DETERMINING AN APPROPRIATE TAG MIXING PERIOD FOR THE INDIAN OCEAN YELLOWFIN TUNA STOCK ASSESSMENT.

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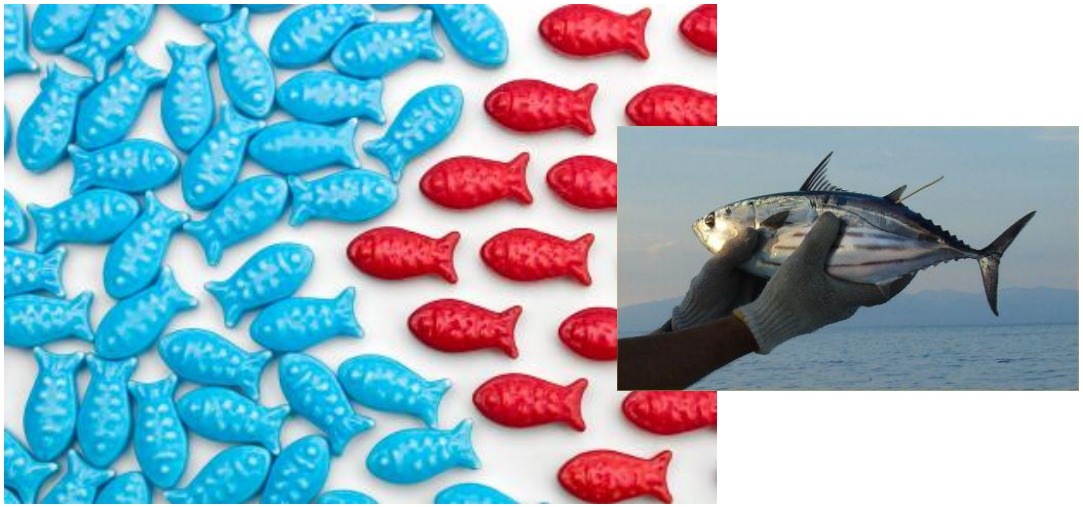
Indian Ocean Tuna Tag Symposium

Introduction

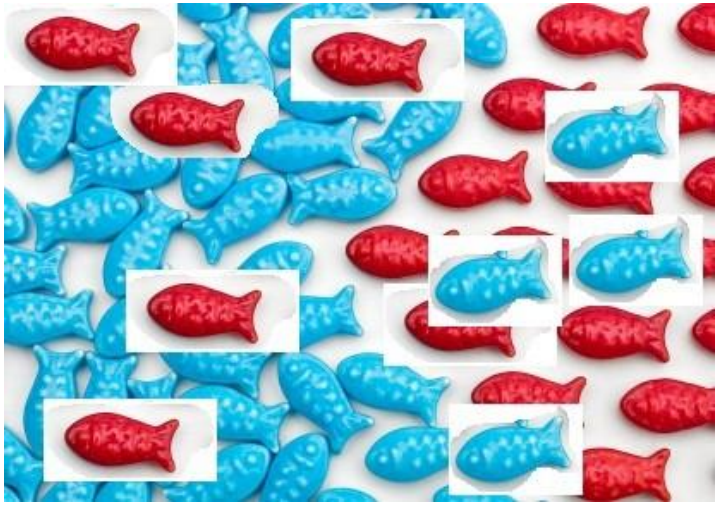
- Tag release/recovery data. Potential to inform stock assessment models regarding stock size and fishing mortality.
- Assumption of homogeneous distribution of tags within (regional) population. Significant bias in estimation of stock size if assumption violated.
- Spatial scale of mixing. IO wide or sub region.
- Duration of mixing period for tags to distribute throughout (regional) population.
- Current stock assessment assumes 4Q mixing period. Model sensitive to period assumed. Shorter mix period/lower biomass. Need to critically evaluate mixing assumptions.



Heterogeneous distribution.
Over sample tags = low biomass and high M.
Under sample tags = high biomass and low M.

Mixing period

Discard tags
recovered during this period.
High proportion of recoveries over initial period.

