

## Reflections and future directions

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It has been just over 14 years since the completion of the Eastern Caribbean Flyingfish Project (ECFFP). This book brings together all of the various research and advice that was generated by that project. At the end of the ECFFP the group produced a list of 'further research requirements' deemed to be important for refining and distinguishing among the management options that are presented in Chapter 25 (Table 1). A few of these have been addressed since then. There have also been two main efforts to move forward with management of eastern Caribbean flyingfish.

### PROGRESS WITH RESEARCH

From 1995 to 1999 the Centre for Resource Management and Environmental Studies (CERMES) at the University of the West Indies, Barbados had a research programme on flyingfish population genetics that resolved the geographic ranges of the stocks and with whom they are shared. Key outputs of this research have been included in this volume (Chapters 19 and 20). The findings indicate three genetically discrete subregional stocks of *H. affinis* located in the eastern Caribbean, the southern Netherlands Antilles and off NE Brazil (Gomes *et al.* 1998, Gomes *et al.* 1999). However, indications of partially restricted gene flow both spatially and temporally within the eastern Caribbean stock, suggest that there may be different spawning groups which need further investigation (Gomes *et al.* 1998).

The existence of an eastern Caribbean management unit for *H. affinis*, was recognised at the final workshop for the Eastern Caribbean Flyingfish Project in Barbados, 1992 (Oxenford *et al.* 1993) and by the WECAFC Working Party on Marine Resources in Belize City 1997 (FAO 1998). This was based on: Tagging studies that suggest a single stock moving throughout the eastern Caribbean area (Dominica to Trinidad and Tobago); Genetic analyses that suggest that the eastern Caribbean stock is separate from stocks around Brazil and Curaçao.

The longevity of *H. affinis* in the eastern Caribbean has now been confirmed to be less than 2 yr in a study using radiochemical dating techniques (Campana *et al.* 1993), allowing a refinement of the adult growth rates.

The trophic relationship between flyingfish, other forage species and larger oceanic pelagic species is currently under investigation as a part of the FAO Lesser Antilles Pelagic Ecosystem (LAPE) Project (FAO 2007).

### MANAGEMENT INITIATIVES

The Pelagic and Reef Fishes Subproject of the CARICOM Fisheries Resource Assessment and Management Programme (CFRAMP) included an activity to address aspects of eastern Caribbean flyingfish. At the Small Coastal Pelagic and Flyingfish Subproject Specification Workshop (SSW) in Grenada in 1996, papers were presented reviewing the status of flyingfish fisheries and outlining proposed research and management activities for flyingfish. These activities were not carried out owing to lack of funding. The contributions to the SSW, although not published, address a number of topics that deserve attention: biology, life history and ecology (Nakashima 1996a, Monteiro *et al.* 1996, Singh-Renton 1996), social science (McConney 1996), fishing practices (Mohammed 1996), fishery assessment and management (Cochrane 1996, Nakashima 1996b). Country reviews presented at this workshop also provide another waypoint in the description of national fisheries for flyingfish.

In 1997 WECAFC established an *Ad Hoc* Flyingfish Working Group that has met twice in Barbados: September 1999 (FAO 1999) and January 2001 (FAO 2002). At the first meeting an analysis of catch and effort data from five countries over the period 1982-1998 was carried out, but the data did not show any trends and were considered inadequate for analysis (FAO 2002). The WG identified three activities that

**Table 1. Research needs for further development of a regional management plan for flyingfish in the eastern Caribbean, as determined at the final workshop of the ECFFP (Oxenford *et al.* 1993).**

