Exploratory Analysis of Maldives Tagging Data Released during RTTP, 2004-2009

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Background

- First to have undertaken a tuna tagging experiment in the IO that made a substantial releases of tropical tunas
  - Supported by IPTP (1990/1991)
  - Proved to be an effective platform for releasing high quality tagged fish
  - Tagging on normal fishing vessels on regular fishing trips
  - Paid pre-agreed cash amount for the releases
  - On the spot cash rewards for recoveries; arranged in Malé and in main tuna purchase facilities
  - Sustained publicity and awareness; T-shirts, posters, tv/radio spots, press releases

- A second tagging experiment was undertaken in 1993-1995 under WB TA funding.
  - Similar approach was followed at release and recovery
  - At recovery instant cash prices was awarded and sustained publicity using print and broadcast (voice/tv) media

Main Results / Findings 1990s

With known Species at Release and Recoveries

	Rleased	Recovered	%
1990			
Skipjack	8033	1210	15.1%
Yellowfin	1908	105	5.5%
Bigye	0	0	0.0%
1993-1995			
Skipjack	6474	553	8.5%
Yellowfin	1303	23	1.8%
Bigeye	0	0	0.0%

Results appeared in:

1. Yesaki, M and A. Waheed (1992): General
2. Bertignac, M., P. Klieber, and A. Waheed (1994): Movement/Assessment
3. Anderson, R. C, M. S. Adam and A. Waheed (1996): General
4. Adam, M.S., B. Stequert and R.C. Anderson (1996): OTC - Growth
5. Adam, M. S. (1999): - General + Growth
6. Adam, M.S and G.P. Kirkwood (2001): Tag Shedding
7. Adam, M.S and J. R. Sibert (2002): Advection Diffusion Model

Main Results / Findings 1990s

- Experiments in 1990/1991 and 1993-1995 lacked any release from other fisheries
  - Fishery interaction was observed one way (Maldives – to the rest of IO fisheries)
  - Required to demonstrate interaction two way

- Major findings:
  - 'Mobile' offshore and 'resident' inshore SKJ
  - Tendency for SKJ to show 'directed movements' with the monsoon currents; westwards during NE Monsoon (Nov–March) and eastwards during SW Monsoon (April – Sept)

RTTP – IO Small Scale Tagging Experiments

- Funding was made available through IOTC to undertake two small-scale tagging experiments
  - 2004 -2005
  - 2007 -2009
- Similar approaches in tagging and recovery were followed
  - Boats were hired during the latter part of the programme

Objectives

- To release representative samples of SKJ, YFT and BET
  - BET was important; No records of BET release in earlier experiments
- To release tags from representative ‘seasons and regions’ of the Maldivian pole-and-line fisheries
  - Large number of releases were actually made around anchored FADs

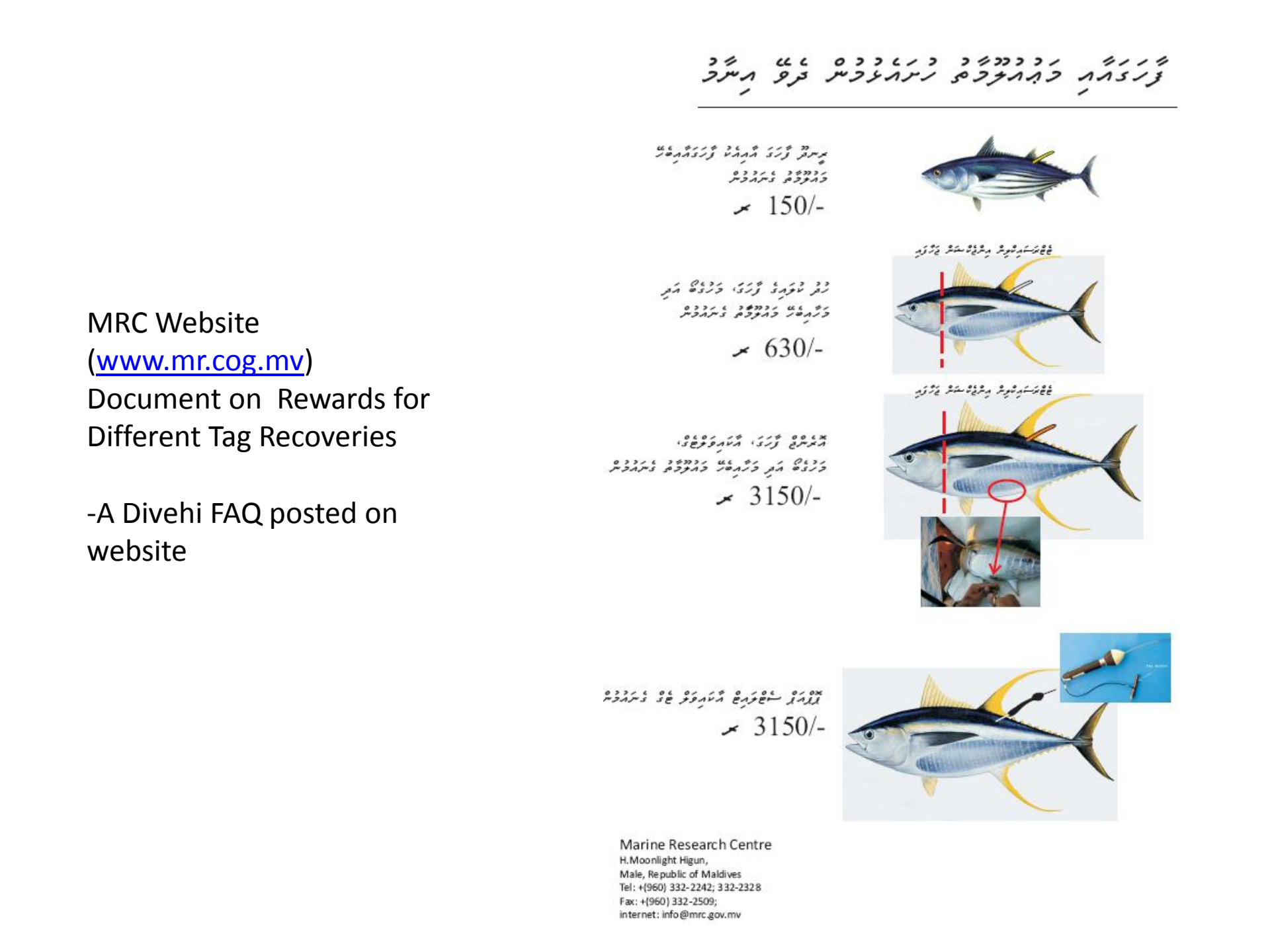
Methodology

- Most of the tagging took place on normal P&L fishing trips. Nearly all fish were caught from livebait P&L
- All tagging took place on cushioned measuring boards
  - Lengths measured of live tuna on (flat) measuring boards were about 1-1.5 cm shorter (have implication for growth studies; later corrected)
- Teams of three; holder, tagger, recorder (during 2008-2009 the recorder and tagger was the same)
- Standard SS applicators pre-loaded with tags kept in pocketed aprons arranged in sets of 50 tags
- Single + Double tagging, Archival tagging took place

