Is CPUE an Indicator of Stock Abundance?  
Case of Gouyave Surface Longline Fishery

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ABSTRACT
Catch per unit effort (CPUE) or catch rate, commonly used as an indicator of stock abundance, often ignores other factors that may affect it. Using data from Gouyave Grenada surface longline fishery for large pelagic species, fished by canoes and pirogues boats, from January 2000 to December 2001, we examined some factors that might affect catch rates such as the effects of: fishing decisions; weather conditions (rough sea days and rainfall), bait availability (landings of flying fish and jacks), and social factors (social events and reported incidence of violence); and other exogenous factors. Four levels of fishing decisions were identified based on social and financial obligations, bait availability and weather condition, gear type, and knowledge of large pelagic species marine environment. Although, no strong statistical significant relationships were found between catch rates and weather condition, bait availability, and social factors; other factors such as improved fishing technology and fishing operations contributed to increased landing. CPUE data needs context for interpretation. Context can be achieved by fishery managers working with fishing industry members, this we term participatory data assessment. This type of assessment can only be effective in a sharing and learning environment.

KEY WORDS: CPUE, Decision-making, Grenada, large pelagic, participatory data assessment, surface longline

Es el CPUE Un Indicador Verdadero de Abundancia de Especies? El Caso de los Pescadores de Palangre de Superficie de Gouyave

La Captura por Unidad de Esfuerzo (CPUE) es comúnmente usada como un indicador de la abundancia de un stock, frecuentemente ignorando otros factores que pueden afectar el CPUE. Esos factores incluyen la demanda local y de exportación de peces, las condiciones climáticas, edad y fuerza física de los pescadores, conocimiento ecológico, disponibilidad de cebo, conocimiento técnico y factores sociales, para mencionar algunos. Nosotros examinamos tres factores usando datos de la pesca de palangre de superficie de Gouyave, Grenada para el período 2000-2001: (1) las condicio-
nes meteorológicas fueron medidas como condiciones borrosas del mar y lluvia total por mes; (2) disponibilidad de cebo, por ejemplo, abundancia de peces voladores y carángidos y; (3) asuntos sociales, por ejemplo los incidentes de violencia y eventos sociales reportados dentro de la comunidad.

Durante la investigación, el CPUE mostró una disminución general. Las mejores condiciones climáticas (combinación de mar borroso y lluvia total mensual) para la pesca tuvieron lugar de Febrero a Mayo. Los datos no mostraron una correlación clara entre las condiciones climáticas y el CPUE. De Octubre a Marzo tuvo lugar la temporada baja para la captura de los peces voladores y carángidos, y fue también cuando el mar se mostró tempestuoso. Sin embargo, cuando el cebo estuvo disponible los valores de CPUE fueron altos. La incidencia de reportes de violencia se incrementaron durante el período de Mayo a Septiembre, el cual se relaciona con el período de los principales eventos sociales. A pesar de que los resultados están basados en solo un año de datos disponibles, la información mostró que al disminuir el CPUE, los incidentes de violencia reportados se incrementaron.

PALABRAS CLAVES: Abundancia de especies, pescadores de palangre, Gouyave

**BACKGROUND**

Catch per unit effort (CPUE) or catch rate is commonly used as a relative measure of stock abundance. However, many fishery managers know that CPUE is affected by gear and technology changes (Gulland 1974). In this paper we argue that it often ignores social, ecological, and technological factors that may affect context. Such factors may include local and export demand for fish, weather conditions, age and physical strength of fishers, ecological knowledge, bait availability, technological knowledge, and social obligations, to name a few.

