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Challenges and Opportunities for Standardization of Maldivian Skipjack CPUE

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Standardized CPUE from commercial fishery data is the most important input for stock assessment work of the Indian Ocean Tuna Commission (IOTC). Lack of standardized CPUE for skipjack tuna has hampered progress on stock assessment of skipjack tuna. The most important and longest time series of skipjack tuna catch and effort data is from the Maldives' pole-and-line fishery. Its direct use is not helpful due to pervasive increase of fishing power and efficiency of the fishing effort over time. In the Maldives this is happening at varying degrees and in several aspects of fishing operation. The size of the vessels has been increasing from mid 1970s. From around 2000, FRP-hulled vessels replaced the traditional wooden-hulled vessel allowing further and rapid increase in size and engine horsepower. Other areas of increasing fishing efficiency are use of the anchored fish aggregating devices, changes in livebait catching and holding techniques, increased use of fish finding equipment and opportunities for disposing large volumes of catch. Standardization of CPUE requires information related to increasing efficiency of fishing power consistent with the resolution of measurement of unit of fishing effort. Regrettably Maldives, like many fisheries, have not been careful in recording and maintaining information on factors attributed to this increasing fishing power. Where information available, time-consuming work is required to correct and validate the data before work on standardization can be completed. The first attempt at standardization of the Maldives CPUE was in 2011 for a short time series from 2004-2009. This allowed for the first time to undertake a proper model-based assessment of Indian Ocean skipjack stock. More work is now required to obtain information to standardize the full time series of Maldives pole-and-line data.

Introduction

Skipjack tuna is one of the most important species fished in the India Ocean. The species is fished from surface gears (pole-and-line, gill net and purse seining methods) all across the Indian Ocean. Recorded average annual landings are currently about 450,000 t with roughly half taken by the coastal countries in the IOTC region.

Maldives is the single most important skipjack fishing nation in the Indian Ocean with a history of pole-and-line tuna fishing for hundreds of years. It has been said that prior to the 1960s Maldives' skipjack would constitute close to 85% of the recorded skipjack landings in the Indian Ocean. The current Maldivian catch contributes to about 18% of the total catch.

Maldives has the longest record of skipjack catch and therefore the longest time series of catch and effort data. Although Indonesia too has a pole-and-line fishery their data is fragmented and not recorded appropriate for CPUE assessment work.

There was rapid increase of skipjack catch in the Indian Ocean following the advent of the industrial purse seining. The industrial purse seine fishery, essentially based in Seychelles, operates in the tropical areas of the western Indian Ocean, in Mozambique Channel and Somali Basin. Total Indian Ocean catch rose to an all time record of 500,000 t in the 2006 and has been declining since then. The same trends are seen in the Maldives and EU-French purse seine fleet catch. While the Somali pirate issues has been attributed for decline of EU-Purse Seine catches, the declines in Maldives catches is difficult to explain. This has prompted attention to skipjack, which was earlier believed to be 'robust' with potential to sustain high levels of the fishing effort.

More recently the pressure to undertake assessment of the stock came from the Maldives as their pole-and-line fisheries is currently undergoing Marine Stewardship Council (MSC) Certification. For the first time, a proper model-based assessment of the skipjack was undertaken in 2011 with special support from the IOTC Secretariat (Kolody et al., 2011). The assessment used a short SKJ CPUE time series from 2004-2009, which was standardized used using vessel characteristics (Kolody et al., 2010 and 2011). The analyses recommended further investigation of the existing data irregularities, and expansion of the logbook programme to improve these analyses in the future.

This paper attempts to provide additional information on data irregularities so as to facilitate further work on standardization of the Maldivian pole-and-line CPUE.

Maldives Skipjack Time Series

CPUE time series are most important and commonly used input data for stock assessment (Maunder 2001). The CPUE is used as a measure of index of stock abundance in the assessment models. However, direct input of CPUE from commercial fishery data is not appropriate as effective effort is increasing as efficiency increase over time. The factors that affect the fishing effort needs to be eliminated and standardized before CPUE can be used a proxy of index of abundance (Harley et al., 2001).

