ANALYSIS OF TAG RECOVERIES IN MAURITIUS (1988-1993) AND PRESENTATION OF CODIFICATION PROCEDURE IN USE

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ABSTRACT

Tagging is considered an excellent tool for estimating the importance of interactions and competition between fisheries as well as to study tuna stocks and migrations. The Regional Tuna Project of the Indian Ocean Commission (IOC) conducted five tagging cruises in the western Indian Ocean, during which 955 fishes were tagged. Out of the total number tagged 15 were recaptured. Tuna tagging in the Indian Ocean was also undertaken by the Indo-Pacific Tuna Programme and by the Japanese National Research Institute of Far Seas Fisheries. 39 tuna marked by these organisations were recovered in Mauritius. Analysis of data collected from the tag recoveries provide some preliminary estimates of growth rate and migration of tuna

INTRODUCTION

Tagging is the most direct method to estimate growth, stock structure, schooling behaviour and migrations; it also provides essential information for estimating mortality (natural and fishing) and fisheries interactions and thus is pertinent for defining proper management of a stock.

The importance of tagging in tuna fishery management was stressed during the Indo-Pacific Tuna Programme (IPTP) Workshop on Stock Assessment of Yellowfin Tuna in the Indian Ocean, held in Colombo in 1991, and the following were recommended during the meeting:

1. IPTP should organise and maintain a central file of all Indian Ocean tagging data;
2. IPTP should act as a channel through which countries and organisations conducting tagging experiments within the Indian Ocean can publicize their activities in order to maximize tag returns;
3. IPTP should also continue to act as an inter-regional coordinator to ensure smooth transfer of relevant tagging information with organisations in other oceans, notably the South Pacific Commission (SPC) and the International Commission for the Conservation of Atlantic Tunas (ICCAT).

Further to these recommendations, it is felt that a unique method of codification should be utilised. We shall present in this paper:

- a brief analysis of data in relation to tagging available in Mauritius;
- the method of codification and input into the computer presently utilised in Mauritius.

ANALYSIS OF TAG RECOVERIES IN MAURITIUS

Data Sources

Data analysed in this paper were collected from the different tagging operations and tag recoveries made from:

- the five tagging cruises undertaken by the vessel *Mascaroi* under the Regional Tuna Project of the "Association Thonière" (Indian Ocean Commission) from 1987 to 1989;
- tagged tuna recovered at the Mauritius Tuna Fishing and Canning Enterprises Limited which were marked during the tagging programme conducted by the IPTP and the National Research Institute of Far Seas Fisheries (NRIFSF) of Japan.

The Regional Tuna Project of the Indian Ocean Commission (IOC) conducted five tagging cruises on board the chartered tuna-fishing vessel *Mascaroi* in the western Indian Ocean during 1988-1989.

955 fishes, which included 419 yellowfin tuna (*Thunnus albacares*), 359 skipjack tuna (*Katsuwonus pelamis*), 175 bigeye tuna (*Thunnus obesus*) and 2 dolphinfishes (*Coryphaena hyppurus*), were tagged in the northwestern region of Madagascar, around Comoros Islands and in the northern part of the Mozambique Channel, as reported in Cayré and Ramcharrun, 1990. A tagging operation was also undertaken around Reunion Island, particularly around Fish-Aggregating Devices (FADs), and some 114 fishes (103 yellowfin, 9 skipjack, and 2 dolphinfish) were tagged and released. The fishes are included and counted among the total number of tunas tagged during the Regional Tuna Project (*i.e.* n = 955) mentioned above.

During the *Mascaroi* tagging programme the pole-and-line fishing method was used to catch the fishes. Tuna caught were measured (fork length (FL) in cm) and marked with a vinyl dart tag before release.

Tuna tagging in the Indian Ocean was also undertaken by the IPTP using small-scale fishing vessels in the Maldives, Sri Lanka and India and by the NRIFSF. Some of the tuna marked by these bodies were recaptured by Mauritian purse seiners and the data are analysed along with those tagged under the Regional Tuna Project.

