

PIT Tag Recovery Study, 2003-2006

Ray Webster

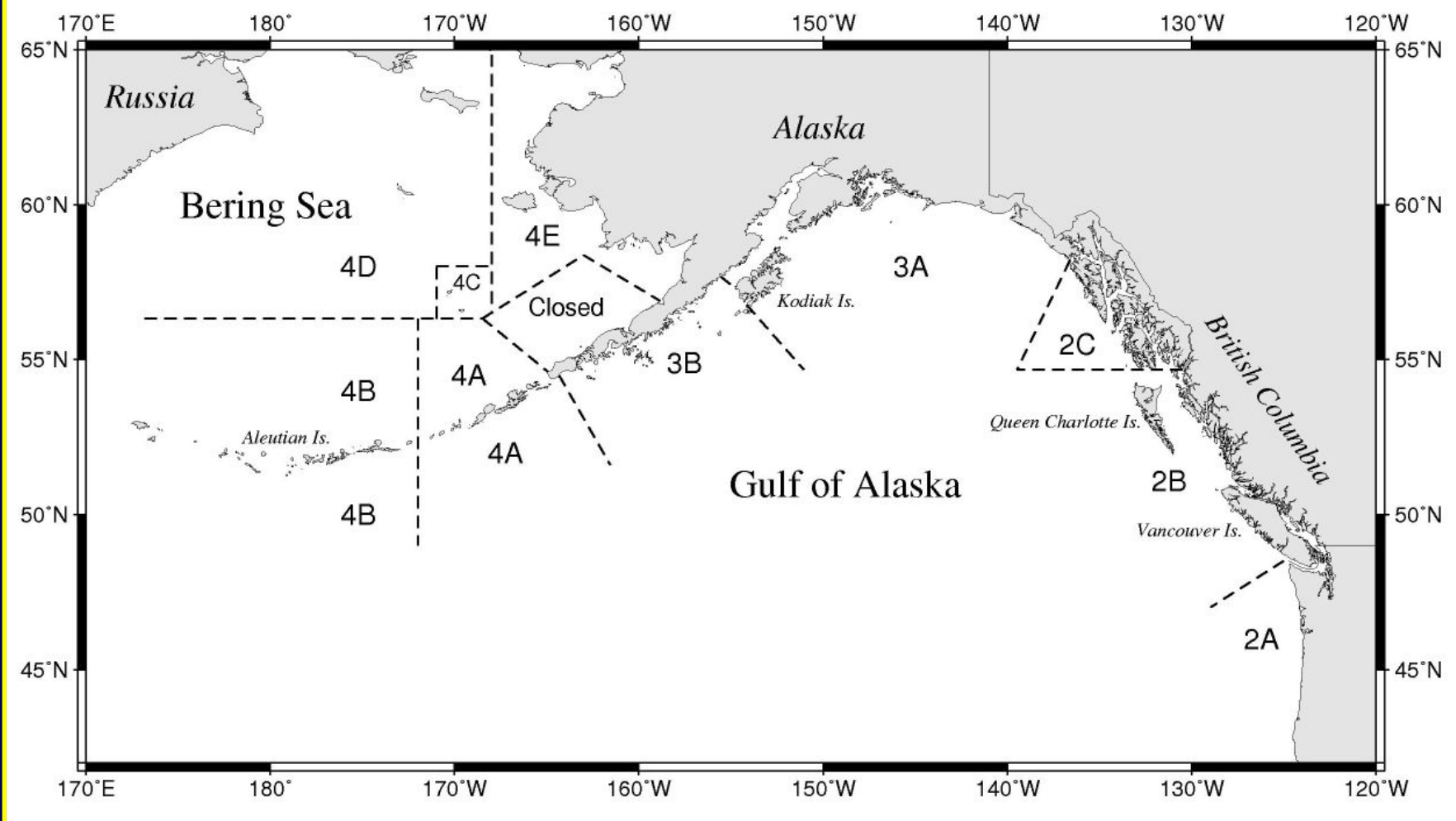


Objectives of the PIT tag study

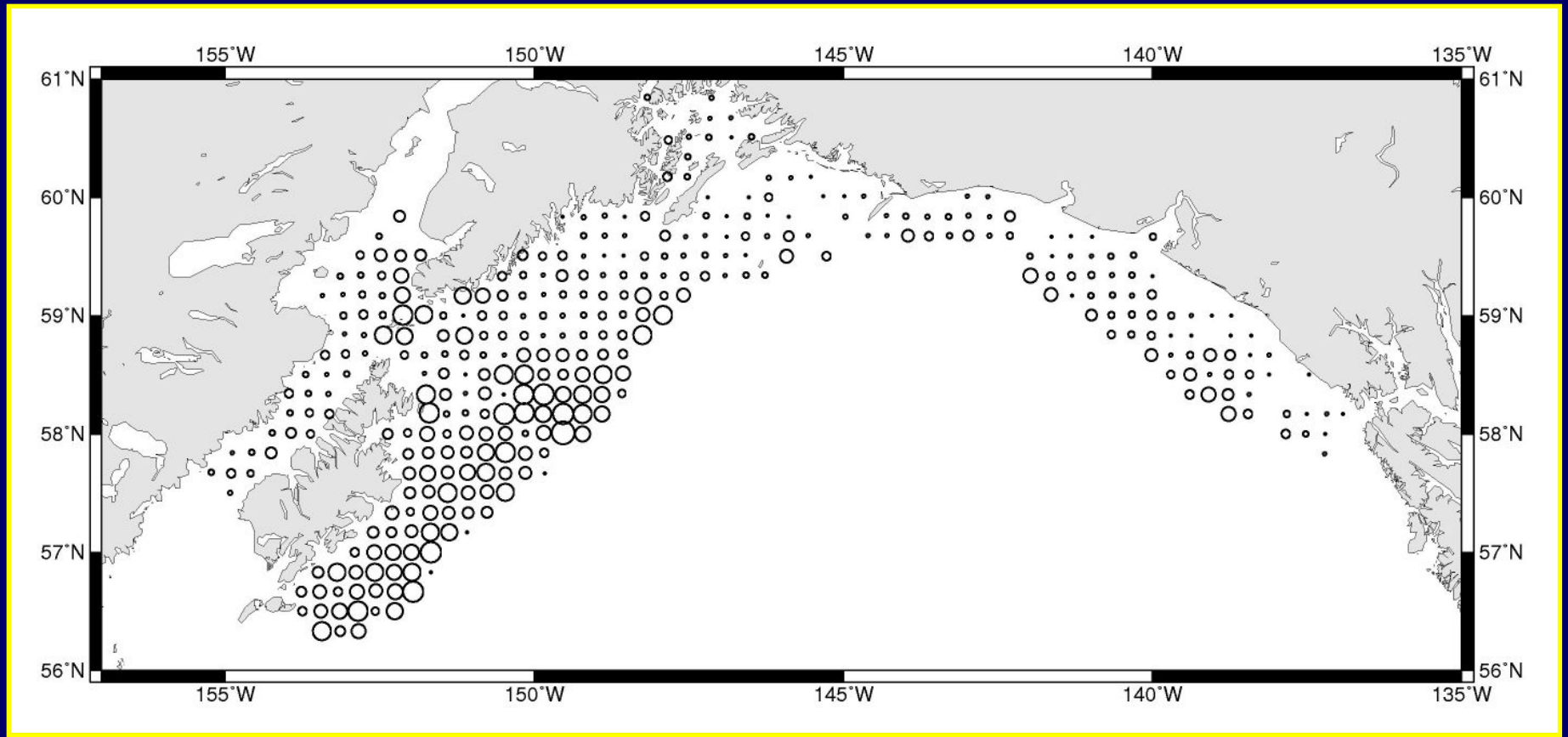
- Primary:
 - Estimate commercial harvest rates in each regulatory area
 - Estimate the rate of natural mortality
- Secondary:
 - Estimate migration rates among regulatory areas

PIT Tag Releases

- 2003: catch on three skates (300 hooks) tagged and released at every survey station coastwide (ca. 44,000 fish).
- 2004: same release procedure in Areas 2B and 3A only (ca. 23,000 fish).



