Alaska Department of Fish and Game: Branded Animals Studies

Hastings, Jemison, Rehberg and Rea
Division of Wildlife Conservation, ADFG

Population Dynamics

Survival, Reproduction Recruitment and Distribution

- Pup branding
-Summer brand resighting throughout SEA and PWS
-Field camp at Lowrie Island and Sugarloaf Island – brand resights

Physiological Studies

Identification of Weaning & Diet

- Stable isotopes (whiskers), Fatty acids (blubber), Scats

Body Condition & Nutrition

- Morphometrics
- Deuterium, BIA
- Blood chemistry
- Muscle biochemistry
- Total body oxygen stores

Contaminants & Disease

- Serology, Parasitology, Virology, Contaminants, Hp

Foraging Ecology

Juvenile Movement & Dive Ontogeny

-Dispersal, development of diving duration and depth
-Organization of diving behavior
- ontogeny of fine scale foraging behavior

Population Dynamics

Survival, Reproduction Recruitment and Distribution

- Pup branding
-Summer brand resighting throughout SE AK and PWS
-Field camp at Lowrie Island and Sugarloaf Island – brand resights

Physiological Studies

Identification of Weaning & Diet

- Stable isotopes (whiskers), Fatty acids (blubber), Scats

Body Condition & Nutrition

- Morphometrics
- Deuterium, BIA
- Blood chemistry
- Muscle biochemistry
- Total body oxygen stores

Contaminants & Disease

- Serology, Parasitology, Virology, Contaminants, Hp

Foraging Ecology

Juvenile Movement & Dive Ontogeny

-Dispersal, development of diving duration and depth
-Organization of diving behavior
- ontogeny of fine scale foraging behavior

Top priority studies

1. Age-specific survival rates
   - *by natal rookery, sex, body size, body condition indices*
   - *by movement patterns/weaning status*
   - *by other physiological/health parameters; diet, dive patterns*

2. Age-specific reproductive rates

3. Age-specific movement patterns

4. Age-specific weaning rates

branded at rookeries

Year	F	H	V	W	
1994	399				
1995	400				
2001	286	213			
2002	141		50	127	
2003	291	101			
2004	278			94	
2005		225	43	147	
Total 2001-05	996	539	93	368	**1996**

branded: dive captures

Year	Central AL	Central GOA	Eastern AL	Eastern GOA	SE	Western GOA
2001		12	10	24	76	6
2002	15			42	39	
2003	9			26	19	
2004	6		2		49	
2005	16			63		
2007				36		
2009					31	
Total	46	12	12	191	214	6

