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Volume 2

Report of Sixth Annual CRFM Scientific Meeting - St.Vincent and the Grenadines, 07-16 June, 2010

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Fishery Management Advisory Summaries

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FOREWORD

The Sixth Annual Scientific Meeting took place during 07-16 June 2010 in Kingstown, St. Vincent and the Grenadines. During this Meeting, CRFM Resource Working Groups examined data from the following fisheries: the reef fisheries of Montserrat, especially the red hind (*Epinephelus guttatus*) and queen triggerfish (*Balistes vetula*) fisheries; and the dolphinfish fishery of the Eastern Caribbean. The LPWG also reviewed blackfin tuna data available from the ICCAT database, and discussed country-specific details of landings information.

An inter-sessional plan for the bio-economic study of the Eastern Caribbean flyingfish fishery was developed by the SCPWG. The CLWG and the SGWG did not meet in 2010; however an inter-sessional study on the economics of the queen conch fishery in the Turks and Caicos Islands was completed during this Meeting. Inter-sessional studies completed for the Eastern Caribbean flyingfish fishery, and the spiny lobster fisheries of Belize and Jamaica under the United Nations University-Fisheries Training Programme in Iceland were also presented and discussed at the Meeting.

The first formal meeting of the Working Group on Data, Methods and Training (DMTWG) was convened, during which a 1½-day basic training course in the use of R (statistical software) was successfully conducted. A plenary session was also held to review and discuss issues and recommendations pertaining to data, methods and training, as well as identify inter-sessional activities for the DMTWG.

The Report of the Sixth Annual Scientific Meeting is published in two Volumes: Volume 1 contains the proceedings of the plenary sessions and the full reports of the CRFM Resource Working Groups for 2010. Six national reports were submitted for consideration by the Sixth Annual Scientific Meeting, and these are published as Supplement 1 to Volume 1. Volume 2 contains part A (Overview), and the fishery management advisory summaries of individual fishery reports comprising part B of each Working Group report, where relevant. Volume 1 is intended to serve as the primary reference for fishery assessment scientists, while Volume 2 is intended to serve as the main reference for managers and stakeholders.

The covers for this volume were designed and prepared by Mr. Shaun Young, while the photographs were provided by Ms. Maren Headley, Mr. Derrick Theophille and Dr. Susan Singh-Renton. These contributions are gratefully acknowledged.

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List of Acronyms and Abbreviations

ACP	-	African, Caribbean and Pacific states
CARICOM	-	Caribbean Community
CFF	-	Caribbean Fisheries Forum
CFMC	-	Caribbean Fishery Management Council
CFRAMP	-	CARICOM Fisheries Resource Assessment and Management Program
CLME	-	Caribbean large Marine Ecosystem
CLWG	-	Conch and Lobster Resource Working Group
CNFO	-	Caribbean Network of National Fisherfolk Organizations
CPUE	-	Catch Per Unit of Effort
CRFM	-	Caribbean Regional Fisheries Mechanism
DECR	-	Department of Environment and Coastal Resources
DMTWG	-	Data and Methods Working Group
EBM	-	Ecosystem Based Management
EEZ	-	Exclusive Economic Zone
FAD	-	Fish Aggregating Device
FAO	-	Food and Agriculture Organization of the United Nations
FMP	-	Fisheries Management Plan
GAM	-	General Additive Models
GLM	-	General Linear Models
ICCAT	-	International Commission for the Conservation of Atlantic Tunas
IFREMER	-	Institut Français de Recherche pour l'Exploitation de la Mer
IMA	-	Institute of Marine Affairs
LPWG	-	Large Pelagic Fish Resource Working Group
LRS	-	License and Registration System
MEY	-	Maximum Economic Yield
MSY	-	Maximum Sustainable Yield
NGO	-	Non Governmental Organization
NMFS-SEFSC	-	National Marine Fisheries Service – South East Fisheries Science Center
NW	-	North Western
REEF	-	Reef Environmental and Education Foundation
RSWG	-	Reef and Slope Fish Resource Working Group
SAP	-	Strategic Action Plan
SCPWG	-	Small Coastal Pelagic Fish Resource Working Group
SE	-	South Eastern
TAC	-	Total Allowable Catch
TCI	-	Turks and Caicos Islands
TDA	-	Transboundary Diagnostic Analysis
TIP	-	Trip Interview Programme
TRP	-	Target Reference Point
UNU-FTP	-	United Nations University – Fisheries Training Programme
USA	-	United States of America
UWI	-	University of the West Indies
VPA	-	Virtual Population Analysis
WCA	-	Western Central Atlantic
WECAFC	-	Western Central Atlantic Fishery Commission

I. REPORT OF THE SMALL COASTAL PELAGIC FISH RESOURCE WORKING GROUP (SCPWG)

Consultant: Professor Juan Carlos Seijo
Chairperson: Maren Headley (CRFM Secretariat)
Susan Singh-Renton (CRFM Secretariat); Yvonne Edwin (St. Lucia); Chris Parker (Barbados); Harold Guiste (Dominica); Leslie Straker (St. Vincent and the Grenadines); Lionel Reynal (IFREMER)

1. Review and Adoption of Meeting Agenda

The Meeting was opened by Professor Seijo and the group adopted the agenda without any changes.

2. Review of the Working Group's Commitments to the CLME Project for Flying fish

The overall objective of the Caribbean Large Marine Ecosystem and Adjacent Regions (CLME) Project is the sustainable management of the shared living marine resources of the CLME and adjacent areas through an ecosystem-based management (EBM) approach. Under the Terms of Reference for TDA Gap Filling Activities and SAP for the Shared Stocks of the Eastern Caribbean Flyingfish Fishery, specific objectives and activities that will contribute to the TDA and for which CRFM has the overall responsibility are:

1. Improvement of availability of data and information including catch/effort information, in the Eastern Caribbean taking into account long lining and mixed landings;
2. Bioeconomic studies of the fishery to establish the bioeconomic criteria and set reliable management measures for the fourwinged flyingfish;
3. Assessment of species interaction between flyingfish and large pelagic fishes to provide for these in management using EBM principles; and
4. Assessment of economic risk and social impacts to refine the management for the fourwinged flyingfish.

3. Review of New Data and Information, National Reports, Fisheries Trends

***Barbados*:** The participant from this country provided a description of how the fishing fleet evolved over time, not only in numbers but also in vessel characteristics and fishing power. The group was informed that data exist from 1949 when comprehensive sampling of the market catches first started, however these data are recorded as total landings and not by individual vessels; detailed trip record data became available from the introduction of TIP/LRS in 1994. The use of inappropriate raising factors in the years prior to 1994 was also highlighted as this resulted in overestimation of landings data.

***St. Vincent and the Grenadines*:** The representative from this country pointed out that there was no targeted flyingfish fishery in St. Vincent and the Grenadines and that the annual landings are usually less than 500 kg. In terms of management policy for the resource, flyingfish is considered an underutilized species with the potential for use in the future, especially as a bait species for the longline fleet which consists of ten vessels.

***St. Lucia*:** St. Lucia indicated that computerized data are available for flyingfish from 1981-2009 and fishery operations are concentrated on the West Coast of the island where the fishers are primarily dependent on the small coastal pelagic fishery.

***Dominica*:** The representative from Dominica informed the group that there has been a shift from the flyingfish fishery to the large pelagic fishery within the last eight years due to the development of the FAD fishery. The annual flyingfish landings are less than 900 kg.

***Martinique*:** The representative from the French West Indies presented the group with flyingfish landings and catch and effort data for Guadeloupe (2008) and Martinique (2009). These data are summarized in Table 1.

Table 1: Landings and effort data for the flyingfish fisheries in Guadeloupe (2008) and Martinique (2009).

Metier	No trips Martinique	Martinique 2009 Landings (kg)	Martinique 2009 CPUE (kg)	No trips Guadeloupe	Guadeloupe 2008 Landings (kg)	Guadeloupe 2008 CPUE (kg)
Decked boat				559		
Drifting net Flyingfishes	316	43,439	138			
Drifting net Exocet-High Sea	251	11,581	46			

lines						
FADs	5,436	1,010	0.2	8,055	88	0.01
High Sea lines	3,658			14,110	248	0.02
other lines	1,864					
other gears	5,210	1173			1,404	
Total estimate		**57,203**			**1,740**	
Low		*19,594*			*1,209*	
High		*114,154*			*2,408*	

3.1 Review of Technical Studies and Management Developments

A study entitled, "Harvesting of Flyingfish in the Eastern Caribbean: A Bioeconomic Perspective" was presented to the group. Flyingfish and dolphinfish are two species which are usually targeted together by the same vessels, on the same trips, and utilizing different gear. The goal of this project was to develop a bioeconomic model based on the predator-prey relationships among flyingfish, dolphinfish and other commercial fish species in the eastern Caribbean. The model was applied to the management question of whether direct harvest of flyingfish or indirect harvest through converted predator biomass was more profitable, given the low ex-vessel price of flyingfish in comparison to the larger pelagics. The model estimated that benefits obtained from direct harvest of flyingfish were $1.7 million US whereas harvest of the increased predator biomass associated with reduced flyingfish harvest resulted in benefits of $ 474 thousand US. This represented a loss of $1.3 million in net benefits which corresponded to 76% of what was obtained by direct harvest of flyingfish. Therefore it was concluded that direct harvest of flyingfish was the better management strategy.

Comprehensive management methods were also discussed by the group and Professor Seijo delivered a presentation entitled "A Simple Decision Theory Framework to Manage Pelagic Fisheries of the CLME under Possible Effects of Climate Change." The focus of this presentation was a simple approach for dealing with uncertainties in fisheries. This approach involves the use of Monte Carlo methods and decision tables with alternative criteria reflecting different degrees of risk aversion and is summarized in Figure 1.

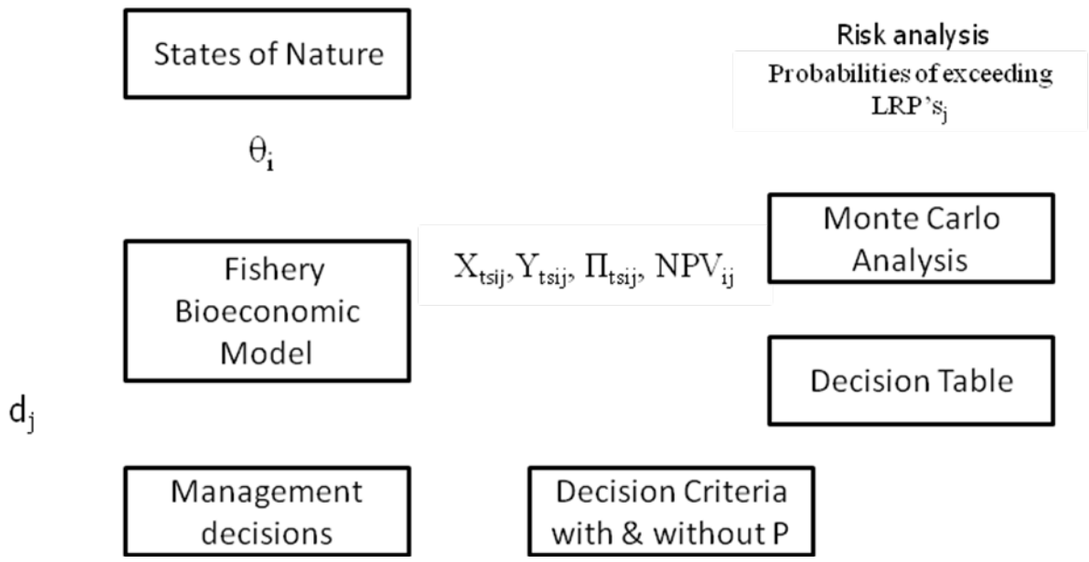

Figure 1: Approach to Developing Decision Tables (Source: Anderson and Seijo, 2010)

4. Review of Management Objectives and Practical Management Strategies

A review of the management objectives for the flyingfish fishery was not conducted; however the group agreed that management strategies must include all the key stakeholders and countries involved in the fishery. The management objectives for this fishery can be found in the Draft Sub-Regional Management Plan for Flyingfish in the Eastern Caribbean (FAO 2009).

5. Fishery Data Preparation, Analysis and Assessment Planning and Implementation

A data form was developed to record the time period for which assorted variables/parameters were available by country (Annex 1). The variables/parameters included raised catch totals, recorded catches, CPUE, length, weight, age, maturity, catchability and fleet sizes.

Flyingfish is a short-lived small pelagic species which is usually sensitive to environmental factors that tend to determine their abundance over space and time, and its fishery is therefore considered as a non-equilibrium one. The ecological interdependence between flyingfish and dolphinfish is also an important aspect for management of these two fisheries. On this note, the group agreed that an Ecosystem Approach to Fisheries was necessary and the steps are described below:

i. define fisheries management questions for the flyingfish fishery and the ecologically inter-dependent dolphinfish fishery in the context of multiple users of the CLME;
ii. identify possible ecological and technological interdependencies among these species within the ecosystem;
iii. select biological/ecological and economic/social performance variables;
iv. define corresponding ecosystem performance indicators for the fishery;
v. establish limit and target reference points for the indicators;
vi. identify alternative management strategies for the fishery within an ecosystem context;
vii. design a dynamic bio-economic model of the ecologically and technologically interdependent fishery;
viii. collect data to estimate model parameters;
ix. identify possible states of nature in uncertain and sensitive parameters;
x. build decision tables and apply decision criteria to deal with risk and uncertainty; and
xi. estimate probabilities of exceeding ecosystem limit reference points (risks) and of achieving desired target reference points.

6. Inter-sessional Work Plan

The SCPWG agreed that the following tasks would be undertaken during the inter-sessional period:

1. Develop a dynamic bioeconomic analysis for flyingfish (*H. affinis*) and dolphinfish (*C. hippurus*) using existing parameter sets and updated annual catches and effort of countries harvesting these resources.

2. Given the ecological interdependency between dolphinfish and flyingfish, extend the bioeconomic model mentioned under (1.) to incorporate predator-prey relationships and determine the corresponding bioeconomic reference points.

3. Build decision tables for alternative management strategies of this fishery considering the uncertainty in possible states of nature and sensitive biological and economic parameters.

4. Undertake risk analysis of management strategies under consideration.

A summary of the necessary data and information which will be provided by the country representatives is set out below.

i. Heterogeneity of fleets in terms of fishing power and capacity – This will require countries to submit vessel, engine and gear specifications by their major fleets which target flyingfish and will include information on:
   - Fleet type
   - Vessel length (m)
   - Engine size (Hp)
   - Gillnets (average lengths and numbers)
   - Trolling/handline/longline (number of lines and number of hooks)
   - No. of fleets

ii. Compilation of economic data to determine the cost per unit of effort by fleet type – This will include cost information for the following:
   - Vessel and Engine
   - Gear cost /unit/ year
   - Average vessel and engine maintenance costs/unit/year
   - Average insurance cost/unit/year
   - Average loan repayment cost/unit/year
   - Average crew share/unit/year
   - Gear repair/replacement, engine and hull repair costs/unit/year
   - Market fees/unit/year

- Depreciation cost/year
- Average fuel cost/unit/trip
- Average oil cost/unit/trip
- Average ice cost/unit/trip/
- Average food cost/unit/trip

iii. Catch and effort data as well as price data – Countries will have to submit catch ad effort (fishing days OR number of fishing trips) data by fleet type for the last five years. In order to calculate total revenue, these data will be necessary for flyingfish, dolphinfish as well as other species targeted during the same trips (e.g wahoo, tunas, sailfish and billfish).

iv. Use of existing population dynamics and ecological dependencies parameters estimated by recent studies for both flyingfish and dolphinfish (FAO, 2008; Mohammed *et al*., 2008; Headley, 2009).

A report of the activities conducted by Professor Seijo with regards to the flyingfish fishery and decision theory was prepared and is included in Volume 1 of this Report (Seijo, 2010).

7. Any Other Business

It was agreed that deadlines and contact persons needed to be identified by country.

8. Adjournment

The meeting was adjourned at 5:00 pm on June 15, 2010.

9. References

Anderson, L. G. and J. C. Seijo (2010) *Bioeconomics of Fisheries Management*. Wiley and Blackwell. USA.

FAO (2009). Report of the third meeting of the WECAFC ad hoc flyingfish working group of the eastern Caribbean, Mt. Irvine, Tobago, 21-25 July, 2008. FAO Fisheries Report *in press*, 87pp.