Understanding context is important in interpreting CPUE data. In this paper we demonstrate that effective understanding of context requires, what we term, participatory data assessment within a sharing and learning environment. We define the term participatory data assessment as the communication between individuals involved in the giving, collecting, processing, and assessing fisheries data, i.e. fishery managers communicating with fishing industry members to understand factors that may affect the interpretation of data, such as CPUE. Participatory data assessment requires a sharing and learning environment. For institutions to learn efficiently we must first know what we have done, document decisions, evaluate, learn by experience, and provide feedback between documentation, evaluation and decision-making (Hilborn 1992). Organizations’ and institutions’ ability to learn depends on their ability to remember what happened in the past, i.e. institutional memory. At times institutional memory is lost due to high staff turnover, lack of mechanism to retain lessons learnt, staff cohesiveness. To improve memory there is need for proper documentation, and capturing information from the staff of fisheries agencies. Berkes, et al. (2001) suggests a number of options.
on how Fisheries Departments can improve institutional learning and by extension its memory.

INTRODUCTION

Grenada is a tri-island state comprising (Grenada, Carriacou and Petite Martinique) located between 11°00' and 12°30' north latitude, and between 61°35' and 61°48' west longitude (Figure 1). It has a total area of 344 km² and a population of over 100,000. The fishery is artisanal and has been divided into 3 stock types, based on fishing effort methods and fish type:

i) Oceanic/large pelagic stocks;
ii) Demersal stocks; and
iii) Inshore pelagic stocks.

The most important fishery resources, in terms of quantity of landings and number of vessels, are the oceanic pelagic stock. The main species landed are yellowfin tuna (*Thunnus albacares*), white marlin (*Tetraptururus albidus*), blue marlin (*Makaira nigricans*), common dolphinfish (*Coryphaena hippurus*), sailfish (*Istiophorus platypterus*), swordfish (*Xiphias gladius*), flyingfish (*Ecocoetidae*), blackfin tuna (*Thunnus atlanticus*), wahoo (*Acanlhocybium solandri*), bigeye tuna (*Thunnus obesus*), skipjack tuna (*Katsuwonous pelamis*), bullet tuna, jacks (scads) and others. This oceanic pelagic fishing is done along fishing areas where the island shelf drops off to the ocean deep and in locations farther offshore (Finlay 1990).
In Gouyave, life revolves around oceanic/large pelagic, using surface longline (referred to in this paper as longline), comprising three major components; the mainline, the dropline, and the floatline. The mainline on vessels in this study ranged from 3—10 km total length, and is made of monofilament nylon with 136 kg breaking strain. Every 18 m along the mainline are inserted braided nylon loops 1.5 cm thick, onto which the droplines are clipped during the gear set. Droplines varied in length from 3 - 32 m, using 5 - 8 different lengths, depending on fishers’ preference; also baited with live flyingfish (*Hirundichthys affinis*) or jacks (Carangidae). Buoylines, 3 m in length, were attached after every third dropline. Flags are placed at both ends of the mainline to signal other boats that a longline is in the area. Mainline and droplines are deployed from separate manual reels (Figure 2).

The fishery in Gouyave is a multi-gear fishery, although the main gear is longline. Fishers combine a number of different gear types to maximize the returns from the fishery. Main combinations of gears are longline with bottom longline, handline, seche, beach seine, trolling, and vertical longline to name a few.

![Figure 2](image.png)