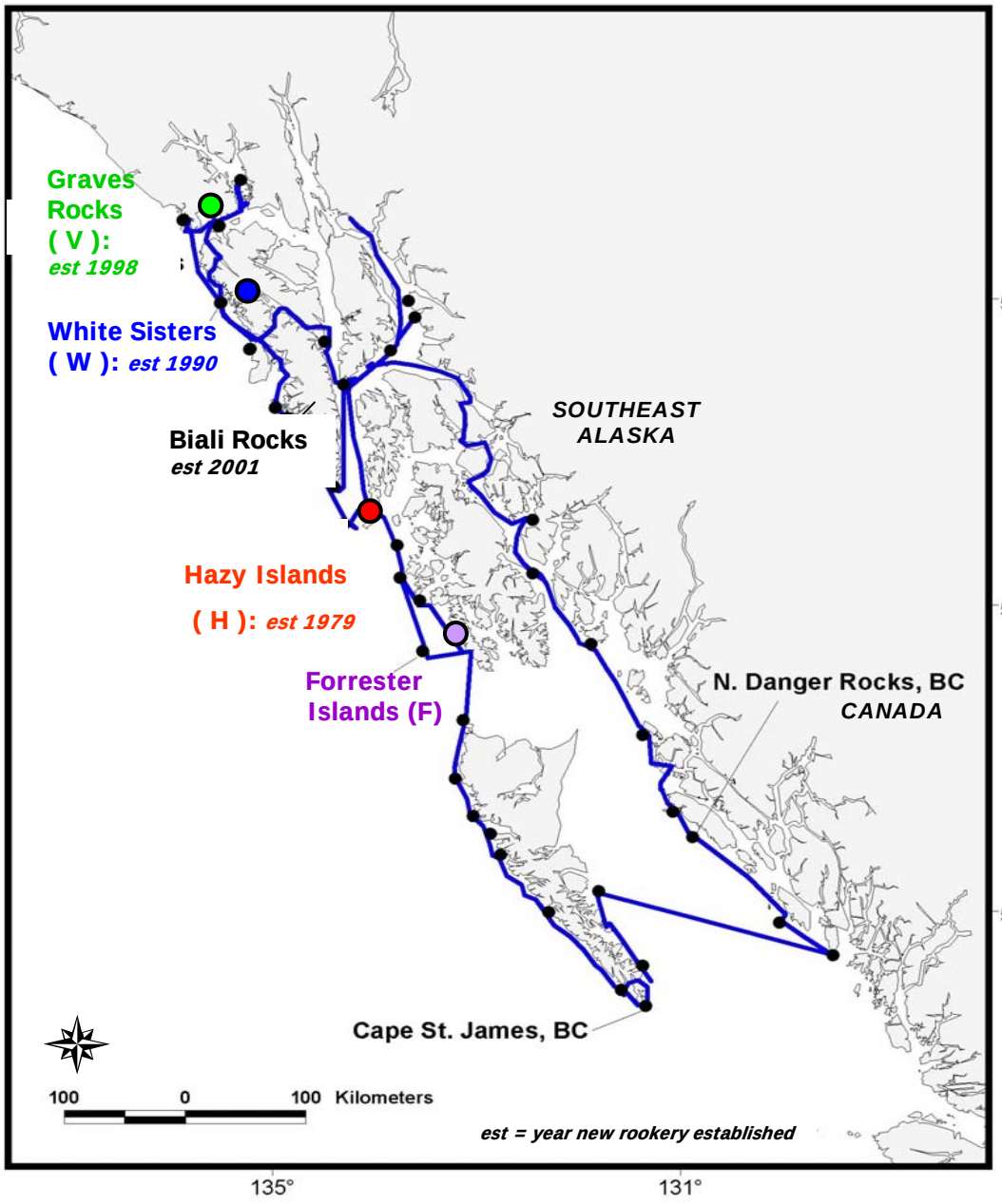
481

branded individuals resighted/summer

Summer	ADFG animals	NMML animals	ASLC animals
2001	506	10	
2002	666	48	
2003	813	28	1
2004	820	29	
2005	1045	48	
2006	772	45	2
2007	709	105	5
2008	641	210	14
2009	634	166	39