Maldives' time series suffer the common issues of 'effort creep' associated with multiple factors. Before discussing the data available for CPUE standardization it may be useful to understand the how data is Maldives collected and compiled.

Despite the long history and tradition of tuna pole-and-line fishing, formal recording of data did not start until 1959. Time series of disaggregated data useful for standardization starts from 1970.

Tuna catches in Maldives are enumerated[1] and recorded in numbers of fish caught. Subsequently conversion factors (or average weights) are used to estimate weights for reporting purposes (Anderson et al, 2003). The unit of effort is taken as number of fishing trips as vessels conduct day trips, leaving home-island to return in evening.

Catches by vessels are recorded on a daily basis from every inhabited Island. The information is reported to the Atoll Office[2] for the purposes of identifying the best islands for deploying collector vessels[3]. The Atoll Office compiles these data and reports the best three fishing islands in the atoll to the Ministry of Fisheries and Agriculture on a daily basis[4]. Although in some cases the daily reports are transmitted to the Ministry via fax, the data is poorly and irregularly reported to the Ministry. In the islands the Daily Fish Report are used to compile Monthly Fishery Reports, which is sent to the Ministry on a regular basis. From 2004 the Monthly Fishery Report is compiled on vessel basis. It is the often the case, and more common in the last couple of years, that Daily Fish Reports are either not compiled or sent to the Atoll Office. Therefore in most cases the Monthly Fishery Report is compiled using the receipts of fish sales or from the notes the skipper maintains. Until January 2010, it is mandatory to conduct 120 days of fishing in order to qualify for the annual vessel registration fees. This requirement has lead to believe some misreporting. But it was believed that there is more under-reporting than over-reporting (Anderson et al., 2003).

Essentially the CPUE time series data is monthly aggregated catch by atolls[5] by vessel type[6] and later by gear type and more recently the data is aggregated by vessel. A table showing the various fields in the database is given in Appendix 2.

A number of issues in the data have been identified (Adam et al., this meeting). These include use of inappropriate data recording forms, errors in transcription, misreporting and errors in entry of vessel registry numbers during data compilation. The monthly aggregation of catch data has particular problem that renders disaggregation of the data into the gear categories difficult without additional information (Adam et al, this meeting).

A particular problem in the Maldives is the prominence given to the 'type' of vessel. In the early days, prior to the 1980s, there were essentially three types of vessels; masdhoni, vadhudhoni and bokkura (pole-and-line vessel, trolling vessel and row boats respectively)

[1] The catch used to be shared among the crew members and so the number of fish caught is always know and therefore easily enumerate.

[2] Each atoll is administered by an Atoll Office, normally based on most densely populated island in the atoll. From 2009 the Atoll Offices are headed by an elected official – Atoll Councilor - but previously, the Atoll Chief was appointed by the President and fired at will.

[3] For most part prior to around mid 2000 the state-owned Maldives Industrial Fisheries Company (MIFCO) collected fish through collector and mother vessels. Collector vessels are strategically deployed to the best fishing area.

[4] This reporting, originally used government to radiobroadcast national tuna landings on daily basis, was also used to decide the best fishing areas to deploy state-owned MIFCO Company's fish collector vessels. The report was irregular from around mid 2000 and now completely stopped after inception of Atoll Councils.

[5] The names of the atolls used in the Catch and Effort Database in given in Appendix 1.

[6] Before 1989 gear category was not recorded. Vessel category was used to implicitly determine whether the catch was from pole-and-line or trolling, the two methods for catching tuna.