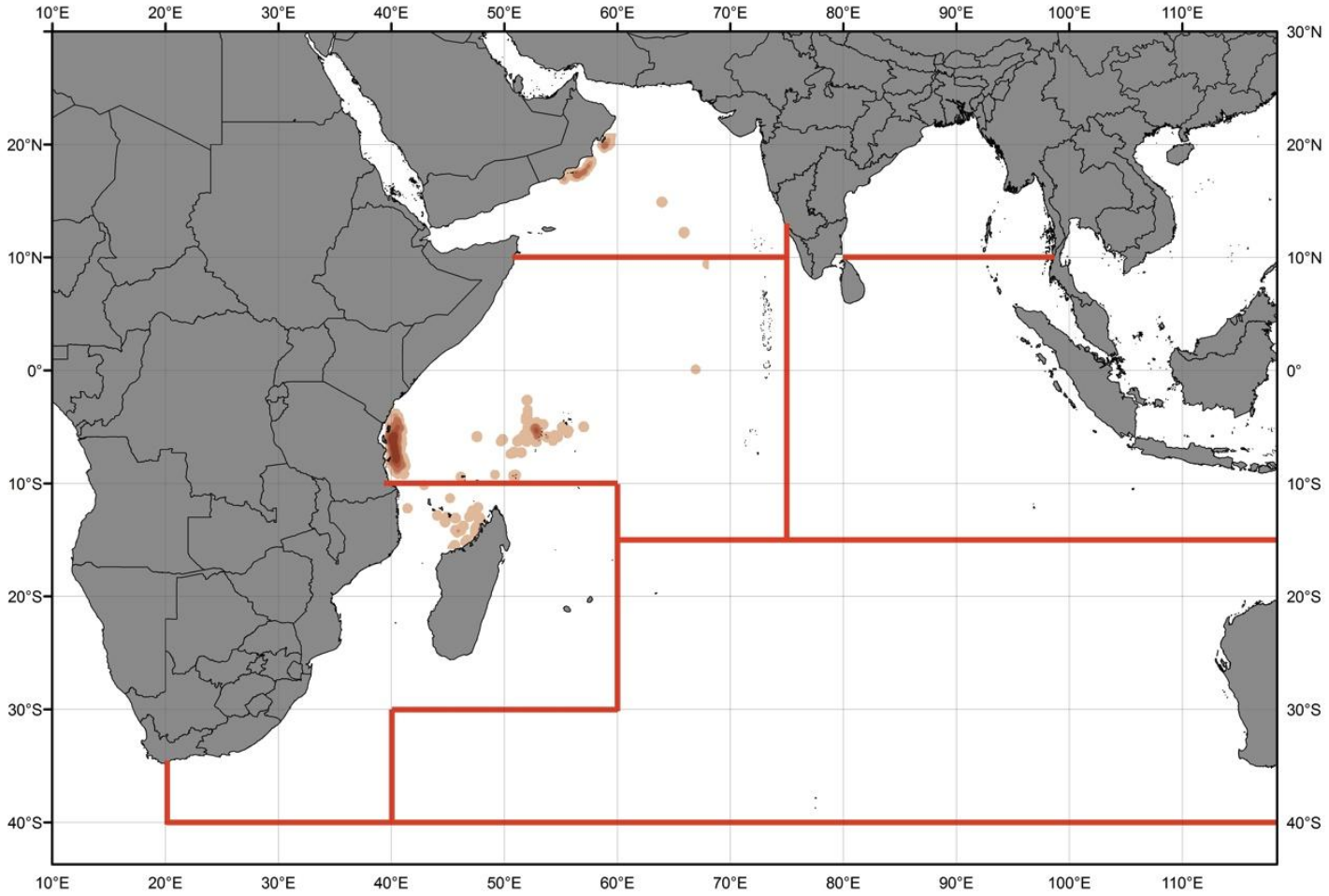


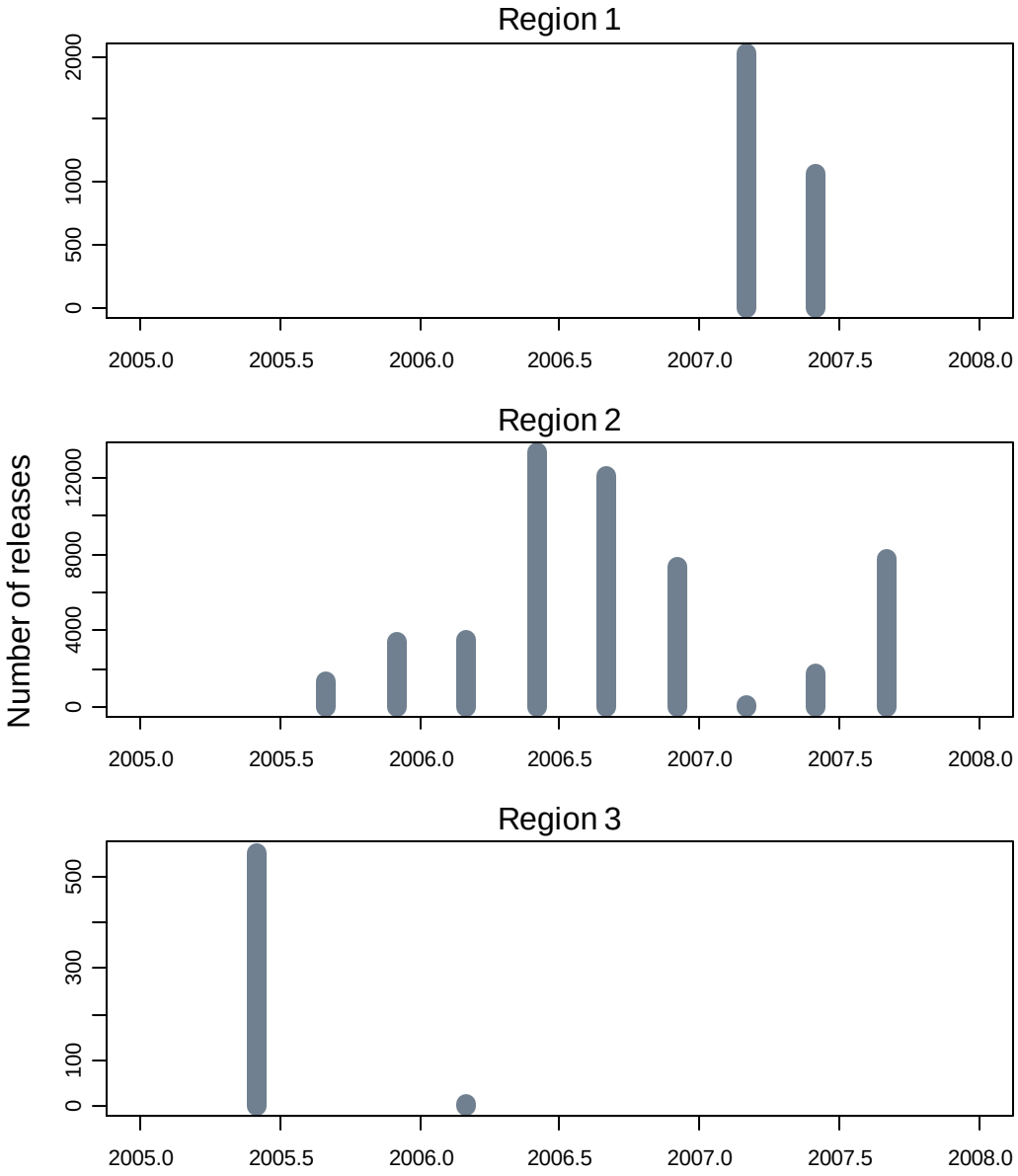
Approximate homogeneous distribution of tags in population.
Unbiased estimate of population size.

Tag release/recovery data set

- RTTP IO tag data set.
- Tag releases dominated by Tanzania releases.
- Recoveries limited to PS (high RR).
- 5,509 yellowfin tag recoveries.
- Precision of tag recovery information (set type, location, date, fish length). Info available for most PS recoveries.
- Location of capture – link to individual set or sets in similar location. Analysis at 1 and 5 deg lat/long spatial scale and quarterly (3 mo).