7356

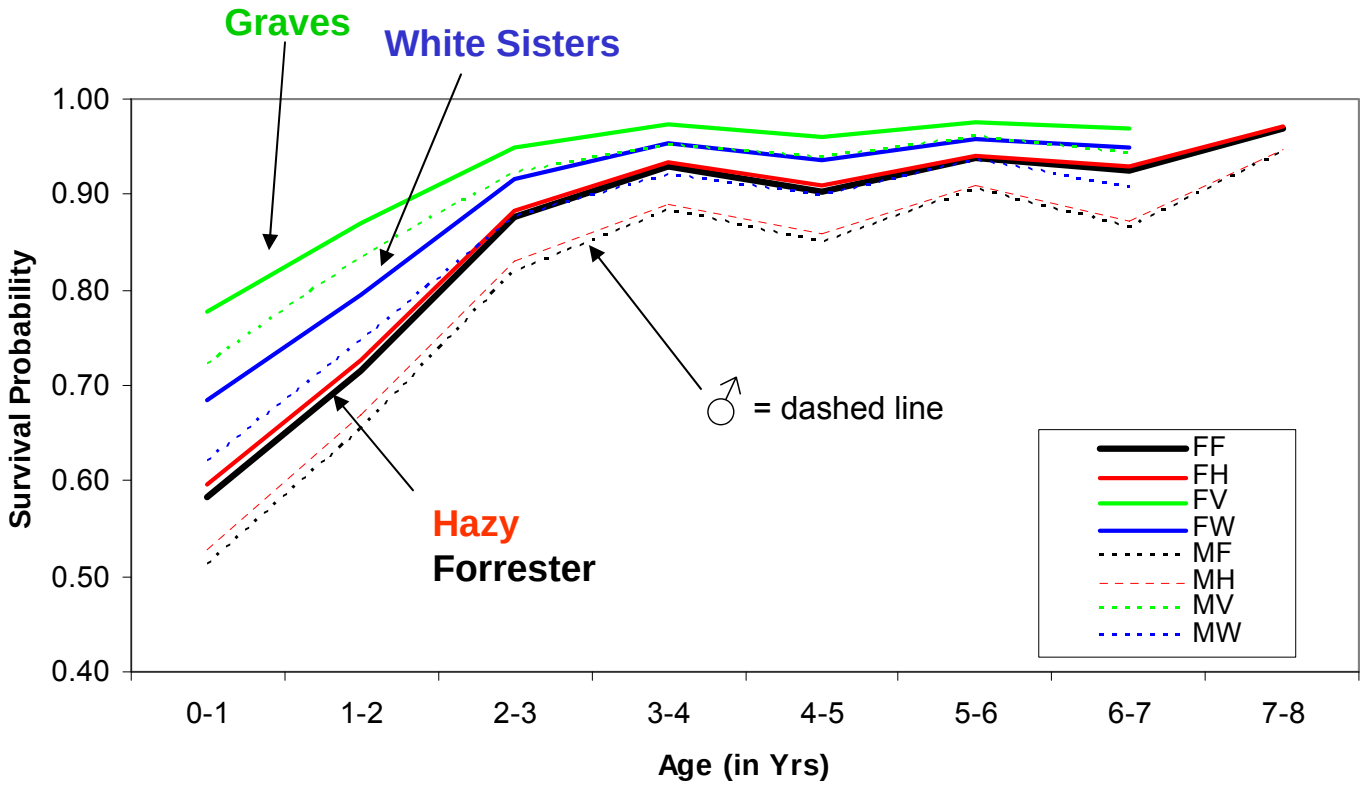
Annual summer resight survey: SE/BC



Survival Analysis: Methods

- Data from 2001-2009, May – August data pooled
- Includes main ADFG summer resight data + resights from Bristol Bay – California *(few males seen outside SE in summer; females seen in BC)*
- All major haulouts in SE and Northern BC visited during 2-3 wk window *(1 visit - small haulout, 2 visits - select large haul-outs, 3-7 visits rookeries, except field camp at Forrester Islands mid-May - ≥ 10 July with high effort)*
- Cormack-Jolly-Seber Model: Program MARK
  - tested effects of natal rookery, sex, age and year
  - age modeled as 2, 3 and all separate age-classes, and as linear trend with age
  - tested all 2 and 3-way interactions
  - Starting from the most complex model: first simplified resight rate then survival rate, after testing goodness of fit
  - estimates from model averaging; models weighted by AICc
  - tested year effects for all ages and only for 1st year survival

Survival Analysis: Results *(estimates from model averaging)*



Females	Cumulative Survival 0-7 Yrs	Relative to V
F	**0.267**	-0.529
H	**0.284**	-0.499
W	**0.405**	-0.285
V	**0.566**	
Males		**Relative to Females**
F	**0.161**	-0.395
H	**0.177**	-0.374
W	**0.285**	-0.296
V	**0.450**	-0.206