Headley, M. (2009) Harvesting of Flyingfish in the Eastern Caribbean: A Bioeconomic Perspective. United Nations University-Final Project.

Mohammed, E., M. Vasconcellos, S. Mackinson, P. Fanning, S. Heileman and F. Carocci. (2008). A trophic model of the Lesser Antilles pelagic ecosystem. Scientific basis for ecosystem-based management in the Lesser Antilles including interactions with marine mammals and other top predators. FAO/Government Cooperative Programme FI:GCP/RLA/140/JPN Technical Document 2, 168 pp.

Oxenford, H. A., R. Mahon, and W. Hunte (1993) eds. The Eastern Caribbean Flyingfish Project. *OECS Fishery Report* No. **9**, 187 pp.

Oxenford, H. A., W. Hunte, R. Deane and S.E. Campana (1994) Otolith age validation and growth-rate variation in flyingfish (*Hirundichthys affinis*) from the Eastern Caribbean. Mar. Biol 118: 585-592

Oxenford, H. A., R. Mahon and W. Hunte. (1995a) Distribution and relative abundance of flyingfish (Exocoetidae) in the eastern Caribbean. I. Adults. Mar. Ecol. Prog. Ser. 117:11-23.

Oxenford, H. A., R. Mahon and W. Hunte (1995b) Distribution and relative abundance of flyingfish (Exocoetidae) in the eastern Caribbean. III. Juveniles. Mar. Ecol. Prog. Ser. 117:39-47.

Seijo, J.C. (2010). Sixth Annual Scientific Meeting of CRFM, Kingstown, St. Vincent, May 9-16, 2010, Report by Juan Carlos Seijo, PhD, Consultant. pp 106-109. In: CRFM Fishery Report -2010, Volume 1. Report of Sixth Annual Scientific Meeting – Kingstown, St. Vincent and the Grenadines, 07-16 June 2010. CRFM: Belize, 109p.

Annex 1. Summary of the time periods for which assorted variables/parameters are available for the flyingfish fishery by country.

Country Name	Raised Catch Total	Recorded Catch	CPUE (TRIP)	CPUE (Day)	CPUE (Other)						Catchability (specify unit)			Gear	Notes
						Length	Sex	Weight	Age	Maturity		Size	Type		
Trinidad & Tobago	1988-1997[2]	1974-1984[1] 1988-1997[2]	1979-1982 1988-2010	Likely same as CPUE (trip) as most pirogues make one trip per day; but to be verified by THA	Verify with THA – some data collected on time spent fishing; use of FADs; use of other gear for capture of associated species.	1991-1992; Nov 1996 to Jul 1998 (several gaps in data)	1991-1992; Nov 1996 to Jul 1998 (several gaps in data)	1991-1995; Nov 1996 to Jul 1998 (several gaps in data)	Otoliths from 20 fish examined in 1992	Feb '91 to Jan '92; Nov 1996 to Jul 1998 (several gaps in data)		1993[3]; 2002[4]	1993; 2002		Information in the following documents can be used to estimate catches in 1957: King-Webster, W. A. 1957. Fisheries Department report on the fisheries of Tobago. October 1957. Fisheries Department, Port of Spain, Trinidad, Trinidad and Tobago: 24 pp. King-Webster, W. A. And H. O. Rajkumar. 1958. A preliminary survey of the fisheries of the islands of Tobago. Caribbean Commission Central Secretariat: 19 pp.
Grenada	1978-2007[5]	NA	NA	NA	NA	1988 - 1995[7, 8, 9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]		A	A	A	
St. Vincent	1978-2007[5]	NA	NA	NA	NA	1988 - 1995[7, 8, 9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]		A	A	A	
St. Lucia	1981-2009[5]	1981-2009	1998-2007[5]	1	Gear	1988 - 1995[7, 8, 9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]		A	FRP, Canoes	GNet	
Barbados	1950-1993	1994-2009	1998-2007[5]			1988 - 1995[7, 8, 9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	2000	1994 - 2009			
Martinique	1987, 2009	1987, 2009	1987, 2008-09		1987, 2008-09	2008 – 2009[7,8,9]	1988 - 1995[7,8,9]	2008-2009	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]			Artisanal, FAD	Troll, Hline	
Guadeloupe	2008	2008	2008	2008		1988 - 1995[7, 8, 9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]					

Dominica	1988 - 2007[5,6]	A	A	A	A	1988 - 1995[7, 8, 9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]	1988 - 1995[7,8,9]		A	A	A	

1. Total recorded catch given in Fabres, B. (1986). The flyingfish fishery of Trinidad and Tobago. pp. 7-10. In: Mahon, R., H. Oxenford and W. Hunte (eds.) Development strategies for flyingfish fisheries of the eastern Caribbean: Proceedings of an IDRC-Sponsored Workshop at the University of the West Indies, Bedford Institute of Oceanography, Nova Scotia, Canada and Bellairs Research Institute of McGill University, St. James: 148 pp.

2. Mohammed, E. (1996c). Reports on the Drifting Fishery of Tobago. 1993/94 Fishing Season. Report of the Fisheries Division of the Ministry of Agriculture, Lands and Marine Resources, St. Clair, Port of Spain, Trinidad, Trinidad and Tobago. 105p.

Mohammed, E. (1998). 1994/95 -1996/97: Reports on the drifting fishery of Tobago (Buccoo and Pigeon Point Landing Sites). Fisheries Division, Ministry of Agriculture, Land and Marine Resources, Port of Spain, Trinidad, Trinidad and Tobago. 224p.

Pandohee, E. (1993). Reports of the Drifting Fishery of Tobago. 1987/88-1991/92 Fishing Seasons. Report of the Fisheries Division of the Ministry of Agriculture, Land and Marine Resources. St. Clair, Port of Spain, Trinidad, Trinidad and Tobago. 185p.

Pandohee, E. (1994). Reports of the Drifting Fishery of Tobago. 1992/93 Fishing Seasons. Report of the Fisheries Division of the Ministry of Agriculture, Land and Marine Resources. St. Clair, Port of Spain, Trinidad, Trinidad and Tobago. 95p.

3. Based on national vessel census

4. FAO. (2002). Report of the Second Meeting of the WECAFC Ad Hoc Flyingfish Working Group of the Eastern Caribbean. Bridgetown, Barbados, 8-12 January 2001. FAO Fisheries Report. No. 670. Rome, 156p.

5. FAO. (2009). Report of the third meeting of the WECAFC ad hoc flyingfish working group of the eastern Caribbean, Mt. Irvine, Tobago, 21-25 July, 2008. FAO Fisheries Report *in press*, 87pp.

6. Mohammed, E., M. Vasconcellos, S. Mackinson, P. Fanning, S. Heileman and F. Carocci. (2008). A trophic model of the Lesser Antilles pelagic ecosystem. Scientific basis for ecosystem-based management in the Lesser Antilles including interactions with marine mammals and other top predators. FAO/Government Cooperative Programme FI:GCP/RLA/140/JPN Technical Document 2, 168 pp.

7. Oxenford, H. A., R. Mahon, and W. Hunte (1993) eds. The Eastern Caribbean Flyingfish Project. OECS Fishery Report No. 9, 187 pp.

8. Oxenford, H. A., W. Hunte, R. Deane and S.E. Campana (1994) Otolith age validation and growth-rate variation in flyingfish (*Hirundichthys affinis*) from the Eastern Caribbean. Mar. Biol 118: 585-592

9. Oxenford, H. A., R. Mahon and W. Hunte. (1995a) Distribution and relative abundance of flyingfish (Exocoetidae) in the eastern Caribbean. I. Adults. Mar. Ecol. Prog. Ser. 117:11-23.
Oxenford, H. A., R. Mahon and W. Hunte (1995b) Distribution and relative abundance of flyingfish (Exocoetidae) in the eastern Caribbean. III. Juveniles. Mar. Ecol. Prog. Ser. 117:39-47

Available A

Not available NA

II. REPORT OF THE REEF AND SLOPE FISH RESOURCE WORKING GROUP (RSWG)

Chairman: Kishmo Clarke (St. Kitts)
Asst. Chair: Anginette Murray (Jamaica)
Consultant: John Hoenig (Virginia Institute of Marine Science)
Nancie Cummings (NMFS, SEFSC- Miami, FL USA)
Other group members:
Mauro Gongora (Belize)
Addevi Persaud (Guyana)
Dominique Lazarre (University of Miami – RSMAS)

A. INTRODUCTION

Inter-sessional tasks identified by the RSWG at the Fifth Annual Scientific Meeting included computerizing of the trip specific landing data for the Montserrat fisheries. These data would be used to develop an analysis set for the Sixth Annual Scientific Meeting. Although only some data were computerized, the RSWG group commenced working with these data. No other data sets were made available for the meeting from other countries until near the end of the meeting when data from Jamaica were obtained. Preliminary work began on the Jamaica data but no results became available to present here. At the opening of the Sixth Annual meeting, the Plenary Chairperson stressed the importance of the various working groups to encourage regional agencies and countries involved in similar work to make their data available in electronic form. The Working Group acknowledges the considerable work that was done by Montserrat to prepare the data.

B. TECHNICAL ANALYSES

1.0 The Red Hind (*Epinephelus guttatus*), Queen Triggerfish (*Balistes vetula)* and other species in the reef and slope fisheries of Montserrat

1.1 Management Objectives

Red hind and Queen Triggerfish are considered as important components of the demersal reef and slope fisheries in Montserrat. The demand for these species has increased over the past five years as compared with other demersal caught species. Five other species are commonly caught with red hind and triggerfish. Consequently, we consider seven species here, the additional species being Longjaw Squirrelfish (*Holocentrus marianus*), Honeycomb Cowfish (*Lactophrys poligonius*), Blue Tang (*Acanthurus coeruleus*), Coney (*Epinephelus fulvus*), and Doctorfish (*Acanthurus chirurgus*).

The Montserrat Fisheries Division has noted the following management objectives for the reef and slope fishery:

- Manage the fisheries stocks to maintain sustainability at the national and at a regional level;
- Implement management measures as needed to ensure viability of the resources through effort controls, size limits, closed seasons, MPA's;
- Maximize fishers revenue while assuring acceptable levels of stock sizes;
- Minimize impacts on habitat and fishery resources to optimize future stock health.

1.2 Status of Stocks

The statuses of the Red hind and Queen Trigger fish stocks, as well as the additional five species considered here, are currently unknown.

1.3 Management Advice

Until a detailed stock assessment is conducted there are no recommended changes to the fishery. However there may be a need to implement corrective measures in the future in-order to achieve sustainability.

Sustainability of the RSF resources can be best achieved if the recommendations from the scientific meeting are implemented successfully within the desired time frame in order for a full evaluation of the resources to be conducted.

1.4 Statistics and Research Recommendations

1.4.1 Data Quality

Several tasks were identified which, if completed during the 2010/2011 intercessional period, should improve the data quality significantly and the management advice generated from analyses of these data.

- The data set was incomplete for 2008 and missing for 2009;
- The information on vessel id should be computerized for each landing record;
- Landings records prior to 2003 should be computerized to extend the time series available for analysis;
- Quality control and assurance protocols should be reviewed to ensure an accurate time series of data;
- The current landings data collection form should be modified to account for discards, spatial area of catch, quantity and type of gear used;
- Develop protocols to improve the timeliness of landings data availability from fishers who may not be accessible during normal working hours;
- Generate preliminary summaries of the computerized data intercessional to use in evaluating the sufficiency of data for future stock assessment evaluations for the multispecies RSF;
- Funding is needed to support these tasks and for the data entry and quality control/assurance;
- The fishable area for the RSF has been reduced in recent years due to volcanic activity; there is a need to quantify the current amount of RSF fishable area and to document any potential ongoing threats (e.g., mud flows, sedimentation) to the marine environment.

1.4.2 Biological data collections

Several critical needs were identified pertaining to biological data collections. These data needs are required in order to describe catch at size and to evaluate seasonal changes in maturity of the RSF species.

- Catch length frequency sampling should be implemented during the 2010/2011 period and continued as an ongoing data collection priority;
- Routine biological data collections (length/weight, maturity, ageing), should be implemented. Species to be studied should be identified during the 2010/2011 intercessional period and should be based on examinations of the landings data. Attention should be given to prioritization of species at both the national and the regional level;
- Information on spawning timing and areas needs to be documented as soon as possible. It is recommended to conduct a survey of the local fishers as a starting point to obtain this information as well as investigate fishing on spawning aggregations;

- Conduct a literature search at the national and regional level to document information on growth, mortality, spawning, maturation, fecundity.

1.4.3 Other data collections

- Conduct a literature search to document and compile a list of all research in volcanic activity and the impacts it has on the marine/fishery environment.

1.5 Data Analysis Summary

All but 20 of the landings records were from Carr's Bay. The 20 records from Little Bay were not analyzed. Almost all of the landings were from the reef fishery; the few observations from the coastal pelagic and ocean pelagic fishery were not analyzed. Almost all of the records are from the pot fishery. Catch rates were summarized only for catches from pots.

1.5.1 Red Hind

Seasonal Trends in Catch Rates:

- Red hind sampled landings were mainly from the Reef fishery and from pots (Table 1a)
- Red hind monthly catch rates showed a weak seasonal trend (Figure 1)
- There is the possibly a weak peak for April 2005, however all other four years in the time series do not show the peak
- For the most recent year, 2008, the catch rate is the lowest on record, sample sizes are very low for January and February (n=1 for February)
- Catch rates for 2008 began very low- this suggests a strong need to examine the remainder of the year's data (Tab. 1b, 1c)

Annual trends in Catch Rates:

- As shown in Figure 2, the annual average catch rate increased for two years, then declined for two years, and the 2007 trend remains unchanged from 2003.

Table 1a. Number of Red Hind Observations by Fishery and Gear Type

Fishery	Gear Type							
	BEACH SEINE	*GILL NET*	*HAND LINE/ BOTTOM/ DRIFTLINE*	*POLE & LINE*	*POTS*	*ROD & REEL*	*SPEAR FISHING*	*UNKNOWN*
COASTAL PELAGIC	19	3	1	0	0	0	0	0
OCEAN PELAGIC	0	0	1	0	0	0	0	0
TFREEF	1	0	42	0	1265	0	16	2

Table 1b. Number of Red Hind Observations by Year and Month

Year	Month											
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
2003	28	23	21	19	25	18	20	27	22	36	16	26
2004	25	24	22	17	22	19	21	24	31	30	23	23
2005	21	29	32	24	20	30	25	33	33	21	24	15
2006	14	22	19	26	25	20	17	12	25	20	21	17
2007	10	7	10	10	9	11	15	13	14	15	18	6
2008	11	1	0	0	0	0	0	0	0	0	0	0

Table 1c. Mean landed Weight (g) per trip of Red Hind Observations by Year and Month													
Year	**Month**												
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
	2003	7079	9072	8856	8284	9308	11038	13200	11407	8309	7900	10093	9613
	2004	9943	7541	12515	8965	7278	9764	8424	11850	14705	12761	8007	13194
	2005	9893	9541	10603	19996	11000	12640	16656	13429	11849	18166	13797	11219
	2006	8975	14123	10815	10520	11249	13018	10593	16443	16366	13721	13608	10059
	2007	11748	10368	11204	12020	9626	9402	10100	13782	8230	7832	5998	5821
	2008	5196	6804	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