Results

Out of the total of 955 tuna marked during the different cruises of the *Mascaroi*, 15 were recaptured. Thus the recovery rate as observed up to November 1990 is 1.6%. The 15 recaptures included 8 yellowfin, 5 skipjack, 1 bigeye, and 1 dolphinfish .

Twenty-four tunas (13 yellowfin, 5 skipjack and 6 bigeye) tagged by the NRIFSF and fifteen tunas (5 yellowfin and 10 skipjack) tagged by the IPTP were recovered at the Mauritius Tuna Fishing and Canning Enterprises Limited.

Growth Rate

Fish at liberty for less than 30 days (15) and those with negative growth (23 fishes) were not considered for growth rate calculation (Table 1).

Due to the small number of recoveries, no positive conclusions can be drawn; however, certain preliminary and gross estimates of growth rate of the species caught can be made.

The growth rate for yellowfin tuna varied between 0.90 cm/month (10.8 cm/year) to 5.61 cm/month (67.3 cm/year), with a mean growth rate of 2.36 cm/month or 28.3 cm/year (Tables 2 and 3).

For bigeye tuna, the mean growth rate was estimated to be 2.14 cm/month or 25.6 cm per year (Tables 2 and 3). The growth rates of these two species are in agreement with those observed in the Atlantic (Cayré *et al.*, 1988) and in the Indian Ocean (Stequert and Marsac, 1986; Cayré and Ramcharrun, 1990).

The growth rate for skipjack tuna obtained was relatively slow. Among the ten recoveries observed, eight had a growth rate of less than 10 cm/year, with 4 having their growth rate below 1.55 cm/year (Table 2).

From the above it seems that skipjack tuna have a very slow growth rate after 46 cm. More investigations should be carried out to establish this fact, as was stated by Cayré and Ramcharrun (1990).

Migration

The skipjack and yellowfin tuna tagged during October to November near Maldives showed a southwestern movement (Figures 1A, 1B and IC) which seems to follow the ocean current in the region, as suggested by Anderson, 1988. The current is normally to the west and southwest during November to March (northeast monsoon). Those tagged in the northern region of the Seychelles also showed a tendency to move towards the southwest. Unlike the above, tuna tagged around Comoros Islands moved towards the north. The differences observed in the directions of migration should be analysed taking into account the tagging dates and location. More tagging data are needed to undertake a valuable analysis.All these migrations suggest that the tuna exploited in the southwest of the Indian Ocean belong to the same stocks.

Conclusion

Considering the importance of tagging as an excellent tool to study tuna stocks, emphasis should be given to a Regional Tagging Programme in which different bodies can participate and exchange their data.

From the small number of recoveries obtained in Mauritius, no definite conclusions can be drawn. However, certain observations can be made:

- Yellowfin and bigeye tuna seem to have a fast growth rate (28.3 cm/year and 25.6 cm/year, respectively) up to a certain length (Table 3), which is not the case for skipjack. The latter has a slow growth rate (10 cm/year), especially after 46cm.
- From the different positions of tuna tagging and recovery, it seems that the tuna harvested in the southwest Indian Ocean come from the same stock.

CODIFICATION PROCEDURE IN USE IN MAURITIUS

Data collected from tagged fishes recovered in Mauritius and from organisations performing these taggings are coded according to a system which is presented here (see appendix for methods of codification and codification forms).

The codification procedure in use in Mauritius is derived from that used by ICCAT. We would recommend IPTP to use a common, homogeneous system of codification so as to:

1. facilitate the collection of tagging data throughout the Indian Ocean.
2. render the tagging data accessible to the member countries of the IPTP.
3. permit the exchange of tagging data with ICCAT and other international organisations such as the SPC.