IPHC regulatory areas



**Example: Tag release distribution
in Area 3A.**

Scanning of commercial landings

- Scan samplers are stationed at major ports throughout the coast.
- The goal is to scan at least 25% of landed halibut in each regulatory area for PIT tags.
- Scanning rates for 2004-2006 were:

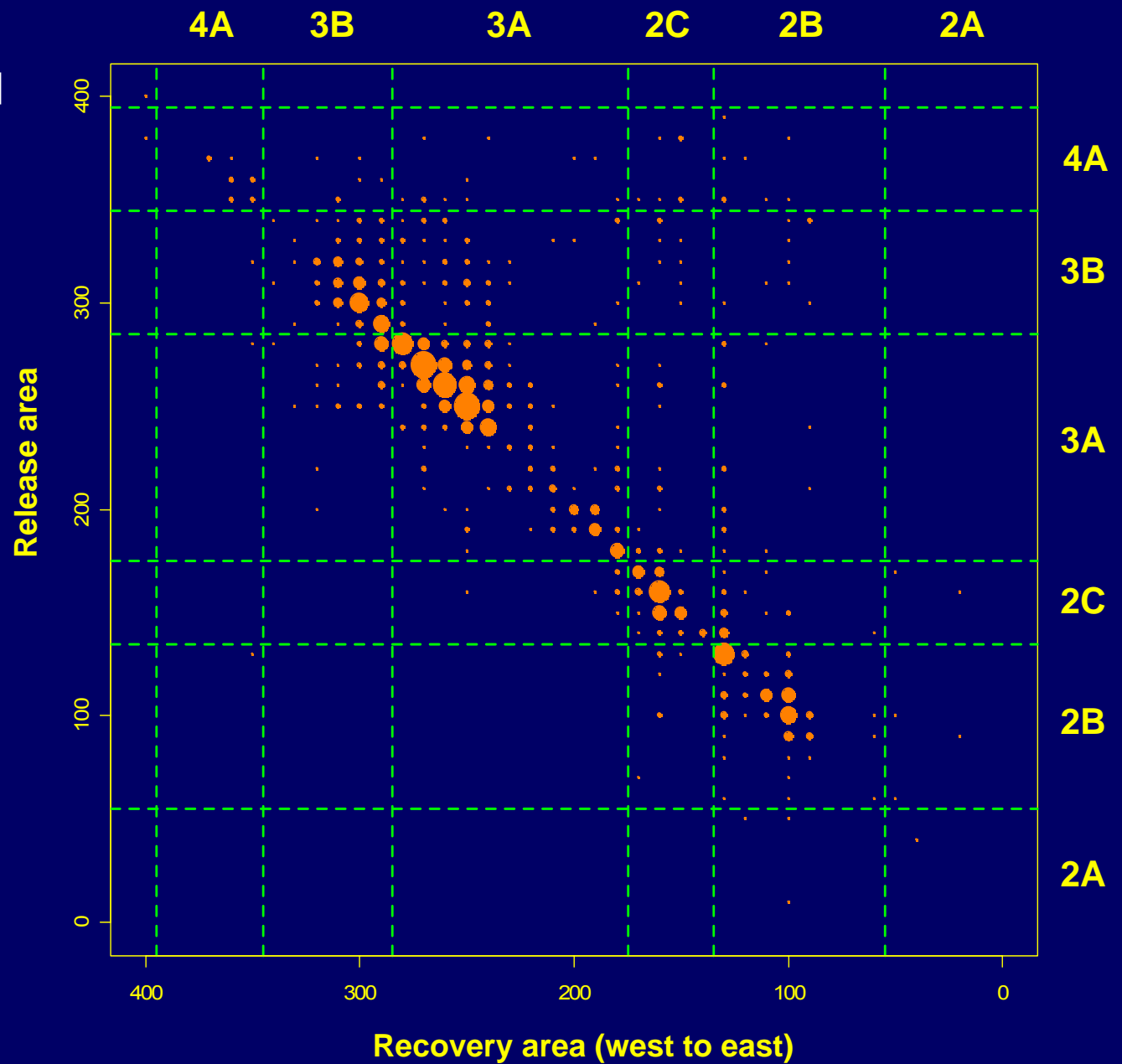
Area	2004	2005	2006
2A	30%	36%	43%
2B	37%	34%	40%
2C	38%	41%	38%
3A	48%	51%	52%
3B	48%	50%	42%
4A	47%	46%	54%
4B	26%	20%	40%
4C	52%	72%	96%
4D	32%	31%	35%



Recoveries of tagged fish from 2003-2006

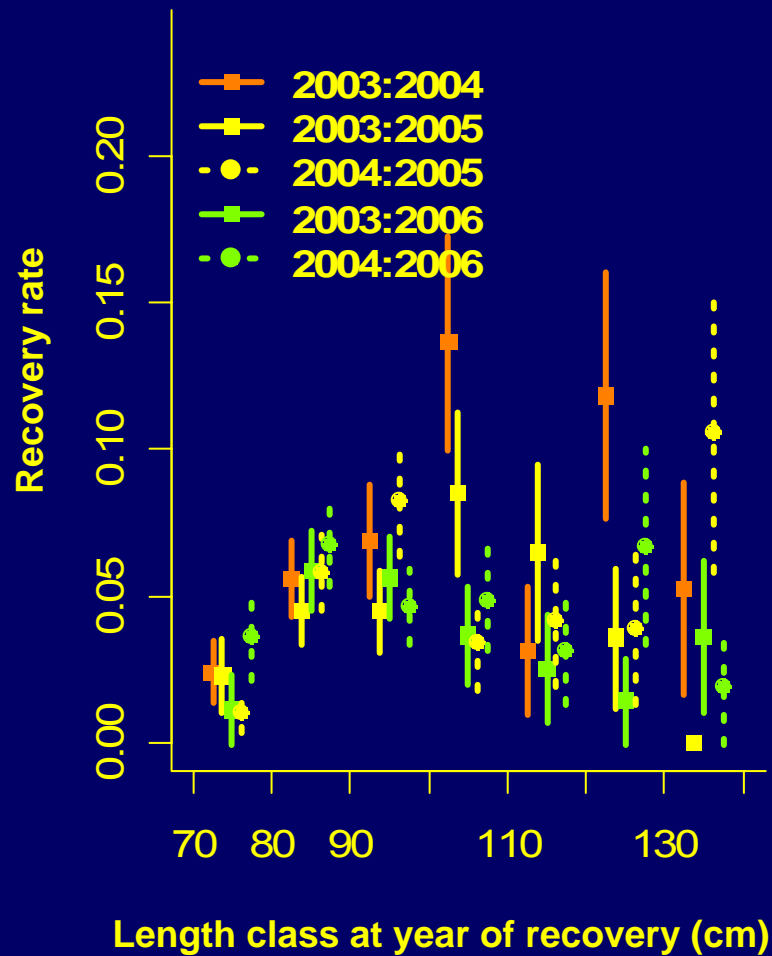
Release Area	Releases 2003-04	Recovery Area, 2003-06									Recoveries 2003-06
		4D	4C	4B	4A	3B	3A	2C	2B	2A	
4D	978	15			1		1		1		18
4B	1128			5			1	1	1		8
4A	3452		1	3	28	6	13	7	9		67
3B	15279				1	228	73	10	9		321
3A	36672				1	78	857	27	17		980
2C	3673						5	222	33	1	261
2B	5800				1			8	280	3	292
2A	299								3	1	4
Total	67281	15	1	8	32	312	950	275	353	5	1951

