

Cleaning the Maldives catch and effort dataset (2004-2009)

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Abstract

Maldives has one of the longest catch and effort time series in the Indian Ocean dating back to 1959. Vessel specific monthly aggregated catch and effort data is available in electronic format from 2004 onwards. Kolody and Adam (2011) standardized the dataset (2004-2010) and in the process, raised several irregularities, most notable being that of single day records and positive effort with zero SKJ catch. Single day efforts were found to be the result of double reporting from vessels that disposed the catch to Male'. Catch and effort data collection from Male' harbor by the Ministry of Fisheries and Agriculture (MoFA) inspector has recently been stopped. Other irregularities in the dataset were records of positive effort with zero catch, presence of duplicate records and multiple records for the same vessel and month with total effort exceeding the days of the month. The 2004 – 2009 dataset initially consisted of almost 86 thousand records inclusive of all fishery, vessel and gear types; MM vessels with PL gear being 63 thousand records (673 thousand effort days). The final cleaned dataset has 36 thousand records representing 601 thousand days of PL effort by mechanized *masdhoni* vessels.

Introduction

Maldives pole-and-line fishery catch and effort data collection can be dated back to 1959, with a time series of disaggregated data that can be used for standardization from 1970 onwards (Adam, 2012). Monthly catch and effort data disaggregated by vessel is available from 2004 onwards. Kolody and Adam (2011) standardized the series (2004 – 2010) using a GLM approach. Several concerns with the dataset were presented by the authors, most notable being the presence of positive effort with zero SKJ catch and a large number of records with single day efforts. This paper presents the data series cleaning attempts so that a clean dataset that can be used for standardization and subsequent input into stock assessment models can be attained.

Nominal catch and effort database (2004 – 2009)

The nominal catch and effort database (2004 – 2009) consists of almost 86 thousand records of monthly catch and effort data, representing a sum of 960 thousand effort days. These included records for 5 types of gear and 8 types of vessels (**Table 1**). The dataset was first filtered to contain only records of PL gear and mechanized *masdhoni* (MM) vessel type. Vessels other than MM (e.g. sailing vessels and row

boats), despite reporting PL as the gear, were removed as these represent only a small fraction of the dataset and could not be used effectively in an assessment. Mechanized *masdhoni* has always been the primary vessel type (95% PL effort in the database) in the tuna fishery of the country.

Table 1. Summary of the database with vessel types and gears used.

	ACRONYM USED IN DATABASE	EXPLANATION	NO. OF RECORDS	TOTAL EFFORT REPRESENTD
GEAR	PL	Pole-and-line	66,385	704,742
	HL	Handline	19101	255925
	TR	Troll line		
	LL	Longline		
	FN	Fixed net		
VESSEL TYPE	MM	Mechanized masdhoni	78979	893093
	MI	Miscellaneous	6507	67574
	MV	Mechanized (trolling) dhoni vadhu		
	SB	Sailing boat		
	SM	Sailing masdhoni		
	SV	Sailing vadhu (trolling) dhoni		
	VD	Vadhu dhoni (trolling vessel)		
	RB	Row boat		

Irregularities in the dataset

Single day effort

The single most pervasive issue with the data series is the presence of a significant number of records with single day efforts. This amounts to 20,087 records. In many instances, vessels have multiple records of single day efforts for a given month, which ideally should have one record of aggregated catch and

effort data. It is noteworthy that almost 98% of the single day efforts were recorded for Male'. Mostly, these records were for vessels that were registered either to Male', islands in Male' atoll or nearby atolls

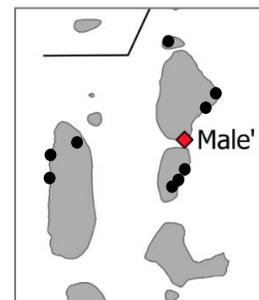


Figure 1. Map of Male' and the nearby atolls. Black markers indicate the localities of vessels that landed the catch to Male'.