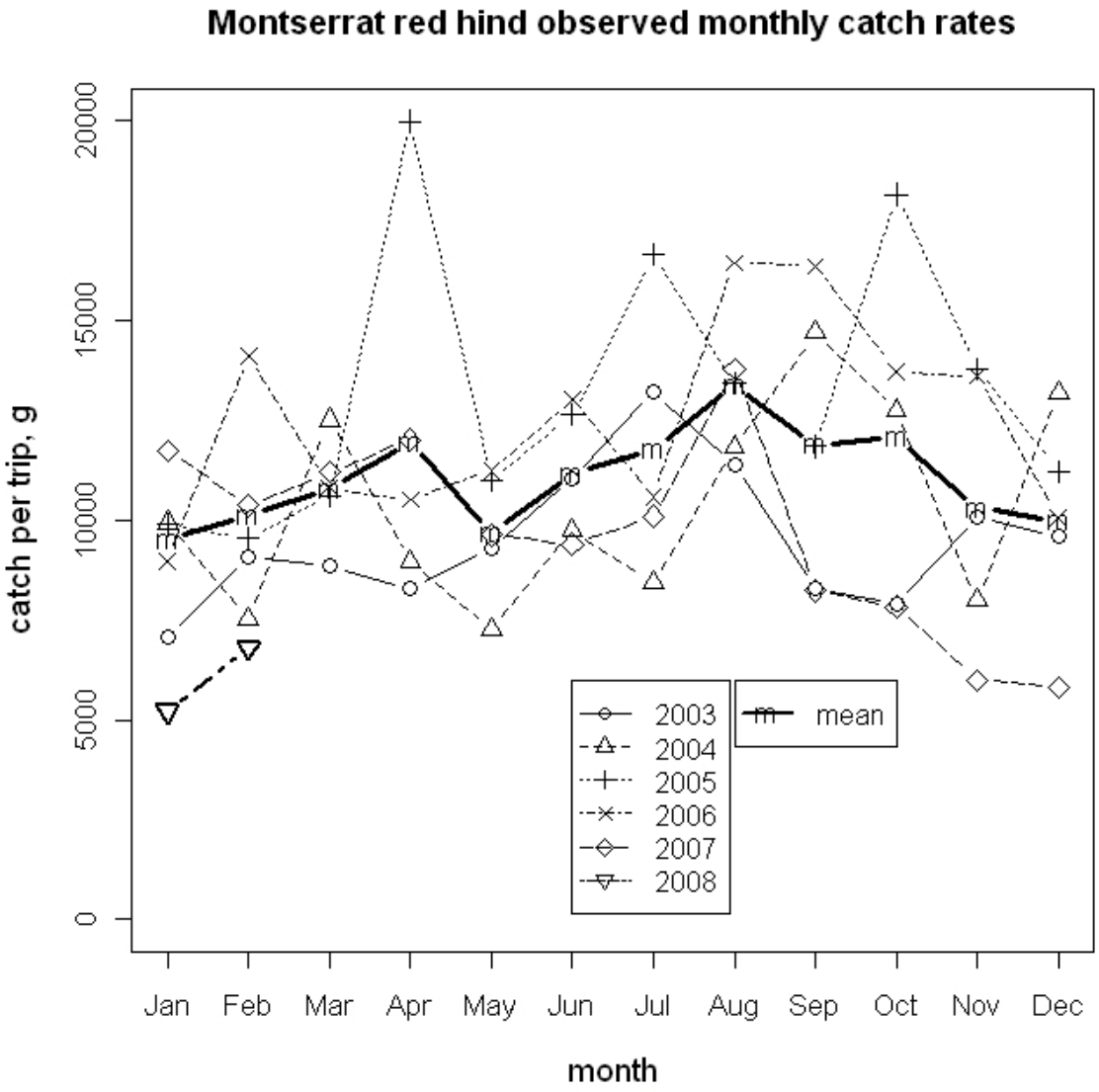

Figure 1. Monthly observed catch rates (grams per trip) by year (2003 - 2008) for Red Hind, Montserrat. The average across all years is shown with the heavyline and symbol=m. Data for 2008 are incomplete and should be interpreted with caution.

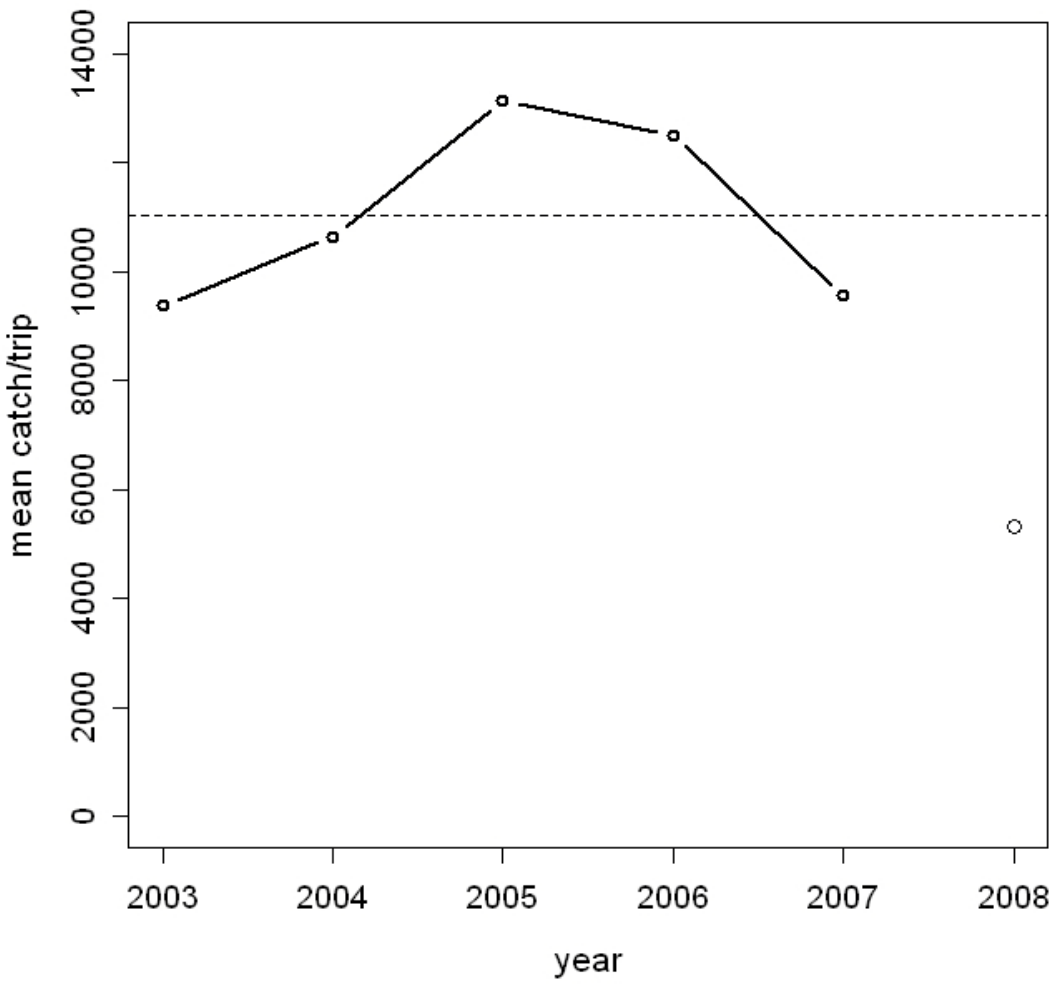

Figure 2. Average annual observed catch rates (grams per trip) for Red Hind, Montserrat. The point for 2008 is based on just two months of data.

1.5.2 Queen Triggerfish

Seasonal Trends in Catch Rates:

- Queen Triggerfish sampled landings were mainly from the Reef fishery and from pots (Table 2a);
- Analysis of monthly catch rates did not reveal any strong seasonal trend (Figure 3);
- The January 2008 catch rate was the lowest on record;
- Sample sizes for 2008 were very low. This in addition to the lowest catch rate on record strongly supports the need for full examination of the 2008 and later data (Tables. 2b, 2c).

Annual Trends in Catch Rates

- Annual Trends in Catch Rates in Queen Triggerfish catch rates did not vary greatly (Figure 4);
- The 2007 annual catch rate was unchanged.

Table 2a. Number of Queen Triggerfish Observations by Fishery and Gear Type

Fishery	Gear Type							
	BEACH SEINE	*GILL NET*	*HAND LINE/ BOTTOM/DRIFTLINE*	*POLE & LINE*	*POTS*	*ROD & REEL*	*SPEAR FISHING*	*UNKNOWN*
COASTAL PELAGIC	0	0	0	0	0	0	0	0
OCEAN PELAGIC	0	0	0	0	0	0	0	0
TFREEF	1	0	20	0	1185	0	17	2

Table 2b. Number of Queen Triggerfish Observations by Year and Month

Year	Month											
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
2003	29	19	18	18	18	14	17	26	24	33	11	18
2004	23	19	17	15	20	19	13	19	23	24	20	17
2005	19	26	34	26	26	31	28	33	27	24	25	18
2006	14	23	18	25	24	18	16	12	25	20	21	13
2007	11	7	11	7	10	11	11	17	19	18	22	7
2008	6	1	0	0	0	0	0	0	0	0	0	0

Table 2c. Mean landed Weight (g) per trip of Queen Triggerfish Observations by Year and Month

Year	Month											
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
2003	6225	6422	6325	6098	7031	6512	7071	8531	6936	6419	6680	11038
2004	10393	6016	8218	4808	6124	6708	6385	6613	7889	7182	4151	8005
2005	6637	6734	7765	13172	9229	7858	12587	10708	9811	14383	9108	10786
2006	8521	10019	9450	10542	9828	10634	7598	13646	10397	9866	8338	8863
2007	9649	9266	7216	11470	9253	6268	8495	7044	4918	8089	5381	6091
2008	4385	2722	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

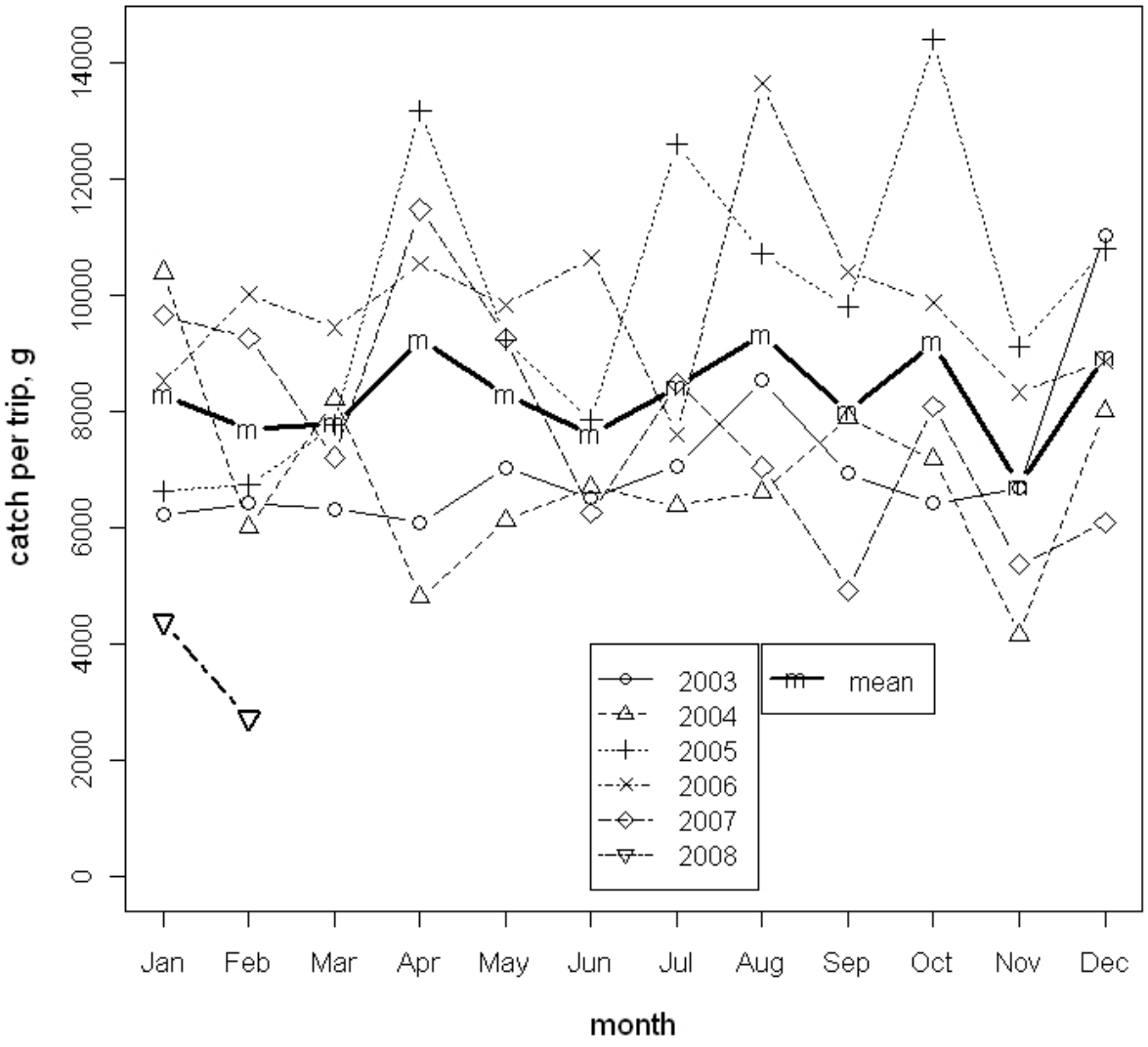

Figure 3. Monthly observed catch rates (grams per trip) by year (2003 - 2008) for Queen Triggerfish, Montserrat. The average across all years is shown with the heavyline and symbol=m. Data for 2008 are incomplete and should be interpreted with caution.

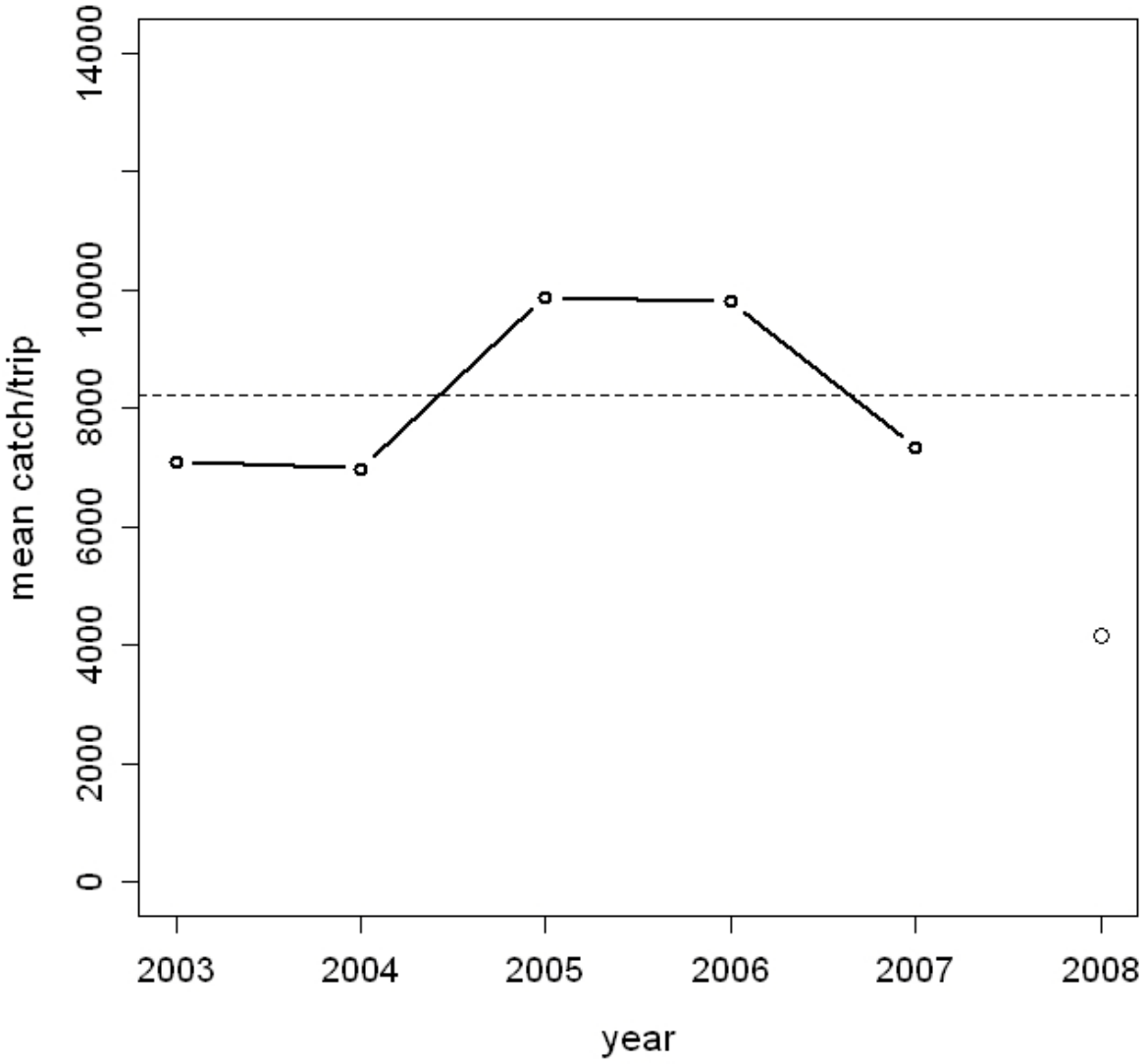

Figure 4. Average annual observed catch rates (grams per trip) for Queen Triggerfish, Montserrat. The point for 2008 is based on just two months of data.