Gulf of Alaska tag recoveries by release stat area and recovery stat area, 2003-2006.

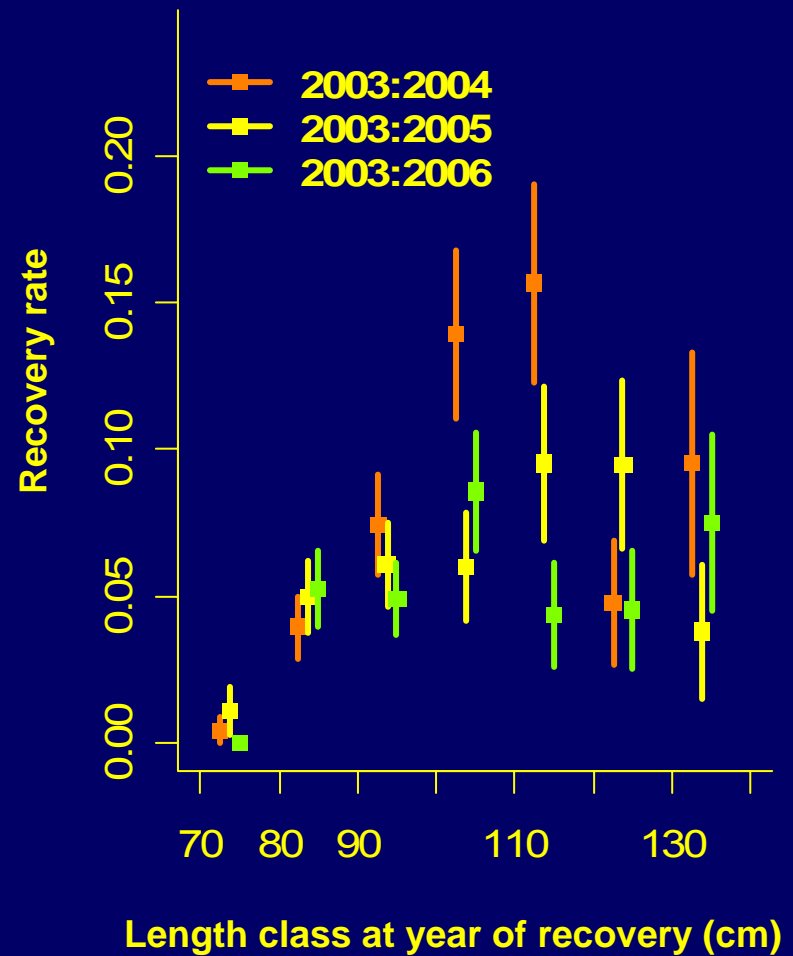


Recovery rates by 10cm length class for 2004-06 by release area

Area 2B

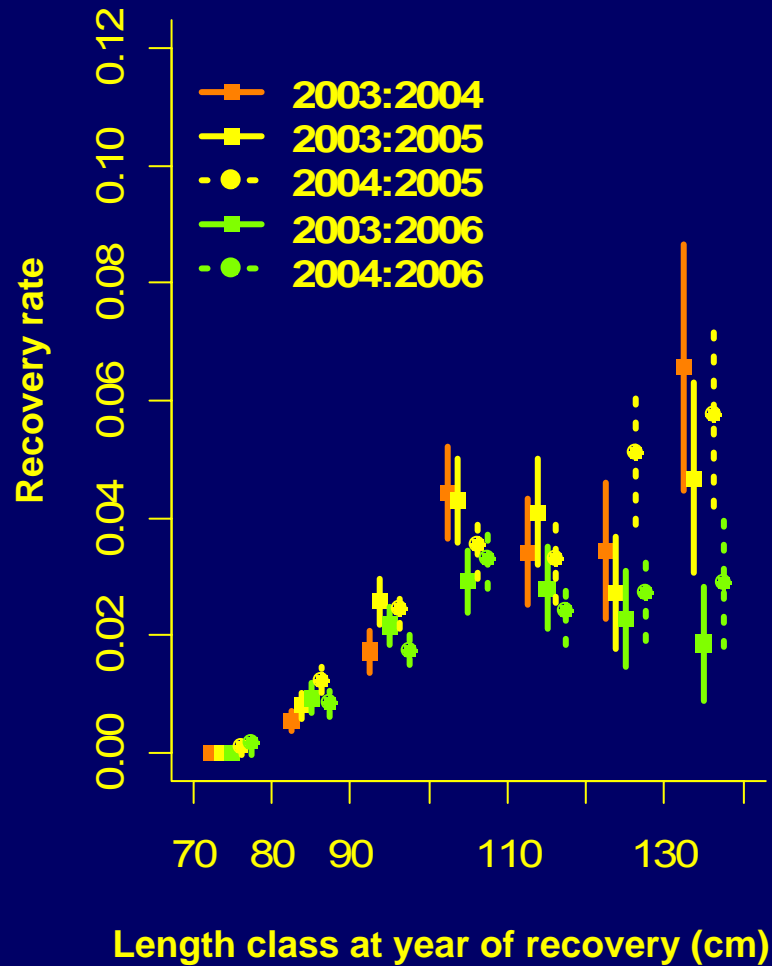


Area 2C

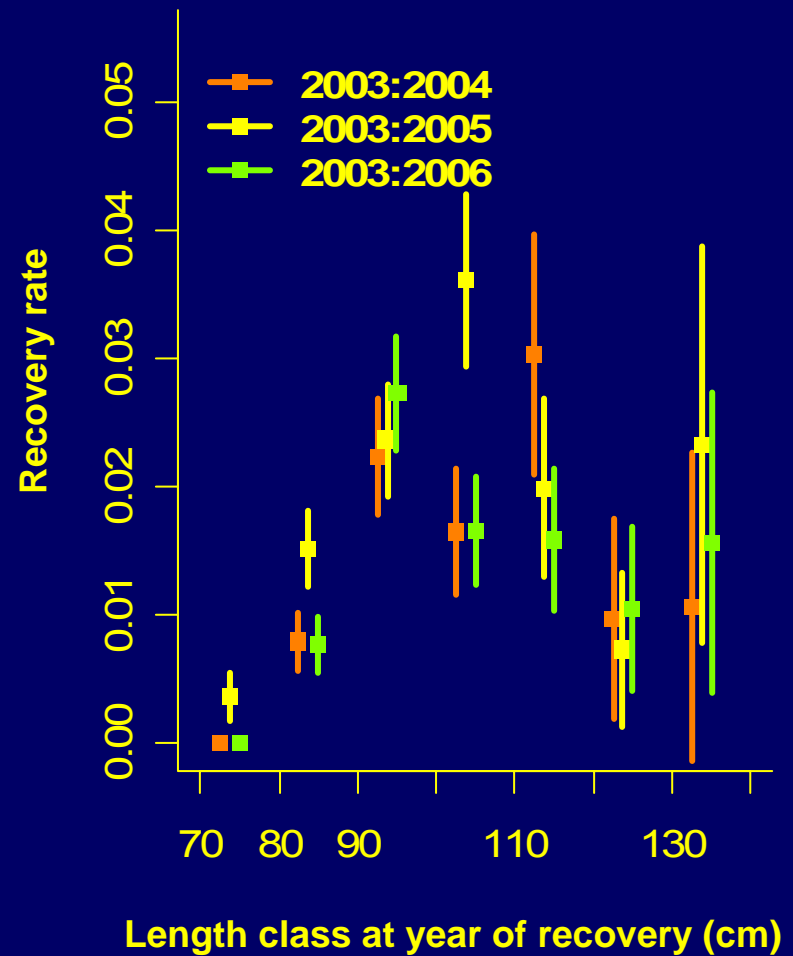


Recovery rates by 10cm length class for 2004-06 by release area

Area 3A



Area 3B



Tag-recovery Models

- Tag recovery models are usually parameterized in terms of survival and tag-recovery probabilities.
- We allow these parameters to be a function of regulatory area, year, and fish length.
- For a single regulatory area, i , define:
 - S_{ij} = probability of survival in year j
 - f_{ij} = probability a tag is recovered in year j

Tag-recovery Models

- For our data, f_{ij} is modeled as $f_{ij} = u_{ij} \theta_{ij} \lambda$, where for area i and year j :