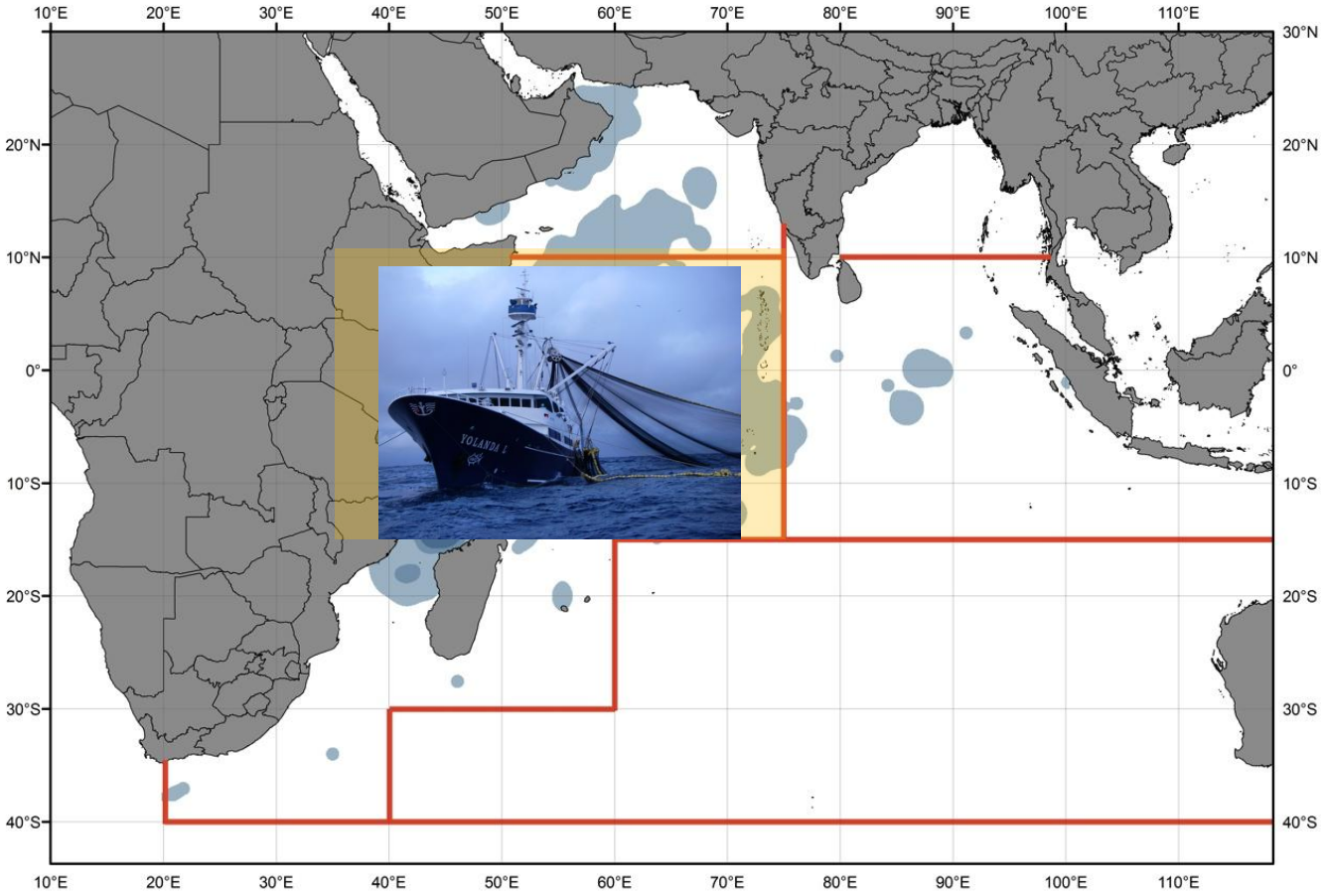
Releases (yellowfin)




Region 1
Region 2
Region 3
Number of releases
0
500
1000
2000
4000
8000
12000
100
300
2005.0
2005.5
2006.0
2006.5
2007.0
2007.5
2008.0

Recoveries (yellowfin)

Relate to spatial scale of stock assessment.

