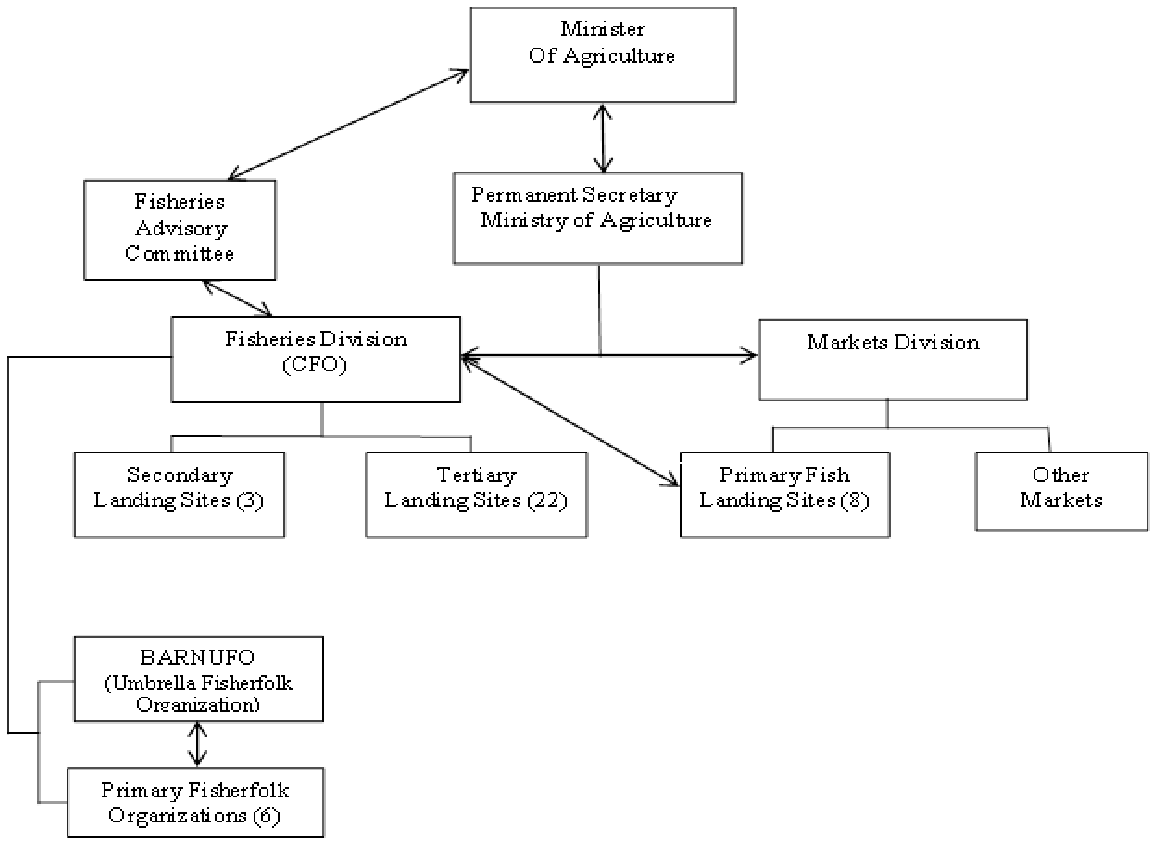
- UN Fish Stocks Agreement (22 September 2000).
- FAO Compliance Agreement (26 October 2000).
- The Tuna Convention establishing ICCAT (13 December 2000).

Barbados is also party to the following relevant international instruments:

- The SIDS Plan of Action (May 1994),
- Convention on International Trade in Endangered Species (CITES) (December 1992),
- Convention on Biological Diversity (CBD) (10 December 1993),
- Cartagena Convention (5 March 1984),
- Oil spills Protocol of the Cartagena Convention (5 March 1984),
- Cartagena Protocol on Biosafety (11 September 2003),
- Specially Protected Areas and Wildlife (SPAW) (2 November 1990)
- International Convention on the Prevention of Marine Pollution from Ships (MARPOL) (and subsequently all Annexes (1-6).

During this plan period, it will be essential to ensure that Barbados can properly discharge its regional and international obligations, and receive adequate benefits from these instruments through strategic participation and representation at relevant meetings and alliances. Some changes to legislation and administration will be necessary. Also vitally important is the need to inform the fishing industry about these instruments and their consequences for the local and international fisheries regimes.

APPENDIX 4 Organization chart for the fisheries sector[9]



[9] Source: Fisheries Division 2010

APPENDIX 5 Fish landing sites in Barbados[10]

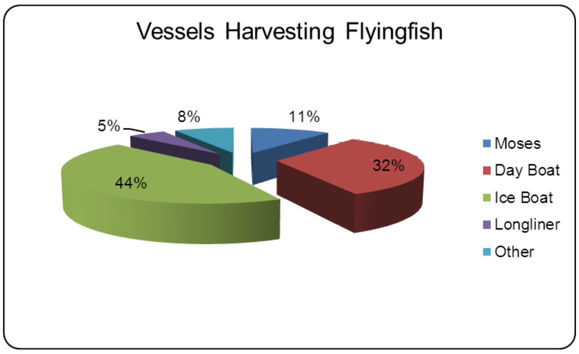
[10] Source: Fisheries Division 2010

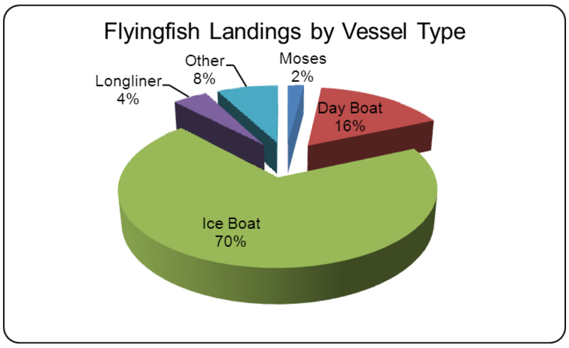
APPENDIX 6 Adjusted fishing effort to Ice Boat equivalent