 - u_{ij} = probability a fish is harvested
 - θ_{ij} = the scanning rate
 - λ = tag reporting rate of scanned tags
- θ_{ij} is known, while tag seeding studies show λ is around 0.97.

Tag-recovery Models

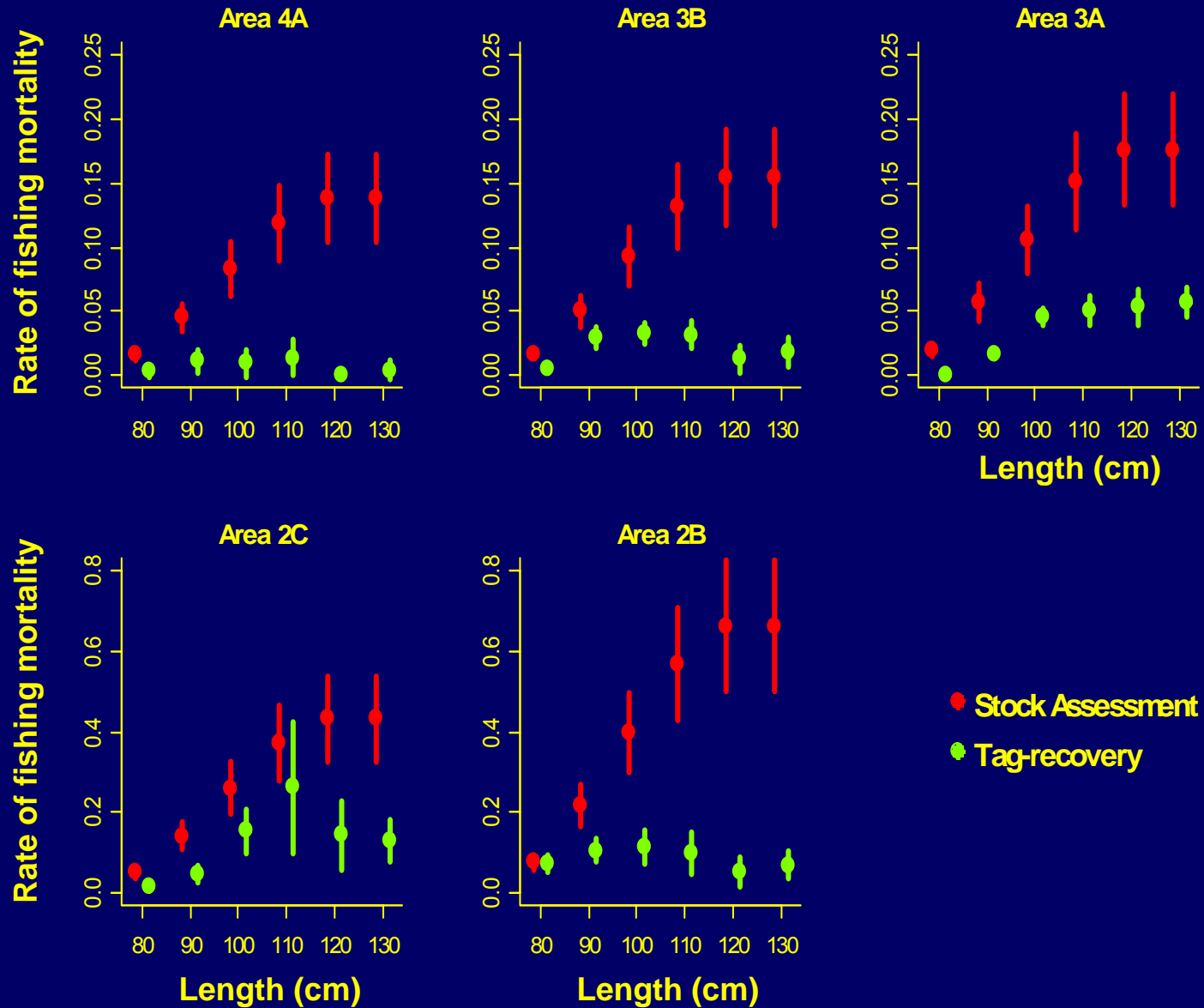
- In fisheries applications, we are interested in estimating rates of fishing mortality, F_{ij} , and natural mortality, M :

$$S_{ij} = \exp(-F_{ij} - M)$$

$$u_{ij} = \frac{F_{ij}}{F_{ij} + M} \left\{ 1 - \exp(-F_{ij} - M) \right\}$$

- F_{ij} is also allowed to be a function of current length, while in our models, M does not vary with area, year, or length.
- Migration among areas is modelled through a transition matrix, Φ , with elements φ_{rs} , where
 φ_{rs} = probability a fish is in area s in year $j+1$ given it was in area r in year j .