**Figure 2.** Schematic diagram illustrating typical traditional surface longline gear used by Gouyave longline fishers.

There were three categories on longline boats in Gouyave (Table 1); small canoes (145), medium pirogues with forward cabins (15), and large semi-industrial boats also called launchers (10). Full description of these vessels is outlined in Table 1. Non-longline fishing boats were < 5 m, mechanized or non-mechanized, operated by two crew. Semi-industrial boats have a higher catch rate and different fishing practices than canoes and pirogues which have similar fishing practices and catch rates of 53 kg/trip and 64 kg/trip, respectively.
Table 1. Description of three categories of longline vessels in Gouyave.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Canoe longline boats (Small)</th>
<th>Pirogues longline boats (Medium)</th>
<th>Semi-Industrial longline boats (Large)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BOAT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crew</td>
<td>2</td>
<td>2-3</td>
<td>3-5</td>
</tr>
<tr>
<td>Boat Size (m)</td>
<td>&lt;5.5 m</td>
<td>6-9 m</td>
<td>9-12 m</td>
</tr>
<tr>
<td>(open)</td>
<td>(forwards cabin)</td>
<td>(wheel house)</td>
<td></td>
</tr>
<tr>
<td>Boat material</td>
<td>Wood</td>
<td>Wood or fibre</td>
<td>Fibre</td>
</tr>
<tr>
<td>Ice</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Storage</td>
<td>Small</td>
<td>Medium - small cabin</td>
<td>Large – sleeping quarters and fish</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>storage</td>
</tr>
<tr>
<td>Water (litre)</td>
<td>19</td>
<td>38</td>
<td>378</td>
</tr>
<tr>
<td>System</td>
<td>Basic</td>
<td>Basic</td>
<td>Advanced navigational system</td>
</tr>
<tr>
<td><strong>PROPELION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Numbers of engines</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Fuel</td>
<td>Gas; 57 litre/day; 2 tanks</td>
<td>Gas; 113 litre/day; 4 tanks</td>
<td>Diesel; 227 litre/trip;</td>
</tr>
<tr>
<td>Power</td>
<td>Outboard 15-75 hp</td>
<td>Outboard 40-90 hp</td>
<td>carries up to 757 litre</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inboard 70-350 hp</td>
</tr>
<tr>
<td><strong>GEAR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gear used</td>
<td>1 manual mainline reel</td>
<td>1 manual mainline reel</td>
<td>1 hydraulic mainline reel</td>
</tr>
<tr>
<td></td>
<td>1 manual dropline reel</td>
<td>1 manual dropline reel</td>
<td>1 manual dropline reel</td>
</tr>
<tr>
<td></td>
<td>1 manual bouyline reel</td>
<td>1 manual bouyline reel</td>
<td>1 manual bouyline reel</td>
</tr>
<tr>
<td>Longline (Monofilament line)</td>
<td>250-300lb. Strain</td>
<td>300-400lbs. Strain</td>
<td>500lbs. Strain mainline</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>450lbs. Strain dropline</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>300-450lbs. Strain bouyline</td>
</tr>
<tr>
<td>Length of longline</td>
<td>3-10 km</td>
<td>5-10 km</td>
<td>11 km</td>
</tr>
<tr>
<td>Number of hooks</td>
<td>150 hooks; 16 m apart</td>
<td>160-180 hooks; 16-18 m apart</td>
<td>300 plus hooks; 27-32 m apart</td>
</tr>
<tr>
<td><strong>FISHING OPERATIONS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trips</td>
<td>1 day trips (8 hours)</td>
<td>1 day trips (up to 24 hrs.)</td>
<td>4-5 days trip</td>
</tr>
<tr>
<td>Fishing area: distance from shore</td>
<td>11-13 km West</td>
<td>Up to 32 km West</td>
<td>Up to 161 km West</td>
</tr>
<tr>
<td>Species targeted</td>
<td>Yellow fin Tuna</td>
<td>Yellow fin Tuna</td>
<td>Yellow fin Tuna</td>
</tr>
<tr>
<td></td>
<td>Blue &amp; White Marlin</td>
<td>Blue &amp; White Marlin</td>
<td>Blue &amp; White Marlin</td>
</tr>
<tr>
<td></td>
<td>Dolphinfish</td>
<td>Dolphinfish</td>
<td>Dolphinfish</td>
</tr>
<tr>
<td></td>
<td>Sailfish</td>
<td>Sailfish</td>
<td>Sailfish</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Swordfish</td>
</tr>
<tr>
<td>Bait</td>
<td>Carry live jacks</td>
<td>Carry live jacks</td>
<td>Carry live jacks</td>
</tr>
<tr>
<td></td>
<td>Catch flyingfish at sea</td>
<td>Catch flyingfish at sea</td>
<td>Catch flyingfish at sea dead bait</td>
</tr>
</tbody>
</table>