(Figure 1). Such vessels generally land their catch to Male’ due to better marketing opportunities.

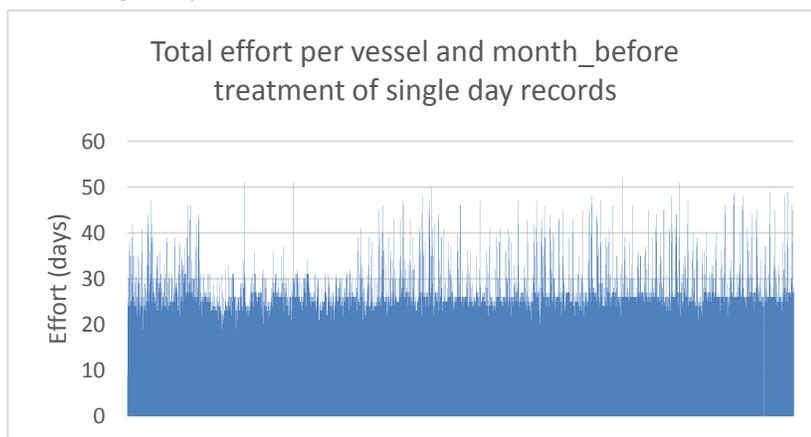
Up until recently, MoFA employed inspectors to collect landing data from vessels in Male’ port. As these records were not aggregated monthly, they remained as single day efforts in the database. In addition to reporting at Male’, these vessels (except those registered to Male’) reported the monthly data to MoFA through their home island offices, resulting in double reporting. The fact that these records most of the time had effort less than days of the month (30 or 31) has allowed them to remain undetected as erroneous records in the database. Entry of these island office reported monthly data without adjusting for the days reported to Male’ has caused a number vessels to have multiple records for a given month, whose total effort far exceeds the days of the month (for example 36 days in Figure 2 below). Data collection from vessels in Male’ harbor has since been stopped.

Year	Atoll_N	Gear	VIN No	Vessel	Old reg	Month	Vessel	Island	Tot_fis	GearQt	Effort
2004	Male'	PL	1623A	P1623A-			1 mm	Gaafaru	0	61	24
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	7	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	0	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	6	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	6	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	6	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	8	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	9	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	7	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	6	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	6	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	7	1
2004	Male'	PL	1623A	P1623A-			1 mm	Male'	0	8	1

Figure 2. Screen capture of the database showing “double reporting”

Treatment of the single day records:

For vessels that made double reporting as in Figure 2, a cutoff of 20 days (reported to the home island) was used to remove the single day efforts reported to Male’. Twenty days is the mean number of days from all the records in the database with effort between 15 (minimum number days a vessels would presumably fish in general) and 30. Based on this criteria, 9116 records were removed and the databases was left with 10,973 single day records. For vessels that were registered to Male’, and those that do not have double reporting, the single day records were aggregated for the month. It was identified that 9161 records could be removed after aggregating their catch and effort into single records. The final dataset, after all the treatments, had 919 single day records. Figure 3 below shows total monthly effort for each vessel before and after removal of single day efforts.



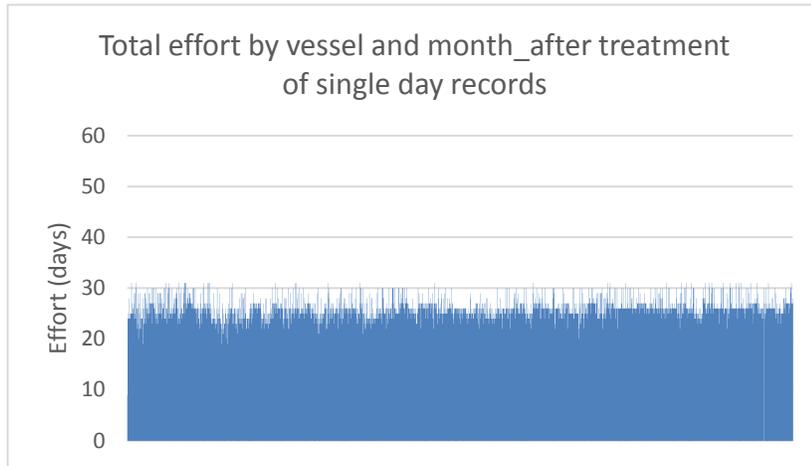


Figure 3. Total effort per vessel. Before (top) and after (bottom) treatment of one day records.