1.5.3 Longjaw Squirrelfish

Seasonal Trend in Catch Rates

- Longjaw Squirrelfish sampled landings were mainly from the Reef fishery and from pots (Table 3a);
- Monthly catch rates did not show any seasonal trends (Figure 5);
- The January 2008 catch rate was tied for the lowest on record;
- As with Red Hind and Queen triggerfish sample sizes for 2008 were very low, again supporting the need to further examine the 2008 data and beyond (Tables 3b,3c).

Annual Trend in Catch Rates

The trend in annual catch rate of Longjaw Squirrelfish increased through 2006 and catch rate was close to average in 2007 (Figure 6).

Table 3a. Number of Longjaw Squirrelfish Observations by Fishery and Gear Type

Fishery	Gear Type							
	BEACH SEINE	*GILL NET*	*HAND LINE/ BOTTOM/DRIFTLINE*	*POLE & LINE*	*POTS*	*ROD & REEL*	*SPEAR FISHING*	*UNKNOWN*
COASTAL PELAGIC	15	2	0	0	0	0	0	0
OCEAN PELAGIC	0	0	0	0	0	0	0	0
TFREEF	1	0	19	0	1213	0	19	1

Table 3b. Number of Longjaw Squirrelfish Observations by Year and Month

Year	Month											
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
2003	31	26	22	14	25	17	21	24	23	33	18	25
2004	27	31	23	16	24	20	19	21	29	27	21	19
2005	20	26	35	23	21	28	27	30	30	22	26	18
2006	17	22	16	26	25	21	15	11	24	21	19	17
2007	9	3	0	0	0	0	9	16	24	17	21	6
2008	8	0	0	0	0	0	0	0	0	0	0	0

Table 3c. Mean landed Weight (g) per trip of Longjaw Squirrelfish Observations by Year and Month

Year	Month											
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
2003	4682	4867	4103	3661	5207	5763	4298	3232	4575	4330	4410	4155
2004	3427	3278	4023	3629	2240	4445	4966	5659	7868	5309	4450	6422
2005	5080	5496	5301	7613	4255	4358	5208	4763	4264	5567	5775	6124
2006	4136	7588	8307	5565	5298	4687	5655	6351	6199	4450	5037	3656
2007	5242	2117	NA	NA	NA	NA	2974	4706	3421	4963	3521	3175
2008	3402	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

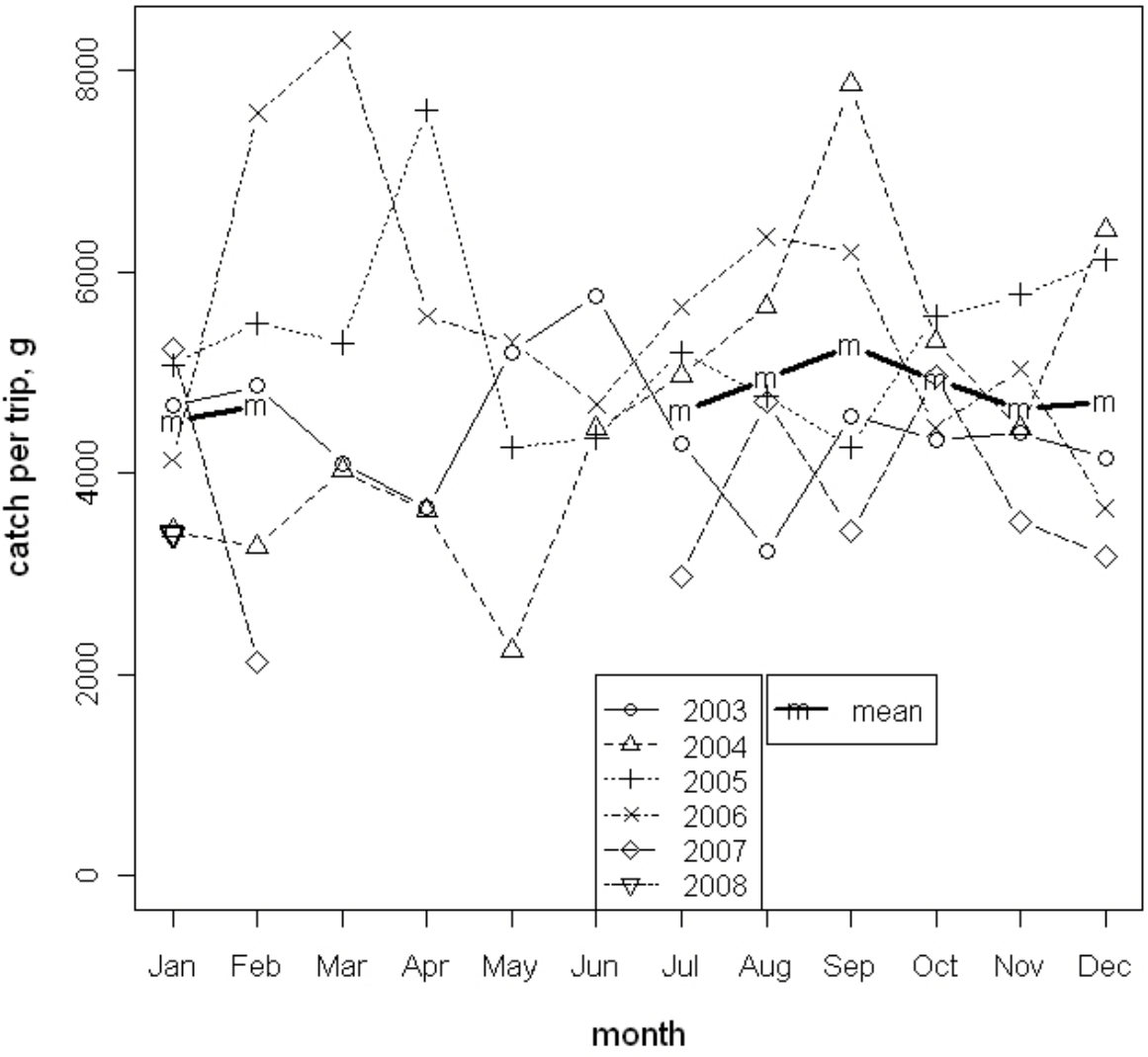

Figure 5. Monthly observed catch rates (grams per trip) by year (2003 - 2008) for Longjaw Squirrelfish, Montserrat. The average across all years is shown with the heavyline and symbol=m. Data for 2008 are incomplete and should be interpreted with caution.

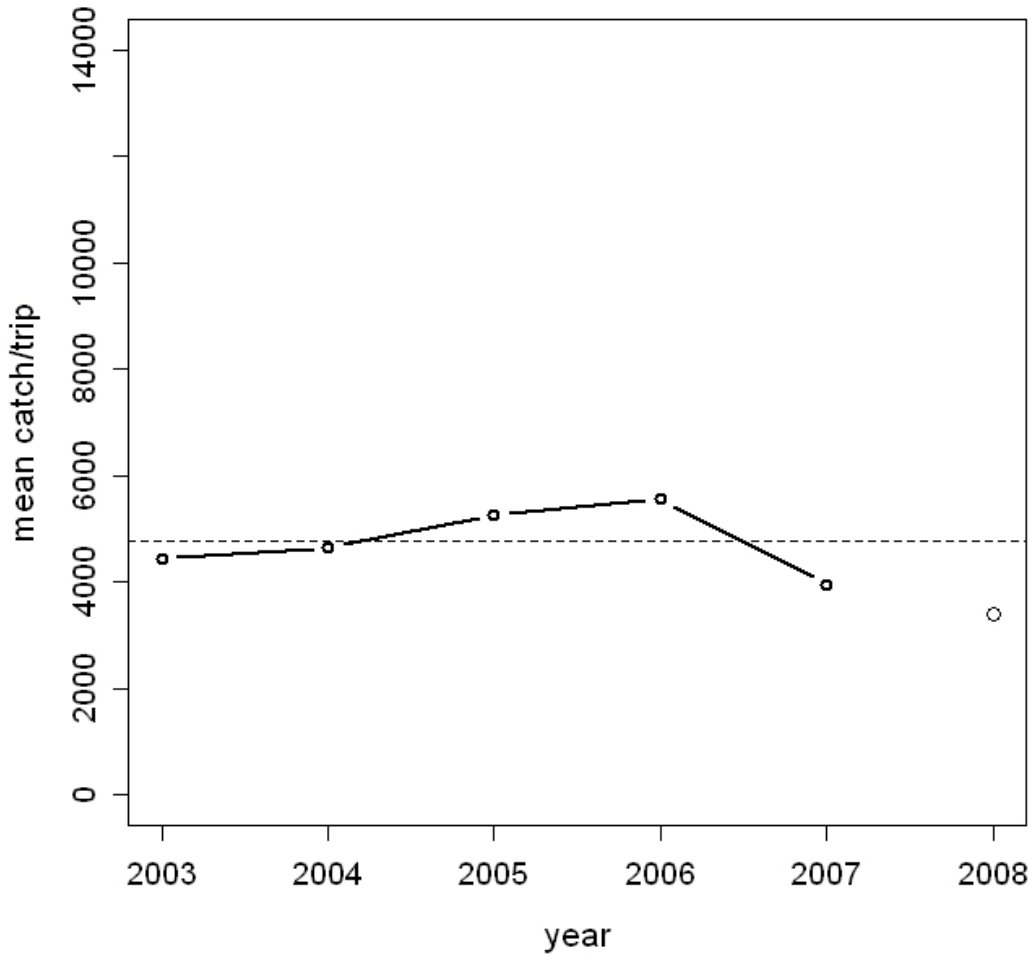

Figure 6. Average annual observed catch rates (grams per trip) for Longjaw Squirrelfish, Montserrat. The point for 2008 is based on just two months of data.

1.5.4 Honeycomb Cowfish

Seasonal Trend in Catch Rates

- Honeycomb Cowfish sampled landings were mainly from the Reef fishery and from pots (Table 4a).
- Monthly catch rates did not show seasonal trends in mean weight landed per trip of Honeycomb cowfish (Figure 7).
- The 2008 January monthly catch rate is above the long term mean, this represented 11 trips.
- February 2008 catch rate represented one data point (1 trip) (Tables 4b, c).

Annual trend in Catch Rates

- The trend in catch rates is up (Figure 8).
- Caution should be used in interpreting trends as sample sizes are low for the last two years of the data set (2007, 2008).

Table 4a. Number of Honeycomb Cowfish Observations by Fishery and Gear Type									
Fishery	**Gear Type**								
		BEACH SEINE	*GILL NET*	*HAND LINE/ BOTTOM/DRIFTLINE*	*POLE & LINE*	*POTS*	*ROD & REEL*	*SPEAR FISHING*	*UNKNOWN*
	COASTAL PELAGIC	0	0	0	0	0	0	0	0
	OCEAN PELAGIC	0	0	0	0	0	0	0	0
	TFREEF	0	0	6	0	988	0	12	1

Table 4b. Number of Honeycomb Cowfish Observations by Year and Month													
Year	**Month**												
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
	2003	16	10	10	13	20	13	14	23	21	25	15	18
	2004	22	22	23	14	15	17	17	16	16	23	19	18
	2005	16	23	27	20	23	24	27	25	22	19	20	12
	2006	12	20	19	18	13	16	13	11	9	15	15	14
	2007	8	3	4	8	12	8	6	11	20	17	14	4
	2008	11	1	0	0	0	0	0	0	0	0	0	0

Table 4c. Mean landed Weight (g) per trip of Honeycomb Cowfish Observations by Year and Month													
Year	**Month**												
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
	2003	4536	3810	5126	4683	5715	4536	6059	5325	5745	5697	5655	7409
	2004	7835	6309	6903	5670	6018	5630	6084	5301	5727	4911	4321	7963
	2005	6606	8658	7661	8845	8047	7881	10399	8455	9505	10218	9095	8959
	2006	8581	12315	12223	10055	8095	9129	10014	9361	10584	9767	10796	9590
	2007	11057	9828	10093	6691	8543	8675	14364	5938	4581	5176	9558	17577
	2008	9154	4536	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

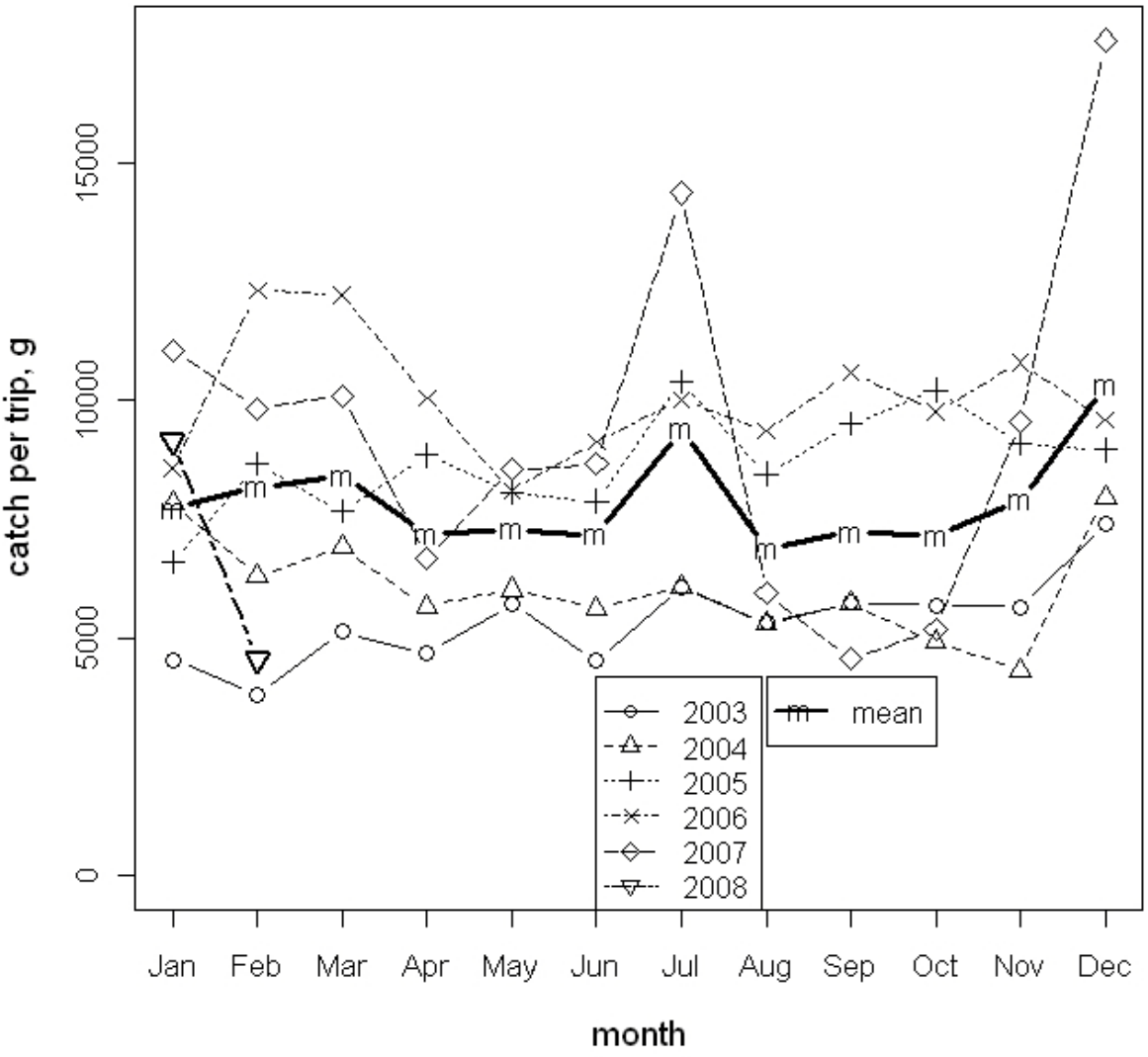

Figure 7. Monthly observed catch rates (grams per trip) by year (2003 - 2008) for Honeycomb Cowfish, Montserrat. The average across all years is shown with the heavyline and symbol=m. Data for 2008 are incomplete and should be interpreted with caution.