that are invariably use pole-and-line, trolling and handline gears respectively. In fact this notion of gear-specific vessel was so pervasive little emphasis was given to record the fished gear prior to 1989. However, with mechanization of the vessels and improvement is socio-economic conditions of the island communities combined with the economic opportunities of other forms fishing (i.e., handline fishing for yellowfin and reef fishing), the type of fishing conducted on vessels varied and so the type of gear and the catch composition also varied. For instance, it is now common to undertake handline fishing on vessel previously conducting exclusively pole-and-line fishing. When this particular vessel reports its monthly aggregated catches, there is no easy way indicating that catches came from more than one gear. In most of these cases the island clerks assigned to the pole-and-line – the most common gear. It is not uncommon that tuna fishing vessel opportunistically switch to handline (targeting yellowfin or sometime reef fish) (Riyaz and Adam, this meeting). Entry of pole-and-line method in such cases has caused confusion in data cleaning. For instance Kolody and Adam (2011) reported several instances where there was effort recorded without skipjack catches. It is now believed these cases are months where vessel reported catches of Group1, Group 2 or Group 3 catches[7]. Also in records where island clerks have indicated breakdown of the various gears, there is no easy way of entering the disaggregated catch information into the database.

Data for Standardization

It is against this background that available data should be looked into for standardization of skipjack CPUE. The following gives descriptions of available data and potential issues associated with them.

Vessel Data

Kolody and Adam (2011) used vessel attributes to standardize the SKJ CPUE from 2004-2009. This was possible because aggregated monthly catch data are reported by vessel, identified by the vessel registry in the database. The pertinent information for standardization of effort is the size of the vessel and/or the horsepower (Figure 1). They are believed to be a factor in influencing the catch rates; larger vessel mean large holding capacity of livebait and catch, and increased horsepower means more efficient searching, effectively increasing available time for fishing.

Vessel specific monthly aggregated data are available from 2004 onwards. In order to obtain the corresponding vessel characteristics the vessel registry number has to uniquely match with the vessel registry number in the Vessel Registry Database maintained by the Fisheries Licensing Unit.

There are a number of problems in correctly matching the records in the catch database and vessel registry database. The Ministry of Transport and Communications issues vessel registry numbers and the numbering system was changed recently which means the old and new version of the registry database is required to match the catch records. There are several instances where vessels registered with an older version changed hands and have issued a registry number in the current format. To make the matters worse there are a number of transcription errors by the island office clerks and also during the data entry into

[7] Group 1, Group 2 and Group 3 are assigned to non-tuna varieties, mostly reef fish. These groupings are extremely arbitrary. Group 1 is the large fish (jacks, breams, barracuda, job fishes, snappers), Group 2 is the medium fish and Group 2 is small fish (round and bigey scads).

computer by the Ministry's staff. There appears to be no validation rule applied on vessel registry during data entry and matching vessel registry records proved to be considerable task.

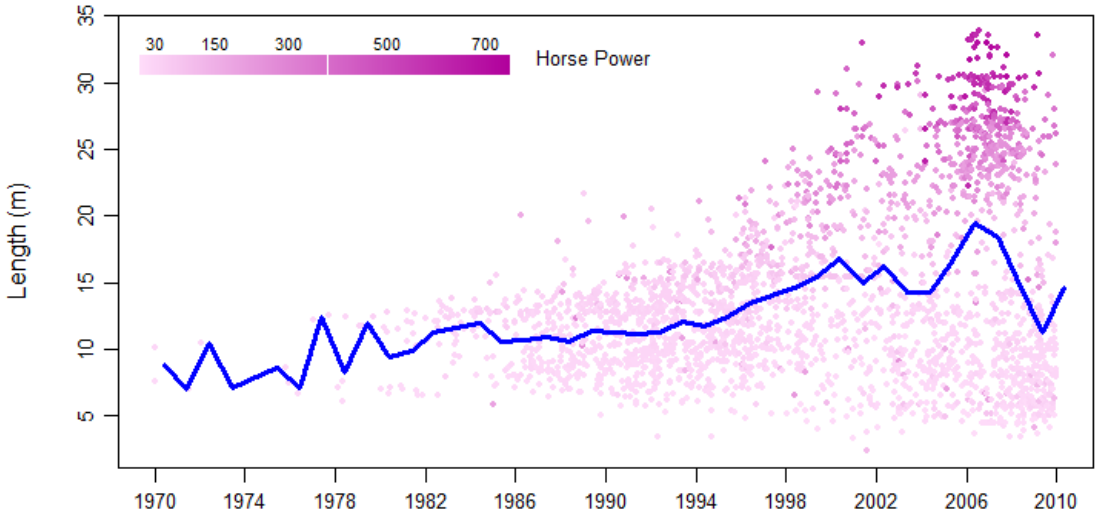

Figure 1: Increase in size and horse power of the registered fishing vessels over the years: 1970 - 2010 (Data: from Ministry o Transport and Communication)