Tagging Posters

MRC Website
(www.mr.cog.mv)
Document on Rewards for Different Tag Recoveries

-A Divehi FAQ posted on website



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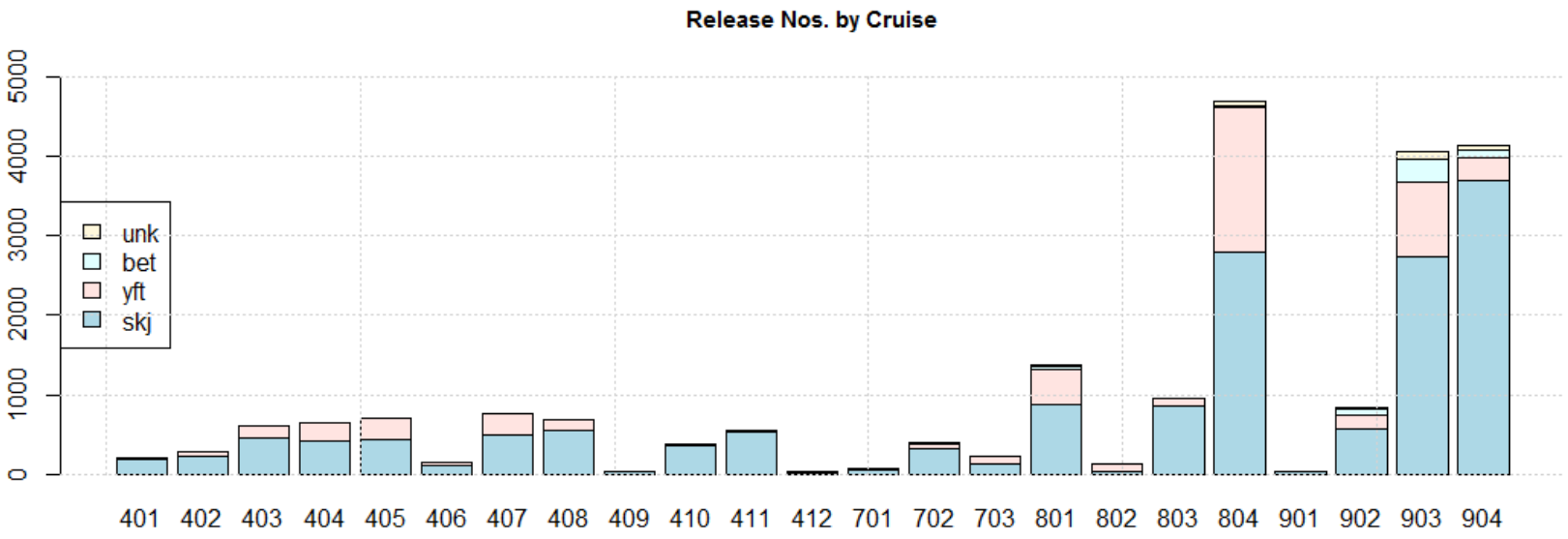
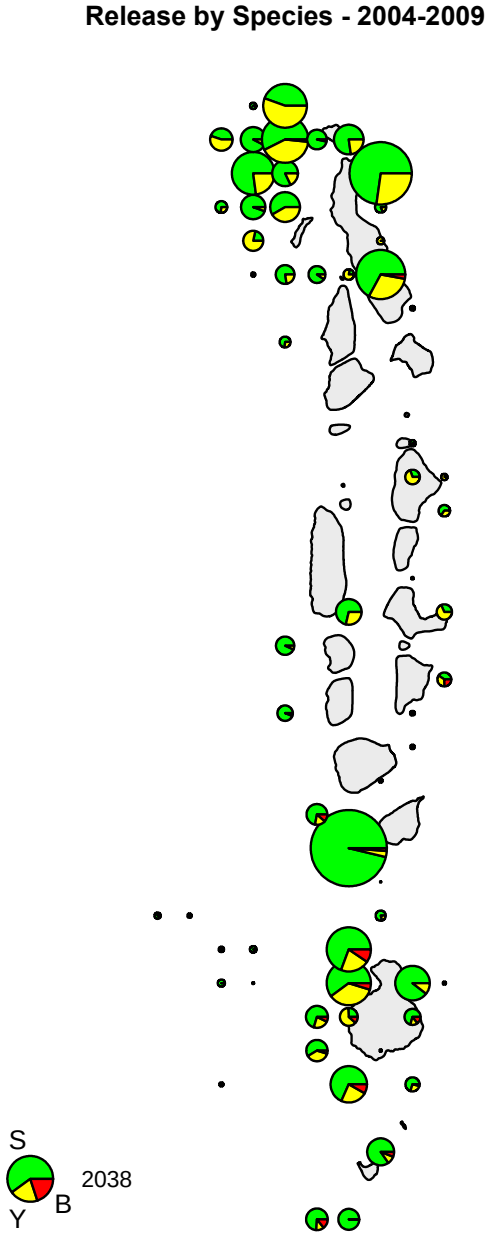
Tag Release by Tagging Cruise