One performance indicator used by the Grenada Fisheries Division (FD) to assess the status of pelagic fish stocks is CPUE. This simple stock assessment uses landings and the effort by fishermen to measure the relative abundance of a stock. However, CPUE has its shortcomings. In this paper we highlight...
some shortcomings by documenting factors which affect landings, effort, and CPUE. Then discuss how the FD could improve interpretation of catch rate data. The objectives were:

i) To determine how Gouyave fishers made daily decisions to fish pelagic species using surface longline, and the impact on landings, effort, and catch rates;

ii) To examine three factors that affected their decisions to go fishing: weather conditions (percent rough sea days and rainfall), bait availability (landings of flyingfish and jacks), and social factors (social events and reported incidence of violence); and

iii) To identify other factors that may impact catch rates. Catch effort data used as illustration was from small boats (canoes) and medium-sized boats (pirogues) for the period January 2000 to December 2001.

It is hoped that by documenting these effects on longline catch rates, useful information will be provided on assessing pelagic fishery and improving national data collection systems.

METHODS

Data Collection

Vessel landings data on catch rates and species composition were obtained from the Grenada Fisheries Division’s daily fish landing records at the Gouyave fish market, for the period January 2000 to December 2001. Proper understanding of the daily landings record entailed working at the fish market to observe how data were recorded and working closely with fishers and market staff in interpreting data. Landings were recorded of species group by weight, gear, effort (trips) and price. In this case only data from small canoes and medium pirogues were used in the study.

Mean monthly rainfall data and other weather variables were obtained from the Land Use Department in the Ministry of Agriculture and the Meteorological Office, Point Saline International Airport. Over 40 Gouyave fishers (mainly knowledgeable boat owners, captains and retired fishers) were interviewed on fisheries local knowledge and decisions to fish longline.

Data Analysis

Weight of pelagic species landed per fishing trip was used as the measure of catch per unit of effort (CPUE) or catch rate. Monthly and yearly catch rates were calculated by boat type (canoes and pirogues) from January 2000 to December 2001. A fishing trip was used as the unit of effort because other available effort data, such as number of hooks, was inconsistent in most cases. Mean species composition by boat types was also compared.

In each case, CPUE monthly information was compared with six variables: percent monthly rough sea days (sea is so rough fisher are unable to go fishing), mean monthly rainfall, monthly landings of flyingfish and medium and large jacks, main monthly social events, and monthly reported incidence of violence. Data were examined using exploratory analysis, such as: frequency tables of variables (e.g. vessel types, species); cross-tabulation of variable
combinations believed to be significant; basic General Linear Model (GLM) analysis to test significance between variables; and Analysis of Variance (ANOVA) where applicable. Only significant results were reported.

RESULTS

Fishing Decisions

Fishers were asked how they made daily decisions about where, when, and how to fish. Four levels of decision-making were identified:

i) Should I go fishing?
ii) Can I go fishing?
iii) What gear can I use? and
iv) Where should I go fishing? (Figure 3).

The first level of decision-making, should I go longline fishing? The main reason Gouyave fishers go to fish is to earn money to meet financial and social obligations. Financial obligations include; providing food and clothing for family, paying monthly bills, repaying loans (bank or money lenders) on homes and fishing equipment, and educating children. Social obligations include; purchasing alcohol for others, and giving fish to community members. If they are not able to meet social obligations, they may decide to go fishing. If they are able to meet their obligations, they may decide not to go fishing.

Second level of decision-making, can I go fishing? Longline fishing requires the use of live or dead bait, i.e. flyingfish \((Hirundichys affinis)\) and jacks \((Carangidae)\); although fishers prefer using live bait. Fishers like using live flyingfish. They say this is the bait the fish prefer. The other bait alternative is medium and large live jacks. Small jacks are used for other fishing such as bottom longline for snappers and handline fishing for blackfin tuna \((Thunnus atlanticus)\). Fishers also base decisions to go fishing on other information such as: Are fishers catching fish in the ocean? is this the time of year for yellowfin tuna? To answer these questions fishers use their performance on previous trips, and the performance of other fishing boats, i.e. how much fish they caught and where they were fishing.