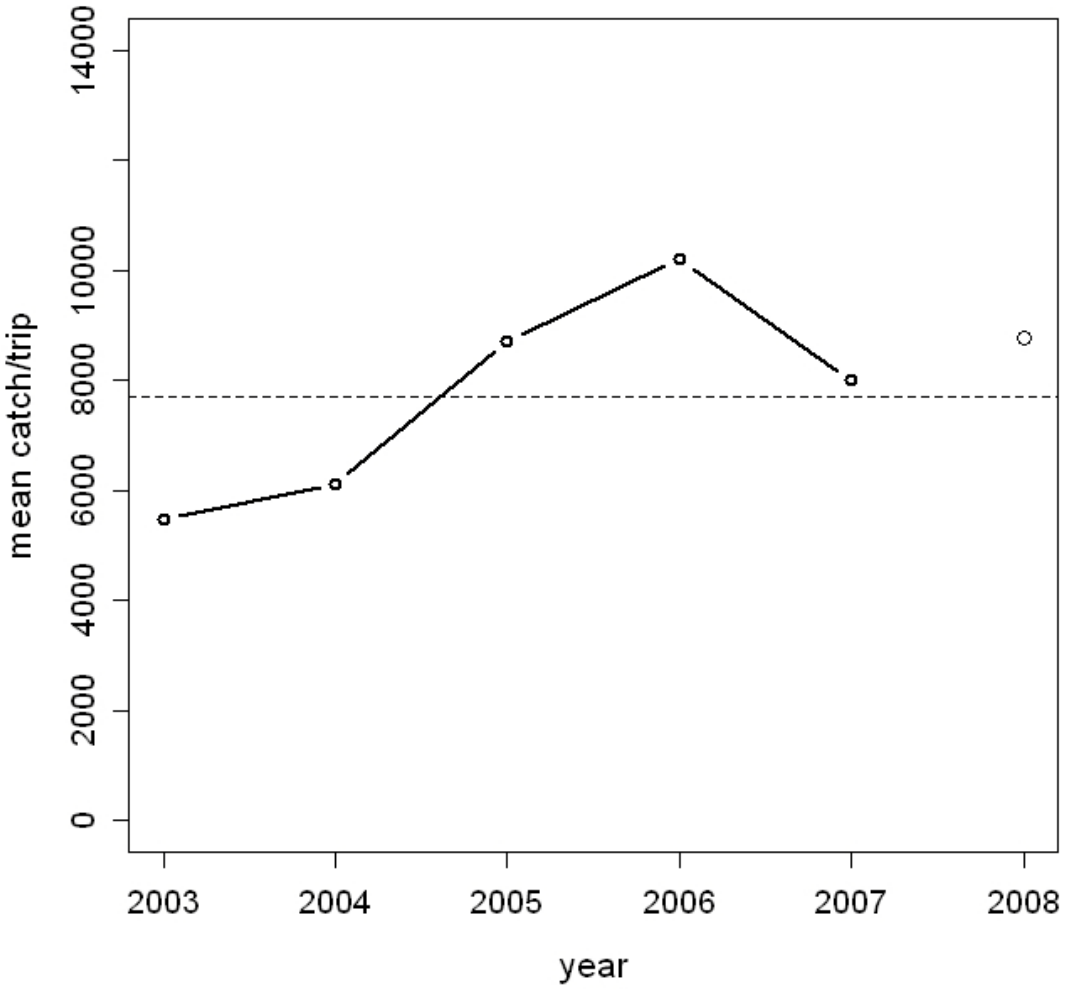

Figure 8. Average annual observed catch rates (grams per trip) for Honeycomb Cowfish, Montserrat. The point for 2008 is based on just two months of data.

1.5.5 Blue tang

Seasonal Trend in Catch Rates

- Blue Tang sampled landings were mainly from the Reef fishery and from pots (Table 5a).
- Blue Tang showed a weak seasonal trend in some years (Figure 9).
- As with the other species, samples sizes for 2008 are extremely low suggesting caution should be used when interpreting trends (Tables 5b, c).

Annual trend

- 2006-2007annual catch rates are above the long term average (Figure 10)
- The trend in catch rate is up.

Table 5a. Number of Blue Tang Observations by Fishery and Gear Type									
Fishery	**Gear Type**								
		BEACH SEINE	*GILL NET*	*HAND LINE/ BOTTOM/DRIFTLINE*	*POLE & LINE*	*POTS*	*ROD & REEL*	*SPEAR FISHING*	*UNKNOWN*
	COASTAL PELAGIC	0	0	0	0	0	0	0	0
	OCEAN PELAGIC	0	0	0	0	0	0	0	0
	TFREEF	1	0	6	0	1201	0	28	1

Table 5b. Number of Blue Tang Observations by Year and Month												
Year	**Month**											
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
	2003	19	19	16	8	24	13	8	13	14	17	9	18
	2004	12	18	20	13	23	21	19	25	33	28	21	23
	2005	15	30	37	27	25	27	29	33	33	25	29	21
	2006	18	25	19	27	26	22	17	2	28	21	22	17
	2007	11	8	11	11	12	13	17	18	24	20	26	9
	2008	9	0	0	0	0	0	0	0	0	0	0	0

Table 5c. Mean landed Weight (g) per trip of Blue Tang Observations by Year and Month													
Year	**Month**												
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
	2003	4035	3867	4621	4139	3440	3454	4423	4083	8230	3549	4082	3604
	2004	3629	3755	4060	2791	2958	3607	3128	3683	6749	3791	3543	4832
	2005	4718	6396	6841	9156	8219	7358	10308	9223	7876	10578	10871	10498
	2006	9702	10669	10337	7946	10241	10062	9846	4309	10643	10541	8825	10406
	2007	10928	6520	7670	8165	6539	6420	7604	10559	5632	7031	7572	6905
	2008	3780	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

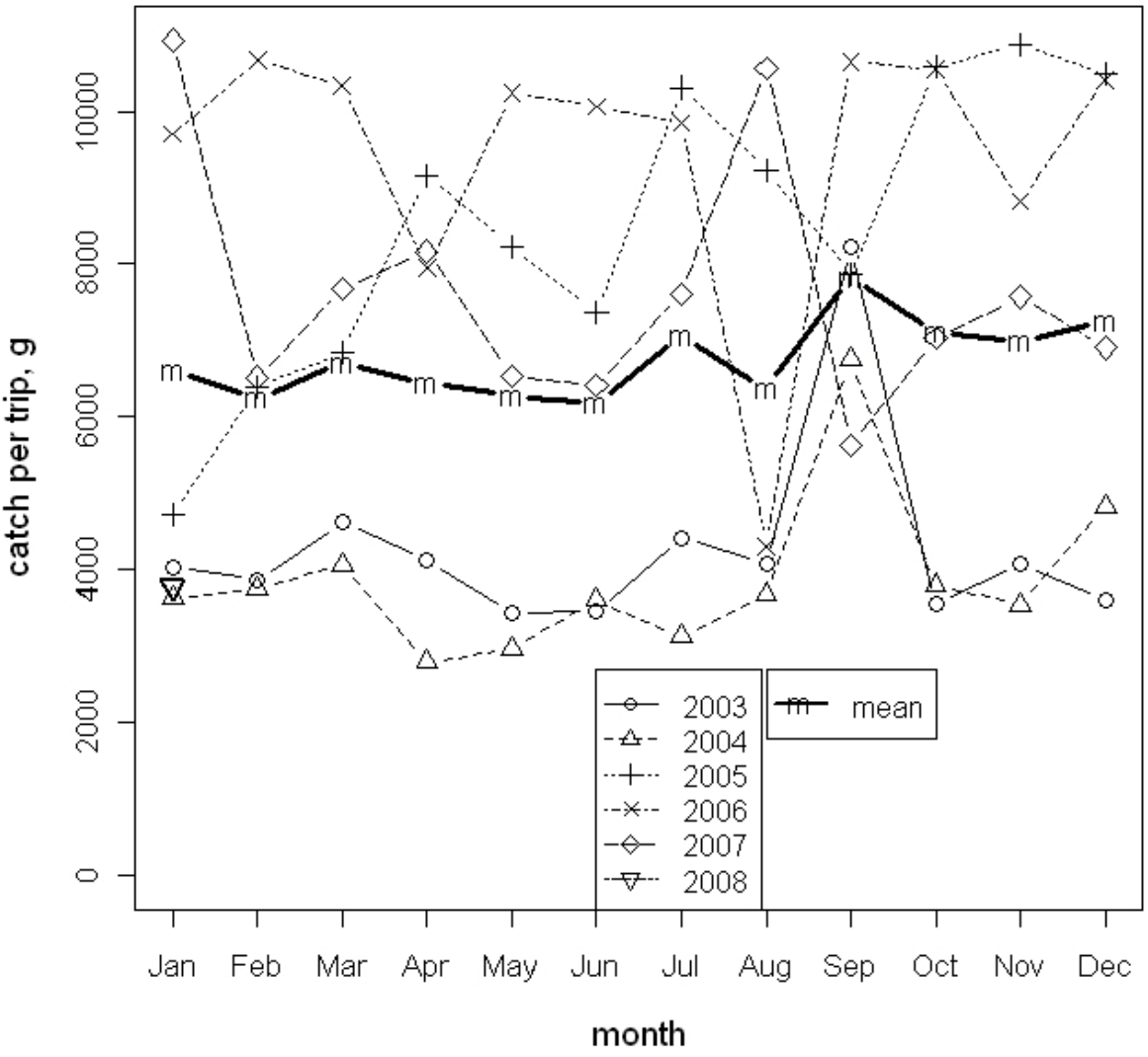

Figure 9. Monthly observed catch rates (grams per trip) by year (2003 – 2008) for Blue Tang, Montserrat. The average across all years is shown with the heavyline and symbol=m. Data for 2008 are incomplete and should be interpreted with caution.

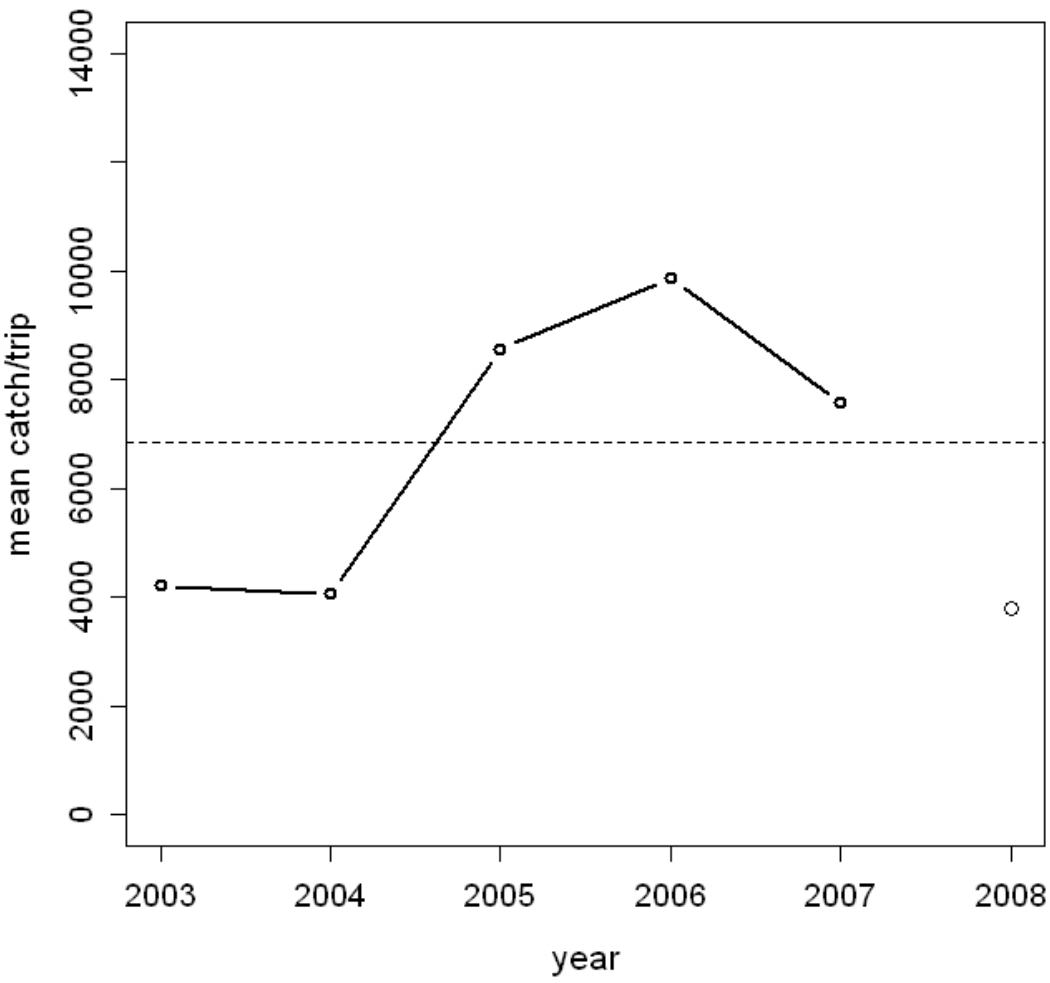

Figure 10. Average annual observed catch rates (grams per trip) for Blue Tang, Montserrat. The point for 2008 is based on just two months of data.

1.5.6 Coney

Seasonal Trends in Catch Rates

- Coney sampled landings were mainly from the Reef fishery and from pots (Table 6a).
- Coney monthly catch rates showed weak increasing seasonal trend (Figure 11).
- The monthly trend is increasing up to August.
- The 2008 values are the lowest value on record however sample sizes are extremely low for 2008 (Tables 6b, c).

Annual trend

The overall trend suggests a decline through 2007 (Figure 12). The 2007 catch rate is 32% lower than the 2003 value which was the highest in the time series.

Table 6a. Number of Coney Observations by Fishery and Gear Type									
Fishery	**Gear Type**								
		BEACH SEINE	*GILL NET*	*HAND LINE/ BOTTOM/DRIFTLINE*	*POLE & LINE*	*POTS*	*ROD & REEL*	*SPEAR FISHING*	*UNKNOWN*
	COASTAL PELAGIC	14	3	0	0	0	0	0	0
	OCEAN PELAGIC	0	0	0	0	0	0	0	0
	TFREEF	1	0	15	0	971	0	23	0

Table 6b. Number of Coney Observations by Year and Month													
Year	**Month**												
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
	2003	19	18	14	14	25	14	10	5	13	9	8	6
	2004	13	27	23	11	31	21	20	25	26	21	15	23
	2005	21	17	26	24	18	27	23	28	23	20	19	20
	2006	16	20	17	25	25	19	15	17	26	24	21	2
	2007	10	4	3	5	8	6	10	12	21	12	14	9
	2008	8	1	0	0	0	0	0	0	0	0	0	0

Table 6c. Mean landed Weight (g) per trip of Coney Observations by Year and Month													
Year	**Month**												
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
	2003	3251	4830	4362	3553	3865	3370	3175	2495	4990	3175	3629	1966
	2004	3489	2386	4103	2103	3074	3107	2631	2685	3577	2948	3175	3361
	2005	3357	2994	4615	5538	3656	5480	5051	2657	2248	2117	1958	2404
	2006	1956	1638	2401	2174	2206	1910	2268	6549	3875	3491	3024	2495
	2007	2873	2268	1512	2381	2495	1588	2382	3584	2081	2350	2344	2527
	2008	1512	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