Positive effort and zero skipjack catch

Another key issue with the dataset is that of positive effort with zero catch of skipjack tuna (Figure 4). It is highly unlikely that there could be such a significant number of positive effort and consistently not catch any SKJ over the course of a month. On the other hand, there is a possibility that at least some of these trips were targeted at non-tuna species. Misreporting of gear is also a possibility in some records. Table 2 below summarizes the different types of records that had positive effort and zero SKJ catch.

Type_Fi	Atoll_Name	Gear	VIN No.	Year	Month	Effort_days	Island_I	sum(SKJ)N	sum(other tun	sum(gp1,2	MT_DG
Skipjack	Male'	PL	8426A	2006	12	1	Male'	0.0000	0.0000	2460	0
Skipjack	Male'	PL	8457A	2008	4	1	Male'	0.0000	0.0000	13	0
Skipjack	Male'	PL	8457A	2008	5	1	Male'	0.0000	0.0000	0	0
Skipjack	Male'	PL	8530A	2008	6	1	Male'	0.0000	0.0000	1099	0
Skipjack	Kolhumadulu	PL	8544A	2009	3	4	Vilufushi	0.0000	0.0000	16	0
Skipjack	Kolhumadulu	PL	8544A	2009	4	8	Vilufushi	0.0000	0.0000	29	0.012
Skipjack	Kolhumadulu	PL	8544A	2009	7	3	Vilufushi	0.0000	0.0000	33	0
Skipjack	Kolhumadulu	PL	8544A	2009	10	5	Vilufushi	0.0000	0.0000	37	0
Skipjack	Kolhumadulu	PL	8544A	2008	1	26	Vilufushi	0.0000	0.0000	545	0
Skipjack	Kolhumadulu	PL	8544A	2008	2	23	Vilufushi	0.0000	0.0000	385	0
Skipjack	Kolhumadulu	PL	8544A	2008	3	19	Vilufushi	0.0000	0.0000	351	0
Skipjack	Kolhumadulu	PL	8544A	2008	4	23	Vilufushi	0.0000	0.0000	355	0
Skipjack	Kolhumadulu	PL	8544A	2008	5	21	Vilufushi	0.0000	0.0000	335	0
Skipjack	Kolhumadulu	PL	8544A	2007	1	26	Vilufushi	0.0000	0.0000	84	0
Skipjack	Kolhumadulu	PL	8544A	2007	3	13	Vilufushi	0.0000	0.0000	56	0

Figure 4. Screen capture showing records of zero SKJ with PL gear

Table 2. Description of the records with positive PL effort and zero skipjack catch

		# RECORDS	TOTAL EFFORT	EXPLANATION
0 SKJ	+ve for other tunas species OR +ve for groups 1,2,3 species OR +ve for sailfish, sharks and dogtooth tuna	17948	156734	Multiple gear (PL, HL, other gear) used over the month to catch different groups of fish. May contain true zero catches.
	0 other tunas +ve groups 1,2,3 species +ve sailfish, sharks and dogtooth tuna	6467	38291	Gear misreported as PL is not used to catch any of these species.