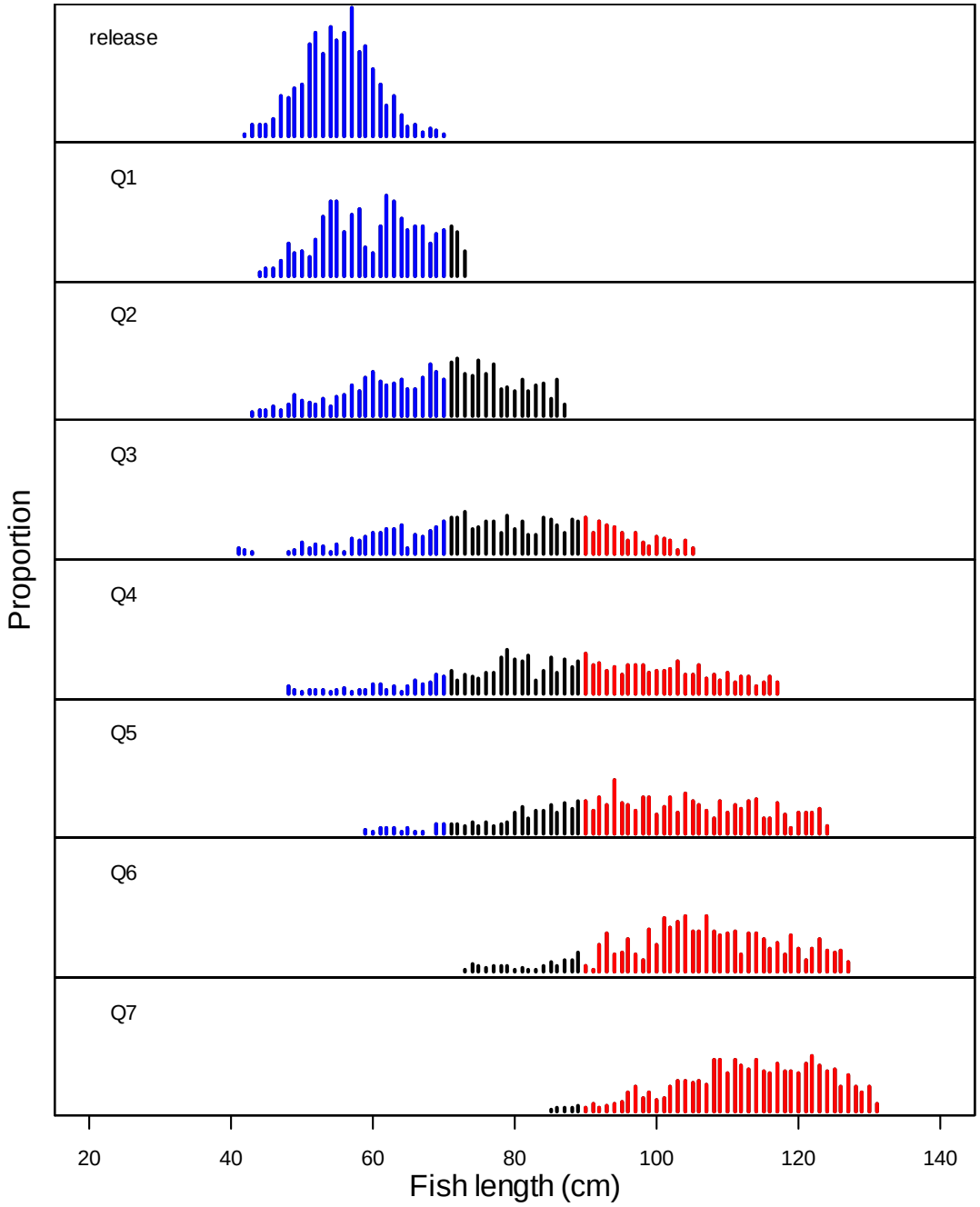


Period at liberty interacts with fishery specific selectivity.

YFT growth rates result in tagged fish exceeding the length range vulnerable to small fish FAD fishery after approx 4 quarters at liberty (BLUE).

Tagged fish become vulnerable to the FS fishery after approx 4 quarters at liberty (RED).

Also large fish caught by the FAD fishery.



FAD recoveries

Recovery YR	QTR	Period at liberty (quarters) 1	2	3	4	5	6	7	8	9	10	11	12	12+
2006	1	23	2	1	0	0	0	0	0	0	0	0	0	0
2006	2	12	7	1	1	0	0	0	0	0	0	0	0	0
2006	3	298	13	23	8	1	0	0	0	0	0	0	0	0
2006	4	269	161	21	24	4	1	0	0	0	0	0	0	0
2007	1	153	192	107	14	9	1	0	0	0	0	0	0	0
2007	2	2	148	118	43	1	5	4	0	0	0	0	0	0
2007	3	92	11	159	178	88	7	12	4	2	0	0	0	0
2007	4	177	52	2	29	39	37	3	6	0	0	0	0	0
2008	1	0	45	5	2	17	23	14	1	0	0	0	0	0
2008	2	0	0	131	17	1	33	52	45	1	1	1	0	0
2008	3	0	0	0	45	8	1	26	23	28	1	3	0	0
2008	4	0	0	0	0	23	7	0	12	14	12	1	0	0
2009	1	0	0	0	0	0	7	1	1	5	7	8	0	0
2009	2	0	0	0	0	0	0	8	1	0	0	3	2	0
2009	3	0	0	0	0	0	0	0	12	6	0	5	10	3
2009	4	0	0	0	0	0	0	0	0	3	0	0	0	3
2010	1	0	0	0	0	0	0	0	0	0	16	3	0	10
2010	2	0	0	0	0	0	0	0	0	0	0	1	2	4
2010	3	0	0	0	0	0	0	0	0	0	0	0	2	2
2010	4	0	0	0	0	0	0	0	0	0	0	0	0	5
2011	1	0	0	0	0	0	0	0	0	0	0	0	0	11
2011	2	0	0	0	0	0	0	0	0	0	0	0	0	3
2011	3	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	4	0	0	0	0	0	0	0	0	0	0	0	0	0

Free-school recoveries

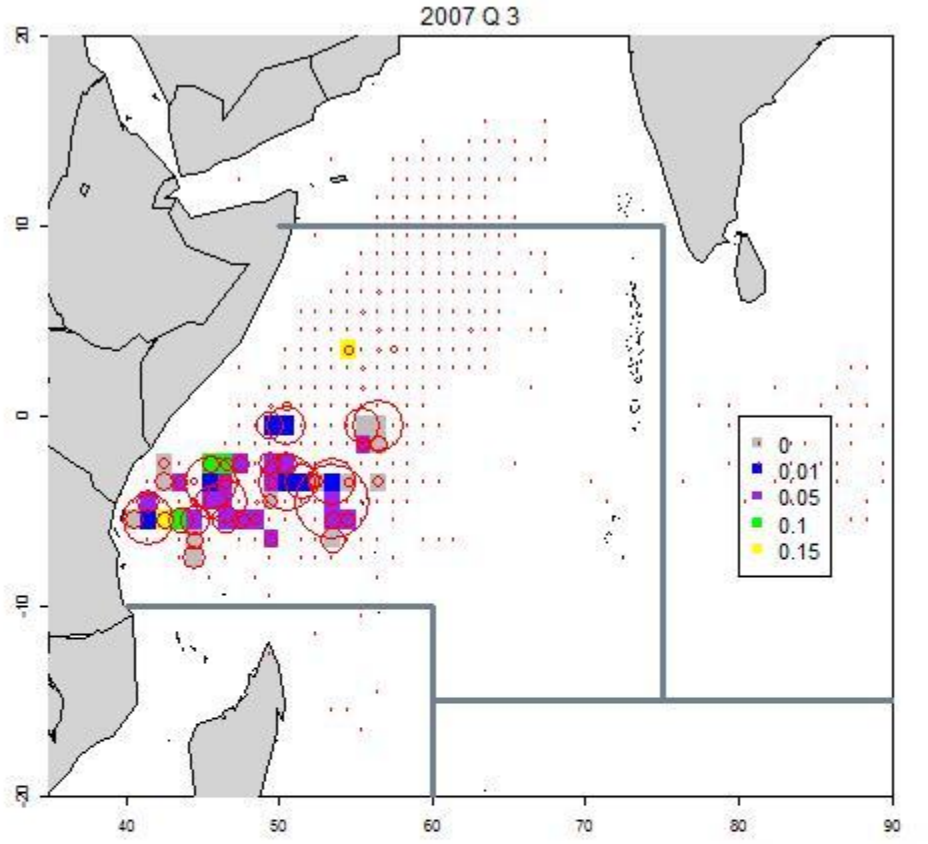
Release YR	QTR	Period at liberty (quarters) 1	2	3	4	5	6	7	8	9	10	11	12	12+
2006	1	8	0	1	0	0	0	0	0	0	0	0	0	0
2006	2	10	4	2	3	0	0	0	0	0	0	0	0	0
2006	3	22	16	3	0	3	0	0	0	0	0	0	0	0
2006	4	5	2	4	1	0	1	0	0	0	0	0	0	0
2007	1	18	36	23	21	2	3	2	0	0	0	0	0	0
2007	2	2	15	28	22	4	8	5	2	0	0	0	0	0
2007	3	2	2	9	16	31	19	12	2	0	0	0	0	0
2007	4	14	3	1	6	15	21	12	5	3	1	0	0	0
2008	1	0	10	2	2	11	45	46	25	11	1	2	0	0
2008	2	0	0	45	3	0	16	24	18	2	1	1	0	0
2008	3	0	0	0	4	0	0	2	6	12	0	1	0	0
2008	4	0	0	0	0	12	5	1	13	21	18	3	2	1
2009	1	0	0	0	0	0	20	3	0	7	28	21	3	5
2009	2	0	0	0	0	0	0	5	0	0	5	0	2	0
2009	3	0	0	0	0	0	0	0	23	6	0	13	9	6
2009	4	0	0	0	0	0	0	0	0	12	1	0	5	15
2010	1	0	0	0	0	0	0	0	0	0	5	2	0	10
2010	2	0	0	0	0	0	0	0	0	0	0	5	1	14
2010	3	0	0	0	0	0	0	0	0	0	0	0	0	2
2010	4	0	0	0	0	0	0	0	0	0	0	0	0	22
2011	1	0	0	0	0	0	0	0	0	0	0	0	0	9
2011	2	0	0	0	0	0		0	0	0	0	0	0	0
2011	3	0	0	0	0	0	0	0	0	0	0	0	0	8
2011	4	0	0	0	0	0	0	0	0	0	0	0	0	3