Weather conditions were also important to fishers. When it is rainy and sea conditions are rough, they do not venture out. They also watch cloud cover, type of clouds, and cloud movements. Cloud cover and type indicates rainy conditions; while, cloud movement indicates wind direction and strength. Based on experience they will venture out during good to fair conditions, but during bad weather conditions, they will stay ashore. Small canoes and pirogues are not safe in bad weather conditions; small canoes can easily become swamped. Captains may have all required for a fishing trip, but if he does not have an accompanying crew, he may have to abort the trip.

Third level of decision-making, what gear should I use? Although the main gear used is longline, fishers use other gears depending on the phase of the moon, size of jacks available (small jacks better for none-longline fishing), whether longline fishers are catching fish, and fishers gear preference.
Figure 3. Levels of decision-making fishers engage in when deciding to go fishing. The diagram is simplified, as decision-making are more complex than presented.

The fourth level of decision-making is where should I fish? A number of factors guided fishers as to where to set their lines at sea, these include, colour (shade) of seawater, movement of current, presence of birds, and the ability to track fish at sea. Fishers commented that green and dark green shade seawater from the Orinoco has a lot of Yellowfin tuna; it has a lot of feed, i.e. more plankton and different types of fish; August brings green water in Grenada fishing areas. Blue seawater, has a lot of sailfish, marlin, and flyingfish.

Fishers agreed that strong current was not good for fishing, because fish go or travel with the current; they feed better in a weaker current. Some fishers preferred a northward current moving towards land, referred to by fishers as ‘up and in tide’. Current traveling in the opposite direction would carry the line further out at sea, increasing their fishing distances. Constant changes in current directions, referred to by fishers as ‘old weather tide’, cause problems for fishers, as this could cause a longline to fold back on itself and become
tangled.

The presence of birds indicates to fishers that fish are in the area. Many fishers believe that birds travel with fish.

Fishers said it was important for fishermen to know how to track fish. Fish are constantly moving in the ocean, today they are traveling 5 km offshore, but next week it may be 10 km offshore. Thus, it was considered by fishers to be important to be aware of the location of the line when set, what section of the line caught more fish, and the locations of other boats and their catches. Thus, they would be able to make a spatial picture of where at sea fish are traveling, and if fish behaviour changed, they could continue tracking the fish based on trial and error fishing.

**FISHING OUTCOMES**

As a result of a number of decision-making options, fishers would decide to go fishing, and with the aid of local knowledge catch fish. The outcome of these decisions, using data for 2000-2001 is presented below.

**Total landings**

During the period 2000-2001, overall fish landings for canoes and pirogues increased significantly (p < 0.05) (Figure 4). Increased landings in 2001 were due mainly to increased landings from canoes (Figure 5). Also, boat type landings were significantly different (p = 0.029).

![Graph of fish landings](image)
Species composition of the landings by both vessel types were similar ($p = 0.077$). However, pirogues caught a higher percentage of yellowfin tuna 58% to canoes 46%; while canoes caught a higher percentage of sailfish 40% compared to pirogues 25% (Figure 6). Overall, the main species caught was yellowfin tuna (Figure 7).
Figure 7. Monthly weight of species landed by all vessels for the period 2000 and 2001.

Catch Rates
The data showed significant differences in yearly and monthly catch rates \( (p < 0.05) \) by vessel types (Figure 8). Pirogues, at the end of 2000, showed a decline in catch rates, however, by February 2001, there was a recovery.

Figure 8. Monthly mean catch per trip (kg) for both canoe and pirogue longliners together and separate from January 2000 to December 2001.
WHY INCREASES IN LANDINGS & CATCH RATES?

Why was there this increase in total landings and catch rates? Was it due to an increase in fish abundance? Fishers identified three main factors that affected their decision to go fishing, weather condition, bait availability and social factors. We will now look at these factors one at a time and statistically determine if there are any relationships between these factors and landing/catch rates.