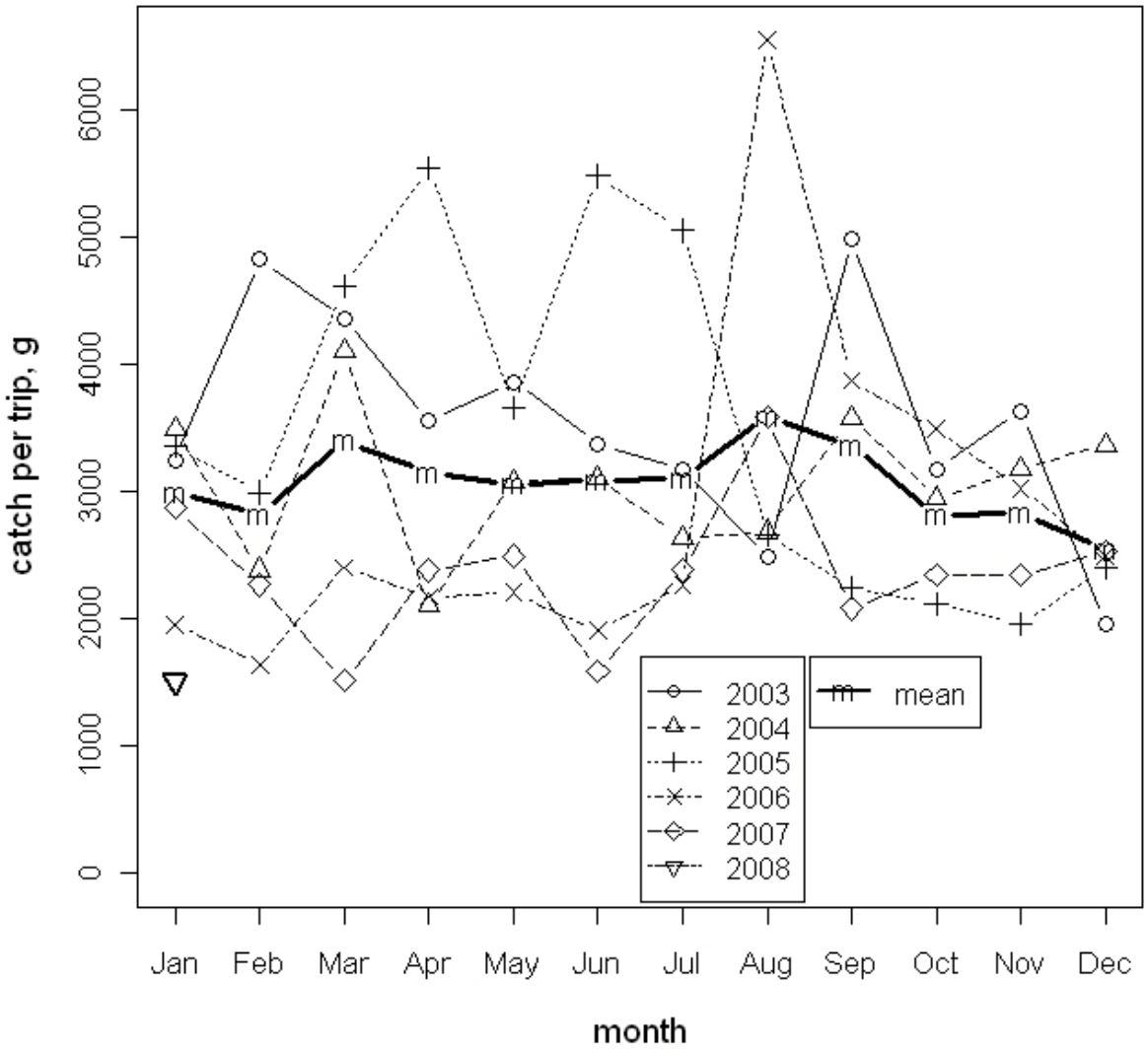

Figure 11. Monthly observed catch rates (grams per trip) by year (2003 – 2008) for Coney, Montserrat. The average across all years is shown with the heavyline and symbol=m. Data for 2008 are incomplete and should be interpreted with caution.

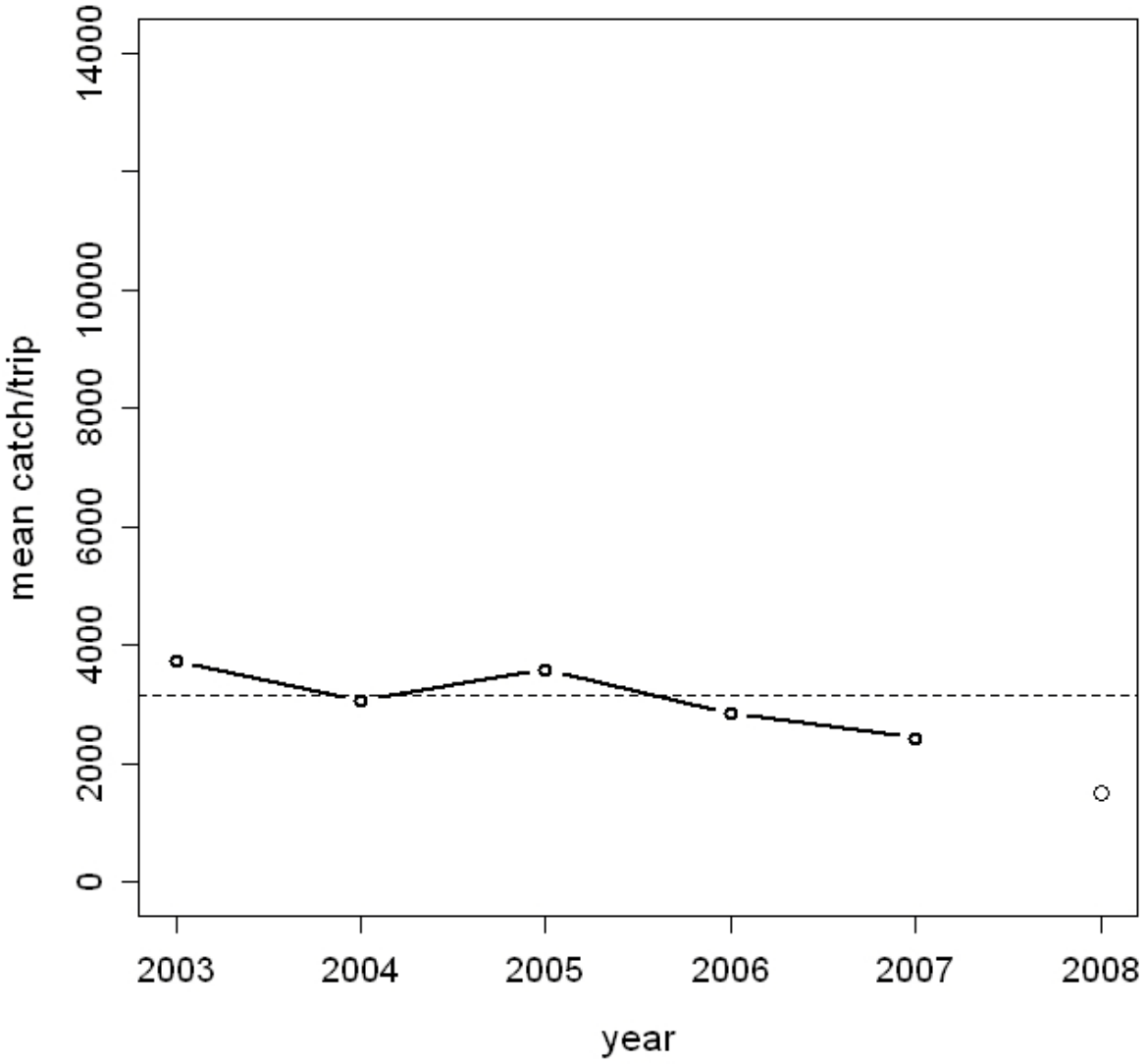

Figure 12. Average annual observed catch rates (grams per trip) for Coney, Montserrat. The point for 2008 is based on just two months of data.

1.5.7 Doctor fish

Seasonal Trends in Catch Rates

- Doctorfish sampled landings were mainly from the Reef fishery and from pots (Table 7a).
- The monthly catch rate data suggested a slight seasonal trend (Figure 13).
- January 2008 was the lowest catch rate on record; sample sizes are extremely low in 2008 suggesting caution should be exercised when interpreting trends (Table 7b, c).

Annual Trends in Catch Rates

Annual catch rates increased from 2003 through 2005 and declined thereafter (Figure 14).

Table 7a. Number of Doctorfish Observations by Fishery and Gear Type									
Fishery	**Gear Type**								
		BEACH SEINE	*GILL NET*	*HAND LINE/ BOTTOM/DRIFTLINE*	*POLE & LINE*	*POTS*	*ROD & REEL*	*SPEAR FISHING*	*UNKNOWN*
	COASTAL PELAGIC	26	5	0	0	0	0	0	0
	OCEAN PELAGIC	0	0	0	0	0	0	0	0
	TFREEF	1	0	7	0	1363	0	20	1

Table 7b. Number of Doctorfish Observations by Year and Month													
Year	**Month**												
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
	2003	31	25	27	16	27	18	14	21	25	38	18	26
	2004	27	26	22	17	24	19	22	27	32	29	27	24
	2005	19	19	39	27	25	27	29	33	33	25	29	21
	2006	17	25	19	27	26	22	17	16	27	22	22	17
	2007	11	8	11	11	12	13	15	18	25	23	26	10
	2008	10	3	0	0	0	0	0	0	0	0	0	0

Table 7c. Mean landed Weight (g) per trip of Doctorfish Observations by Year and Month													
Year	**Month**												
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
	2003	5180	4772	4687	4394	4654	5065	4504	5940	6713	5240	4914	4484
	2004	4855	5164	5134	3442	3893	5419	4536	5124	7598	4786	4250	5160
	2005	5610	6923	6304	8131	7040	5880	7868	7395	6777	8854	8978	9698
	2006	7978	7911	8260	6804	8566	8289	7204	6634	8988	9196	7299	8538
	2007	8247	4706	5319	7051	5821	5513	7530	8644	5407	5719	7729	7303
	2008	3493	4234	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

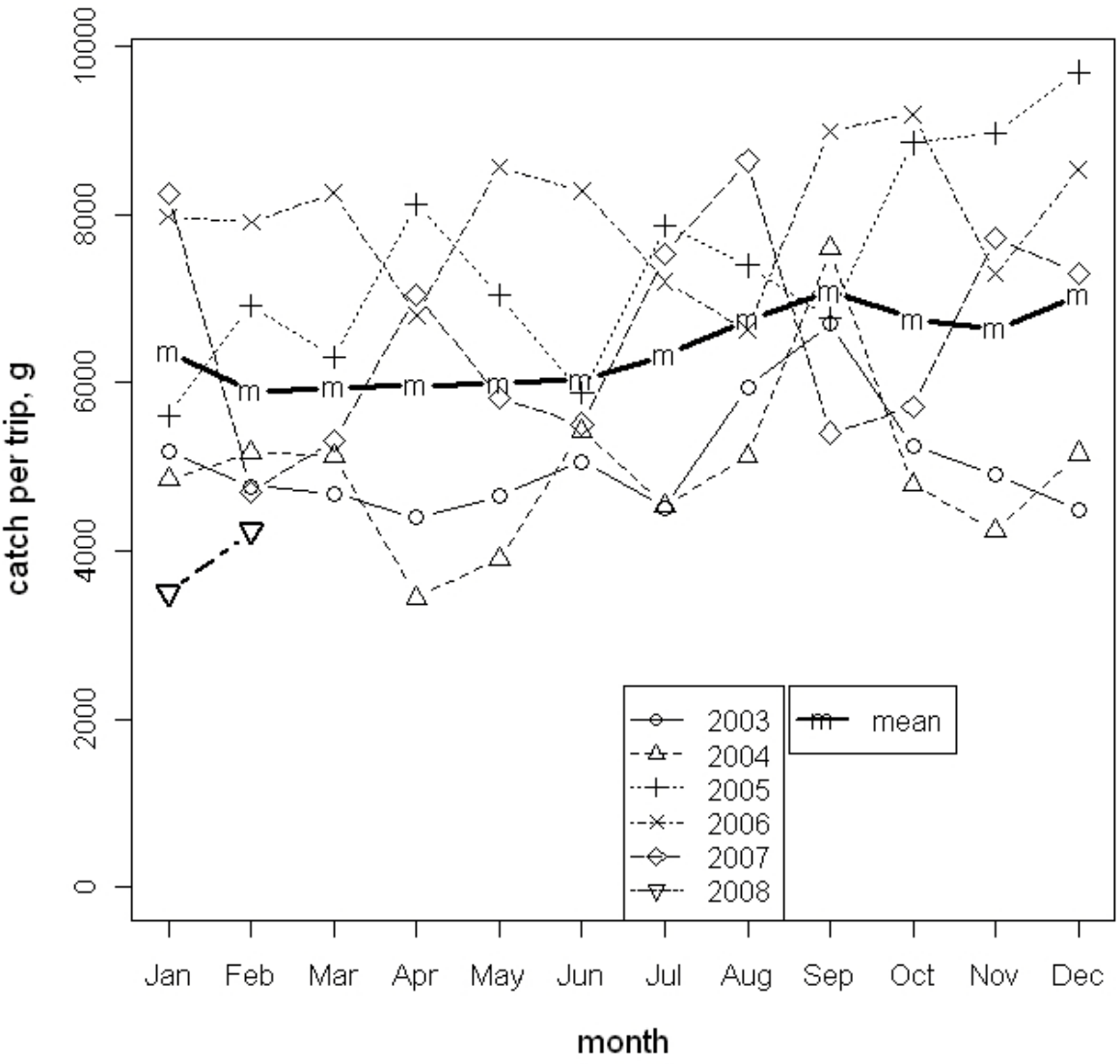

Figure 13. Monthly observed catch rates (grams per trip) by year (2003 - 2008) for Doctorfish, Montserrat. The average across all years is shown with the heavyline and symbol=m. Data for 2008 are incomplete and should be interpreted with caution.

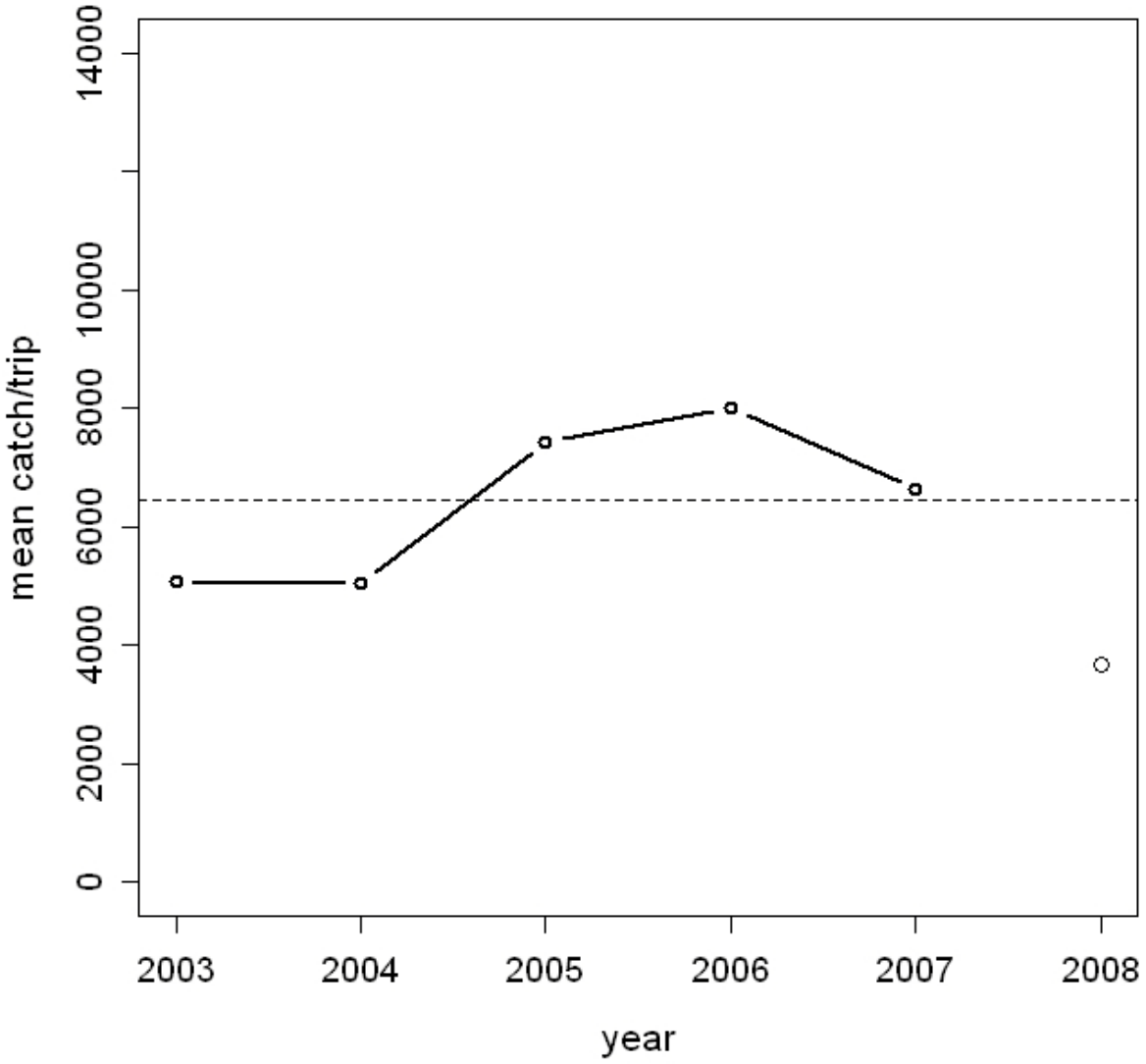

Figure14. Average annual observed catch rates (grams per trip) for Doctorfish, Montserrat. The point for 2008 is based on just two months of data.