Year	Moses	Day Boat	Ice Boat	Longliner	Other	Total	Iceboat equivalent
1997	26	127	102	14	144	413	269
1998	38	190	143	17	6	394	243
1999	25	142	140	17	6	330	220
2000	25	116	123	14	44	322	216
2001	31	109	139	15	22	316	215
2002	32	104	139	14	13	302	206
2003	27	96	144	12	36	315	221
2004	39	94	145	13	31	322	219
2005	32	71	132	11	13	259	182
2006	30	73	132	17	15	267	190
2007	32	76	134	24	15	281	201
2008	39	64	128	12	2	245	169
2009	40	64	130	17	6	257	179
Average	32.00	102.00	133.15	15.15	27.15		
In iceboat equivalents	1.38	41.28	133.15	15.15	18.90		
Scaling factor	0.04317	0.40468	1	1	0.69604		

	Harvest (avg t/v)	**Remarks**
Moses	0.24	
Day Boat	2.25	
Ice Boat	5.56	Include both Ice Boat and Longliner
Other	3.87	Vessels were not categorized in the landing data at the time of recording

All vessel types operating in the fishery before using the scaling factor to adjust the fishing effort to 'Ice Boat equivalent'



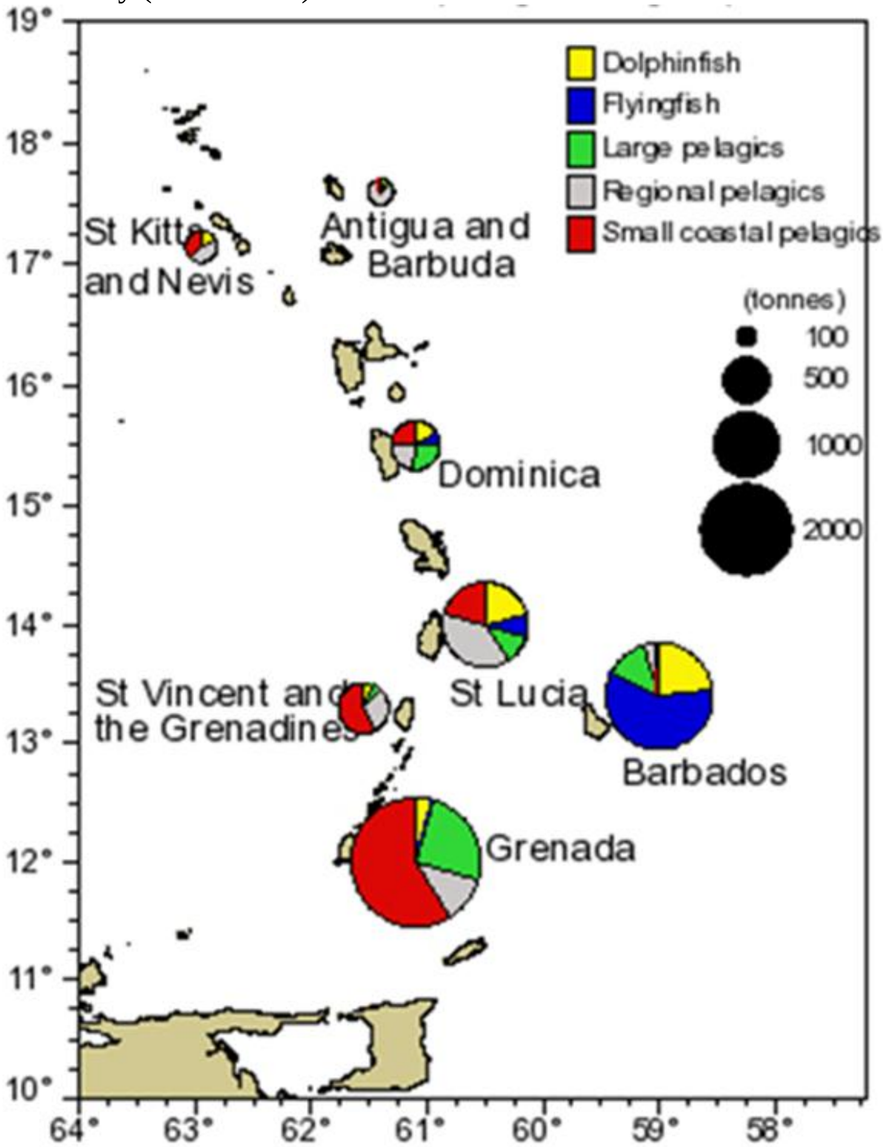


APPENDIX 7 Imports from Guyana and Trinidad and Tobago

Imports from Guyana and Trinidad and Tobago (Bangamary and Flyingfish)			
Year	Import Quantity		Import Value
	kg	tonnes	BDS $
1999	70644	11.77	504,077
2000	113009	18.83	893,642
2001	67385	11.23	679,738
2002	178025	29.67	1,362,080
2003	204776	34.13	1,506,222
2004	341638	56.94	1,658,494
2005	147188	24.53	971,036
2006	167525	27.92	1,163,634
2007	146923	24.49	973,334
2008	145701	24.28	1,223,597
2009	170432	28.41	1,100,618
	Average	26.56	1,094,225

APPENDIX 8 Eastern Caribbean islands in the LAPE area[11]

LAPE areas showing the catches pelagic fish groups within the EEZ of the islands within the Caribbean Community (CARICOM)



[11] Source: FAO 2008