Kolody and Adam (2011) noted that close to 90% of records were cleaned for their analysis for 2004-2009. Further cleaning work will be required for 2010 and 2011 data.

Anchored Fish Aggregating Devices

Fish aggregating devices (FADs) are an important aspect of the Maldivian pole-and-line fishery. Unlike thousands of drifting FADs released by the purse seine fishing method Maldives pole-and-line fishery uses anchored fish aggregating devices (aFADs) deployed in oceanic water some 12-15 miles from the shore.

The first aFAD was deployed on 24 February 1981, which lasted only 10 days. Since then close to 400 aFADS were deployed around the Maldives (Figure 2 and Figure 3). From 1990 around 50 aFADs are maintained in strategic locations that have become accepted by fishermen (Figure 2).

No one doubts the importance of aFADs in the Maldives; they are generally believed to attract and maintain tuna schools around them. It has now become normal practice and routine for the fishermen to visit the closest aFAD first thing in the morning after livebait fishing is complete. Only if fishing were poor around the aFADs would they search for free swimming schools. Kolody and Adam (2011) suggested that aFAD may influence CPUE and abundance from hyper-stability conditions. Unfortunately there are no direct records maintained for fishing events around aFADs. However, it has been estimated that at present considerable amount of pole-and-line fishing takes place around aFAD associated schools. Similarly it has been said that that substantial number of large yellowfin tuna fishery are also caught around the aFADs during night in the handline fishery. These fishermen use the

aFAD as an anchor resulting decline in the mean lifespan of the aFADs in the recent years (Figure 4).

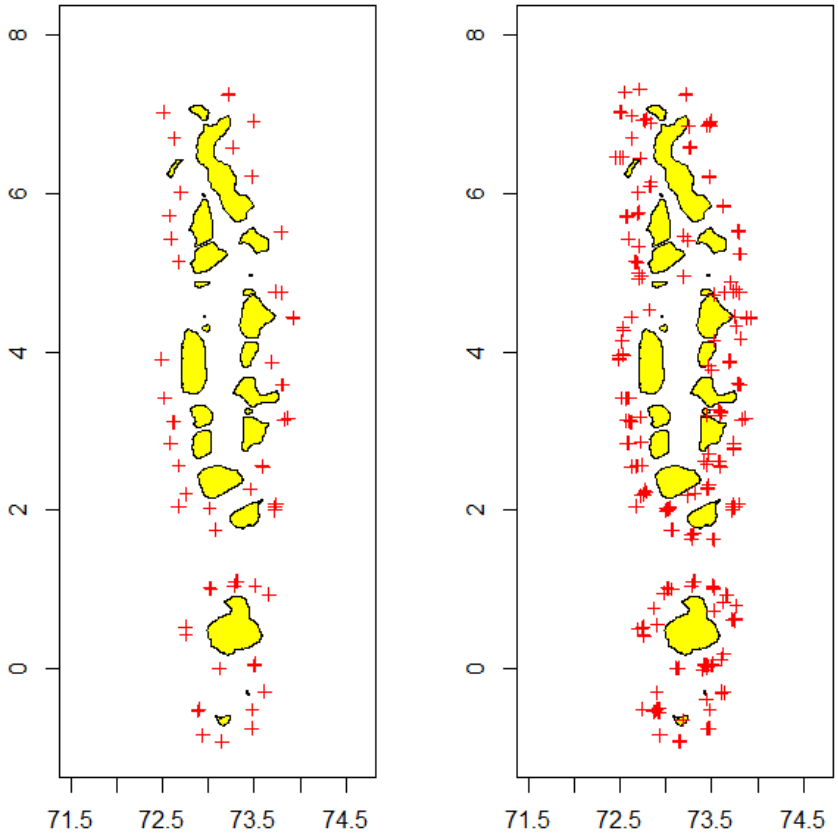

Figure 2: Anchored fish aggregating devices around the Maldives. aFADs are regularly maintained around 50 sites (left) and the aFADs that have been deployed from 1981 – 2011., Source: MoFA FAD Section.