Precision of model averaged estimates

	min(se)	avg(se)	max(se)
0-1	0.02	0.03	0.04
1-2	0.02	0.03	0.03
2-3	0.02	0.03	0.03
3-4	0.01	0.02	0.04
4-5	0.01	0.02	0.03
5-6	0.01	0.03	0.05
6-7	0.02	0.03	0.05
7-8	0.04	0.05	0.07

Preliminary unpublished data, do not cite

Survival Analysis: Preliminary conclusions

These are model-averaged survival estimates. Graves Rock (and less so White Sisters) have particularly high survival – especially at ages 0-2 yrs.

These differences among rookeries result in ~50% less Forrester and Hazy individuals alive at 7 yrs of age compared to animals from Graves Rock, and nearly 30% less White Sisters individuals alive at 7 yrs of age compared to Graves Rock. Cumulative survival of males to 7 yrs of age ranged 20-40% lower than females.

Future modeling of these data will include multi-state models to determine if survival of males is biased low by their greater tendency to move out of Southeast/BC, and will examine if natal rookery versus areas used (where they were born and what areas they generally use were correlated in preliminary analyses) are better predictors of survival probability. Body size and physiological parameters will also be examined.

Reproductive Rates: Methods

- 2005-2009: 3-7 half-day surveys over a 2-4 day window/rookery during early-mid July

- Since 2005 *(when 2001 cohort reached 4 yrs of age)*
  - all 4 SE rookeries + Biali Rocks

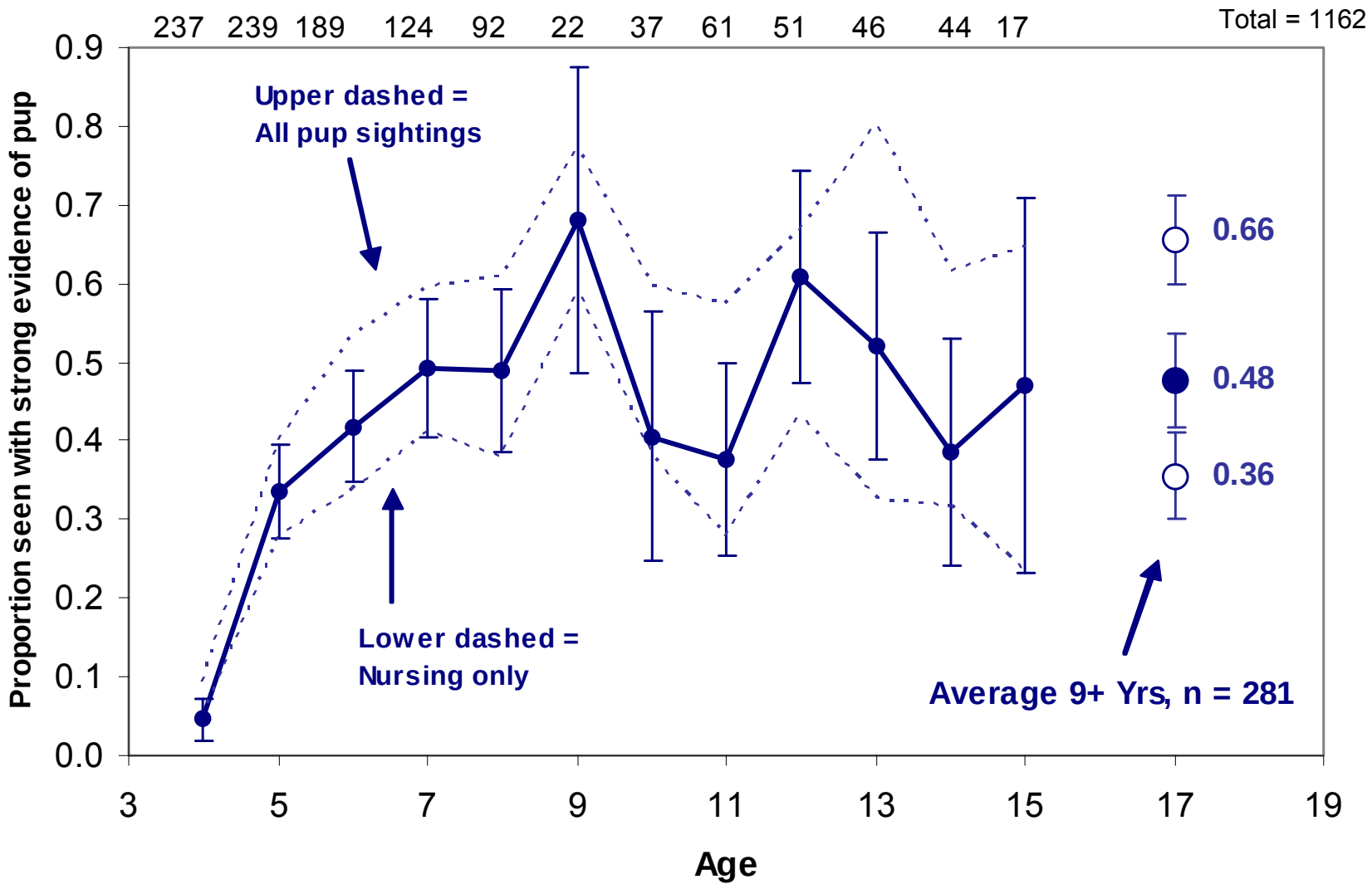
- Since 2007-08:
  - ADFG – Seal Rocks and Fish (PWS), Sugarloaf (CGOA)
  - NMML: Marmot (CGOA) and Ugamak (EAL)