Analysis

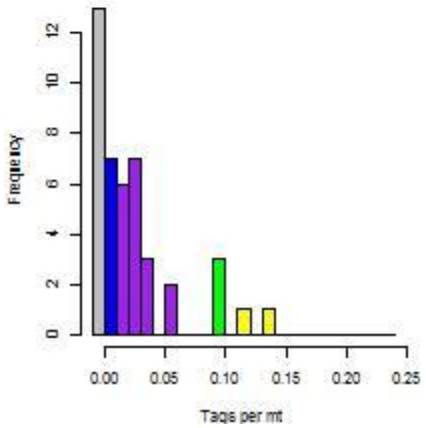
- Mark rate (number tags/mt) of the population (catch). Examine the variability in the distribution of tags within the catch.
- Tag recoveries meet the criteria of being at liberty for at least X quarters.
- Three categories of tag recoveries: small fish (< 80 cm) FAD, large fish FAD and free-school.
- PS catch data, by set type (FS or FAD) , available at 1° lat/long resolution. All fleets combined.
- Examine at 1° or 5° lat/long and quarterly (3 mo) time interval. Minimum catch threshold (25 mt or 100 mt).
- Qualitative rather than statistical analysis.
- Evaluate range of mixing periods (related to length at release and selectivity of respective PS fisheries and natural mortality). 1-6 quarter mixing period.
- No information on the areas where fishing did not occur.

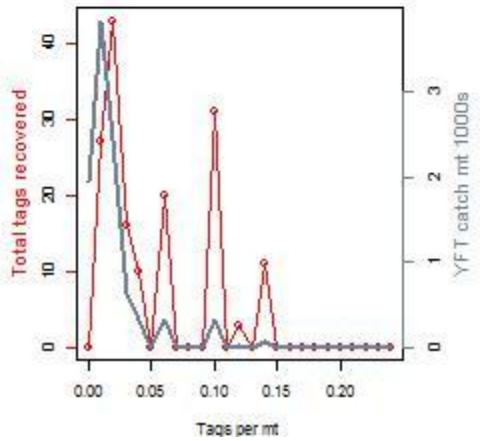
YFT quarterly catch distribution (degree lat*long).

Mark rate (tag/mt)



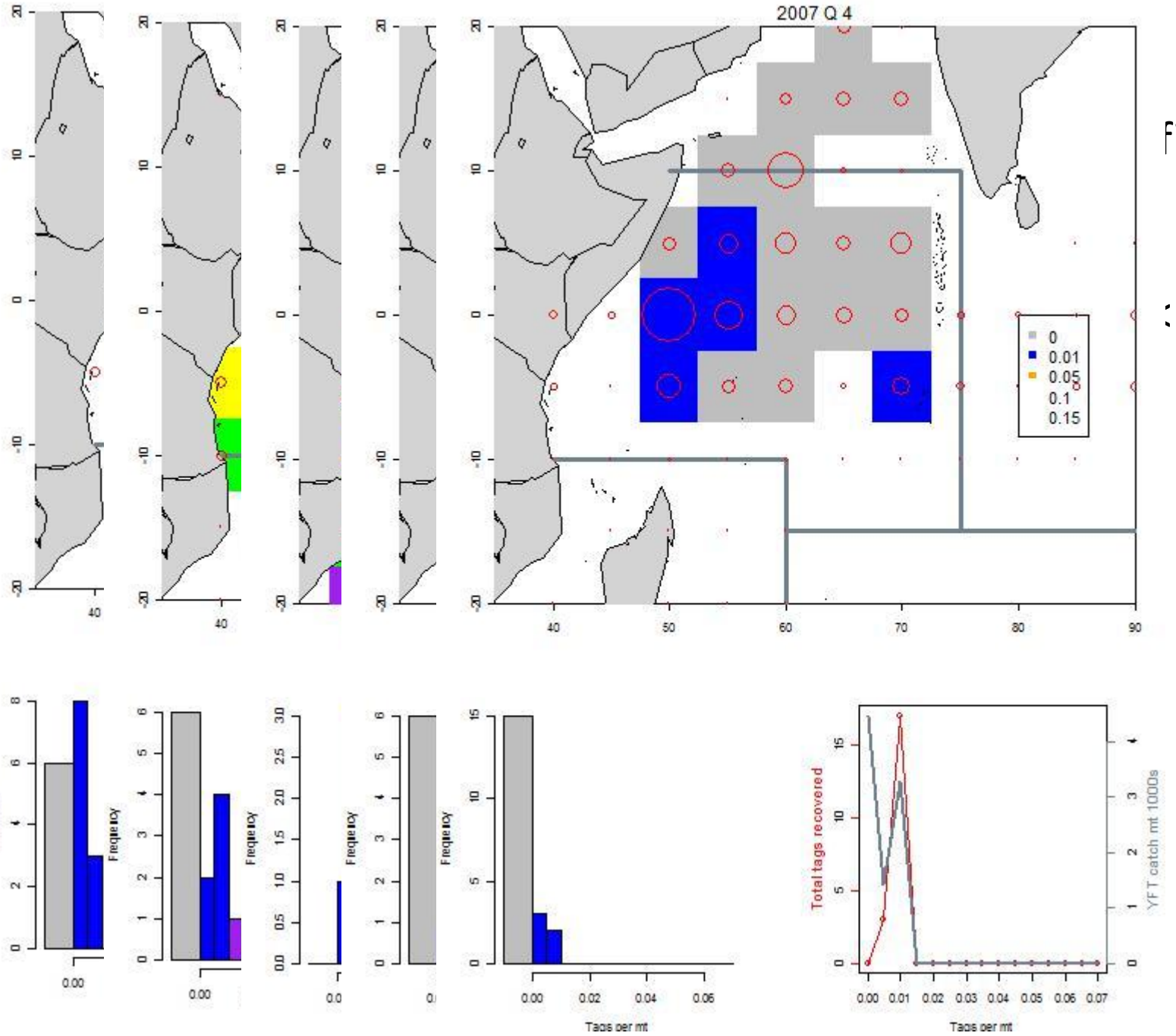
Frequency of tag mark rate (number of lat*long cells)