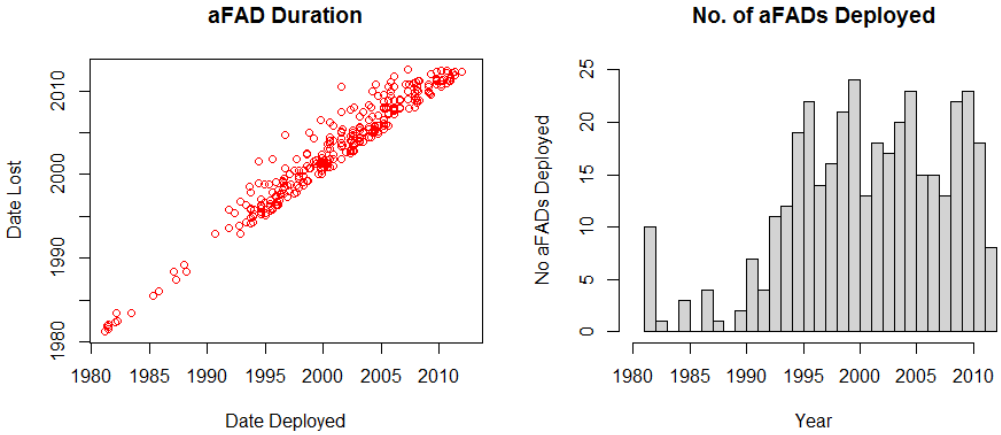

Figure 3: No of aFADs deployed in the Maldives Tuna fishery (source: MoFA – FAD Section)

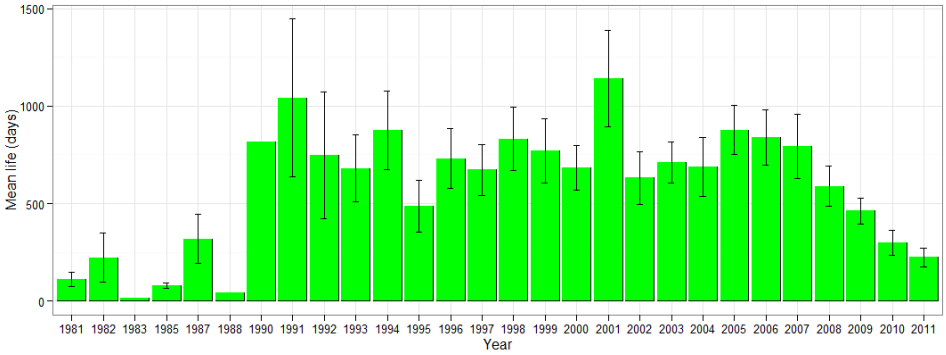

Figure 4: Figure to show the mean life-span of the aFADS and its decline in the recent years due to the development of handline fishermen using as an anchor during night time fishing. Source: MoFA FAD Section.

Fished Area and Month

There is no doubt that skipjack catch rates are affected by the season and region. A number of analyses have shown such effects (Anderson, 1993, and Adam, 1999). The nominal catch effort database is aggregated by atoll and by month providing information for factoring time-area effect (Kolody and Adam, 2011). The normal practice is those vessels registered in the home-island operate form that island. They conduct day trips; leaving early in the morning to return by evening. Since these vessel do not venture more than 40-50 miles the catches from the atoll gives quite an accurate picture of the catch in the time-area.