The fishery of small pelagics, namely bigeye scad (*Selar crumenophthalmus*), mackerel scad (*Decapterus macarellus*) and Indian mackerel (*Rastrelliger kanagurta*) has been expanding in the Maldives, especially in Male' region. This has mainly been due to increased demand and booming of handline yellowfin tuna and recreational reef fish fishery where they are used as bait. As the main gear used to catch bigeye scad is miniature version of pole-and-line, it is most likely that the catches are reported as being caught using (the miniature) pole-and-line. This is evidenced by the presence of records with PL gear used and catch of Group 3¹ species. In such cases, the datasheets and the database would not differentiate between the two sets of pole-and-lines.

Treatment of records with positive effort and zero catch:

Of those that reported zero SKJ catches, 6467 records (38291 effort days), were deemed as non-skipjack targeted efforts. This was concluded based on the fact that despite reporting PL as the gear, the catch does not represent those species that are caught using PL and hence were removed from the dataset.

¹ In the catch and effort data collection system, Species other than tunas are combined into Groups 1, 2 and 3. Group 3 represent fish of small size such as bigeye and round scad.

Duplicate records

The database had 1011 records which were duplicated (**Figure 5**), i.e. same data across all categories. It is possible that these duplicates were created at some stage in retrieval of data from the database. The duplicates were also removed from the dataset.

VIN No.	Year	Month	Effort_days	Vessel	Island_I	sum(SKJ)M	sum(all)	sum(gp1,2)	MT_SSK	NO_SSK	MT_LSK	NO_LSK	MT_YFN	NO_YFN
1141A	2007	2	17	MM	Komando	13.4076	8116.1600	142	10.4265	4965	2.9811	523	0.689	265
1141A	2007	2	17	MM	Komando	13.4076	8116.1600	142	10.4265	4965	2.9811	523	0.689	265
1141A	2007	3	16	MM	Komando	3.6573	2683.1647	32	1.7934	854	1.8639	327	0.559	215
1141A	2007	3	16	MM	Komando	3.6573	2683.1647	32	1.7934	854	1.8639	327	0.559	215
1141A	2007	4	12	MM	Komando	2.1525	4143.6471	78	2.1525	1025	0	0	1.001	385
1141A	2007	4	12	MM	Komando	2.1525	4143.6471	78	2.1525	1025	0	0	1.001	385
1141A	2007	5	13	MM	Komando	0.3549	2989.7179	54	0.3549	169	0	0	0	0
1141A	2007	5	13	MM	Komando	0.3549	2989.7179	54	0.3549	169	0	0	0	0
1141A	2007	6	13	MM	Komando	15.1599	12298.9101	524	14.9604	7124	0.1995	35	0.1794	69
1141A	2007	6	13	MM	Komando	15.1599	12298.9101	524	14.9604	7124	0.1995	35	0.1794	69
1141A	2007	7	18	MM	Komando	18.7845	20567.4550	213	18.7845	8945	0	0	15.5662	5987
1141A	2007	7	18	MM	Komando	18.7845	20567.4550	213	18.7845	8945	0	0	15.5662	5987
1141A	2007	8	15	MM	Komando	18.7152	14985.7212	876	18.7152	8912	0	0	5.8136	2236
1141A	2007	8	15	MM	Komando	18.7152	14985.7212	876	18.7152	8912	0	0	5.8136	2236
1141A	2007	9	19	MM	Komando	17.9466	20024.8167	1457	17.9466	8546	0	0	11.089	4265
1141A	2007	9	19	MM	Komando	17.9466	20024.8167	1457	17.9466	8546	0	0	11.089	4265

Figure 5. Screen capture of the dataset showing duplicate records.

Multiple records for the same month with total effort higher than 30

As this was a monthly catch and effort dataset that describe the vessels' activities aggregated over a month, each vessel should have a single record for each month of fishing. In the case of multiple records, the sum of effort should be less than the days of the month. However, the database reported 1277 records with sums of effort greater than days of the month (e.g. **Figure 6**Figure 6).