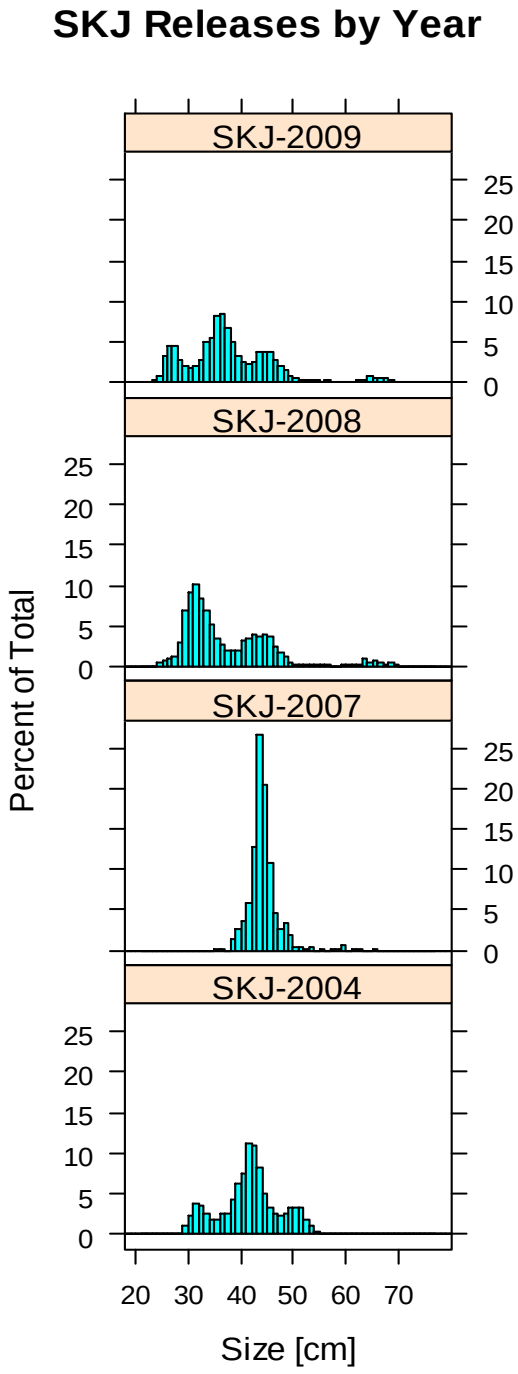


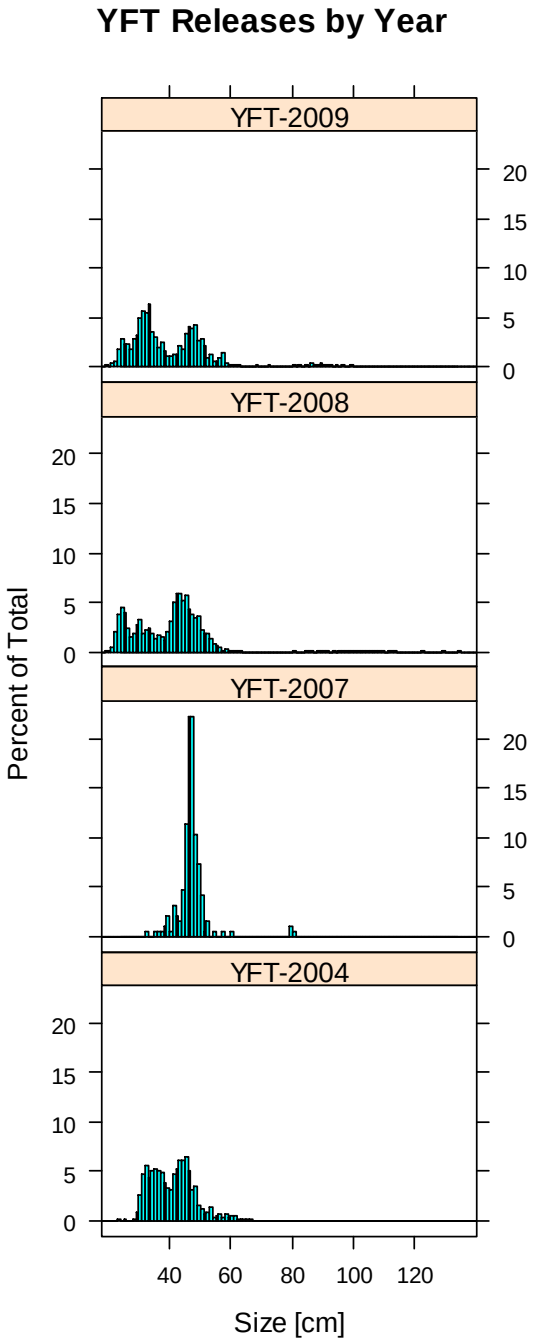
Release by Season: SW / NW

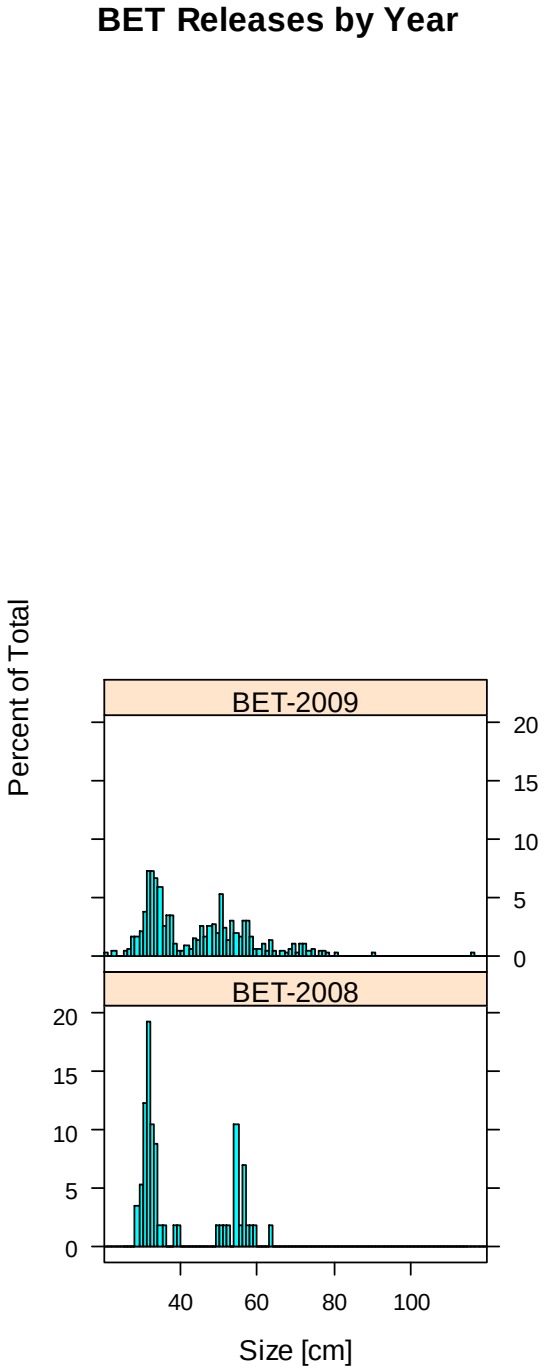
				RELEASES					
Cruise	Time period	Main Rel Area	Monsoon Season	S	Y	B	U	Total	%
401	May-04	SW of Ari Atoll	Interchange	183	13		3	199	0.9%
402	Aug-04	NW of Ha Atoll	South West	215	72		1	288	1.3%
403	Aug-04	NW of Ha Atoll	South West	447	165		3	615	2.8%
404	Aug-04	NW of Ha Atoll	South West	406	236		1	643	2.9%
405	Aug-04	NW and Wof HDh Atoll	South West	439	259		2	700	3.2%
406	Aug-04	NW of Ha Atoll	South West	107	34			141	0.6%
407	Aug-04	NW of HDh Atoll	South West	483	268		3	754	3.4%
408	Aug-04	NW of HDh Atoll [?]	South West	548	144			692	3.2%
409	Aug-04	NW of Ha Atoll	South West	28	5			33	0.2%
410	Aug-04	NW of Ha. Atoll	South West	358	16			374	1.7%
411	Aug-04	NW of Ha Atoll	South West	526	25		2	553	2.5%
412	Aug-04	E of North Malé Atoll	South West	4	20			24	0.1%
701	Aug-07	E of North Malé Atoll	South West	41	21			62	0.3%
702	Oct-07	W of Sh. Atoll	South West	321	63		2	386	1.8%
703	Oct-07	West of Huvadhoo Atoll	South West	120	109		1	230	1.0%
801	Jan-08	East of Sh. Atoll	North East	876	434	40	28	1378	6.3%
802	Feb-08	E of North Malé Atoll	North East	38	87		1	126	0.6%
803	Mar-08	Huvadhoo Channel; E+W of Huvadhoo Atoll	North East	858	95		1	954	4.4%
804	Dec-08	E & W Thiladhunmathi Atoll (spread out)	North East	2,791	1,828	19	57	4695	21.4%
901	Jan-09	East of North Malé Atoll	North East	23	14	2		39	0.2%
902	Feb-09	East and South of Gaafu Alifu Atoll	North East	559	185	83	9	836	3.8%
903	Mar-09	W & S Huvadhoo Atolll + SW of Addu	North East	2,739	935	287	103	4064	18.5%
904	Apr-09	East and West of South Double Chain	North East	3,695	282	103	52	4132	18.9%
		Total		15,805	5,310	534	269	21,918	100.0%
		Precent Releases		72.1%	24.2%	2.4%	1.2%	100.0%	

RELEASES:
Most of the releases on 2004 occurred in the north
Releases in 2008-2009 occurred in the south




SKJ Releases by Year
SKJ-2009
SKJ-2008
SKJ-2007
SKJ-2004
Percent of Total
Size [cm]


YFT Releases by Year
YFT-2009
YFT-2008
YFT-2007
YFT-2004
Percent of Total
Size [cm]


BET Releases by Year
BET-2009
BET-2008
Percent of Total
Size [cm]

Double Tagging / Tag Shedding

SP	REL	REC	%
SKJ	518	75	14.4
YFT	308	62	20.1
BET	61	7	11.4

Max. Likelihood Estimation Method:

Tag Shedding Estimates
Type I: 0.3 – 0.5

Type II:
0.0000952402 –
0.0000129896 per year

#SKIPJACK (2 with negative liberty removed)
#nobs
28

#liberty	t1	t2
1	4	0
2	2	0
3	2	0
4	8	0
5	1	2
6	7	2
7	1	6
8	0	1
9	0	3
10	1	0
11	0	1
12	3	0
14	1	0
17	2	0
18	1	2
22	1	0
26	1	0
31	4	0
32	0	1
33	2	0
34	0	1
37	0	1
38	1	0
40	0	1
52	0	1
54	0	1
58	1	0
168	0	1

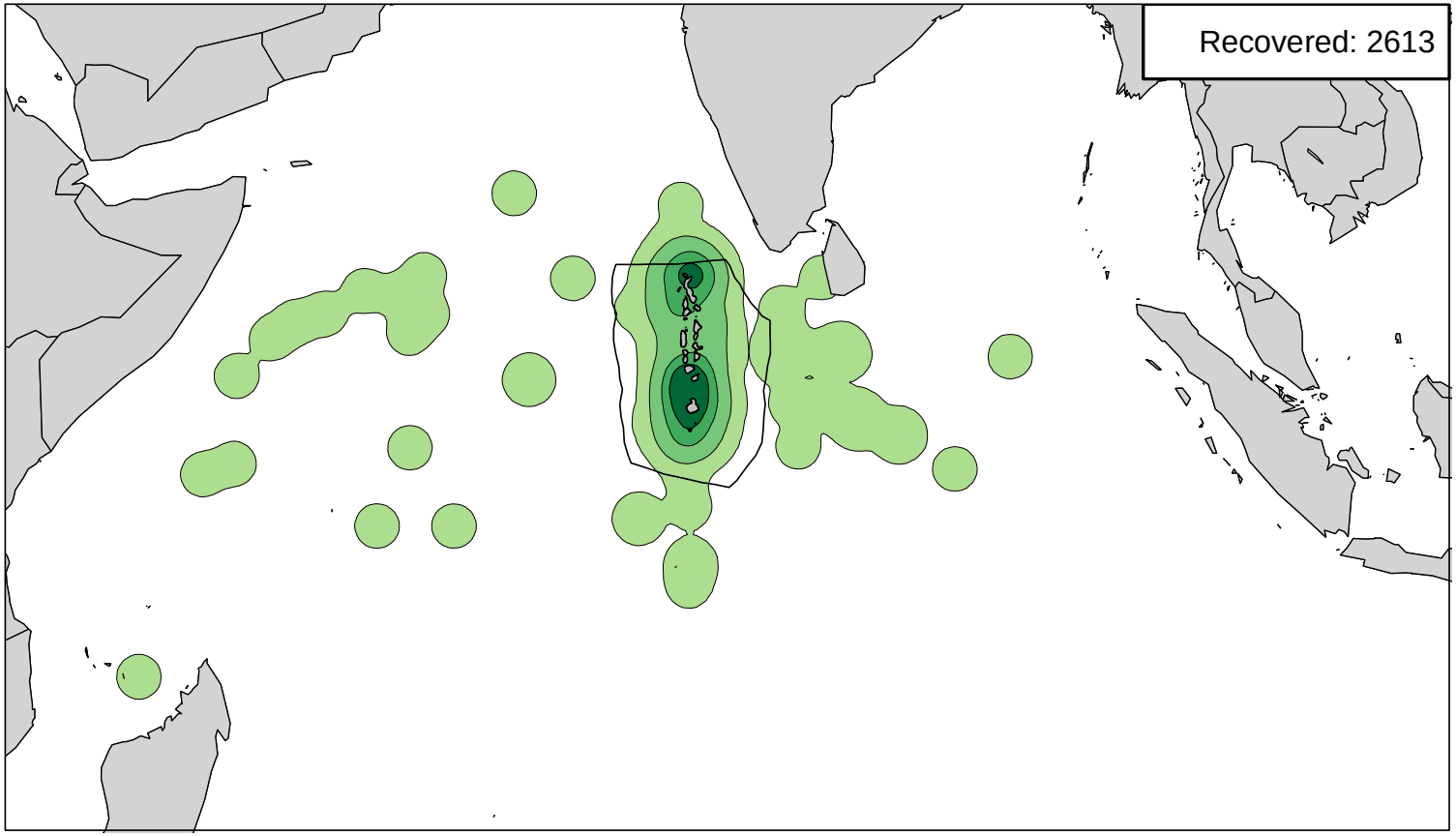
#ALL SPECIES, 4 with negative day liberty removed
nos obseveraion
47

#Liberty	T1	T2
1	4	0
2	2	1
3	2	1
4	8	1
5	1	7
6	7	6
7	1	8
8	0	2
9	1	4
10	1	2
11	0	2
12	5	3
13	1	1
14	1	0
16	4	0
17	2	1
18	1	4
19	0	2
20	0	3
21	0	1
22	1	0
24	0	1
26	1	0
30	0	2
31	4	0
32	0	1
33	2	0
34	0	1
37	2	1