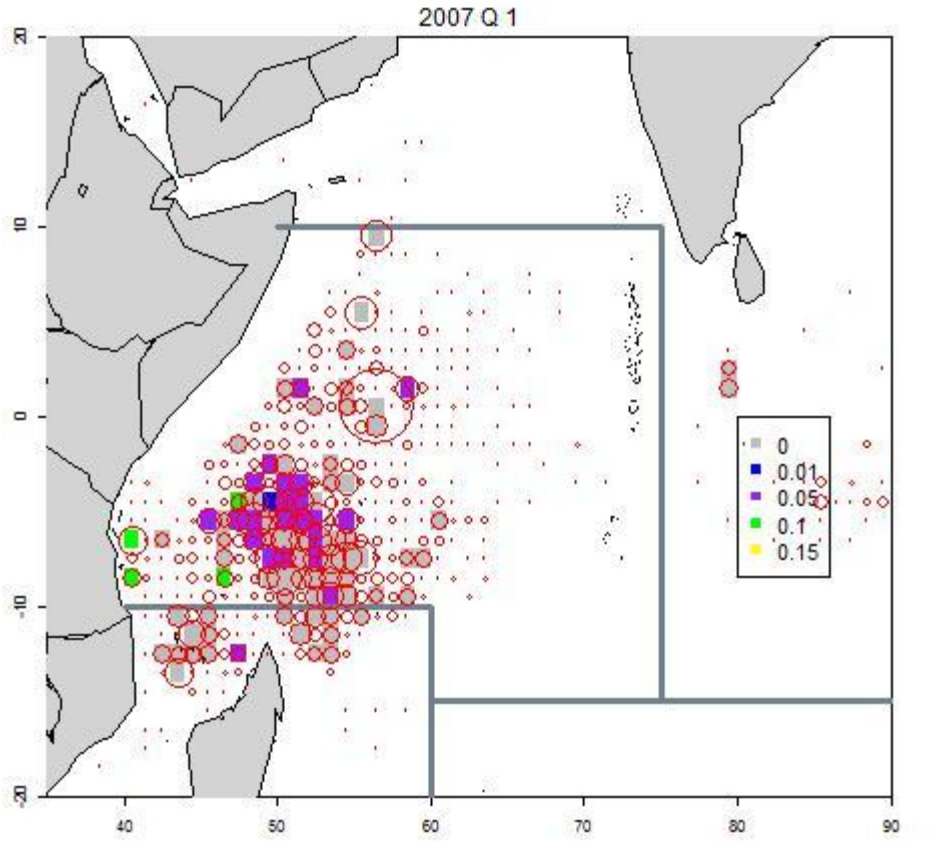
Distribution of total YFT catch by tag mark rate (grey).

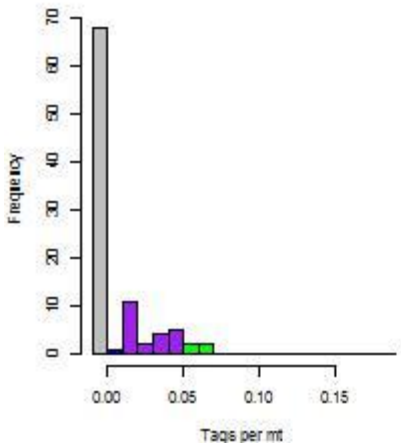
Sum of tags recovered by mark rate category (red).

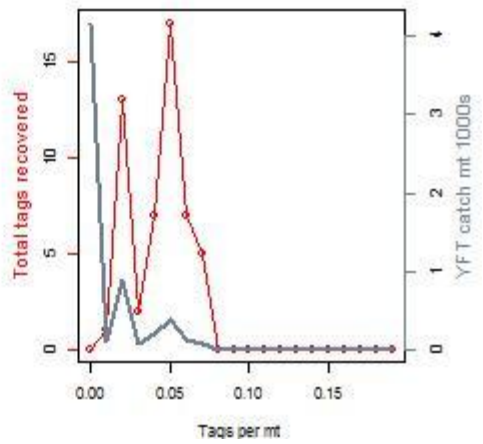


fishery,

: 80 cm)