1.6 Special Notes

None.

1.7 Policy Summary

The policy of the Montserrat government as it relates to the RSF is to ensure the fishery resources are sustainable. As part of this objective, it is planned that in 2010, training of some RSF fishers will be done to educate them about pelagic fisheries operations, in an attempt to reduce RSF effort.

III. REPORT OF THE LARGE PELAGIC FISH RESOURCE WORKING GROUP (LPWG)

Christopher Parker – Barbados (Chairman)
Dr. Freddy Arocha – invited scientist Venezuela
Mons. Lionel Reynal – French Caribbean territories
Dr. Carolina V. Minte-Vera – Brazil
Ms. Yvonne Edwin – St. Lucia
Mr. Harold Guiste – Dominica
Mr. Crafton Issac – Grenada
Mr. Leslie Straker – St. Vincent and the Grenadines
Ms. Cheryl Jardine-Jackson – St. Vincent and the Grenadines
Dr. David Die (USA) – Consultant

A. OVERVIEW

Introduction

During the first session of the working group, all members present were asked to identify all data and information that they were aware of regarding their national dolphinfish and blackfin tuna fisheries. Following these individual reviews, the type and time-range of each of the data-sets were summarized in a tabular form for ease of review. It was determined that this year's meeting would focus primarily on conducting as thorough an analysis of dolphinfish as possible and only a data review for black-fin tuna.

Dolphinfish

During the discussion that ensued regarding the initial presentations of national data sets and information, it was agreed that there was some convincing evidence that the dolphinfish fished in Eastern Caribbean waters may form part of a more widely dispersed stock or complex of stocks ranging along the northern coast of the South American continent, at least from Ceara State in Brazil to Venezuela. As previous assessments conducted by the CRFM LPWG were confined to the Eastern Caribbean only, it was agreed, to promote comparability in the results of the assessments through time, that the available eastern Caribbean dataset be again assessed separately at this meeting. In addition, data relevant to establishing the possible extended geographic range of the stock and its structure should be critically examined. The results of these assessments will be presented in a separate report.

Blackfin tuna

The group reviewed the available catch data for blackfin tuna in the ICCAT database and discussed some country-specific details of the landings information. Data for seventeen countries are available in the database; however no data are currently available for some Eastern Caribbean countries where catches might be expected, given the known range of the species. The groups listed the countries for which there are catch rates and/or length frequency data available. Finally the group reviewed recent studies on biology and stock structure. Although there is no comprehensive study of stock structure, a genetic study and a tagging study may indicate that there is some finer-scale population structuring within the region. Evidence in the literature also indicates that blackfin tuna may spawn in rather coastal areas.

CLME project

The group also reviewed its commitments to the CLME project. CRFM is an active participant in the Caribbean Large Marine Ecosystem Project (CLME) and a leader in the CLME activities related to large

pelagic fish and flying fish. Large pelagic assessments within the CLME are to develop and promote Ecosystem Based Management (EBM).
The CLME identified a series of activities that are required to strengthen the TDA in reference to large pelagic fish to be done by the CRFM:

1. Enhancement of fisheries data collection
2. Undertake region-wide assessments of stock status for key species such as dolphinfish and blackfin tuna
3. Assess the economic importance and impact of recreational fisheries in the region by focusing on a few case study fisheries.

In order to accomplish these activities and others related to the strengthening of the Transboundary Diagnostic Analysis for large pelagic fish, the CLME has contracted the CRFM for a period of 2.5 years. As part of this contract the LPWG has conducted an assessment of dolphinfish at the present meeting and is preparing to conduct an assessment of blackfin tuna at the next scientific meeting of the CRFM. A proposal for the recreational study was developed by Professor Seijo, and is provided in his general report, included as Appendix 8 in Volume 1 of this Report (Seijo, 2010).

Recommendations

At the end of the meeting the working group makes the following recommendations.

Dolphinfish

- Future assessments of dolphinfish should consider a stock that occupies the area from South and East of Puerto Rico to Northern Brazil
- A new assessment of dolphinfish is not recommended before 2012
- Although the assessment does not suggest a need to control harvest, there is a pressing need to improve the data available for this stock, so as to improve the accuracy of future assessments. This is specially the case for estimates of total harvest from those countries that have not provided them to the CRFM.

Blackfin tuna

- An assessment of blackfin tuna should be attempted at the 2011 meeting of the LPWG.
- Efforts should be made prior to an assessment, to recover missing data or correct inconsistent data for the Eastern Caribbean
- A review of catch histories should be sought from other countries that historically have reported large catches such as Dominican Republic and Cuba and from countries like Venezuela where harvest estimates differ between sources.

CLME project

- The CRFM should make sure that the subset of recreational fisheries selected for study are both representative of the range of fisheries of interest to the LPWG and have enough information available on them to be good candidates for the study.
- In designing further activities for the CLME contract the CRFM should give priority to those activities that will enhance data collection on large pelagic fish

B. FISHERY REPORTS

1. Dolphinfish (*Coryphaena hippurus*) fishery: Management Summary Eastern Caribbean

Rapporteur: Christopher Parker

1.1 Policy and objectives

For most of the countries fishing dolphinfish in the eastern Caribbean, the management objectives for dolphinfish specifically, were not available to the authors at the time of writing. As a result, the CRFM Large Pelagic Fisheries Working Group requests guidelines from the Caribbean Fisheries Forum on the individual country management objectives for the dolphinfish to direct future stock assessments and further refine management recommendations for the species.

1.2 Status of stocks

Estimates of total harvest of dolphinfish by the countries of the eastern Caribbean have increased from about 700 t in the mid 1970s to about 1200 t in recent years, albeit with large fluctuations from year to year (Figure 1). Unfortunately these estimates suffer from the lack of accurate and consistent reports from some countries of the region, thus there remains significant uncertainty in the level of historical catches.

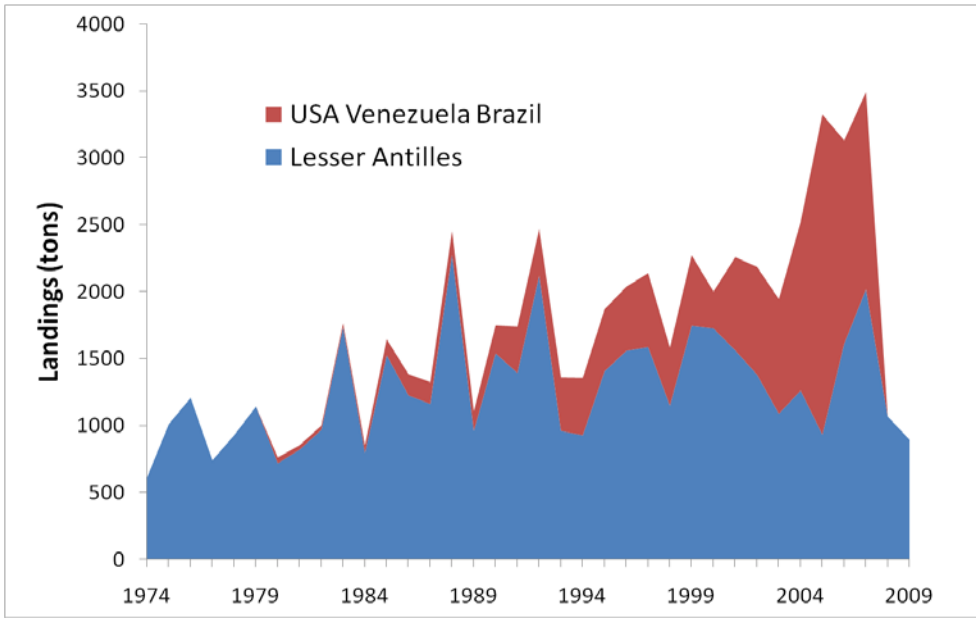

Figure 1: Estimates of total landings (tons) of dolphinfish by island nations of the Eastern Caribbean (Lesser Antilles) and by the fleets from USA, Venezuela and Brazil. Catches of 2008 and 2009 are preliminary.

Since 1994, relative abundance of dolphinfish in the eastern Caribbean, based on mean (standardized) catch per trip, have fluctuated between about 32.8 kg/trip and 74.7 kg/trip. Relative abundance was unusually high in 2009 and 2010 (Figure 2).

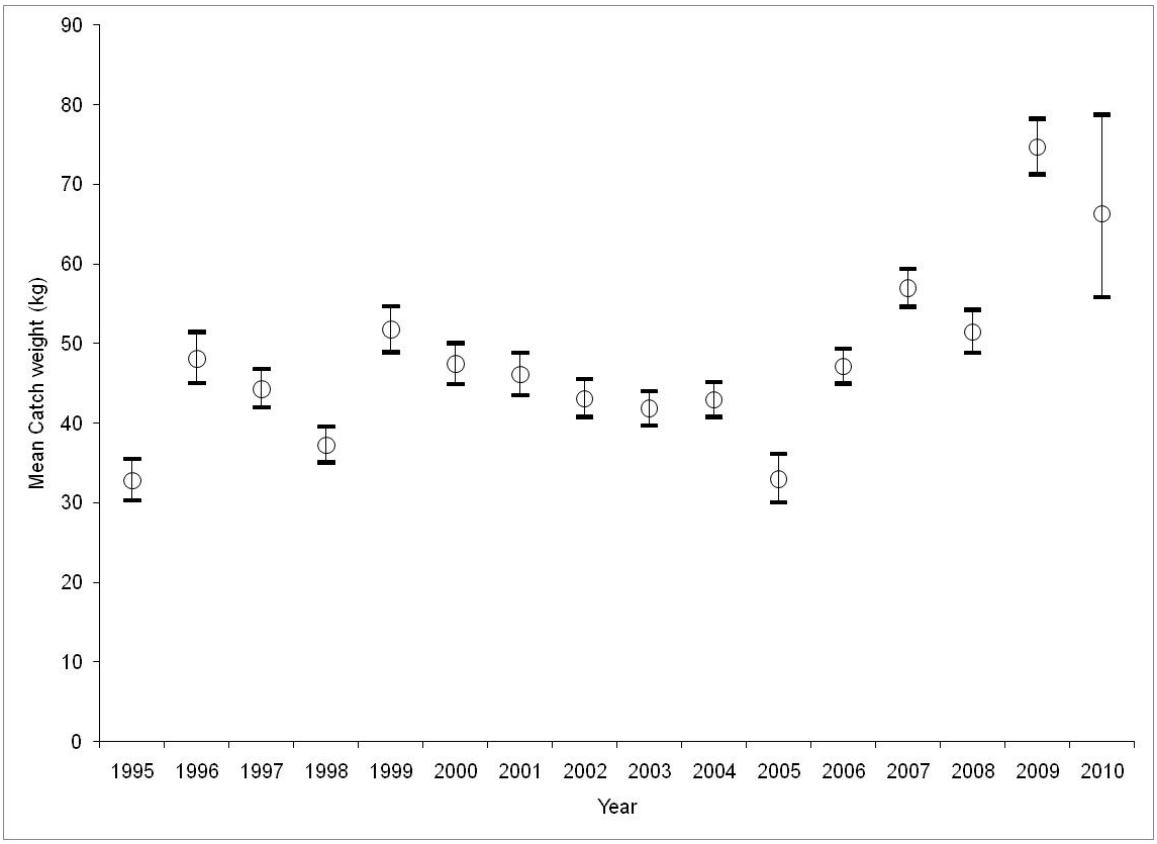

Figure 2: Standardised mean annual catch per trip (kg) for Eastern Caribbean for fishing years 1995-2010

New information on seasonal trends in catch rates estimated from General Additive Models (GAM) from fleets of non-island countries (Brazil, Venezuela and USA), suggest that dolphinfish migrate from Northern Brazil to the Eastern Caribbean, some also entering the southeastern Caribbean Sea. This confirms the hypothesis that the stock of fish caught in waters of the Eastern Caribbean is part of a much wider ranging dolphinfish stocks complex that extends as far as the northern coast of Brazil, the offshore equatorial area and the southeast of the Caribbean Sea (figure 3).

When the catches from non-island countries that fish this wider area of the Southern Caribbean stock are added to those from island countries the total harvest from the stock fluctuates around 1500 t in the 1990s but reaches levels in excess of 3000 t in recent years. Catches from some of the fleets operating in this wider area of the stock also suffer from incomplete reporting.

Relative abundance indices, based on standardized catch rates, for the fleets of non-island countries, available since the mid 1980s, also fluctuate between years without a significant trend.

The lack of a trend in relative abundance combined with an apparent increase in harvest does not allow for an accurate estimation of MSY or other reference points for the stock. Although it is not possible to estimate these reference points, the lack of a trend in relative abundance indices in the presence of an apparent increase in harvest suggest that the stock has not being overly affected by removals from fishing in the last 20 years or so. It is important to note that this does not mean that the stock has not declined, rather that declines are not detectable for the period for which there is available data. For other pelagic fish stocks in the region, such as billfish, the majority of the declines in stock size occurred in the 1960s and 1970s, before the period for which there is reliable data on dolphinfish for the Eastern Caribbean.

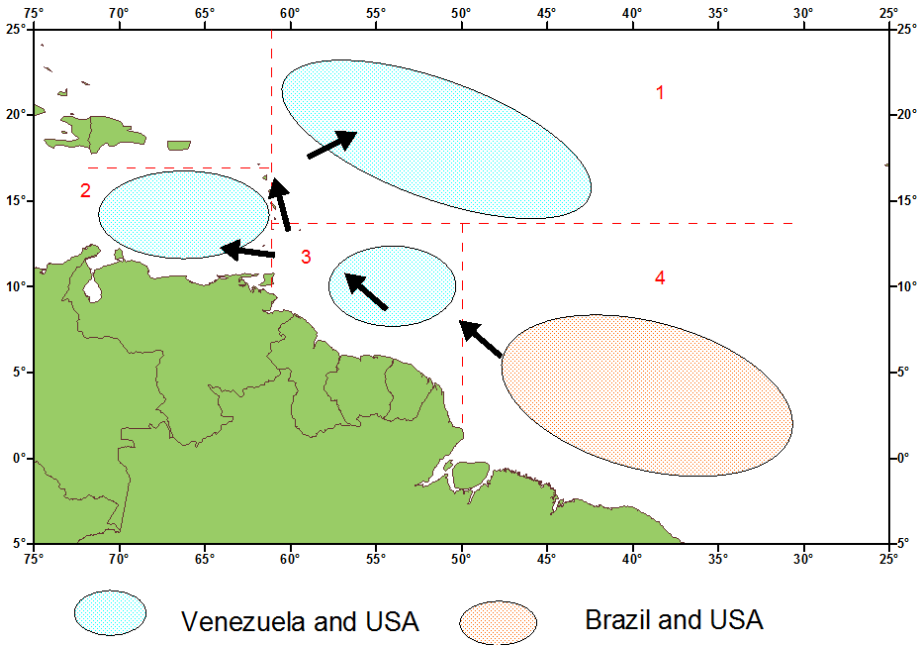

Figure 3: Depiction of the fishing areas where longline fleets of Venezuela, Brazil and USA report dolphinfish bycatch (ovals) and migration (arrows) inferred from GAM models of seasonal trends in catch rates.

1.3 Management advice

Based on the indices of abundance examined in the current study, there is no evidence to suggest that the stock is in a state of decline at current harvest levels. However, the assessments conducted at this workshop cannot be considered conclusive enough to predict the long-term sustainability of the fishery at current or increased levels of exploitation. Given this a precautionary approach should be adopted in managing this fishery and further developing of this fishery should not be promoted until the stock structure and dynamics are better understood.

Given the number of nations that are likely fishing the same dolphin stock and the possible extended geographic range of the stock or stocks complex, future stock assessments and management of this fishery must be based on continued collaborative arrangements between the CARICOM and major non-CARICOM fishing nations in the region including Venezuela, Brazil, France and the USA.

In order to improve future management countries should continue to give priority to the collection of accurate catch, effort and size data on dolphinfish and endeavor to recover and fill the gaps of historical catches from the earlier periods of the fishery.