The above assumption however, will be violated in the recent years and more so in the last 4-5 years. The increase in size and horsepower of the vessel mean that vessel no longer operate around and from their home-island. Larger vessels often relocate the operation to good fishing areas spending week before returning home-island. The availability and ability of storing ice[8] on board has meant that some vessels conduct multi-day fishing even for pole-and-line operations. But despite the changes in fishing operations vessels report their catch to the home-island[9]. This would mean that catch assigned to areas (atolls) would be wrong. There is potential to partly resolve this issue. From 2004 records are available by vessel. It is likely that skippers or vessel owners still maintains records of the sales receipts, which would indicate at lease location (name of atoll / island) of their sale. The fish collectors also maintain detail records of their purchase including the vessel registry. If this information is available part of this problem may be solved.

Bait Logbook Data

From around early 1990s the Marine Research Centre maintains a team of fishermen-field-officers on key fishing islands for the purpose of tuna size sampling. These field officers are actually fishermen on fishing vessels who goes fishing regularly. The primary task of these field officers, who are on renewal annual work contracts, is to measure a sample of fish from their day's catch on every fishing trip. An additional assignment is to complete a bait logbook. The logbook is to be completed everyday 365 days a year. Days that do not go fishing have to be recorded with the reason for not fishing. On days where livebait fishing was done, the main species had to be recorded including the time spend to bait fishing.

[8] Ice became popular, thanks to the explosive growth of export oriented handline fishery targeting large yellowfin tuna. Such vessel carries RFP ice-boxes (800 – 1500 litres) and their trips last 10-14 days.

[9] From January 2010 logbooks have been introduced where the location of catch (or position at noon) is recorded. Currently the two system of reporting is going on.

Although not all the field officers have paid full attention to completing bait logbooks there have been few field officers who have provided records for long periods of time. Unfortunately none of these data have been looked at. These data are considered to be important for standardization CPUE.

Information on Fish Collector Vessels

Kolody and Adam (2011) postulated that use of collector vessels might increase the home range of the fishing vessels. Collector vessels are smaller vessels (50-60 GT capacity) that operate by the commercial fish collectors[10]. Fish collectors deploy the collector vessels in the best fishing atolls making it convenient for the fishermen returning with the catch. Collectors keep records of the activities of the collector vessels with location, duration of operation and presumably amount they collected along with vessel information. The information is not directly available in the Ministry, but very likely that collectors would release such information for research work. Again, this is another sources of information that will be useful to the standardizing the Maldives CPUE.

New Logbooks and Supplementary Information

It has been recognized for some time that traditional method of data collection is increasingly becoming unreliable and inaccurate. But lack of resources and expertise has delayed overhauling work of the data collection and compilation system. The enforcement of the EU-IUU regulation starting from 01 January 2010 allowed inception this important work in the Maldives. New logbooks have been introduced from January 2010. Both traditional system of enumerated catch reporting and logbook systems are in place and the coverage of logbooks is increasing. The most recent data compilation for 2010 and 2011 used the daily logbook data. It is expected a near complete coverage of the logbook reporting for 2012 landings. Once completely dependent on daily logbook reporting system, Maldives will be reporting the data by based geographic grids (½ x ½ degree grids) instead of atoll-based reporting.

Additionally emphasis has been paid to recording daily tuna collection data as required for issuing EU-required catch certificates. This includes skipjack and yellowfin tuna purchases from pole-and-line fishery and also large yellowfin tuna from handline fishery including the few landings from longline fleet.

In order to facilitate this process and integrated web-enabled database infrastructure is being developed. Some modules are of the database are already in use and it is expected the full commissioning of the database will complete during 2013.

[10]There are three main fish collectors are Government owned MIFO (Felivaru in the North, Koodoo in the South) and the Maandhoo in the Central Maldives is owned by Horizon Fisheries (see the figure in Appendix for their locations).