YFT FAD small fish recoveries

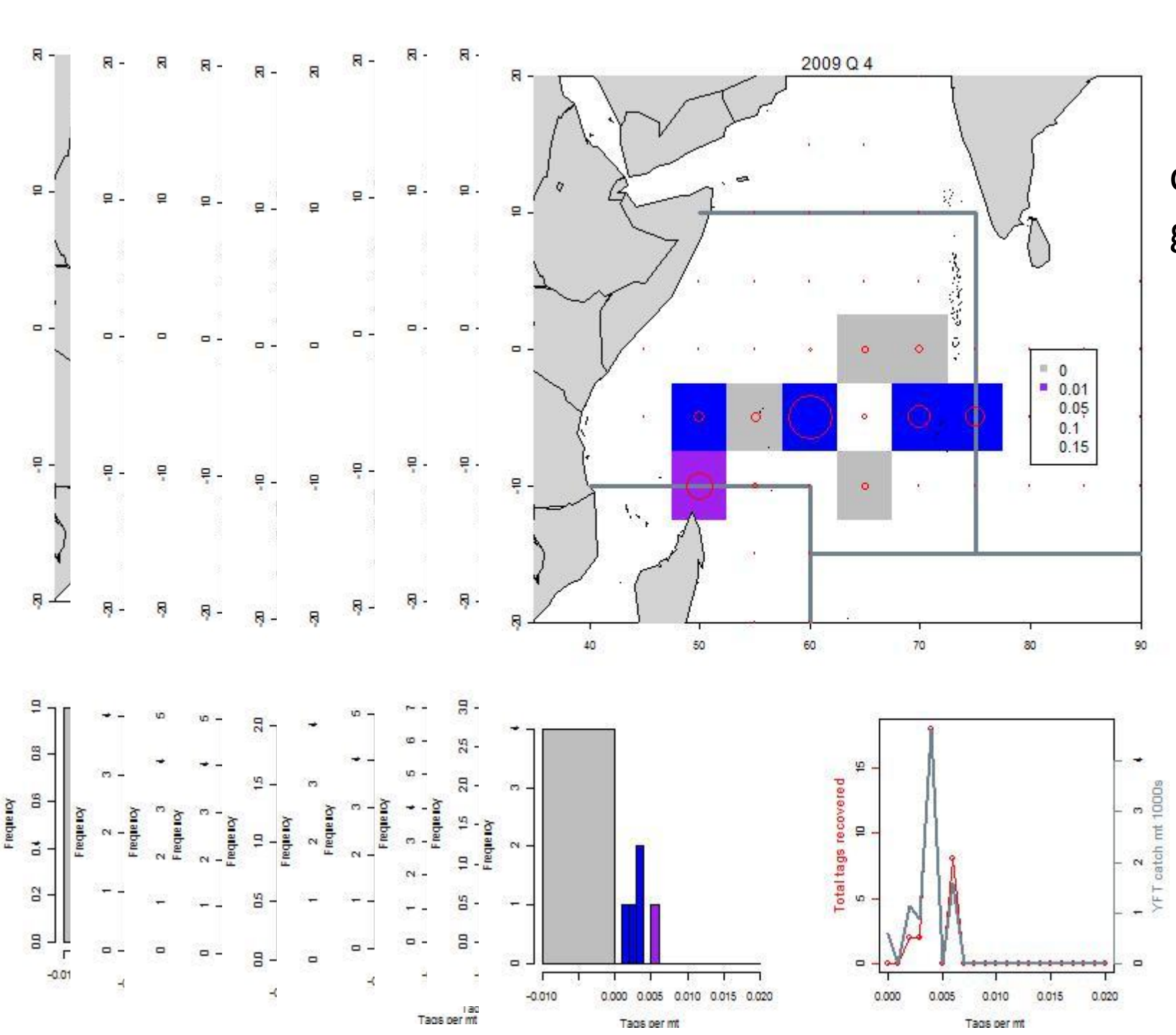
Locations where considerable catch but no tags e.g. SE area of main fishing grounds. Also northern areas.

High proportion of fished lat*long cells with no tags. These cells account for a large proportion of the total YFT FAD catch.

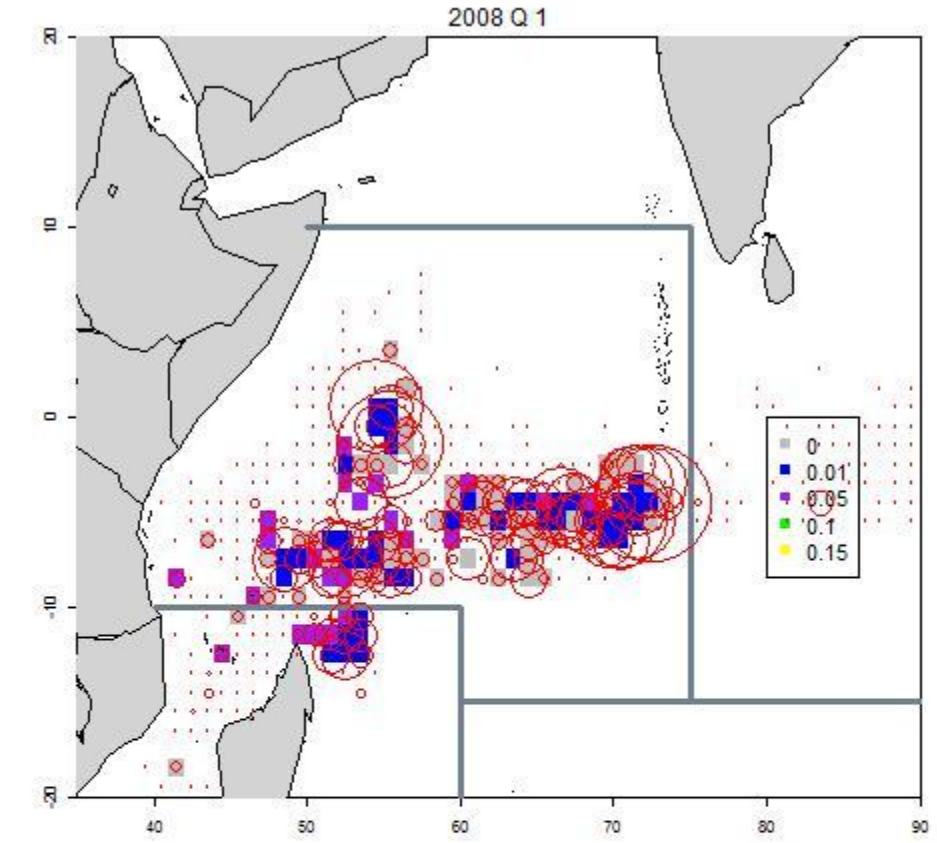
Wide range of mark rates observed among locations where catch was taken.

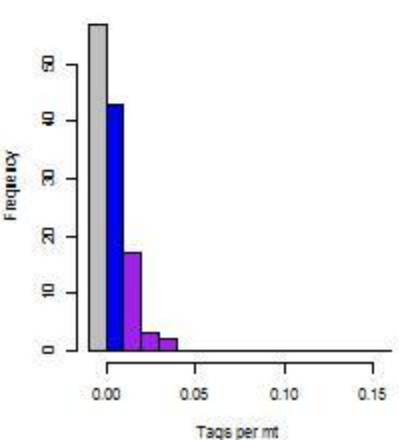
Some locations with a very high mark rate.