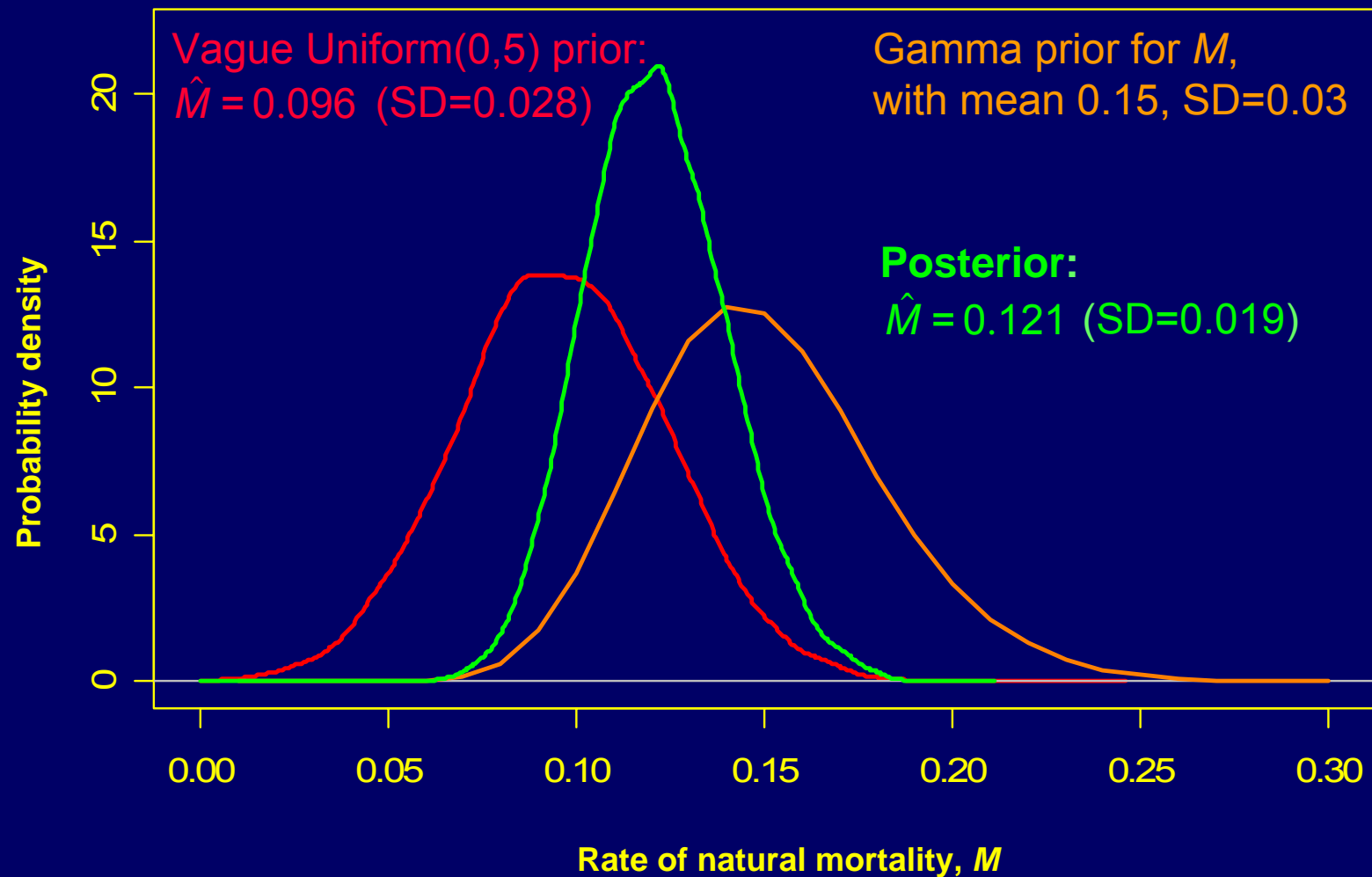
Estimates of commercial fishing mortality rates: tag-recovery model vs 2006 stock assessment



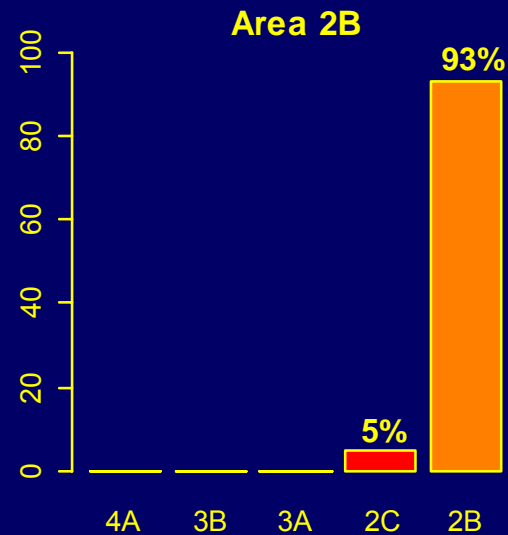
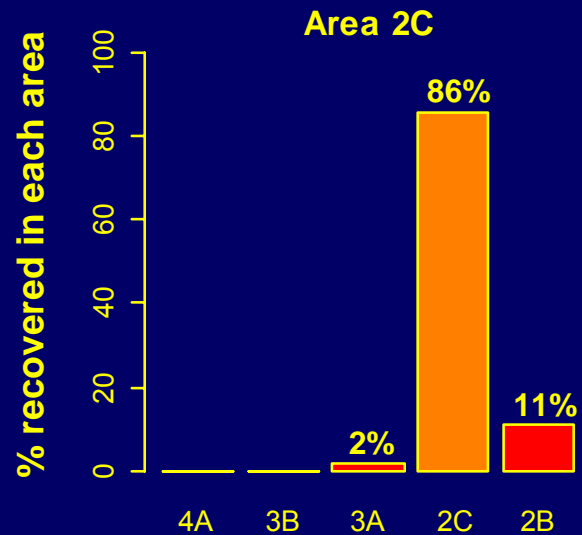
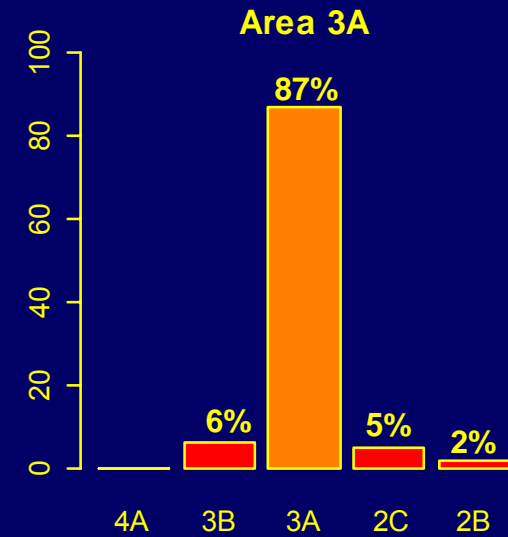
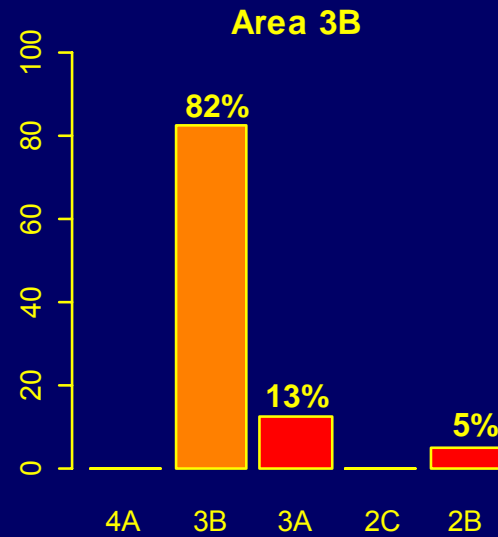
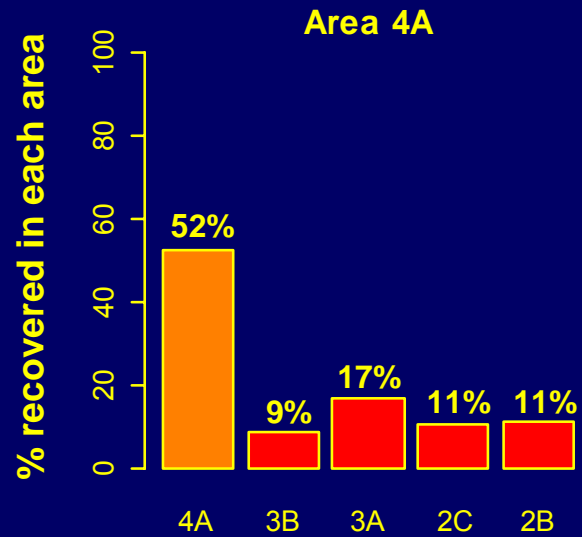
Tag-recovery Analysis