Table 1. **Fish recovered and their growth rate by month and by year**

Species	*Tag number*	*Date tagged*	*Length (FL) (cm)*	*Date of recapture*	*Length (LF) (cm)*	*Days at sea*	*Monthly growth rate*	*Annual growth rate*
YFT	594	21.10.88	63	24.10.88	63	3	0.00	0.00
YFT	ZB6489	2.2.90	54	6.2.90	45	4	-67.50	-810.00
YFT	554	21.10.88	55	26.10.88	58	5	18.00	216.00
YFT	562	21.10.88	57	29.10.88	57	8	0.00	0.00
YFT	ZB1426	5.2.91	52	14.2.91	52	9	0.00	0.00
YFT	597	21.10.88	54	31.10.88	54	10	0.00	0.00
YFT	604	21.10.88	51	31.10.88	51	10	0.00	0.00
YFT	ZB2504	31.8.91	44	15.9.91	43	15	-2.00	-24.00
YFT	ZC2990	10.11.91	59	30.11.91	54	20	-7.50	-90.00
YFT	ZC4004	10.11.91	65	3.12.91	36	23	-37.83	-453.91
YFT	ZB4746	30.9.89	47	16.11.89	42	47	-3.19	-38.30
YFT	ZB9141	14.11.90	55	20.1.91	57	67	0.90	10.75
YFT	MA8950	15.11.90	50	8.2.91	50	85	0.00	0.00
YFT	MA8789	14.11.90	44	8.2.91	52	86	2.79	33.49
YFT	ZB1459	5.2.91	57	15.5.91	64	99	2.12	25.45
YFT	ZB6751	15.3.90	58	30.6.90	78	107	5.61	67.29
YFT	ZB6319	24.1.90	58	15.5.90	59	111	0.27	3.24
YFT	ZB6940	22.3.90	48	29.7.90	53	129	1.16	13.95
YFT	ZB9357	15.12.90	56	27.4.91	64	133	1.80	21.65
YFT	MA8659	14.11.90	48	28.4.91	30	165	-3.27	-39.27
YFT	MA9846	14.11.90	47	30.4.91	38	167	-1.62	-19.40
YFT	ZB4335	17.8.89	56	6.2.90	33	173	-3.99	-47.86
YFT	MA6327	14.10.90	48	26.4.91	43	194	-0.77	-9.28
YFT	237	6.10.88	67	15.6.89	83	252	1.90	22.86
YFT	762	22.1.89	73	9.3.90	110	411	2.70	32.41
YFT	329	8.10.88	67	13.6.90	114	613	2.30	27.60
SKJ	ZB7128	20.4.90	51	5.5.90	50	15	-2.00	-24.00
SKJ	ZB4756	30.9.89	55	16.11.89	50	47	-3.19	-38.30
SKJ	ZB4235	4.8.89	55	25.9.89	60	52	2.88	34.62
SKJ	ZB4644	6.9.89	50	10.11.89	43	65	-3.23	-38.77
SKJ	MA9116	8.11.90	64	8.2.91	40	92	-7.83	-93.91
SKJ	MA9336	10.11.90	58	1.3.91	49	111	-2.43	-29.19
SKJ	MA9160	8.11.90	46	1.3.91	56	113	2.65	31.86
SKJ	485	10.10.88	52	5.3.89	56	146	0.82	9.86
SKJ	MA9641	13.11.90	43	26.4.91	33	164	-1.83	-21.95
SKJ	257	8.10.88	52	25.3.89	55	168	0.54	6.43
SKJ	ZB8052	10.9.90	43	1.3.91	45	172	0.35	4.19
SKJ	MA9344	11.10.90	54	30.4.91	37	201	-2.54	-30.45
SKJ	471	10.10.88	53	1.6.89	54	234	0.13	1.54
SKJ	MA5715	14.10.90	57	19.6.91	60	248	0.36	4.35
SKJ	MA7016	16.10.90	52	10.7.91	37	267	-1.69	-20.22
SKJ	MA7714	16.10.90	54	23.7.91	55	280	0.11	1.29
SKJ	842	4.7.89	53	10.4.90	54	280	0.11	1.29
SKJ	MA5493	13.10.90	53	23.7.91	38	283	-1.59	-19.08
SKJ	MA8397	13.11.90	57	10.1.92	35	423	-1.56	-18.72
SKJ	84	25.4.88	49	30.8.89	51	492	0.12	1.46
BET	ZB1458	5.2.91	50	14.2.91	51	9	3.33	40.00
BET	ZB1460	5.2.91	48	14.2.91	49	9	3.33	40.00
BET	ZB1326	5.2.91	55	14.2.91	54	9	-3.33	-40.00
BET	ZB2793	14.9.91	46	10.10.91	42	26	-4.62	-55.38
BET	ZB2428	27.8.91	44	10.10.91	46	44	1.36	16.36
BET	ZC4093	5.12.91	51	31.1.92	35	57	-8.42	-101.05
BET	913	22.1.89	73	22.1.90	99	365	2.14	25.64
COR	608	21.10.88	83	24.10.88	0	3	-830.00	-9960.00