1.4 Stock assessment summary

Total catch records for dolphinfish for territories in the WCA were obtained from various sources including directly from representatives of the national fisheries authorities and the FAO database examined and reviewed.

The Working Group initially examined nearly 220,000 trip catch records for three CRFM nations (Barbados, St. Lucia, St. Vincent) spanning the period 1994 to 2010. Trinidad and Grenada submitted

summarized data for the period under consideration. However as these data were not disaggregated to the level of individual trips they could not be included in the CPUE-based abundance analyses that were undertaken at this meeting.

Changes in annual mean catch per unit effort (trip) were used as indices of abundance for the Eastern Caribbean dolphinfish fishery. A General Linear Models (GLM) was applied to standardize the data with respect to key factors identified (vessel type, season, island). The standardized annual CPUE estimates lack a significant trend, although they fluctuate between years. CPUE indices were unusually high for 2009 and 2010.

A review of the available data on stock structure was conducted including examination of tagging data from a project based in SE USA, seasonal catch per unit of effort trends from Brazilian, Venezuelan and USA fleets that harvest dolphinfish in the area and stock structure studies conducted in Brazil. Examination of all these data confirmed the migration of dolphinfish from the Equatorial area offshore from Brazil to the eastern Caribbean and the southeastern Caribbean Sea. A significant number of tagged fish were recaptured in the SE Caribbean, fish that were released in the SE coast of the USA. These recaptures question the hypothesis that the southern Caribbean stock is isolated from the stock in the northern Caribbean and the Eastern coast of the USA.

1.5 Statistics and research recommendations

Following are a number of recommendations to be addressed by the CRFM and individual countries for improvement of the quality of future assessments:

1.5.1 Recommendations for the Caribbean Regional Fisheries Mechanism

1. Continue collaboration with non-CRFM territories within the WCA region including the USA, Venezuela and France in future stock assessments.
2. Through the LPWG, further assess the implications of alternative stock structure hypotheses for dolphinfish in the WCA region.
3. Continue to monitor trends in regional catches and catch rates to identify any signs of changes in stock size and promote regional collaboration on appropriate management strategies to be implemented.
4. Encourage and assist countries to develop a regional database on historical catches and fishing effort, extending to a time period prior to the commencement of the CARICOM Fisheries Resource Assessment and Management Programme in the early 1990s. This exercise will involve intensive data mining from scientific, historical and administrative documents (published and grey literature) designed to expand the time series of available data, improve the contrast in the data set and contribute to improved parameter fitting in assessment models.

1.5.2 Individual countries

1. Countries must ensure that appropriate systems are in place to collect, record and report landings data for dolphinfish.
2. Provide accurate and complete data on total catches (or landings) of dolphinfish in the format and level of detail required by the CRFM for incorporation into stock assessments:
   a) Provide more detailed information on fishing effort associated with each catch record e.g. boat/ gear type and number of gear units as well as number of hours fishing or the number of hooks used. This information can facilitate improved estimates of catch per unit of effort and relative indices of abundance.
   b) Where necessary, revisions to sampling strategies should be considered to improve estimates of fishing effort, especially the identification of trips that target pelagic fish. This is required to

properly estimate the number of trips that did not successfully catch dolphinfish because the relative frequency of these trips can also indicate changes in abundance.

c) Conduct extensive review of historical data (data mining) aimed at providing information on historical catch rates and catches to improve the data base available for future assessments.

3. Submit fleet information to CRFM outlining on-going and historical developments to allow elucidation of the effects of changes in the fleet, fishing methods and technology on catch rates.

1.6 Special comments

None.

1.7 Policy Summary

The working group requires more information and guidance from the CRFM Forum on regional policies being considered for dolphinfish.

References

Chapman, R.W., G.R. Sedberry, B. Luckhurst, H.A. Oxenford and R. Wingrove (In prep.) Global Population Structure of Mahi Mahi**,** *Coryphaena hippurus* L., inferred from mitochondrial DNA and nuclear gene analyses.

George, S., Singh-Renton, S. and Lauckner, B. (2001). Assessment of Wahoo (*Acanthocybium solandri)* Fishery using Eastern Caribbean Data. Pp 25 – 40 In: CFRAMP. 2001. Report of the 2000 Caribbean Pelagic and Reef Fisheries Assessment and Management Workshop. *CARICOM Fishery Report* No. **9.** 139p.

Gibbs, R.H. Jr., and B.B. Collette. (1959). On the identification, distribution and biology of the dolphins, Coryphaena hippurus and C. equiselis. Bull. Mar. Sci. Gulf Carib., 9: 117-152.

Mahon R. and P.A. McConney (eds.). (2004). Management of large pelagic fisheries in CARICOM countries. *FAO Fisheries Technical Paper* No. 464. Rome, FAO. 149 p.

Oxenford HA (1999) Biological characteristics of the dolphinfish (*Coryphaena hippurus*) in the western central Atlantic: a review. Sci. Mar., 63 (3-4): 277-301.

Oxenford HA, Hunte W (1986) A preliminary investigation of the stock structure of the dolphin, *Coryphaena hippurus*, in the western central Atlantic. Fish Bull 84**:** 451-459.

Parker, C. (2001) A description of the Barbadian fishery for dolphin fish (Coryphaena hippurus). 2000 Caribbean Pelagic and Reef Fisheries Assessment Workshop. In: CFRAMP, 2001. Report of the 2000 Caribbean Pelagic and Reef Fisheries Assessment Workshop. *CARICOM Fishery Report* No.**9**. 127-139.

Ribeiro, A. de M. (1918). Fauna Brasiliense (Peixes). Tomo V. Eleutherobranchios Aspirophoros. Physoclisti. *Archiv. Mus. Nac. Rio de Janeiro* 21: 1-227.

Rivera, G. A. and R. S. Appeldoorn (2000). Age and growth of dolphinfish, *Coryphaena hippurus*, off Puerto Rico. Fish. Bull. 98(2): 345-352.

Seijo, J.C. (2010). Sixth Annual Scientific Meeting of CRFM, Kingstown, St. Vincent, May 9-16, 2010, Report by Juan Carlos Seijo, PhD, Consultant. pp 106-109. In: CRFM Fishery Report -2010, Volume 1. Report of Sixth Annual Scientific Meeting – Kingstown, St. Vincent and the Grenadines, 07-16 June 2010. CRFM: Belize, 109p.

Shcherbachev, Yu. N. (1973). The biology and distribution of the dolphins (Pisces, Coryphaenidae). [In Russ.] Vopr. Ikhtiol., 13: 219-230. Transactions In the Journal of Ichthyology., 13: 182-191.

Vladykov, V.D., and R.A. McKenzie. (1935). The marine fishes of Nova Scotia. Proceedings of the Nova Scotian Institute of Science. 19: 17-113.

IV. ECONOMIC STUDY OF QUEEN CONCH FISHERY OF THE TCI

1.1 Management Objectives/Questions

The overall management objective of the Turks and Caicos Islands is to promote sustainable development of the fisheries resources by adopting cautious conservation and management measures in conjunction with the 'Guidelines on the precautionary principle' (FAO *Technical guidelines for Responsible Fisheries.* No.2. Rome, FAO. 1996). More specifically, the management objectives of the Queen Conch fishery that are addressed in this document are:

1. Ensure that the catch in any one-year does not exceed the Maximum Sustainable Yield (MSY).
2. Restore and maintain populations of marine species to sustainable levels.
3. Ensure that the benefits from the exploitation of the fisheries resources are optimized by Belongers

The Turks and Caicos Island have been able to conduct an assessment on the Queen Conch fishery over the past decade with reasonable certainty. However, the Fisheries Management Plan (FMP) objectives, above, encompass more than biological information such as economics, social influences and environment. The purpose of this analysis was to answer the following management questions, which are directly related to the management objectives:

1. Is the current Queen Conch commercial landing quota set correctly?
2. What is the most efficient effort for the Queen Conch fishery?
3. What is the effort at MSY and at MEY for the Queen Conch fishery?

1.2 Status of the Fishery

The Turks and Caicos Islands (TCI) commercially fish primarily for both spiny lobster (*Panulirus argus*) and queen conch (*Strombus gigas*). Although intensively fished and possibly over-fished in certain areas (Ninnes, 1994), the Queen Conch populations of the Turks and Caicos Islands are generally considered to be stable. Assessments indicate that the catch rates were operating a constant level, which inferred that the stocks are operating at optimum levels. It is assumed that unexploited 'deep-water' stocks exist that contribute significantly to recruitment of the fished stocks in shallower waters (Ninnes and Medley, 1995). The overall fishing effort under the current national annual export quota of 600,000 lbs. (272,160 kg) is considered to be maintaining the stock size at suitable levels (Anon., 1999). However, in September of 2008 two major hurricanes, Hanna and Ike, struck the TCI directly, which is assumed to have affected the various fisheries both biologically and economically, mostly by affecting habitat for these species.

Queen conch commercial catches and effort are recorded at each of the five Class A processing facilities; where it is landed whole without a shell, although exported as "clean meat", which is 40% of the whole landed conch. Small retrofitted boats (fiberglass with 85-200 hp outboard engines) depart for fishing at approximately 7:00am and return at 5:00pm, carrying 1-2 divers and a boat driver that accounts for one boat-day.

There are still some areas of research that can be conducted a second time. A visual survey was conducted in 2001 with the expectation to conduct additional surveys every four (4) years to authenticate the assessment model. However, with financial constraints a second visual survey has yet to be conducted. Also, a local consumption survey was completed by the DECR in 2004/2005 and was

incorporated into the assessment model. However, with an increasing population immigration that occurred from 2006-2008, an updated survey needs to be completed.

Finally, in order to address management questions and objective a collection of economic information was required. In 2010 a survey was conducted with the local fishers and processors to obtain economic and social information to the various fisheries. Now the TCI can assess not only the biological parameters, but also the economic parameters.

1.3 Management Advice

Management has a hard task of creating and maintaining a sustainable resource, while considering other management objectives such as employment, economic incentives and restraints and environmental influences. It is well recognized that fisheries managers must prioritize objectives and may even have to surrender some objectives for others to succeed.

Currently TCI has been able to attain some of the objectives and now must consider the cost and benefits to other achievable objectives. Based on the Fisheries Management Plan Objective: *to ensure that the benefits from the exploitation of the fishery are **optimized** by belongers;* both users and managers should consider applying effort restrictions at a rate of no more than the current effort of 113 licensed commercial vessels.

At this point it is essential for the TCI to obtain information to validate all the parameters of the stock assessment. The TCI should conduct a second visual survey of the Caicos Bank to both validate the model and provide spatial information for the species. This information may then be used in spatial distribution analysis that will in turn affect economic analysis as it determines the spatial distribution of fishing intensity and the corresponding costs from port of origin to alternative fishing grounds and patches.

The Queen Conch fishery of the TCI is at a point, where it can now conduct decision tables that consider alternative management decisions, possible states of nature, and the calculated performance of biologic and economic variables. This approach will allow considering the fishery uncertainties, and calculate the corresponding risks of alternative management decisions.

1.4 Statistics and Research Recommendations

The priority for future scientific activities is to improve and enhance current data collection, specifically:

- Conduct a visual survey to obtain spatial characteristics and validate the stock assessment.
- Work with Department of Economics and planning to obtain economic and social information with regards to the fisheries in the 2011 census.
- Conduct a Decision tables that consider alternative management decisions, possible states of nature, and the calculated performance of biologic and economic variables.
- Conduct a local consumption survey to determine the local consumption rate.

1.5 Assessment Summary

The bio-economic assessment of the *Strombus gigas* (Queen Conch) fishery developed in the intersessional period and during this meeting can provide managers with a more complete picture of the current status of the conch fishery with regard to catch, biomass and rent derived from the resource. Additional details are provided in the consultant's general report, which is included as Appendix 8 in Volume 1 of this Report (Seijo, 2010).

It should be pointed out that two devastating major hurricanes impacted the TCI in 2008, attributing to the decrease in CPUE. In the past seven (7) years fishers have been working at a high level of effort for the fishery and fishers are now realizing the impacts of effort through decreasing profits (Figure 1).

With a current restriction on catch based on Maximum Sustainable Yield (MSY), biomass is essentially preserved, but fishers, under open access are progressively eliminating fishery profits.

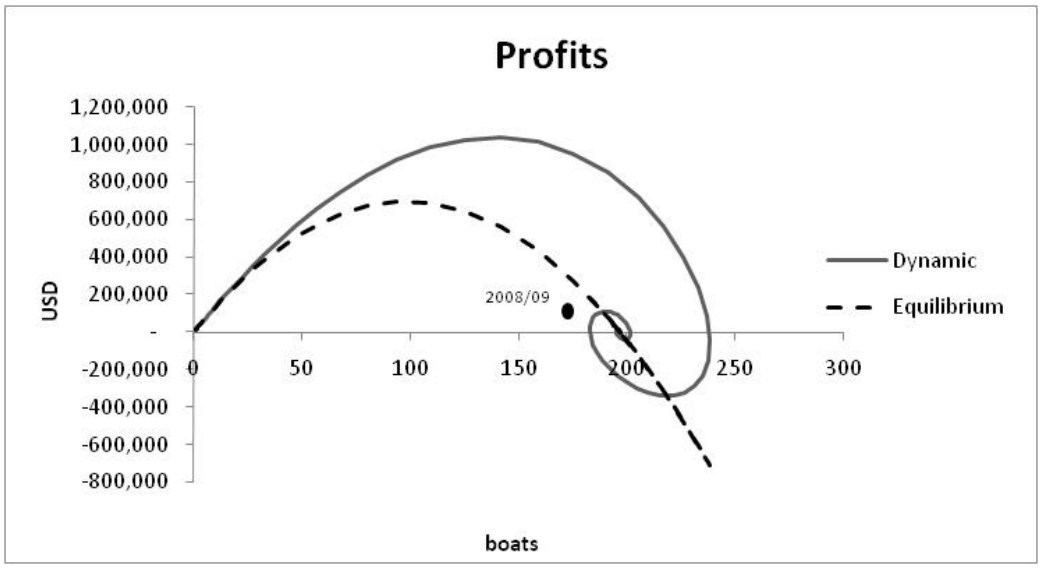

Figure 1. Sustainable and dynamic trajectories of profits. The dot represents the 2008/09 season

1.6 Special Comments

None.

1.7 Policy Summary

The Fisheries Policy aims to ensure the sustainable use of the living marine resources and ecosystems through increased cooperation and collaboration with all the stakeholders for the improved welfare of the people of the TCI. The natural resources are national assets and the heritage of the TCI people, and should be managed and developed for the benefit of the present and future generations.

References

Anonymous. (1999). Report on the Queen Conch Stock Assessment and Management Workshop. Council and CARICOM Fisheries Resources Assessment and Management Programme. Belize City, Belize. 1-105 p.

Medley, P. and Ninnes, C. (1995). Fisheries Management in the Turks and Caicos Islands. Report of the Department of Environmental and Coastal Resources, Grand Turk, Turks and Caicos Islands, BWI. 7 p. Unpublished.

Medley, P.A.H, Ninnes C.H. (1998). A stock assessment for the conch (*Strombus gigas* L.) fishery in the Turks and Caicos Islands. *Bulletin of Marine Science*. Vol. **16** No.1. pp 153-160.

Ninnes, C. (1994). A review on Turks and Caicos Islands fisheries for *Strombus gigas* L. In: Queen Conch Biology, Fisheries and Mariculture (RS Appledorn & B Rodriguez, et al) pp. 67-72.

Seijo *et a*l. (1998). Fisheries Bio-economics, theory, modeling and Management. *FAO Fisheries Technical Paper* **368**.

Seijo, J.C. (2010). Sixth Annual Scientific Meeting of CRFM, Kingstown, St. Vincent, May 9-16, 2010, Report by Juan Carlos Seijo, PhD, Consultant. pp 106-109. In: CRFM Fishery Report -2010, Volume 1. Report of Sixth Annual Scientific Meeting – Kingstown, St. Vincent and the Grenadines, 07-16 June 2010. CRFM: Belize, 109p.

Smith, V. (1969). On Models of Commercial Fishing. *Journal of Political Economy*. **77**:181-198.

Tewfik, A. and C. Bene. (2003). Effects of Natural Barriers on the Spillover of a Marine Mollusc: Implications for Fisheries Reserves. Aquatic Conservation: Marine Freshwater Ecosystem. 13:473-488.