- Tag-recovery estimates of commercial fishing mortality are very low, particularly in Areas 3 and 4.
- These estimates would lead to much higher estimates of exploitable biomass than those given by the stock assessment.
- Stock assessment and the NMFS trawl survey estimates of exploitable biomass in Areas 3A+3B+4A are similar, while an estimate derived from the tag-recovery results is five times greater.

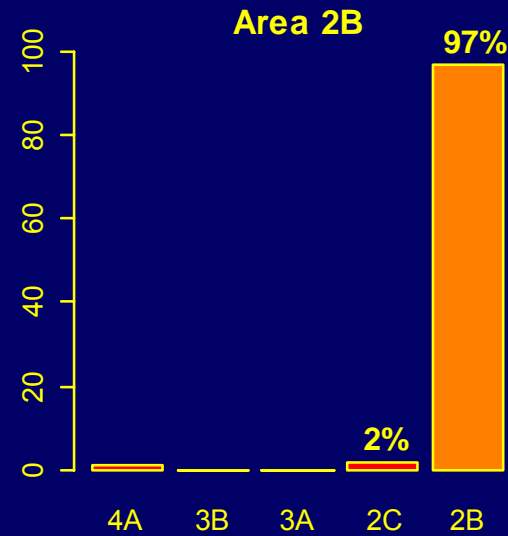
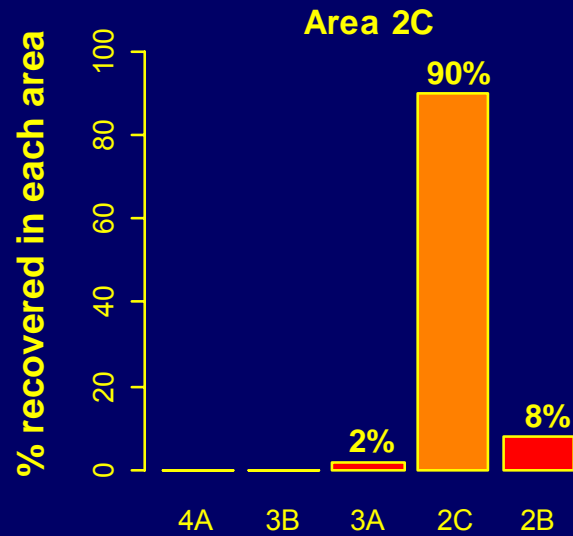
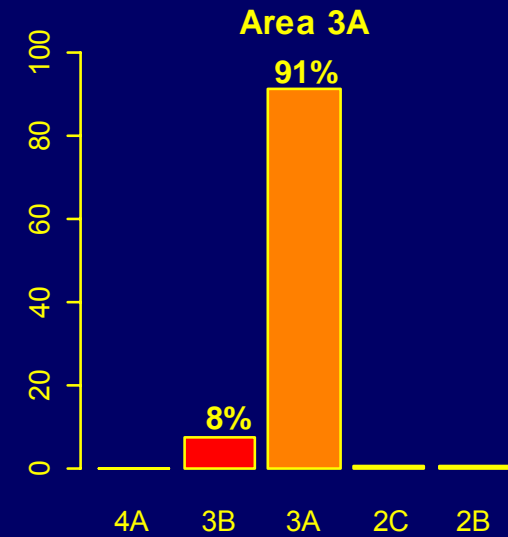
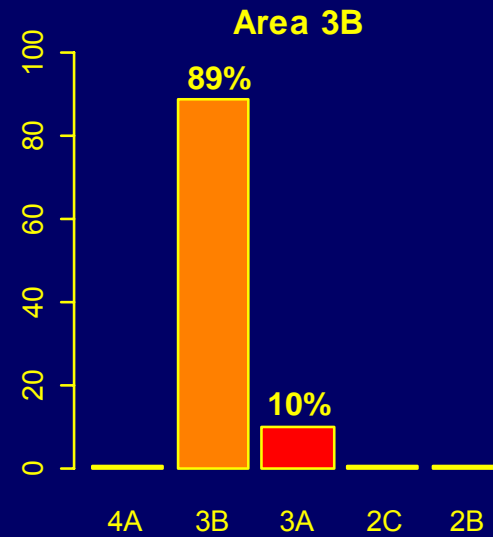
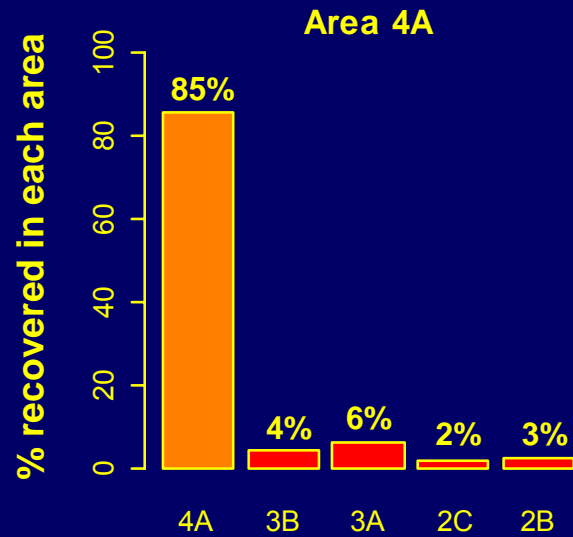
Bayesian modelling of the rate of natural mortality



Movement from release area after 1 year (% of total recoveries for each release area)