  Additional years of data are required for analysis

- Robust design:
  resighting rate of females by reproductive status, pup detection probabilities, reproductive rates, and survival costs of reproduction

Proportion seen with pup at rookeries: Results

(all sites/years)



Preliminary unpublished data, do not cite

Reproductive Rates: Preliminary conclusions

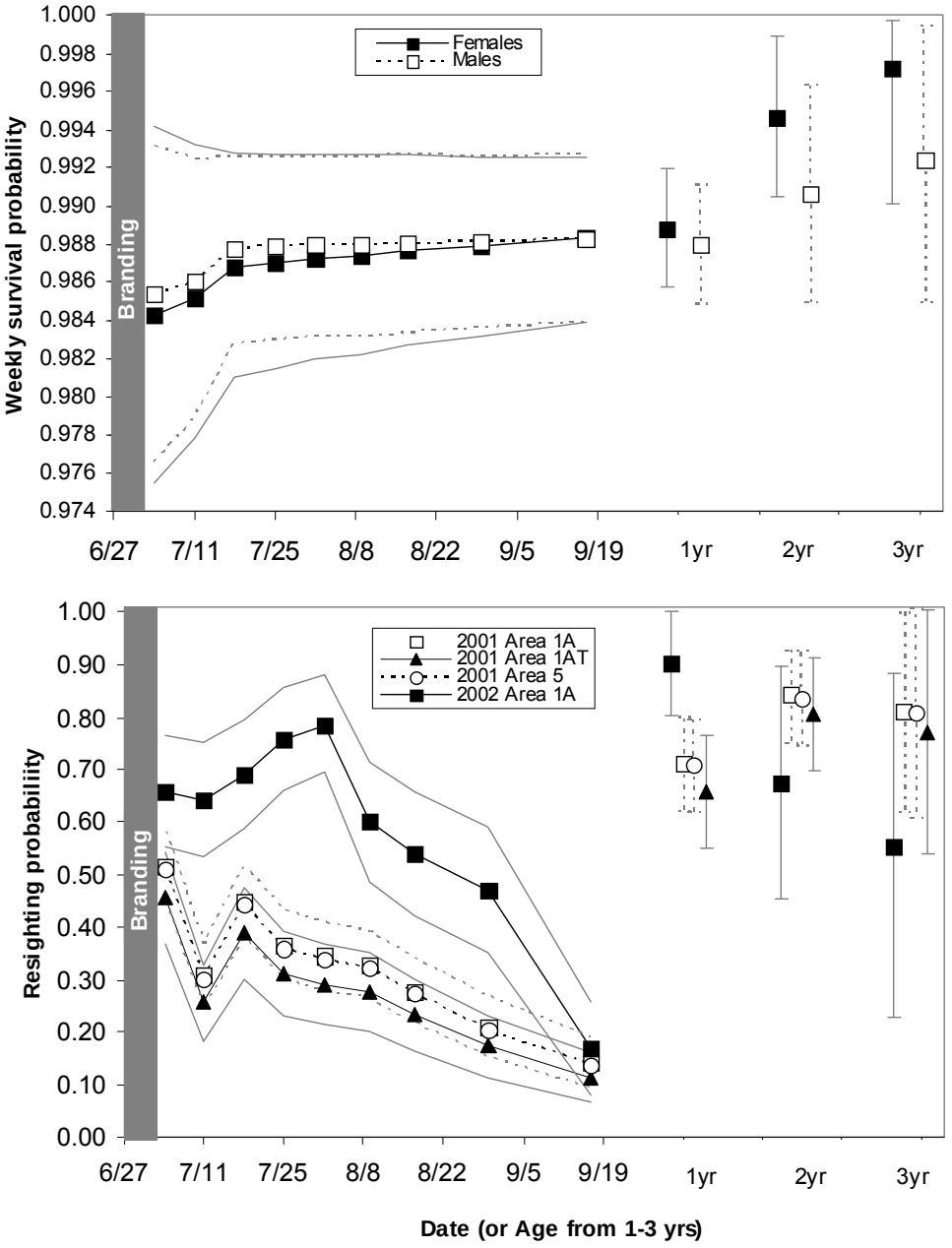
Because these surveys are conducted early to mid July, after essentially all pups are born, it really serves as an index and is better described as the production of more "viable" pups (pups produced and alive by the end of the pupping window) and does not include at least some early pup mortality.

These surveys are based on a robust design with half-day surveys within year as secondary occasions and years as primary occasions. We were interested in a model used by Bill Kendall to estimate manatee reproductive rates that estimated probabilities of detecting offspring and resighting females based on reproductive status so that estimates of reproductive rates would not be biased by these parameters.

Few pups are produced by 4 yr olds and at least 0.50 of females at rookeries are with pup based on the strong evidence category, or 0.66 for the most lenient “with pup” category or 0.36 for the most stringent nursing category. However, these are not reproductive rate estimates because female resight rates, pup detection rates, and females not at rookeries are not yet considered.

Pup survival to 3 months post-branding at Lowrie Island:

Hastings et al. 2009, JOURNAL OF WILDLIFE MANAGEMENT 73(7):1040–1051



Pup survival to 3 months post-branding at Lowrie Island:

