



Estimating Movement Rates of Pacific Cod (*Gadus macrocephalus*) in the Bering Sea and the Gulf of Alaska Using Mark-Recapture Methods

NPRB Project 620

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Four data sets were considered

- RACE I** Released throughout the eastern Bering Sea between 1982 and 1990 as part of the AFSC, RACE Division summer trawl survey (Shimada and Kimura, 1994)
- ADF&G** Released in the Gulf of Alaska (mostly nearshore and mostly near Kodiak Island) between 1997 and 2006 by the Alaska Department of Fish and Game (D. Urban)
- FIT** Released near Unimak Pass in 2002 and 2003 as part of AFSC Fisheries Interaction Team experiments on localized depletion of Pacific cod
- RACE II** Archival tags released near Kodiak Island and near Unimak Pass between 2001 and 2005 by the AFSC RACE Division (Nichol and Chilton, 2006)

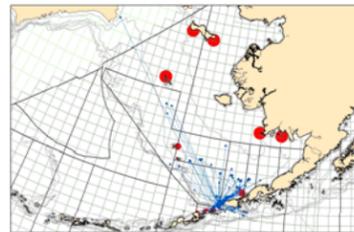
Summaries of the four data sets

	RACE I	ADF&G	FIT	RACE II
Number Released	12,396	13,858	6,393	634
Number Recaptured	375	802	2,487	287
Mean Recovery Rate	3.0%	5.8%	38.9%	45.3%
Year X Area Combinations	76 out of 153	41 out of 60	10 out of 20	9 out of 28

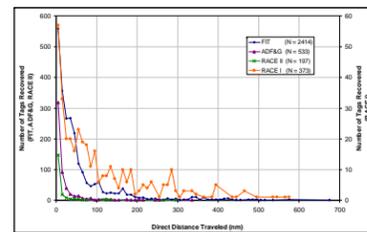
We had intended to use these data in an expanded Brownie model (Brownie et al, 1993) as utilized to estimate movement rates of Pacific Halibut (Anganzuzi et al, 1994). However, none of these data sets suited the models, being too disjoint in both time and space.

Qualitative Descriptions of movement: Site Fidelity?

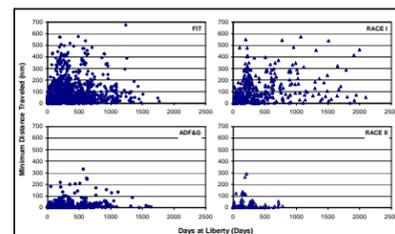
Distance and direction between release and recovery in the eastern Bering Sea. (FIT data only)



Number of tags recovered by release and recovery distance (all data sets)



Release and recovery distance by days at liberty (FIT data only)



Distance between release and recovery and time at sea (FIT data only)

	Release Group 1 (April 2002)	Release Group 2 (February 2003)	Release Group 3 (November 2003)
Mean distance (between release and recovery)	71 nm	52 nm	53 nm
Days at liberty	332	209	260

These data cannot tell us if the cod stayed in place for most of a year or went away and came back.

Estimating Survival and Exploitation

Use Brownie I model (Brownie et al, 1985), analysis restricted to FIT data only.

There are a number of assumptions. In particular:

- Tag induced mortality estimated through independent, shipboard experiments
- Reporting rates estimated by assuming 100% of archival tags were reported because of high reward

The model predicted different survival and exploitation rates in different years.

Year	Survival		Exploitation	
	Estimate	Standard Error	Estimate	Standard Error
2002	0.5384	0.0255	0.1612	0.0088
2003	0.3617	0.0279	0.3224	0.0078
2004	0.4527	> 1.0000	0.2587	0.0173
2005	NA	NA	0.1434	> 1.0000

Differences among years are due to differences in timing of tag releases among release groups.

Selectivity: size specific recovery rates

- Assume: Natural mortality is NOT size dependent
- Tagging-induced mortality is negligible
- Availability and spatial distributions are not size dependent

Standardized recovery rates by size group and recovery gear type with days-at-liberty restricted to less than one year (FIT data only). An approximation of gear selectivity.