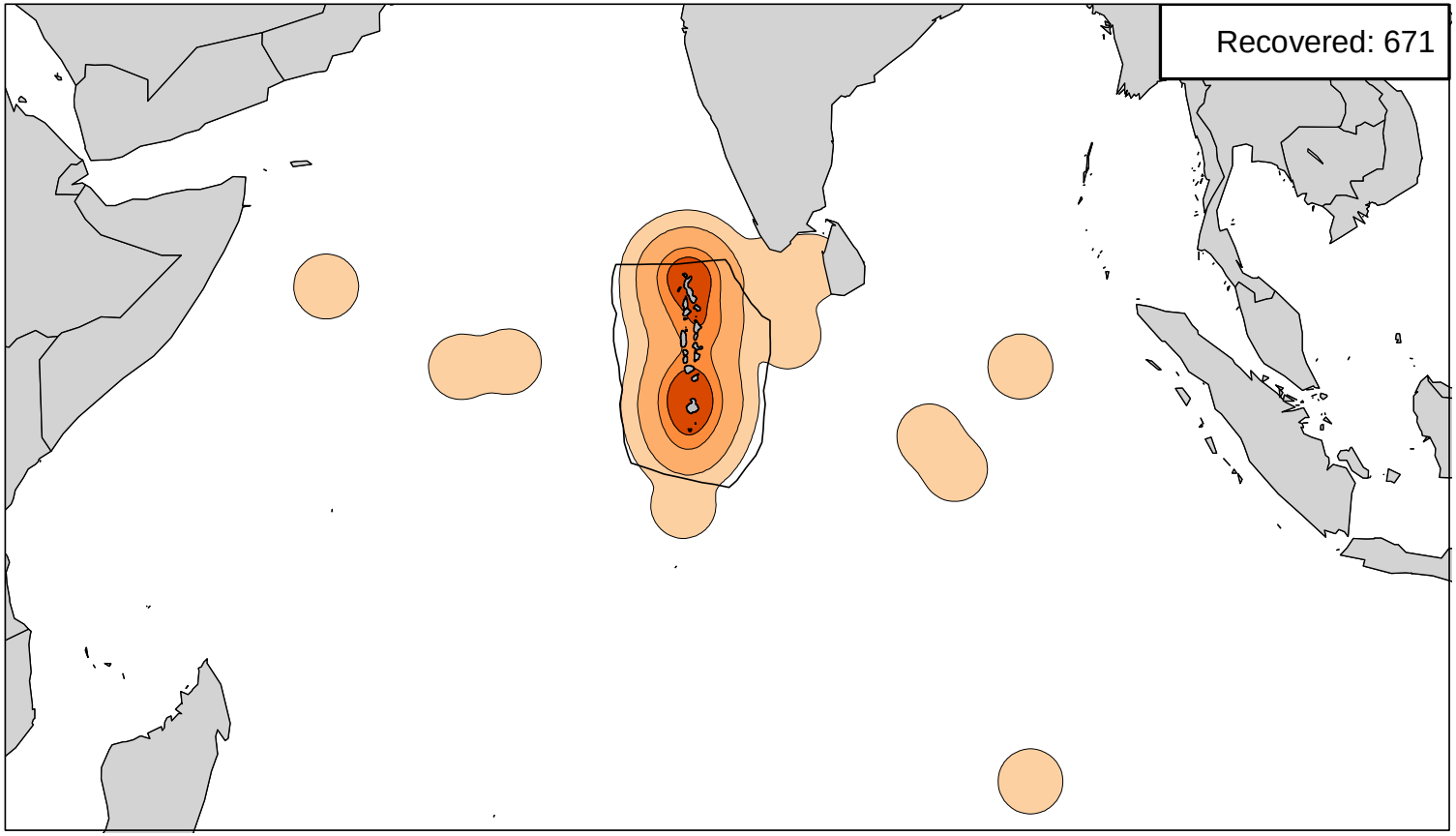
Recoveries

				RECOVERIES					
Cruise	Time period	Main Rel Area	Monsoon Season	S	Y	B	U	Total	% Rec
401	May-04	SW of Ari Atoll	Interchange	9	-	-	-	9	4.5%
402	Aug-04	NW of Ha Atoll	South West	9	7	-	-	16	5.6%
403	Aug-04	NW of Ha Atoll	South West	24	8	-	-	32	5.2%
404	Aug-04	NW of Ha Atoll	South West	20	12	-	1	33	5.1%
405	Aug-04	NW and Wof HDh Atoll	South West	19	5	-	-	24	3.4%
406	Aug-04	NW of Ha Atoll	South West	20	4	-	-	24	17.0%
407	Aug-04	NW of HDh Atoll	South West	58	23	-	1	82	10.9%
408	Aug-04	NW of HDh Atoll [?]	South West	64	10	-	-	74	10.7%
409	Aug-04	NW of Ha Atoll	South West	4	-	-	-	4	12.1%
410	Aug-04	NW of Ha. Atoll	South West	37	3	-	-	40	10.7%
411	Aug-04	NW of Ha Atoll	South West	54	-	-	1	55	9.9%
412	Aug-04	E of North Malé Atoll	South West	2	3	-	-	5	20.8%
701	Aug-07	E of North Malé Atoll	South West	3	1	-	-	4	6.5%
702	Oct-07	W of Sh. Atoll	South West	26	5	-	-	31	8.0%
703	Oct-07	West of Huvadhoo Atoll	South West	28	18	-	-	46	20.0%
801	Jan-08	East of Sh. Atoll	North East	52	52	-	-	104	7.5%
802	Feb-08	E of North Malé Atoll	North East	22	58	-	-	80	63.5%
803	Mar-08	Huvadhoo Channel; E+W of Huvadhoo Atoll	North East	101	6	-	-	107	11.2%
804	Dec-08	E & W Thiladhunmathi Atoll (spread out)	North East	504	181	-	-	685	14.6%
901	Jan-09	East of North Malé Atoll	North East	1	3	1	-	5	12.8%
902	Feb-09	East and South of Gaafu Alifu Atoll	North East	84	31	10	-	125	15.0%
903	Mar-09	W & S Huvadhoo Atolll + SW of Addu	North East	813	233	78	1	1,125	27.7%
904	Apr-09	East and West of South Double Chain	North East	783	67	12	-	862	20.9%
		Totals		2,737	730	101	4	3,572	16.3%
		Percent Recoveries		17.3%	13.7%	18.9%		16.3%	