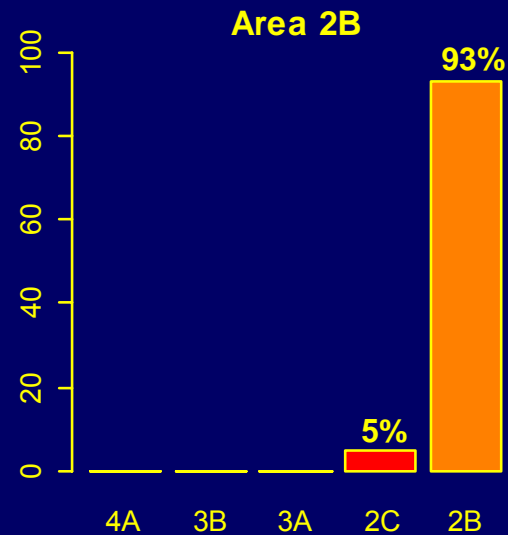
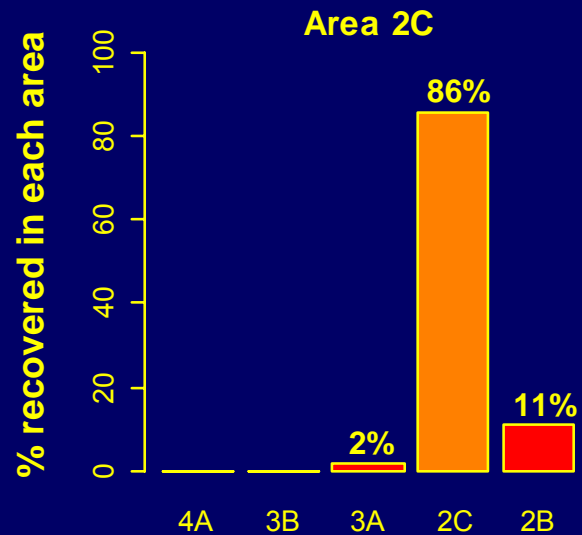
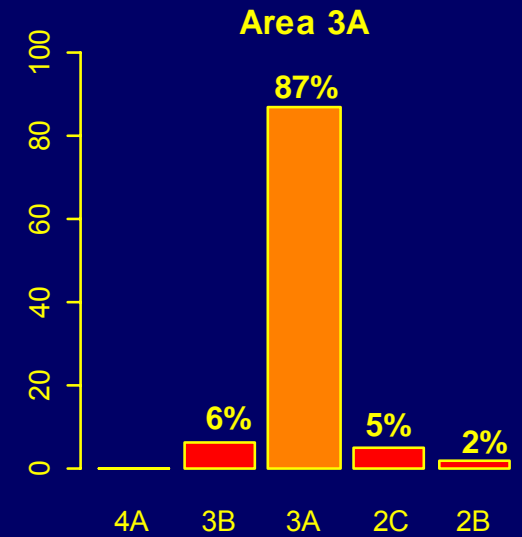
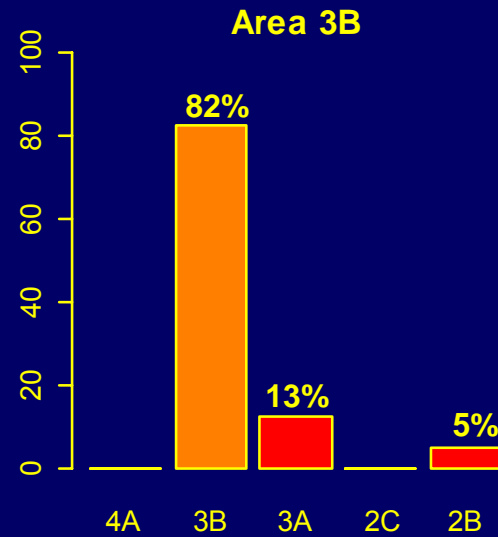
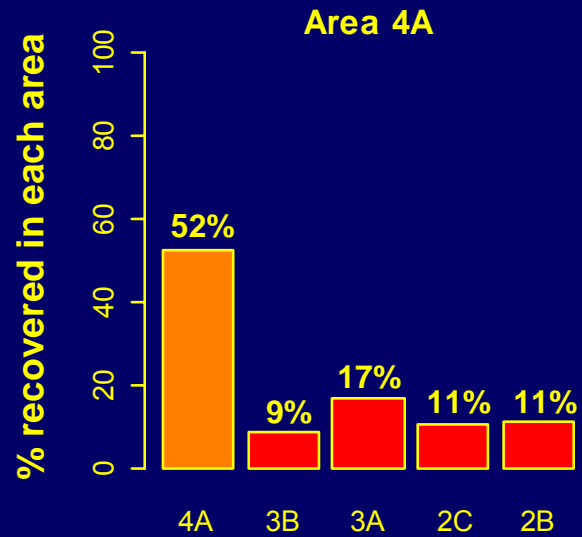
Model estimates of 1 year migration rates (%) from release areas (accounting for recovery rates)



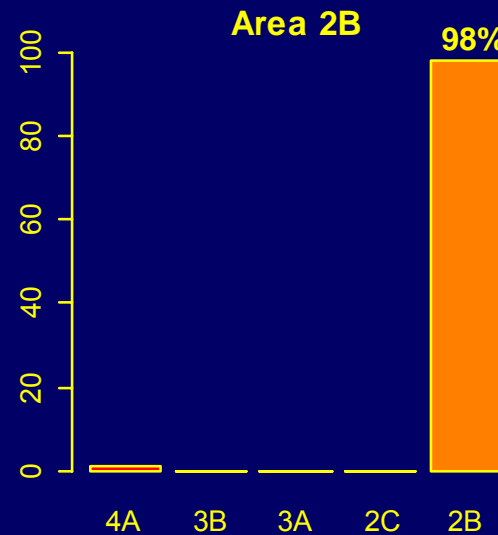
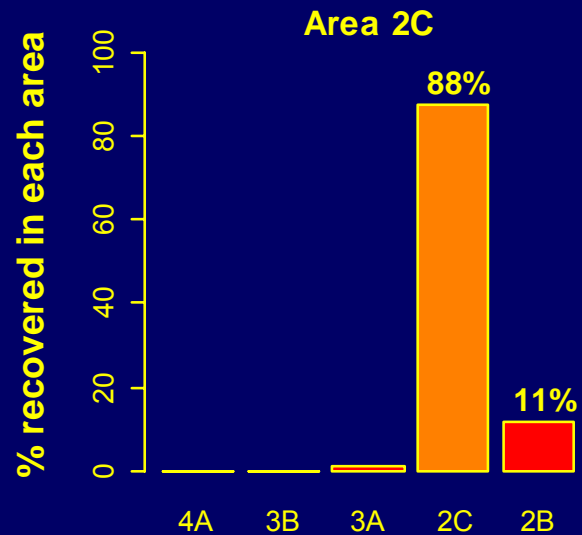
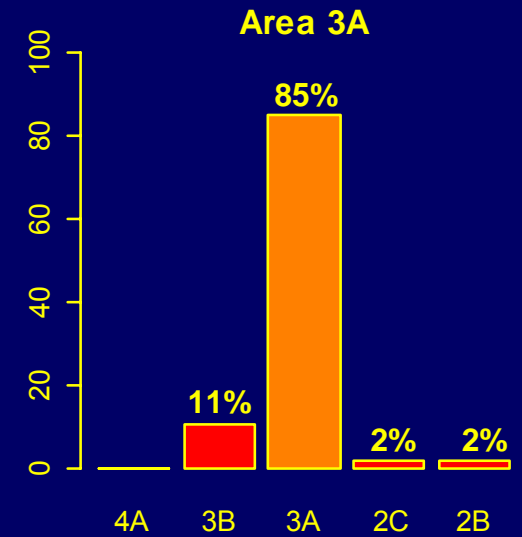
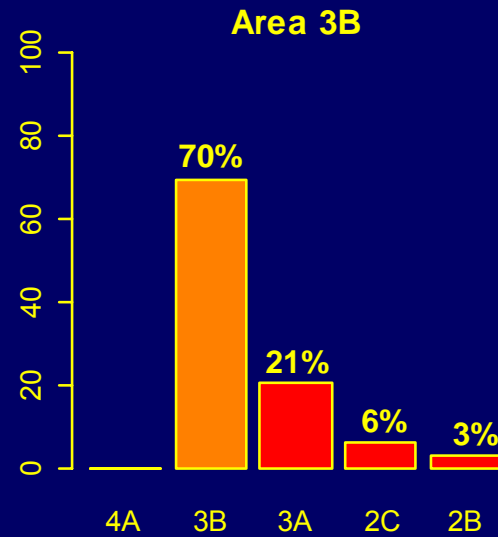
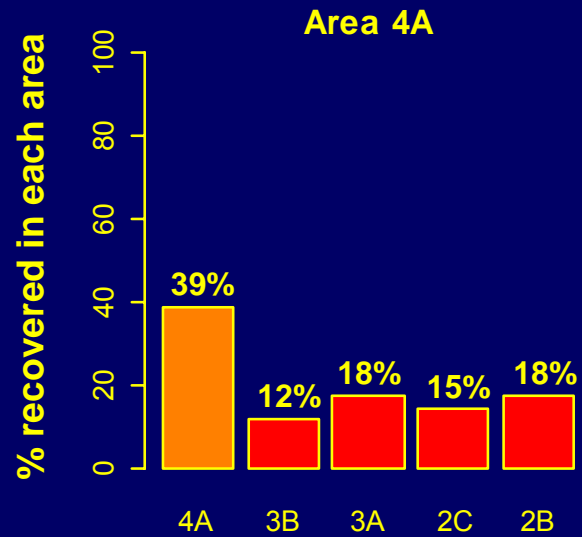
Fish Migration