Research Area	Priority	Time Frame
Estimate flyingfish biomass used as bait to support other fisheries (particularly important in Grenada)	Medium	Long-term
Estimate mortality factors on flyingfish (e.g. predation mortality on spawners)	Medium	Long-term
Obtain more information on Curacao flyingfish fishery	High	Short-term
Investigate alternative spawning habits of flyingfish to determine if i) spawn on surface substrata causes them to sink, ii) benthic spawning occurs	Medium	Short-term
Investigate the frequency and duration of spawning of individual fish relative to the spawning season	Medium	Long-term
Investigate relationship/biotic dependency of large pelagics on flyingfish	High	Long-term
Obtain accurate CPUE data throughout region, including i) estimate of time/effort spent specifically targeting flyingfish, and ii) effects of gear competition on current catch rates	High	Long-term
Standardise effort data throughout the region by calculating fishing power conversion factors for the different vessel types exploiting flyingfish	High	Long-term
Pursue investigation of effect of oceanographic and biotic variables on stock-recruitment relationship to improve yield predictions	Medium	Long-term
Improve crude abundance estimate through i) investigation of flyingfish depth distribution and proportion of school flying at approach of a survey vessel, and ii) more tagging	High	Long-term
Refine risk assessment model to include new information	High	Short-term
Check correlation between adult abundance, as indicated by visual survey data, and catch rates obtained in same area on same day	High	Short-term
Examine mobility of centres of abundance	Medium	Long-term
Explore feasibility of commercial exploitation of <i>Parexocoetus brachypterus</i>	Low	Long-term
Conduct comprehensive socioeconomic study of the flyingfish fishery	High	Long-term
Refine growth rate estimates of older fish	High	Short-term
Investigate flyingfish patch characteristics (e.g. causes and implications for catch rates)	High	Short-term

should be pursued towards the cooperative management of the eastern Caribbean flyingfish stock:

1. Analysis of fishery catches and fishing effort
2. Review of social and economic aspects
3. Preparation of a Regional Fisheries Management Plan (FMP).

At the second meeting of the WG in 2001, re-analysis of catch and corrected effort data was attempted in a workshop setting, but the data for all islands except Barbados were confounded by an inability to distinguish between vessels that targeted flyingfish and those that did not (FAO 2002). Some of the sociological information on the flyingfish fishery identified at the first meeting as being needed, was collected and presented at the second working group meeting in 2001 (FAO 2002). Country fishery updates presented at both WG meetings provide the most recent information on the fisheries (FAO 1999, 2002). The

regional FMP was developed in draft form and remains to be reviewed and adopted (Oxenford 2002).

In the meantime, access to flyingfish stocks continues to be a contentious issue between Barbados and Trinidad and Tobago. Much of the contention appears to centre on perceptions of trade rather than scientific issues. The results of the ECFFP were a major component of the information synthesised in the first months of 2003 by the Joint Technical Working Group (JTWG) established by these two governments to put together the best available body of information on this fishery. Still lacking is an appropriate governance mechanism for the resource. The JTWG and the WECAFC WG provide the opportunity for exchange and synthesis of technical information, although the former involves only two of seven states involved in the fishery, but there is still no appropriate forum for decision-making for this fishery.

There are plans for the Caribbean Large Marine Ecosystem (CLME) Project to take up the challenge of regional level management of flyingfish fisheries (Fanning *et al.* 2007). The CLME Project has a focus on governance of transboundary living marine resources and will pursue these within a LME governance framework (Fanning *et al.* 2007).