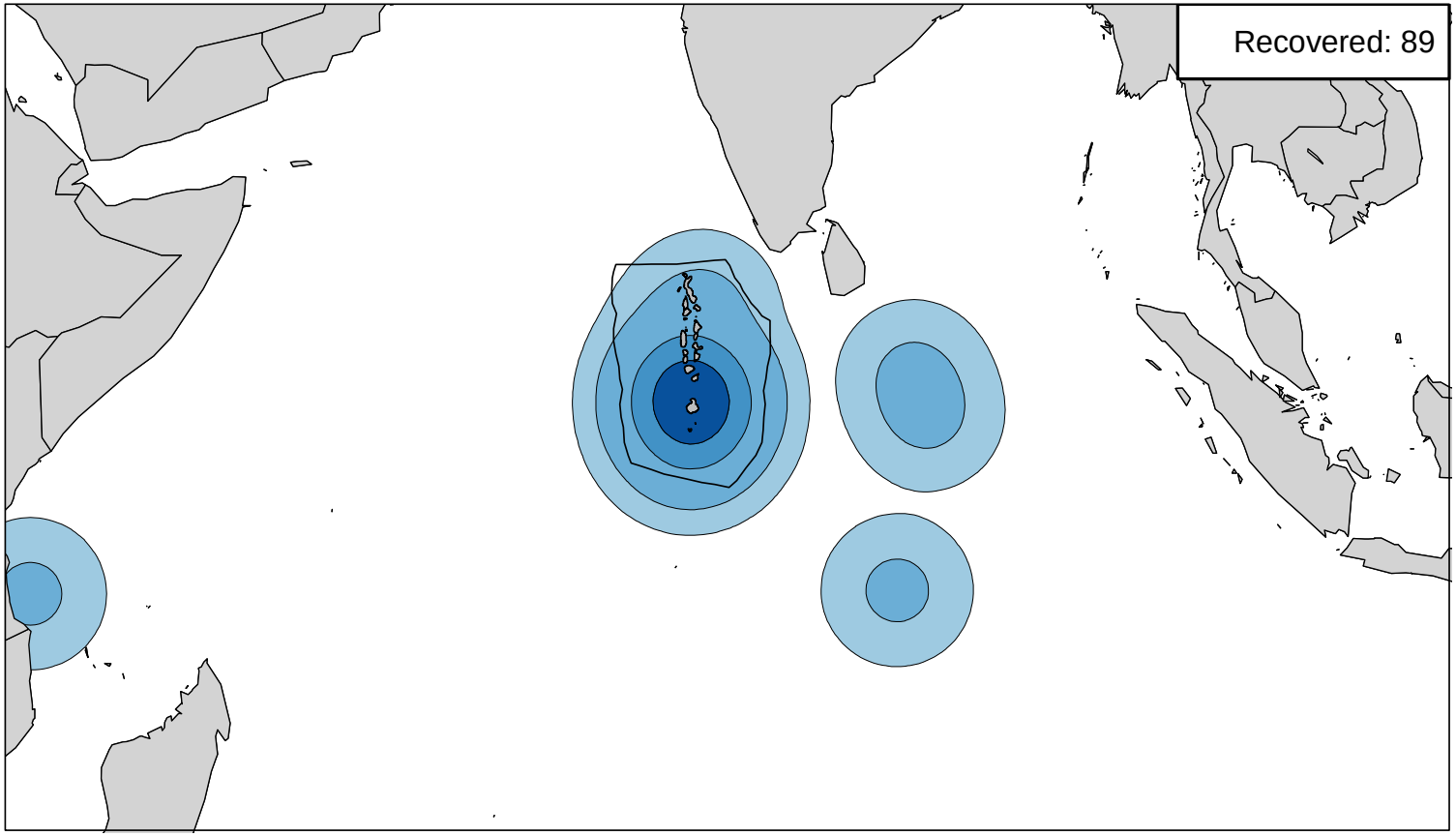
RTTP-IO-MDV Skipjack



RTTP-IO-MDV Yellowfin



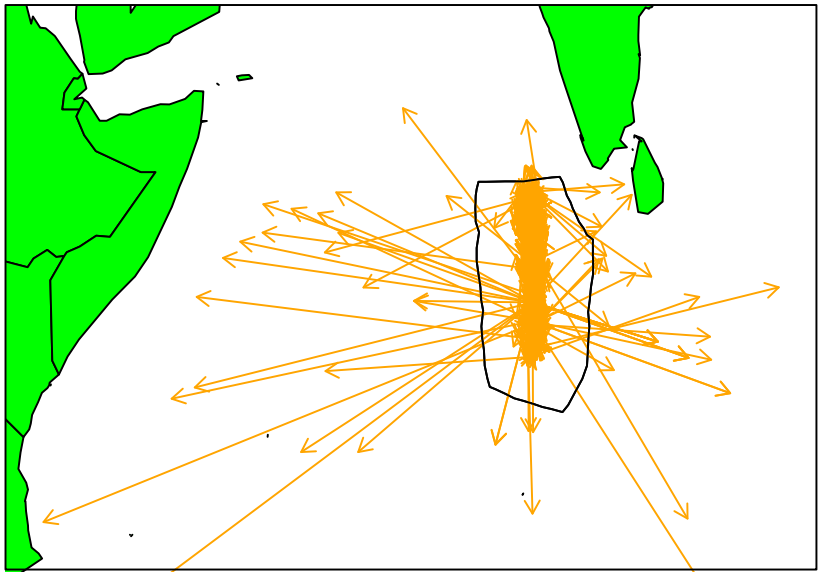
RTTP-IO-MDV Bigeye



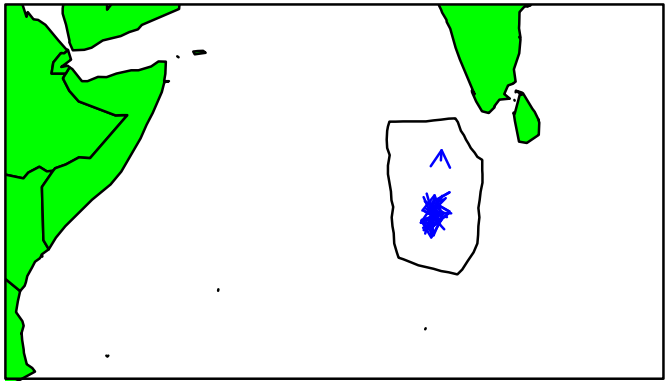
Long Distance Recovery

Displacements (all species) < 30 days liberty

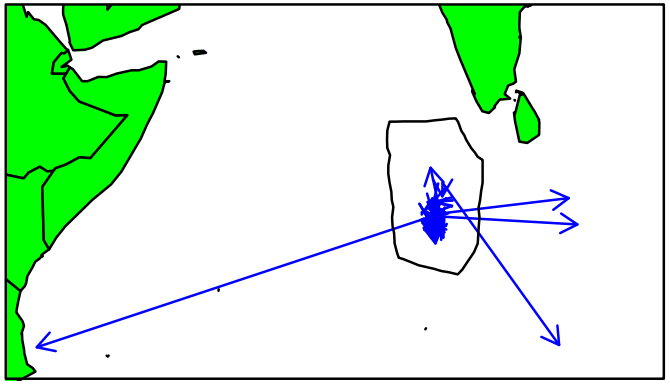
Displacements (all species) > 30 days liberty