Weather Conditions

To represent weather conditions, two variables were selected, mean monthly rainfall and percent rough sea days. The data showed no significant differences in yearly rainfall data (p = 0.135), but differences at the monthly level (p < 0.05). Rainfall was highest between July and December, while rough sea days were usually between January to March and October to December. Overall good fishing days, i.e. calm seas and little rainfall were from March to May (Figure 9). There was no significant relationship (p < 0.05) between catch rates or total landings and weather conditions. The data also showed that with an increase in rainfall there was a decline in mean numbers of trips per month (Figure 9).

![Figure 9. Mean monthly percent rough sea days, rainfall, and trips per month for the period 2000-2001](image)

Bait Availability (flyingfish and jacks)

Prior to the 1980s, large quantities of flyingfish were landed as food. At that time, they were caught using dipnet and handline using very small hooks. In the 1990s however, with changes in gear and fishing fleet technology for oceanic pelagic species, flyingfish were predominantly targeted for bait using gillnets; although some were retained and sold as food. Fishers would fish for flyingfish by luring them with coconut branch and macerated fish, then using gillnet (mesh size 2.54 cm) approximately 30 m in length to catch them. By 2000, flyingfish were caught mainly for bait by 163 boats from seven fish
landing sites (mainly on the west coast) of Grenada (Rennie 2001). Flyingfish were highly seasonal, from January to June each year. At the end of the season, fishers used to moor or pull up boats and wait until the next fishing season. In 1995 fishers started experimenting with the use of live jacks, as bait, from the beach seine fishery. By 2001, all boats had converted to using medium and large live jacks. This change meant that fishers could fish for large pelagics all year round. Figure 10 shows that the effect of fishers using a combination of flyingfish (at the beginning of the year) and jacks (at the end of the year) was an increase in total fish landing. It should be noted that fishers caught flyingfish using gillnets, where bait was first removed, and the remainder landed. Data presented shows excess food fish landed, not total catches. Presently, jacks which were used as food fish, are now being used as bait, and only the excess is landed as food fish.

![Graph showing monthly ocean fish and bait landings](image)

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**Figure 10. Monthly ocean fish and bait (flyingfish and jacks) landings**

Social Factors (social events and incidence of violence)
Financial (fishers) and social (community) obligations, and social events may force fishers to increase fishing effort to make money to provide for their family, enjoy themselves, and gain status among their peers. Six main social events were identified (Figure 11): January, national sailing competition in Grand Anse, St. George’s; April, Easter Regatta in Gouyave; June, Fishermen’s birthday celebration in Gouyave; August, carnival celebrations in Gouyave; September, back to school; and December, Christmas celebrations. “Success” of these social events depends on fishers’ ability to spend money. Social events are associated with high alcohol consumption. We use reported incidence of violence to the police (threats, assaults, stealing, and drug possessions), because these were the only hard numbers available. Overall,
there was no statistically relationship between reported incidence of violence and fishing landings and catch rates \( (p > 0.05) \).

![Chart showing monthly reported incidence of violence and main monthly social events of importance to fishers in Gouyave](image)

**Figure 11. Monthly reported incidence of violence and main monthly social events of importance to fishers in Gouyave**

There were some statistically significant correlations between factors that affected decision-making (weather, bait, social factors) and outcome (catch rates); although not strong enough to explain the significant increase in landings.

**EXOGENOUS FACTORS**

Further investigation revealed that exogenous factors that affect fishers’ decisions to fish that may contribute to an increase in outcome. These factors include market forces, improved fishing technology, and changes in fishing operations.