Table 2. **Recaptures considered for analysis.**

Species	*Tag number*	*Date tagged*	*Length (FL) (cm)*	*Date of recapture*	*Length (FL) (cm)*	*Days at sea*	*Monthly growth rate*	*Annual growth rate*
YFT	ZB9141	14.11.90	55	20.1.91	57	67	0.90	10.75
YFT	MA8789	14.11.90	44	8.2.91	52	86	2.79	33.49
YFT	ZB1459	5.2.91	57	15.5.91	64	99	2.12	25.45
YFT	ZB6751	15.3.90	58	30.6.90	78	107	5.61	67.29
YFT	ZB6940	22.3.90	48	29.7.90	53	129	1.16	13.95
YFT	ZB9357	15.12.90	56	27.4.91	64	133	1.80	21.65
YFT	237	6.10.88	67	15.6.89	83	252	1.90	22.86
YFT	762	22.1.89	73	9.3.90	110	411	2.70	32.41
YFT	329	8.10.88	67	13.6.90	114	613	2.30	27.60
SKJ	ZB4235	4.8.89	55	25.9.89	60	52	2.88	34.62
SKJ	MA9160	8.11.90	46	1.3.91	56	113	2.65	31.86
SKJ	485	10.10.88	52	5.3.89	56	146	0.82	9.86
SKJ	257	8.10.88	52	25.3.89	55	168	0.54	6.43
SKJ	ZB8052	10.9.90	43	1.3.91	45	172	0.35	4.19
SKJ	471	10.10.88	53	1.6.89	54	234	0.13	1.54
SKJ	MA5715	14.10.90	57	19.6.91	60	248	0.36	4.35
SKJ	MA7714	16.10.90	54	23.7.91	55	280	0.11	1.29
SKJ	842	4.7.89	53	10.4.90	54	280	0.11	1.29
SKJ	84	25.4.88	49	30.8.89	51	492	0.12	1.46
BET	913	22.1.89	73	22.1.90	99	365	2.14	25.64

Table 3. Monthly and annual growth rates by species and the corresponding number of observations.

Species	Number of observations	Growth rate per month (cm)	Growth rate per year (cm)
YFT	9	2.36	28.3
SKJ	10	0.8	9.6
BET	1	2.14	25.6

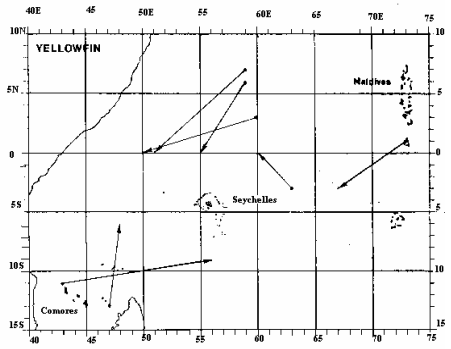
REFERENCES

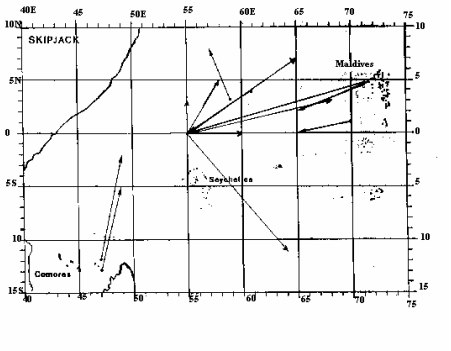
CAYRÉ, P. AND B. RAMCHARRUN. Results of the tagging conducted within the Regional Tuna Project (Indian Ocean Commission) in 1988 and 1989. Presented at the Expert Consultation on Stock Assessment of Tunas in the Indian Ocean, Bangkok (2-6 July 1990).