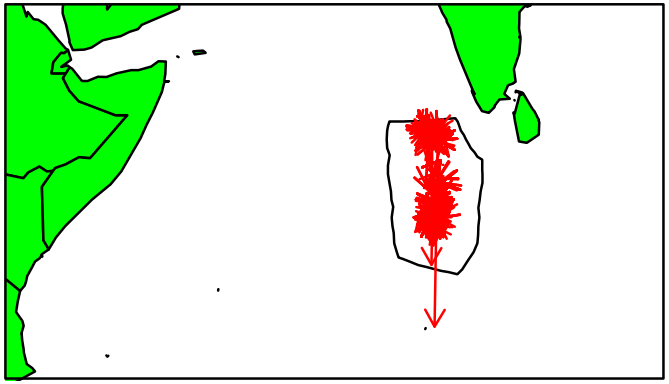
Displacements (BET) < 30 days liberty



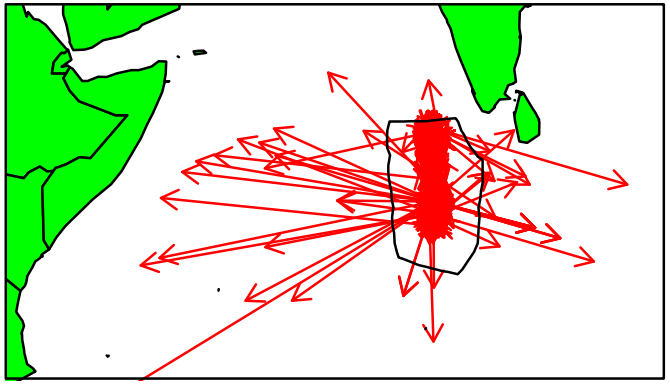
Displacements (BET) > 30 days liberty



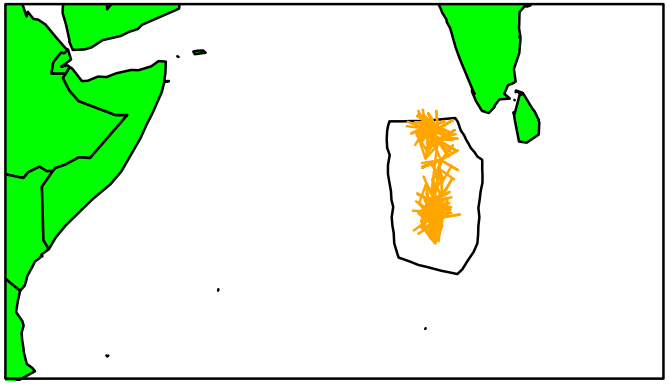
Displacements (SKJ) < 30 days liberty



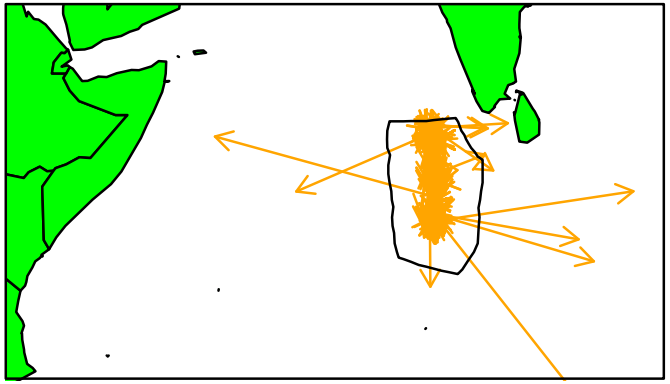
Displacements (SKJ) > 30 days liberty

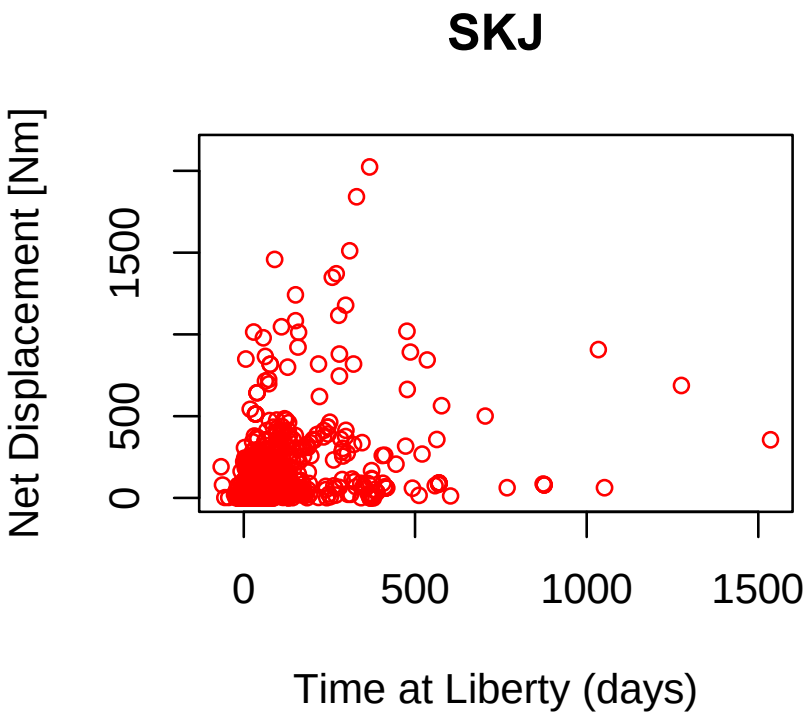


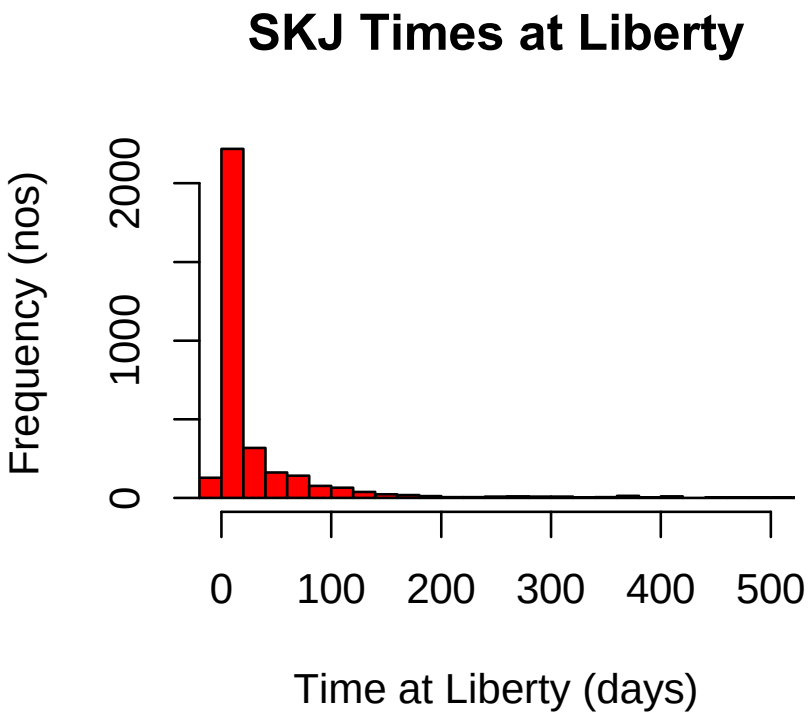
Displacements (YFT) < 30 days liberty



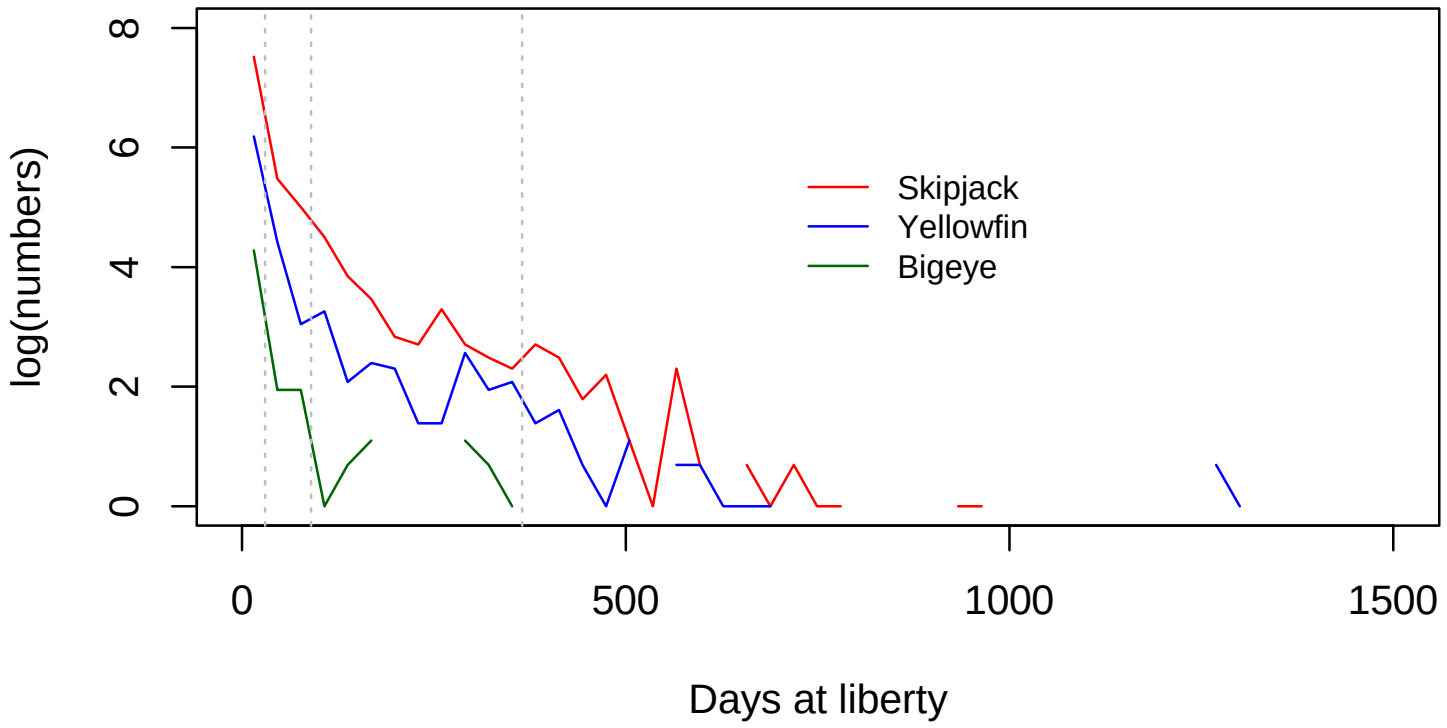
Displacements (YFT) > 30 days liberty



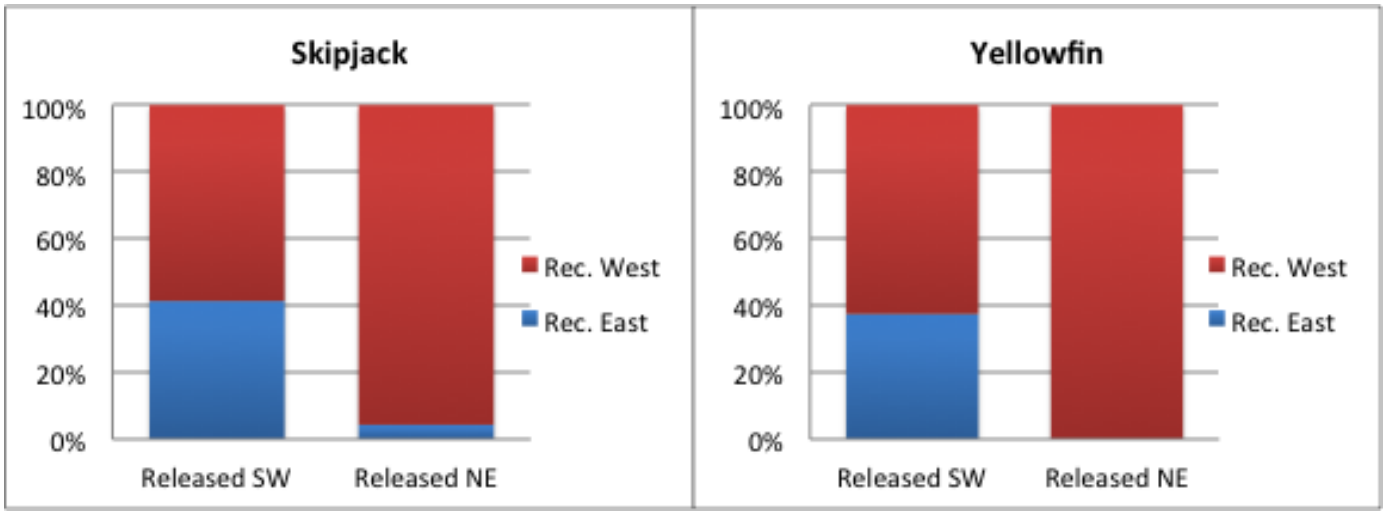

SKJ
Net Displacement [Nm]
0
500
1500
0
500
1000
1500
Time at Liberty (days)


SKJ Times at Liberty
Frequency (nos)
0
1000
2000
0
100
200
300
400
500
Time at Liberty (days)

Tag Attrition Rates



Overseas Recoveries of SW and NE Releases in the Maldives



There is strong signal of movement to Western side from releases in the NE Season (Nov – March), when the surface currents are towards west

Reporting Rates

- Tag seeding – was considered futile in the Maldives
  - Fish were handled individually and difficult to seed without knowledge of fishermen.
- Large number of frequent landings sited with small quantities of landings
  - Logistically impossible to ensure forms, measuring equipment are available at these sites
- Smaller number of frequent (daily) landings sites with large volumes
  - Landing takes place at night, difficult to keep track fish with tag
  - Tags have landed in Thai Canneries
- Often times it is believed that tags would have been just plucked from fish and reported later (with imaginary information!!#$)
- Fishermen disillusioned by the rapid (political) change and fragmentation of old system – distrust to the government

Recovery Information Dubious!

SKJ Recoveries on TAG_Sp ID		YFT Recoveries on TAG_Sp ID		BET Recoveries on TAG_Sp ID	
Total Recovered	2737	Total Recovered	730	Total Recovered	101
Recovered as YFT	111	Recovered as SKJ	255	Recovered as SKJ	31
Recovered as BET	8	Recovered as BET	29	Recovered as YFT	52
Without recapture date	171	Without recapture date	69	Without recapture date	12
Wrong recapture date	115	Wrong recapture date	8	Wrong recapture date	0
No recapture length	37	No recapture length	11	No recapture length	2

Composition and Size Distribution of tuna catch around aFADs

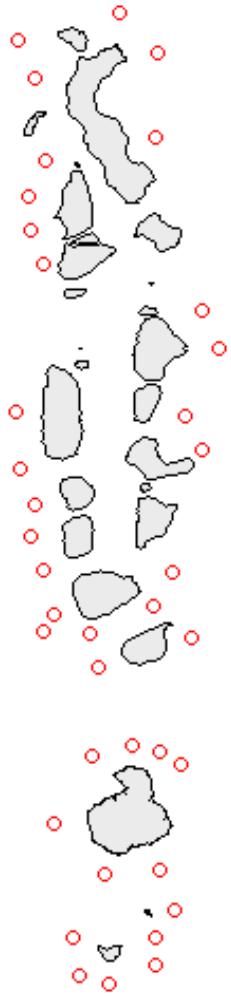
- FADs (drifting or anchored) attract and entrain tuna around them
  - Fishermen exploit this phenomenon both in PS and PL
  - EU-PS Fleet has separate statistics for PSLS and PSFS
    - Different Composition of tuna and their size distribution
- Maldives does not have this data separately
  - RTTP-IO Release in Maldives provide a unique opportunity to obtain this information for the release sets
    - Assumes that fishing events that tagging took place were iid as those of normal fishing events and the choice of fish for tagging were random.