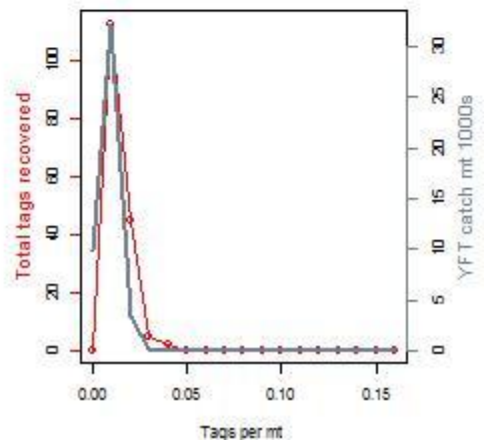
Same patterns evident with a longer mixing period (3 or 4 quarters). Reduced number of recoveries.


2009 Q 4
0
0.01
0.05
0.1
0.15
Total tags recovered
YFT catch mt 1000s
Tags per mt
Frequency

chool
g







YFT FS recoveries

Some locations with no tag recoveries but no systematic spatial pattern.

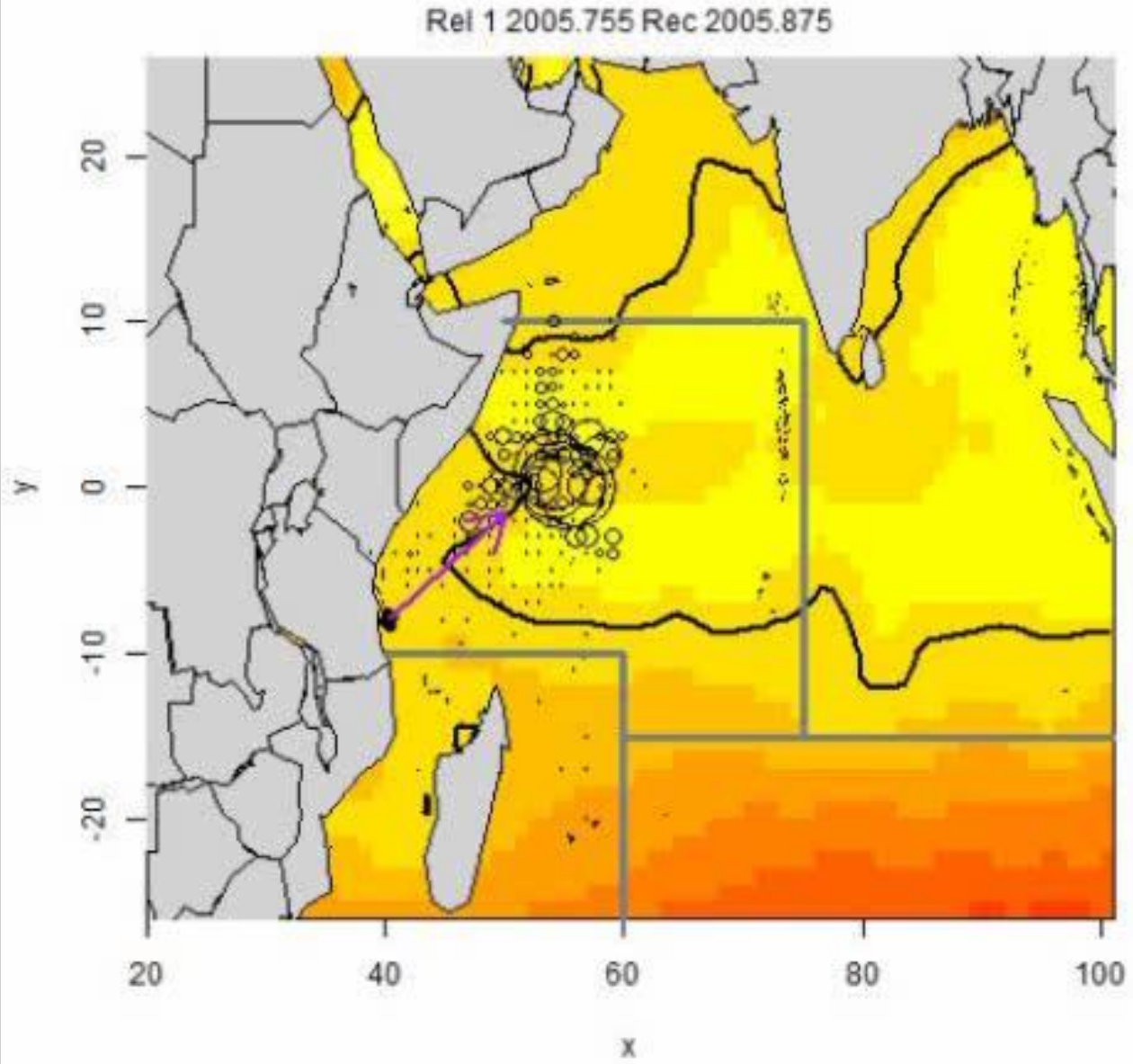
Mark rates tend to be lower than observed for FAD fishery. Considerably lower variability in mark rate among locations than observed from FAD fishery.

Locations with no tags do not account for a large proportion of the total catch.

Observations are insensitive to duration of mixing period (relates to growth and selectivity).

Tag dispersal mechanism

- Dispersal of tags from the main tag loci off the Tanzania coast. Determines how rapidly and how widely tags are distributed in population.
- YFT catch along the 28-29C isotherm (PS and LL).
- Tag dispersal along the isotherm.
- Dispersal of tags from loci following eastward retraction of isotherm.
- Suggestion that oceanography limited dispersal of tags to the eastern Indian Ocean.


Rel 1 2005.755 Rec 2005.875
y
20
10
0
-10
-20
20
40
60
80
100
x

Summary

- Preliminary, qualitative analysis
- Spatial scale of mixing. IO region or sub region or local scale.
- Range of other analyses to examine affinity of tagged fish from same release.
- PS FAD recoveries. Heterogeneity in tag mark rate for smaller and larger fish. Spatial structure in recoveries. Mixing period greater than 6 months removes large proportion of tags.
- PS FS recoveries. Most tags in population for 12 mo. Some indication of spatial heterogeneity in tag distribution.
- Mixing observations are somewhat independent of selected mixing period due to fishery selectivity and growth.
- Need to balance utility of tag data with potential biases introduced to stock assessment and other studies.

Next steps

- Statistical rigor to current analysis.
- Revise SA spatial structure? Minor refinements only.
- Investigate the extent of potential biases (in M, F and management advice) through a simulation study. Resampling of tag/release recovery data set.