- The raw data suggest there are high rates of annual migration, particularly eastward from Areas 3B and 4A.
- The raw data do not account for differences in recovery rates between areas.
- Nevertheless, through examining these data, the patterns of halibut migration become apparent.

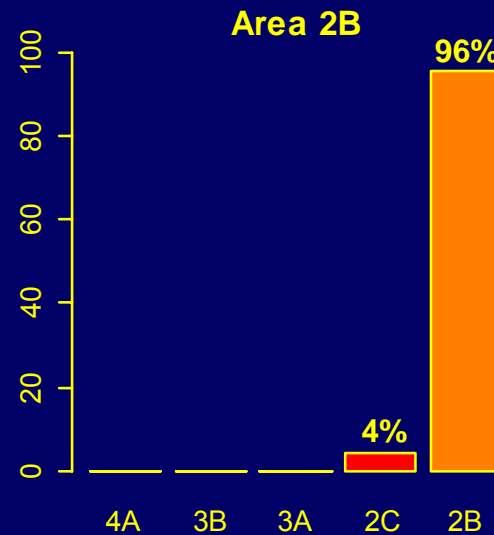
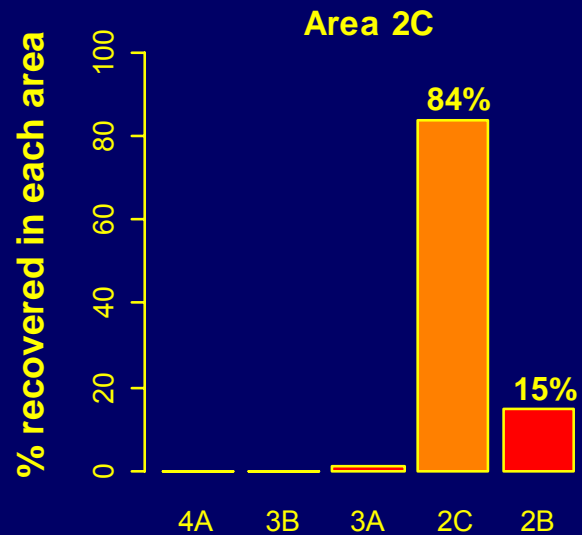
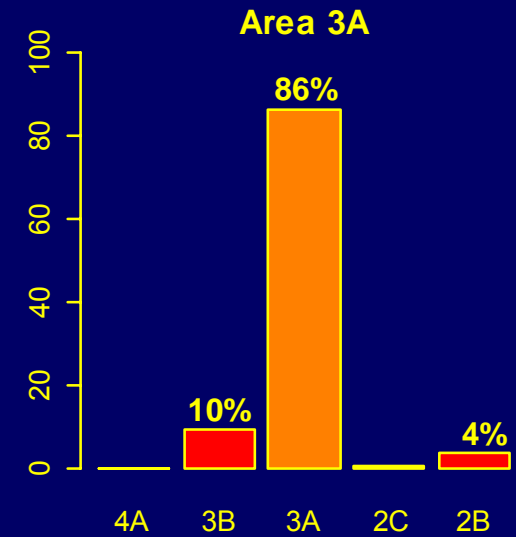
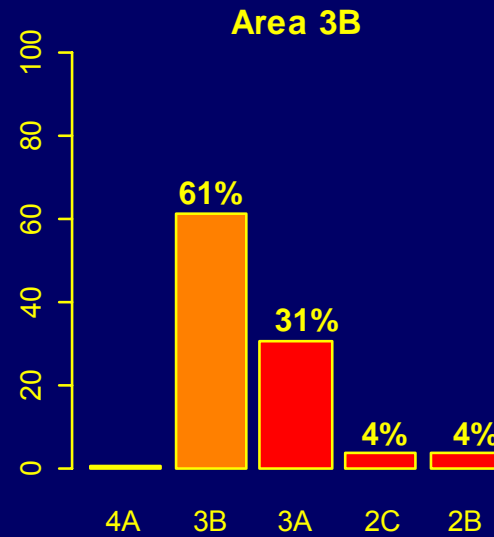
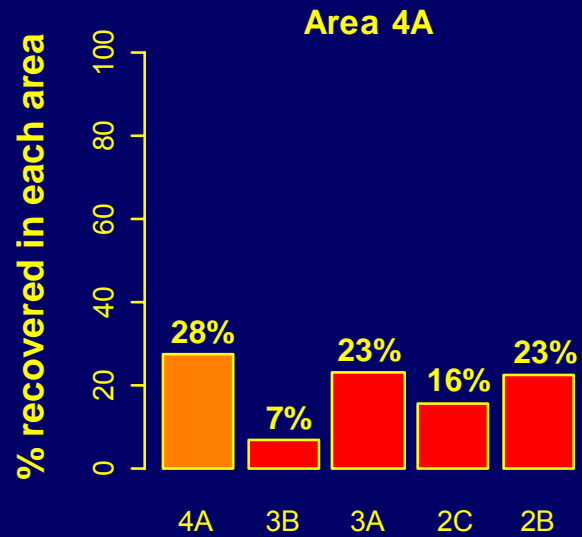
Movement from release area after 1 year (% of total recoveries for each release area)



Movement from release area after 2 years (% of total recoveries for each release area)



Movement from release area after 3 years (% of total recoveries for each release area)



Immigration

For 2003 coastwide releases, what proportion of recoveries in each regulatory area are from other areas?

Area	2004	2005	2006
2B	22%	30%	37%
2C	12%	13%	14%
3A	11%	18%	22%
3B	19%	19%	22%
4A	0%	0%	17%

Summary

- In 2006, we continued to observe low tag-recovery rates in western areas.
- However, recovery rates increased over previous years in Areas 4A and 4D:
 - Will this trend continue in the next two years?
- We observed significant migration of tagged fish, largely in an eastward direction.
- This migration occurs for fish of all length classes.