Gear	VIN No.	Year	Month	Effort_days	Cu_Efo_day	Island_I	sum(SKJ)M	sum(all)	sum(other tuna)	sum(gp1,2)
PL	1228A	2005	5	25	25	Kadholhu	1.7640	5775.5585	2.2664	1147
PL	1228A	2005	6	18	18	Kadholhu	2.4339	3774.8528	2.0098	363
PL	1228A	2005	8	25	25	Kadholhu	3.3474	3803.2063	0.8836	627
PL	1228A	2005	9	12	12	Ugoofaru	1.2600	1505.9400	2.3400	0
PL	1228A	2005	9	21	33	Kadholhu	2.1966	2808.0013	1.2324	309
PL	1228A	2005	10	20	20	Ugoofaru	2.2050	2024.6890	1.2420	0
PL	1228A	2005	11	25	25	Kadholhu	3.2229	2655.3626	0.4032	303
PL	1228A	2005	11	15	40	Ugoofaru	4.8114	2290.1114	0.6500	0

Figure 6. Example of multiple records with total effort greater than days of month.

Treatment of multiple records with total effort higher than days of month:

Catch of records where the total effort was greater than days of the month were recalculated for the mean of effort days. The recalculated catch were either slightly less than or close to the mean of catch. Such records represented a small fraction (< 3%) and therefore is not expected to have a significant effect on overall outcome of the dataset. **Figure 7** presents the monthly total effort for each vessel in the dataset, before and after treatment for multiple records.

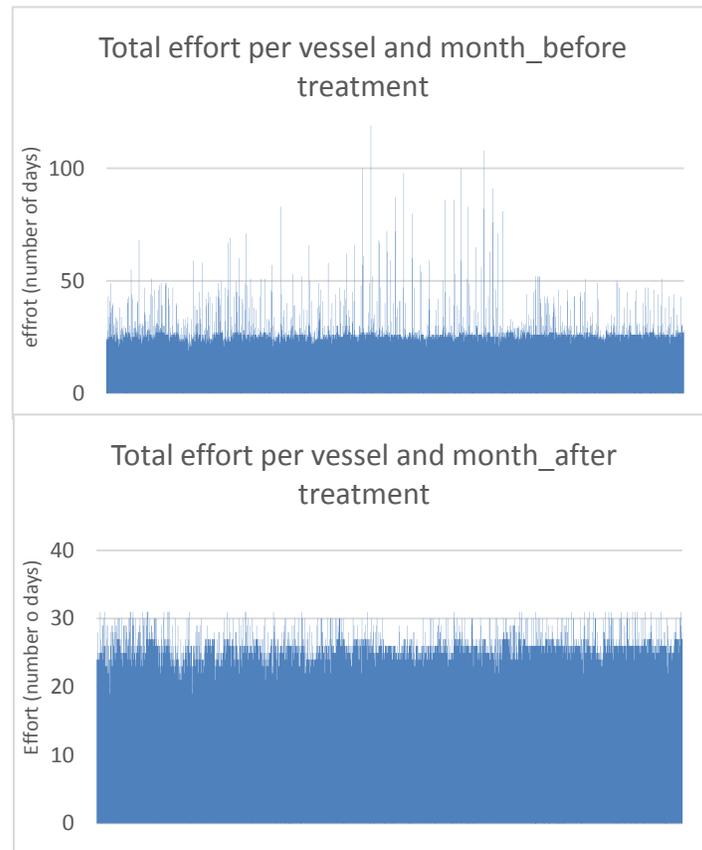


Figure 7. Total effort per vessel and month. Before (top) and (after) treatment.

Conclusion

The paper presented the key irregularities with the catch and effort data series (2004-2009). The main issues were that of single day records, positive effort with zero skipjack catch using PL, duplicate records and multiple records with total effort higher than days of month. The initial dataset which included all fishery, vessel and gear types had 86 thousand records of catch and effort data. The cleaned final dataset consist of 36364 records (601 thousand effort days) of mechanized *masdhoni* effort using PL gear. Data series for 2010-2013 will need to be incorporated for an updated catch and effort dataset that can be used for stock assessment purposes of Indian Ocean tuna species.

References

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