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Annex 1

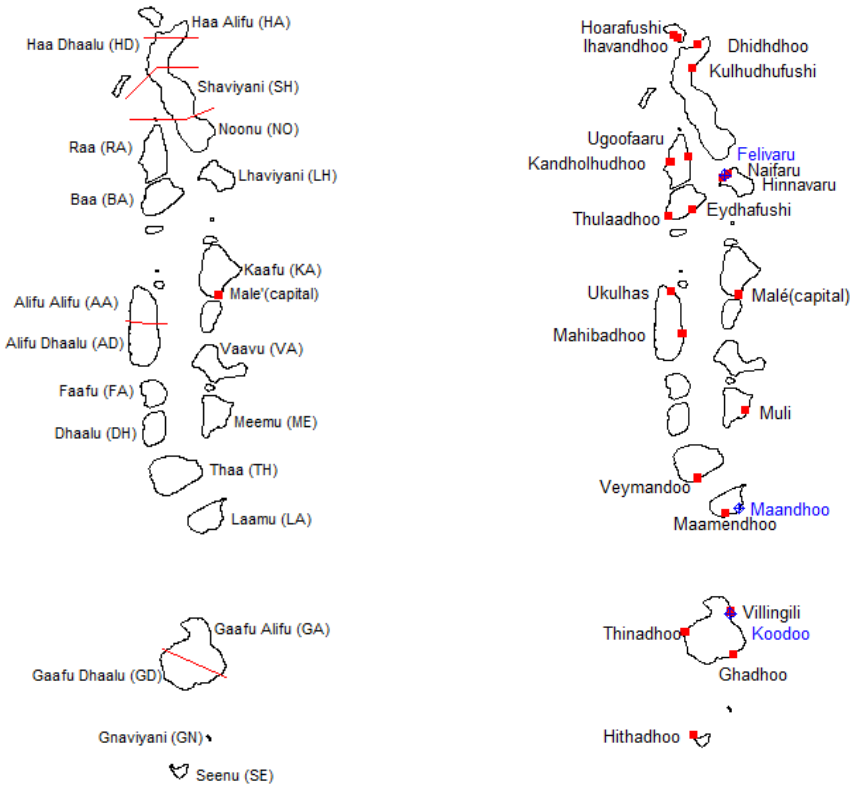

Figure 5: Names of Atolls and two letter code used in the Catch Effort database (left) and major fishing islands (right) with major fish collection centres (in blue color)

Annex 2:

Maldives Nominal Catch and Effort Data - Field-Map [Uncleaned, September 2012]

	Fishery					VESSEL																		GEAR						
	BoduKann	Faana	Lobster	Resort	Skipjack	BBN	TROL	BBMN	BBM	BBN	HAND	TROLM	TROLN	UNCL	MI	MM	MV	RB	SM	SV	VD	ML	HV	FN	HL	LL	MI	PL	TR	V
1970						x	x																							
1971						x	x																							
1972						x	x																							
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1989									x	x	x	x	x	x										x	x	x	x	x	x	
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1992									x	x	x	x	x	x										x	x	x	x	x	x	
1993									x	x	x	x	x	x										x	x	x	x	x	x	
1994									x	x	x	x	x	x										x	x	x	x	x	x	
1995									x	x	x	x	x	x										x		x		x	x	
1996									x	x	x	x	x	x										x	x	x	x	x	x	
1997									x	x	x	x	x	x										x	x	x		x	x	
1998															x	x	x	x	x		x		x	x	x	x	x	x	x	
1999															x	x	x	x	x		x			x	x	x	x	x	x	
2000															x	x	x	x	x		x			x	x	x	x	x	x	
2001															x	x	x	x	x		x			x	x	x	x	x	x	
2002															x	x	x	x	x		x			x	x	x	x	x	x	
2003															x	x	x	x	x	x	x	x		x	x	x	x	x	x	
2004	x	x		x	x											x	x	x	x	x	x			x	x	x	x	x	x	x
2005	x	x	x	x	x										x	x	x	x	x	x	x			x	x	x	x	x	x	x
2006	x	x	x	x	x										x	x	x	x	x	x	x			x	x	x	x	x	x	x
2007	x	x	x	x	x										x	x	x	x	x	x	x			x	x	x	x	x	x	x
2008	x	x	x	x	x											x	x	x	x	x	x			x	x	x	x	x	x	x
2009																x	x	x												
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