Composition and Sizes of Tuna around anchored FADS

- Asserts that catches around aFADs have different composition and size distribution

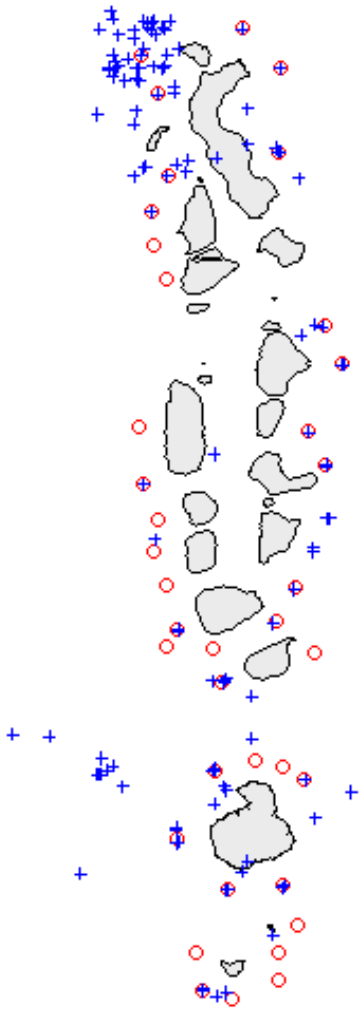
- Require a define what constitute catch around FAD;
  - ISSF Definition: catches from dFADs during day light hours and within 1 nautical mile distance
  - But Modeling by Klieber et al. (1987); effect of FAD may be noticeable up to 12 nautical miles!

FADs & Release Schools



Programme: 2004-2009, Wed Sep 05 22:50:57 2012

There is quite large number of tags that were released around aFADs



Species / Size Composition around FADs

Within 10 miles of AFADs

sp	n	%	M_Size	SD
B	460	2.9%	44.32	12.29
S	12056	75.4%	38.49	8.04
Y	3268	20.4%	40.46	11.27

> 10 miles of AFADs

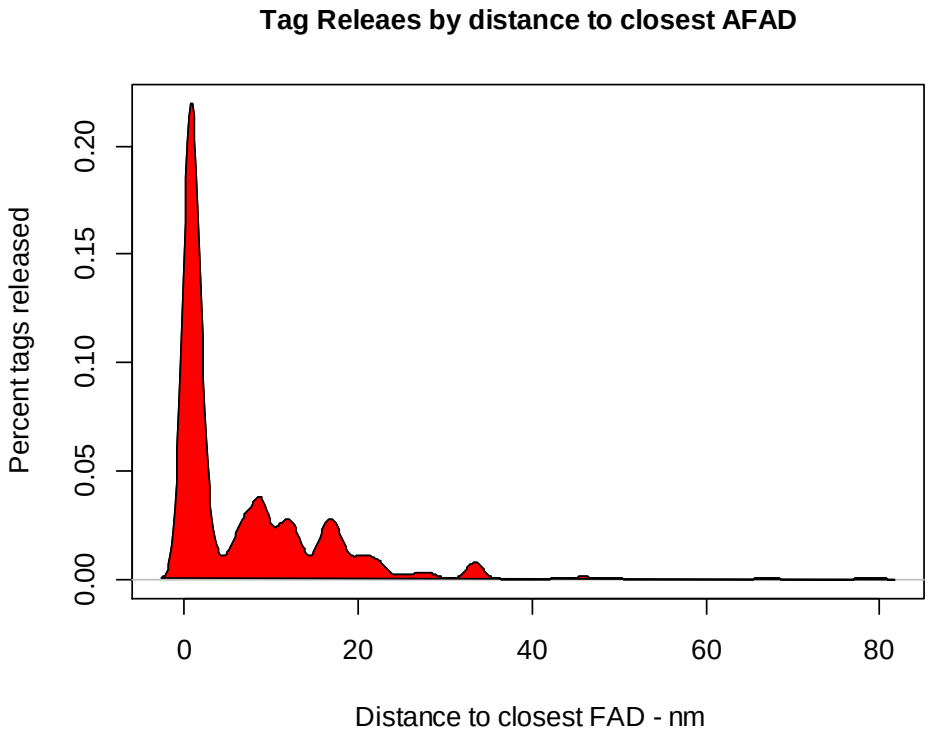
sp	n	%	M_Size	SD
B	74	1.3%	43.93	18.39
S	3682	62.9%	42.33	7.84
Y	2042	34.9%	43.31	6.36

Within 5 miles of AFADs

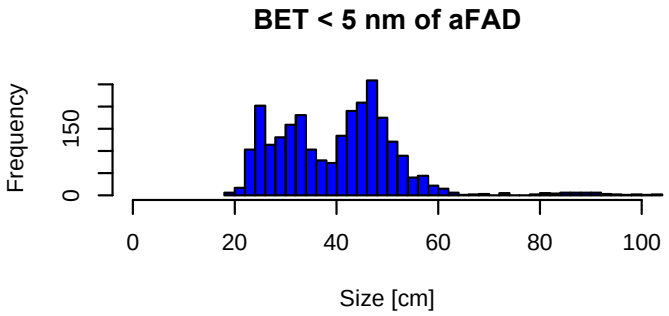
sp	n	%	M_Size	SD
B	362	2.8%	45.01	12.67
S	9698	75.9%	37.55	7.58
Y	2554	20.0%	40.78	7.31

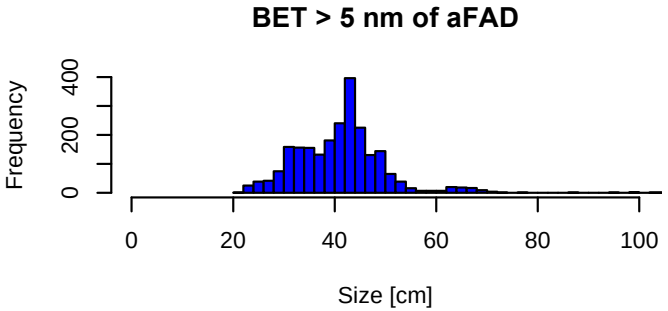
> 5 miles of AFADs

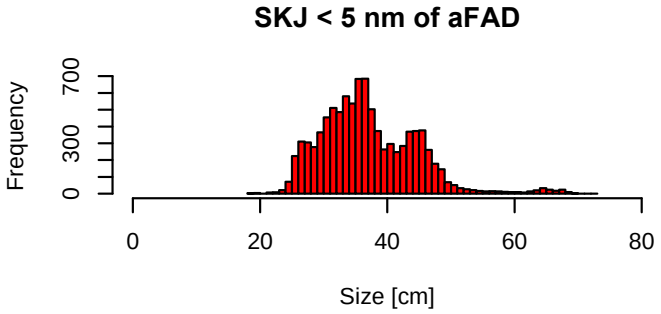
sp	n	%	M_Size	SD
B	172	1.9%	42.67	14.35
S	6040	66.6%	42.34	8.17
Y	2756	30.4%	42.28	4.72

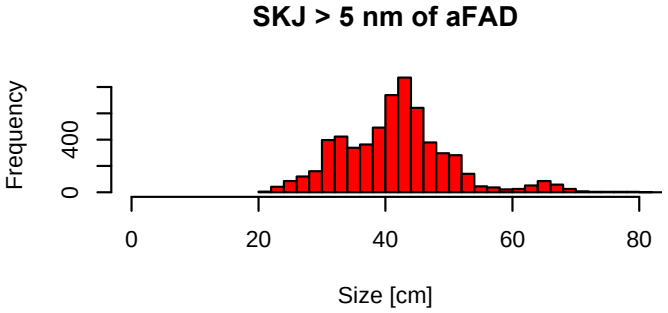


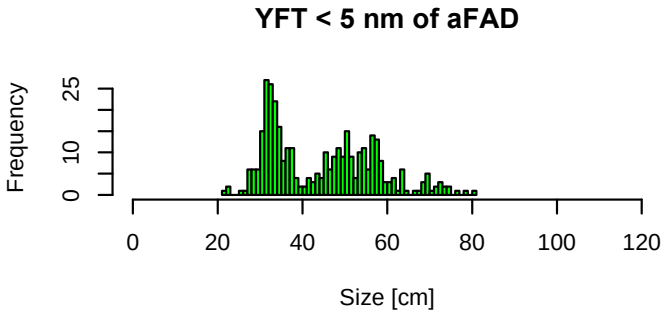
Composition and Size Distribution of catch around aFAD

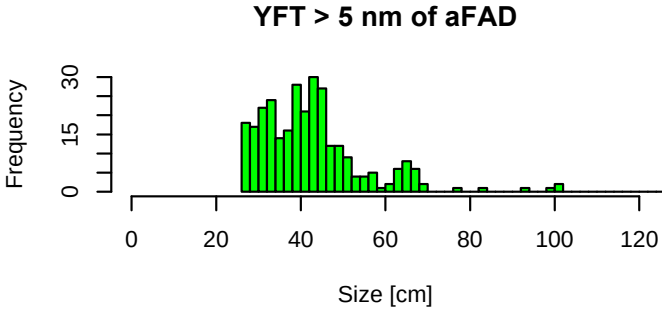












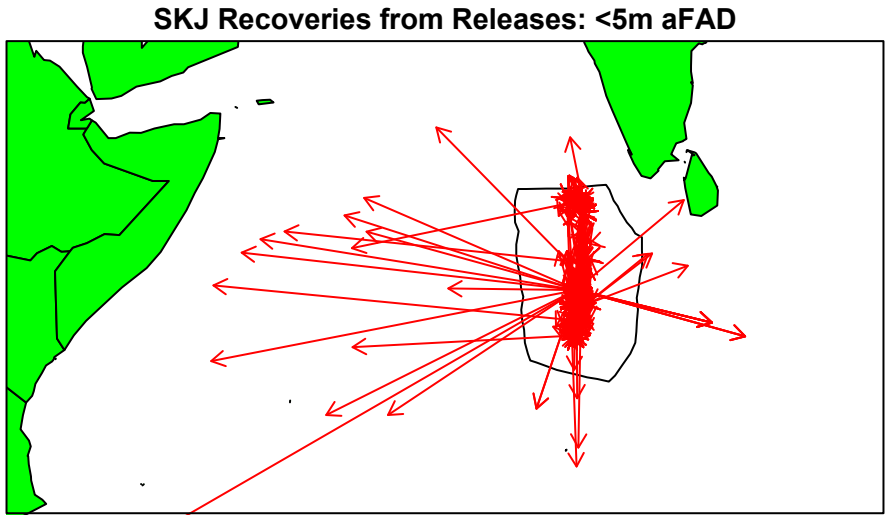
Summary - composition and size distribution