**Market Forces**

Observation of landing data (Figure 7) showed that increases in landings, are often followed by declines. This phenomenon can be explained by: the fish market reaching its storage capacity, forcing fishers to reduce fishing trips per month; high fish prices compared to other meats; and high supply and low demand for fish. Quality (grades 1 & 2) yellowfin tunas landed in Gouyave are exported, by processing companies, NORDOM Seafoods Ltd. located in Gouyave, Caribbean Seafoods Ltd., and Grenada Commercial Fisheries Ltd. (GCFL) in St. George’s. Bycatch (sailfish, swordfish, marlin, and dolphinfish) and poor quality, not suited for export, yellowfin tuna are sold and distributed by local vendors and processing companies mentioned above.

Firstly, the storage capacity of Gouyave fish market is about 40 tonnes of fish. If local consumer demand is low, whether due to prices or species preference, fish remain in the market, reducing fishers’ ability to go fishing
because there is nowhere to store additional fish caught. Secondly, the price of fish is high compared to retail cost of other meats, e.g. chicken at US$0.93, beef and pork at US$1.85, and fish at US$1.85 - $2.60 depending on species. Thus, consumers prefer purchasing chicken rather than fish. According to consumers, “a pound of chicken feeds a family better than a pound of fish”. Thirdly, at times there is so much fish on the market, supply is greater than demand, and even with a drop in price, there are not enough buyers. Finally, if the export price of yellowfin tuna falls, it is not economical for processing companies to purchase from fishers.

Improved Fishing Technology

Boats and longlines were adapted mainly to improve the economic efficiency of the boats and facilitate changes in bait use. In November 1999, Hurricane Lenny destroyed approximately 25% pirogues in Gouyave. By September 2000, fishers after evaluating the operational cost and performance of canoes versus pirogue boats decided to move into canoe style operations. Thus fishers who lost pirogue boats and other fishers wanting to own vessels, purchased multi-purpose canoes. This resulted in a decline in pirogue boat operations and an increase in canoes (Figure 12). In January 2001, pirogue numbers started to increase, as boat owners recruited new crew. However, as the benefits of canoe operations became obvious, i.e. similar catch rates, low operational cost, and higher incomes, more fishers were attracted to canoes.

Fishers made changes to boats to accommodate the use of live jacks. Canoes and pirogues were remodeled with bait wells, to transport live bait, longline reels were built to fit canoes; and fishers started experimenting with lighter breaking strain monofilament plastics.

Figure 12. Number of canoes and pirogues operating monthly from January 2000 to December 2001 in Gouyave
Changes in Fishing Operations

Along with improved fishing technology, fishing operations also changed to improve efficiency and effectiveness. The main change was to accommodate changes in bait type. When using flyingfish as bait, fishers would first catch flyingfish using gillnet then bait the longline, drift with the current and set the line, from north to south. When using jacks as bait, fishers had to purchase and store jacks from beach seine fishers. On the morning of the trip, they would put bait in the bait-well and head out to sea. On reaching the fishing area, they would bait hooks, steam and set the line moving east to west. Using jacks as bait is a faster procedure, you set out the line early and return to shore early (2-4 PM). Using flyingfish is a whole day operation, which requires first catching the flyingfish, then using it as bait. Fishers usually return to shore 7-10 PM at night.

DISCUSSION

Fishers’ decisions to go fishing were based on a number of considerations, some concerning biological or market factors, but others concerning social factors. These considerations affect landings, effort, and catch rates. Type of bait affects landings. Availability of bait, crew reliability, and the fishers’ ability to meet social and financial obligations affects effort. Fishers’ decision to fish a certain area, experience, and local knowledge of fishing affects catch rates (Table 2).

Statistical tests of three factors (weather condition, bait availability, and social factors) showed correlation between catch rates and landings. Clearly, weather conditions measured as percent rough sea days and rainfall had some effect on numbers of trips per month (Figure 6); and knowledge of the use of jacks increased landings (Figure 10). More importantly, exogenous factors such as changes in fishing operations, fishing technology, and marketing had the most impact on catch rates and landings for the period under investigation, although we were not able to prove it scientifically.