Hastings et al. 2009, JOURNAL OF WILDLIFE MANAGEMENT 73(7):1040–1051

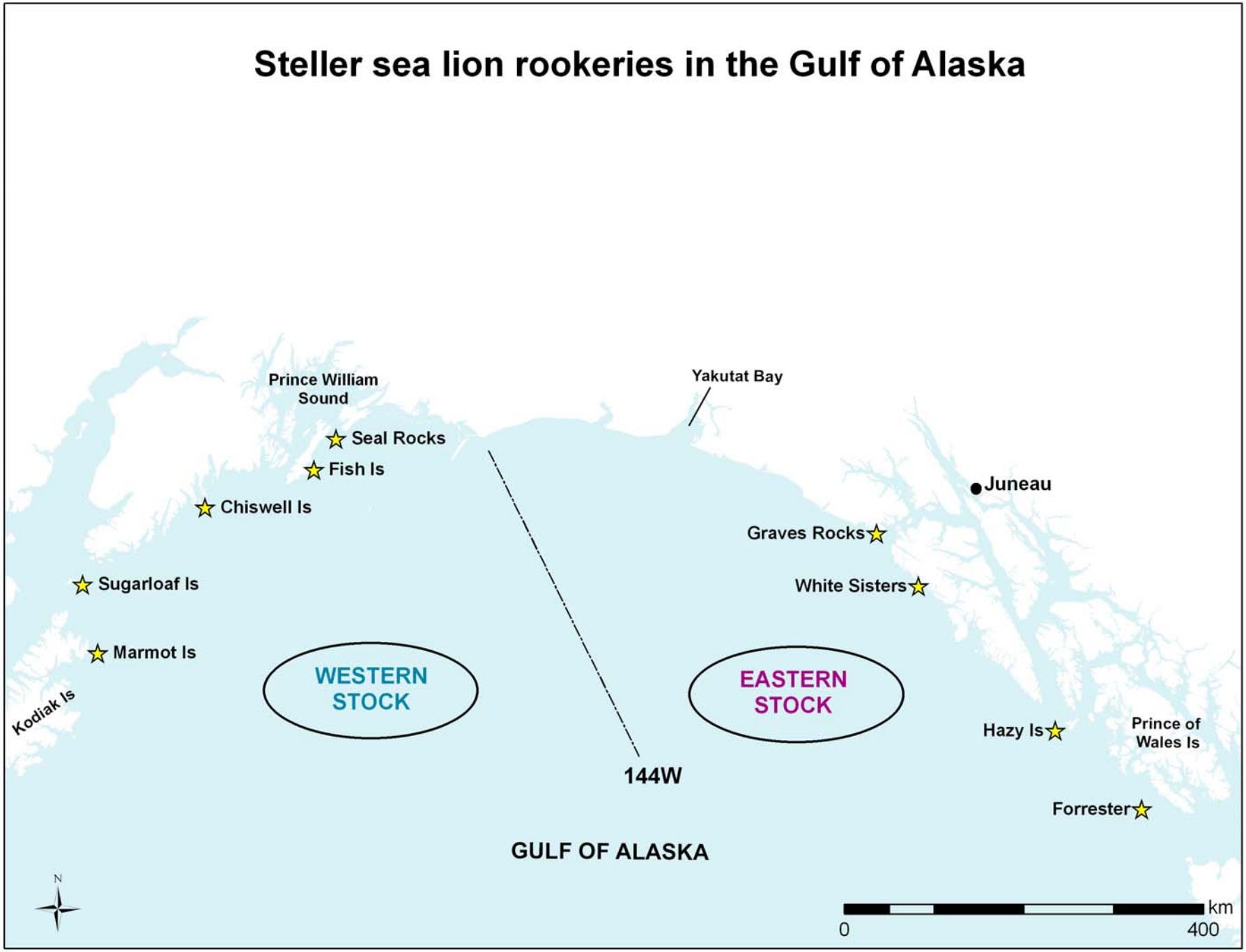
Available information on survival rates and demonstrated that acute mortality following the branding disturbance was not supported at our study site.