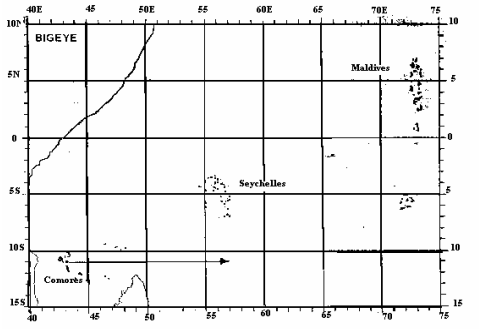
CAYRÉ , P.(1990). Behaviour of yellowfin (*Thunnus albacares*) and Skipjack tuna (*Katsuwonus pelamis*) around FADs, as determined by sonic tagging. Presented at the Indo Pacific Fishery Commission Symposium, Colombo, Sri Lanka (14-17 May 1990).

STEQUERT, B. AND F. MARSAC. La pêche de surface des thonidés tropicaux de l'Océan Indien. FAO Doc. Tech. Pêches (282): 213p.

Figure 1*. Apparent migration of tuna. Yellowfin (1a), Skipjack (1b), and Bigeye (1c).*







Appendix. Codes in use

A - TAGGING

1, 2) Cruise N° (col. 1-4):

In the first 2 columns, insert flag n° of the country which carried out the tagging operation. Code ICCAT for instance.

3) Type of Gear (col. 5)

Pole and line	1
Purse seine	2
Line	3
Sport fishery	4
Long line	5
Madrague	6
Others	8
Unknown	blank or zero

4) Type of Tag (col. 6)

Yellow dart	2
Sonic tag	3
Two darts	4
T. shaped tag	5
WMOI type	6
Red dart (tetracycline)	8
Unknown	blank or zero

5) Species (col. 7, 8) -

Yellowfin (YF)	1
Skipjack (SJ)	2
Bigeye (BE)	3
Albacore (GE)	4
Thonine (*E. alleteratus*)	5
Frigate tuna (*Auxis thazard*)	6
Sailfish	7
Sarda	8
Others	9
Dolphinfish	10

6) Tag N° (col. 9-14)

The tag number consists of 6 columns. The first two columns are used to enter prefix in 2 letters or 1 letter and one lef blank (col. 9-10). The following 4 columns are used to enter 4-digit number.

7) Date (col. 15-20) - in the following order: year/month/day.

8) Position (col. 21-29)

Based on the CWP code, the position is coded in the following order:

Quadrant (col. 21), latitude and longitude (in degrees and minutes) in columns 22-29. The quadrant is delimited by the intersection of the Equator and the Greenwich Meridian. For the Indian Ocean the codes are:

1 - if north of the Equator

2 - if south of the Equator

In case a position is known to the nearest degree, code minutes as 00.

If a position happens to be exactly on the meridian or parallel, enter 01.

9) Length (col. 30-32) - Fork length in centimetres. If unknown, leave blank.

10) Operation N° (col. 33-34) - Whole numbers in ascending order (beginning with 1) for each cruise. The maximum n° of operation is 99. Each operation corresponds to a tagged shoal.

11) Fish Condition (col. 35)	**Code**
Fish in good condition	blank or zero
Fish less active	1
Fish bleeding	2
Survival doubtful	3

B - TAG RECOVERY

12) Recaptured Species (col. 36-37) : Refer to see Section 5

13) Date (col. 38-43) : Year, month, day as in Section 7.

14) Position (col. 44-53)

In column 44, the size of the square where recapture takes place must be coded.

Code	Square size
1	1° x 1°
5	5° x 5°
9	10° x 10°

In columns 45 - 53 enter CWP code as in section 8.