Table 2. Factors that affect landings, effort, and catch rates

| Bait type          | Should I go fishing | Can I go fishing | Gear use | Weather conditions | Social obligations | Where fishing | Market forces | Technology | Operations |
|--------------------|---------------------|------------------|----------|-------------------|-------------------|---------------|---------------|------------|------------|------------|
|                    |                     |                  |          |                   |                   |               |               |            |            |            |

Catch rate, in this case does not merely reflect species abundance. Fishing trip inadequately captures effort. Effort, defined as the exertion put out by fishers to catch fish, is based on decisions about the weather, effectiveness of bait, social obligations, improved fishing technology and operations to catch fish. Decisions, outcomes and exogenous factors were highly variable, and Gouyave fishers have proved adaptive and responsive to changes in the fishery.
and their personal circumstances, resulting in highly variable effort and landings.

To reflect changes in the fishery, data documentation and assessment need to be adaptive and responsive to these changes. Standard data requirements developed in the 1990s will reflect the fishery in the 1990s. But if one uses the same format in 2000, fisheries managers will miss contextual information such as:

i) Bait fishery (e.g. landings from beach seine vessels which lands bait by species, type of bait fishers used, and total catches of flying fish not just landings);

ii) Fishing technology (e.g. documenting changes in boat and longline technology);

iii) Fishing operations (e.g. documenting changes in fishing operations, longline operations in the 1990s was different from 2000/01); and

iv) Records of no catch trips (e.g. during early years of longline fishing, it was unusual for boats to return without catching any fish. In 2000/2001 on about 30% of trips, fishers returned to shore with no fish)

Without context, data on catch rates are difficult to interpret. So if we were to ask, are Gouyave fishers catching more fish now than say 10 years ago, a quick glance at the data, one would say yes, but on further investigation, the answer is inconclusive. One fisher rightly said, “It is difficult to say, we have more and better boats and now we fish all year. With more boats the catch might appear more, but each boat catching less.”

What is needed is participatory data assessment, which creates the forum where context is understood. In Grenada, fisheries data is collected by Data Collectors or fish market staff at fish landing sites or markets in villages; the data is entered in a computerized system by a Data Entry Clerk; and then assessed by Fisheries Officers at the central Fisheries Division in the city. Usually, at the time of assessment context is lost, especially when data is analyzed at the macro level. Thus participatory data assessment is required, where information on context is shared between the givers of data (fishers, market staff), collectors (data collectors), processing, and assessing data (fishery managers). Interaction may involve fishing trips, discussions of findings, monitoring fishing operations and technological changes, etc. This type of assessment provides the Fisheries Division with valuable feedback which will eventually lead to changes in the type of data they collect.

The Fisheries Division needs to create an environment of sharing and learning for participatory data assessment to be effective. Information sharing requires communication and good relations between the Fisheries Division staff and members of the fishing industry. Learning requires documenting changes in the fishery, reviewing and monitoring of data collection activities to ensure the system is capturing relevant information, and implementing feedback strategies. Generally, catch and effort data is recorded exclusively by the Fisheries Division, and nothing else. There needs to be a format to document additional information (quantifiable and non-quantifiable information) which will provide context for data assessment (Berkes et al. 2001).

In conclusion, data without context may be just as bad as too little data for
assessment. Fisheries management and planning depends on information, and one source of information is landings and catch rates. Wrong interpretation could result in the closure of a fishery. To ensure that context is incorporated in fisheries assessment, Fisheries Division must have participatory data assessment at fishing community levels, and more importantly, an environment of sharing and learning among individuals in the fishing industry.

ACKNOWLEDGEMENTS
We would like to thank Gouyave fishermen, and staff of the Grenada Fisheries Division, Gouyave fish market staff, and the CARICOM Fisheries Unit for their valuable time and patience in sharing their knowledge to make this paper possible. I also appreciated the useful comments from earlier outline and draft for this paper, from Dr. Robin Mahon. The project has been supported by the International Development Research Centre of Canada (IDRC), Social Sciences and Humanities Research Council of Canada (SSHRC) with grants to Dr. Fikret Berkes.

LITERATURE CITED