## REFERENCES

- Campana, S., H.A. Oxenford and J.N. Smith. Radiochemical determination of longevity in flyingfish *Hirundichthys affinis* using Th-228/Ra-228. *Mar. Ecol. Prog. Ser.* 100: 211-219
- Cochrane, K. L. 1996. Possible strategies for the monitoring, assessment and management of fisheries for small coastal pelagics and *Hirundichthys affinis* over the next three years. CARICOM Fishery Resource Assessment and Management Programme, Small Coastal Pelagics and Flyingfish Subproject Specification Workshop, Grenada 1996, Unpublished, 55 pp.
- Fanning, L., R. Mahon, P. McConney, J. Angulo, F. Burrows, B. Chakalall, D. Gil, M. Haughton, S. Heileman, S. Martinez, L. Ostine, Adrian Oviedo, S. Parsons, T. Phillips, C. Santizo, B. Simmons, C. Toro. 2007. A large marine ecosystem governance framework. *Marine Policy* 31: 434-443.
- FAO. 1999. Western Central Atlantic Fishery Commission Report of the First Meeting of the WECAFC *Ad Hoc* Flyingfish Working Group of the Eastern Caribbean. FAO Fisheries Report No. 613, 45 pp.
- FAO. 2002. Western Central Atlantic Fishery Commission Report of the Second Meeting of the WECAFC *Ad Hoc* Flyingfish Working Group of the Eastern Caribbean. FAO Fisheries Report No. 670, 156 pp.
- FAO 2007. Scientific basis for ecosystem-based management in the Lesser Antilles including interactions with marine mammals and other top predators. Report of the Second Meeting of the Ecosystem Modelling Working Group. FI:GCP/RLA.140?JPN Field Document 6, 42 pp.
- Gomes, C., H.A. Oxenford and R.B.G. Dales. 1999. Mitochondrial DNA D-loop variation and implications for stock structure of the four-wing flyingfish, *Hirundichthys affinis*, in the central western Atlantic. *Bull. Mar. Sci.* 64(3): 485-500.
- Gomes, C., R. Dales and H.A. Oxenford. 1998. The application of RAPD markers in stock discrimination of the four-wing flyingfish, *Hirundichthys affinis* in the central western Atlantic. *Molecular Ecology* 7: 1029-1039.
- Gomes, C., H.A. Oxenford and R.B.G. Dales. 2000. Restriction site mapping of the mitochondrial DNA of the four-wing flyingfish, *Hirundichthys affinis*. *DNA Sequence* 11 (3-4): 277-280.
- McConney, P. 1996. Contribution of social science to understanding catch and effort data from the Barbados fishery for flyingfish and large pelagics. CARICOM Fishery Resource Assessment and Management Programme, Small Coastal Pelagics and Flyingfish Subproject Specification Workshop, Grenada 1996, Unpublished, 16 pp.
- Mohammed, E. 1996. A preliminary investigation of fishing operations in the flyingfish fishery off Tobago (1988-1995). CARICOM Fishery Resource Assessment and Management Programme, Small Coastal Pelagics and Flyingfish Subproject Specification Workshop, Grenada 1996, Unpublished, 28 pp.
- Monteiro, A., A. C. A. El-Deir, R. P. Lessa, and C.T. Lira. 1996. Fisheries biological research on *Hirundichthys affinis* in Brazil: and historical and current view. CARICOM Fishery Resource Assessment and Management Programme, Small Coastal Pelagics and Flyingfish Subproject Specification Workshop, Grenada 1996, Unpublished, 14 pp.
- Nakashima, B. S. 1996a. A review of biological aspects of the life cycle and fisheries for small coastal pelagic species and *Hirundichthys affinis*. CARICOM Fishery Resource Assessment and Management Programme, Small Coastal Pelagics and Flyingfish Subproject Specification Workshop, Grenada 1996, Unpublished, 19 pp.
- Nakashima, B. S. 1996b. A proposal for standardization of catch rate data. CARICOM Fishery Resource Assessment and Management Programme, Small Coastal Pelagics and Flyingfish Subproject Specification Workshop, Grenada 1996, Unpublished, 4 pp.
- Oxenford, H.A. 2002. Draft sub-regional fisheries management plan for flyingfish in the eastern Caribbean. WECAFC *Ad Hoc* Flying Fish Working Group of the Eastern Caribbean FAO-SLAC/Activity RA-233-S100-1010.
- Singh-Renton, S. 1996. Interactions between large pelagic fisheries and those for coastal pelagics and flyingfish: implications for fisheries performance. CARICOM Fishery Resource Assessment and Management Programme, Small Coastal Pelagics and Flyingfish Subproject Specification Workshop, Grenada 1996, Unpublished, 10 pp.