15) Length (col. 54-57) - Fork length in millimetres

16) Weight (col. 58-61) - Whole weight of the fish in hectograms (1 hg = 100 gms)

17) Age (col. 62-63) - If the age of the fish recaptured is known, convertit to months

18) Sex (col. 64)

Male	1
Female	2
Cannot be determined	3
Not examined	0 or blank

19) Vessel (col. 65-71)

Each fishing vessel is identified by the following codes:

Nationality	Col. 65,66
Type	Col. 67
Category	Col. 68
Order Number	Col. 69-71

These codes are kept in a special file.

20) Set (col. 72-74)

If the set (purse seiner) or the shoal (baitboat) from which the tagged fish has been taken is known, code the following information:

Total catch in tons	-	Col. 72, 74
Composition = main species identified by the captain as per section (5)	-	Col. 75,76

21) Recovery Place

Port where the vessel landed the recovery tag. Example:

Reunion Island	= 44
Mauritius	= 43
Seychelles	= 42
Madagascar	= 45

22) Recording

This code allows one to assess the reliability of the fish measurement. It is based on the recovery place.

- aboard the vessel, fish observed by a technician during capture:	1
- aboard the vessel, fish not observed by a technician during capture:	2
- During landing of the vessel, fish observed by a technician:	3
- During landing of the vessel, fish not observed by a technician:	4
- During transshipment, fish observed by a technician:	5
- During transshipment, fish not observed by a technician:	6
- In a cannery, fish observed by a technician:	7
- In a cannery, fish not observed by a technician:	8
- Other unknown case:	blank

Code du Bordereau B/C 1981

Tagging

Zone	*Object*	*Column*	*Code*
1)	Cruise Number	1, 2	Code ICCAT (Annex)
2)		3, 4	Decimal
3	Gear	5	Code ORSTOM (Annex)
4	Type of tag	6	Code ORSTOM (Annex)
5	Species	7, 8	Code ORSTOM (Annex)
6	Tag No	9, 14	The tag reference
7	Date	15-20	Year, month, day
8	Position	21-29	Code CWP
9	Size	30-32	Fork length in cm
10	Operation No	33-34	Decimal
11	Fish condition	35	Leave blank in neither 1, 2 or 3 depending on the wound: 1 = ?? 2 = Bleeding 3 = Survival doubtful

Example of COUNTRY CODE:

IPTP Tagging Programme	= 99
JAPAN	= 12
MAURITIUS	= 22

Example of PORT CODE:

REUNION ISLAND	= 44
MAURITIUS	= 43
SEYCHELLES	= 42
DIEGO	= 45

Code du Bordereau B/C 1981

TAG RECOVERY

Zone	*Object*	*Column*	*Code*
12	Recaptured Species	36, 37	Code ICCAT (See 5)
13	Date	38-43	Year, month, day
14	Position	44-53	CWP Code Square Code 1 = 1° x 1° 5 = 5° X 5° 9 = 10° x 10°
15	Size	54-57	Fork length in mm
16	Weight	58-61	In hectogram
17	Age	62-63	In month
18	Sex	64	1: male; 2: female: 3: immature blank if not examined
19	Vessel used for recovery	65-71	Code ORSTOM, Boat file If not on file code at least the country and category
20	Set	72-77	Weight of the set
21	Port of recovery	78-79	Port where the vessel landed the recovered tag
22	Enregistrement	80	Code PIANET from 1 to blank in annex

CODIFICATION FORM

TAGGING																TAG RECOVERY																					
					DATE			POSITION									DATE			POSITION										VESSEL			SET				
									LAT		LON											LAT		LON													
CRUISE NO	GEAR	TYPE OF TAG	SPECIES	TAG NUMBER	YEAR	MONTH	DAY	QUADRANT	DEGREES	MINUTES	DEGREES	MINUTES	LENGTH (cm)	OPERATION NO	FISH CONDITION	SPECIES	YEAR	MONTH	DAY	SQUARE CODE	QUADRANT	DEGREES	MINUTES	DEGREES	MINUTES	LENGTH (cm)	WEIGTH (Hg)	AGE (Months)	SEX	COUNTRY	CATEGORY	NUMBER	WEIGHT	COMPOSITION	NUMBER	RECOVERY PLAC	RECORDING