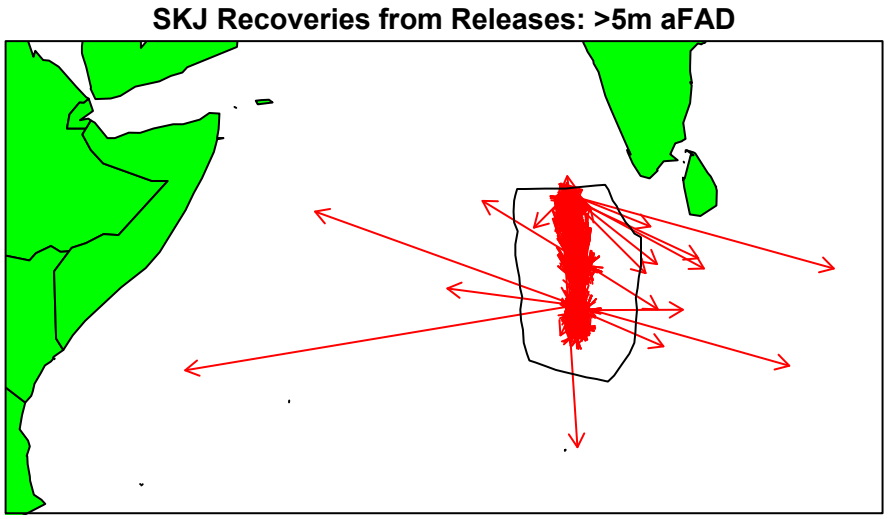
- Proportion of the BET and SKJ are higher closer to the aFADs
- Bigeye tuna are more concentrated closer to aFADs and sizes around the aFADs are larger
- SKJ and YFT sizes are smaller around aFADs,

How Sticky Tunas are to ‘Maldives feature’ and aFAD network?

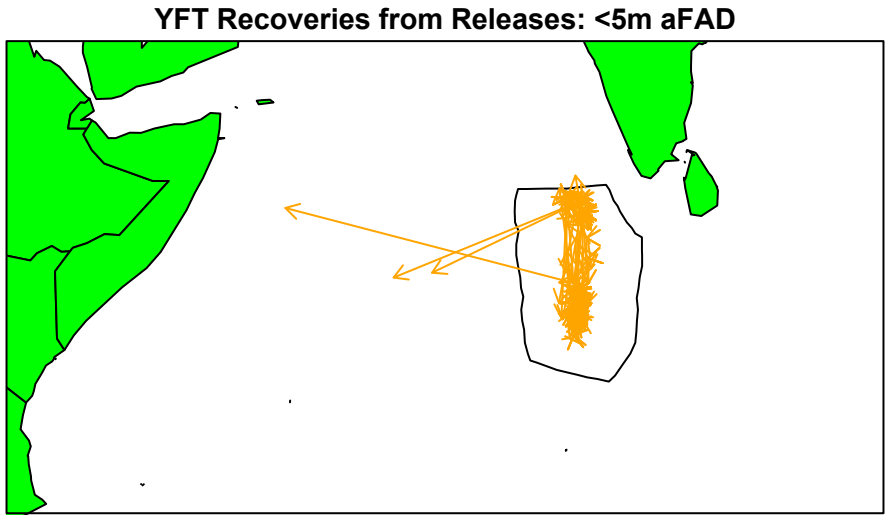
- What are the fate of recoveries that were released ‘closer’ to the aFADs as opposed to the ‘further away’ from the aFADs?

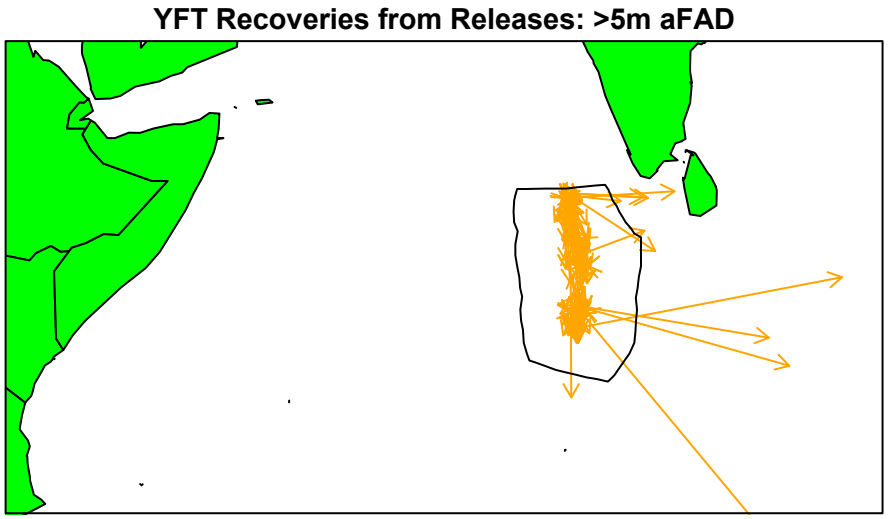
Recoveries of SKJ



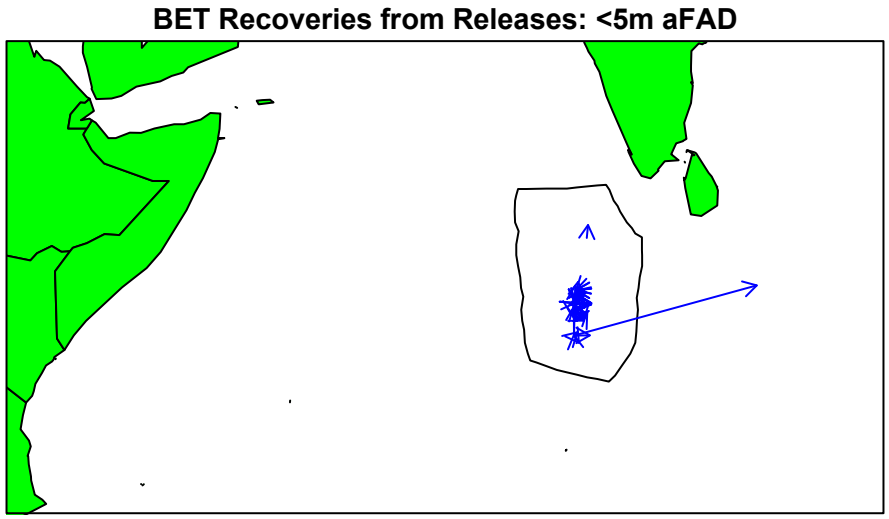


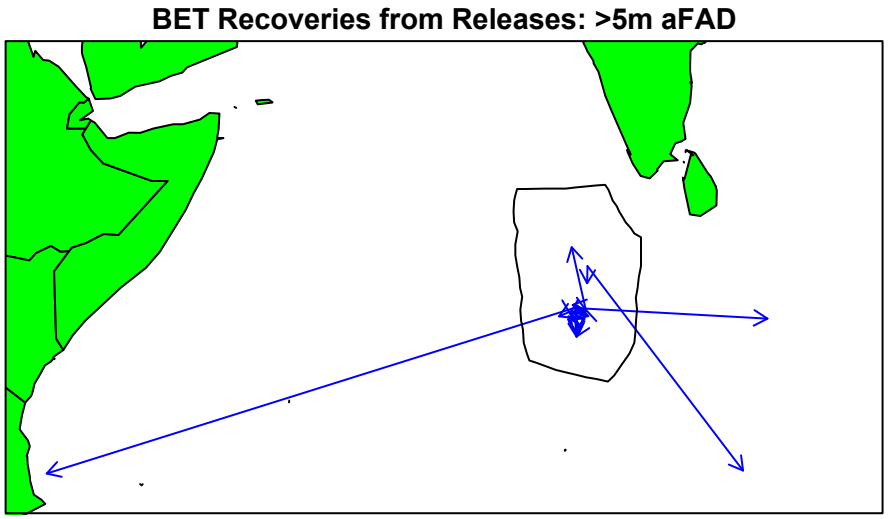
Recoveries of YFT





Recoveries of BET





RTTP-IO Release

With known Species at Release and Recoveries

	Rleased	Recovered	%
1990			
Skipjack	8033	1210	15.1%
Yellowfin	1908	105	5.5%
Bigye	0	0	0.0%
1993-1995			
Skipjack	6474	553	8.5%
Yellowfin	1303	23	1.8%
Bigeye	0	0	0.0%
2004			
Skipjack	3744	320	8.5%
Yellowfin	1257	77	6.1%
Bigeye	0	0	
2007-2009			
Skipjack	12,061	2583	21.4%
Yellowfin	4,053	535	13.2%
Bigeye Tuna	534	54	10.1%

Acknowledgements

- MRC Tagging Teams – for the field work / data entry
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- Jean-Pierre Hallier & Tom Nishida – for taking part in tagging cruise and for the advice and support
- Guillermo Moreno - for cleaning the Maldives SS data, despite all the problems it had!
- Japanese Government + EU – For financing the Maldives Small Scale Projects
- IOTC Secretariat for executing the Small Scale Tagging Projects
- Fishermen of Maldives and in the IO fisheries for their support in returning the tags

Thank you for your attention

Any questions or comments?