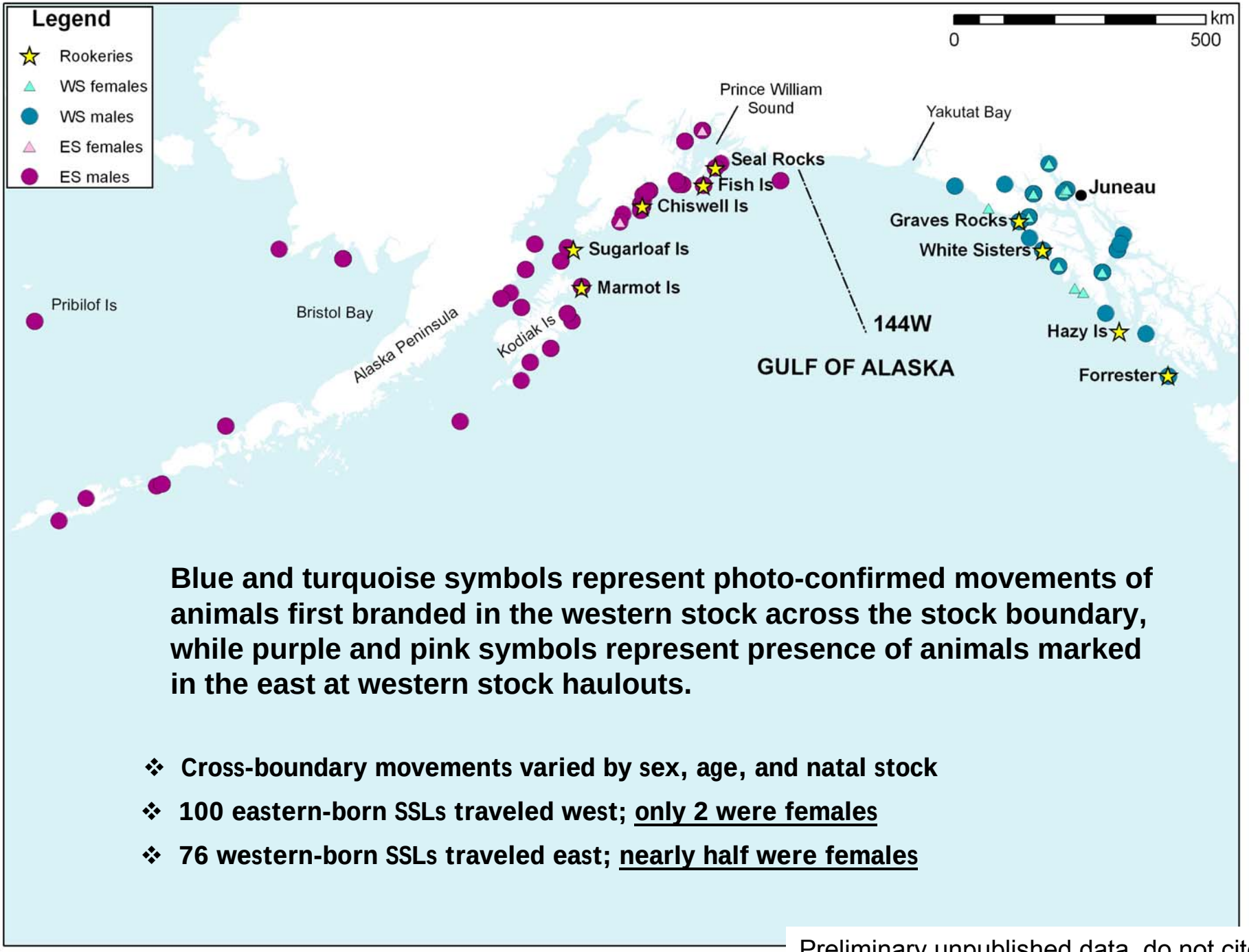
A small dip in survival during the first 2 weeks post-branding was statistically significant but biologically negligible and, if caused by the disturbance or branding, would have resulted in only 0.5–0.7% additional mortality, or one pup for every 200 marked.

Weekly survival of branded pups was nearly identical to estimates from a control group of undisturbed, unbranded pups born to 10–11-year-old branded adult females in 2005 (0.987–0.988/week) and similar to pup survival estimates from other otariid studies.

Available data did not indicate substantial mortality to 12 weeks postbranding resulting from the branding disturbance.

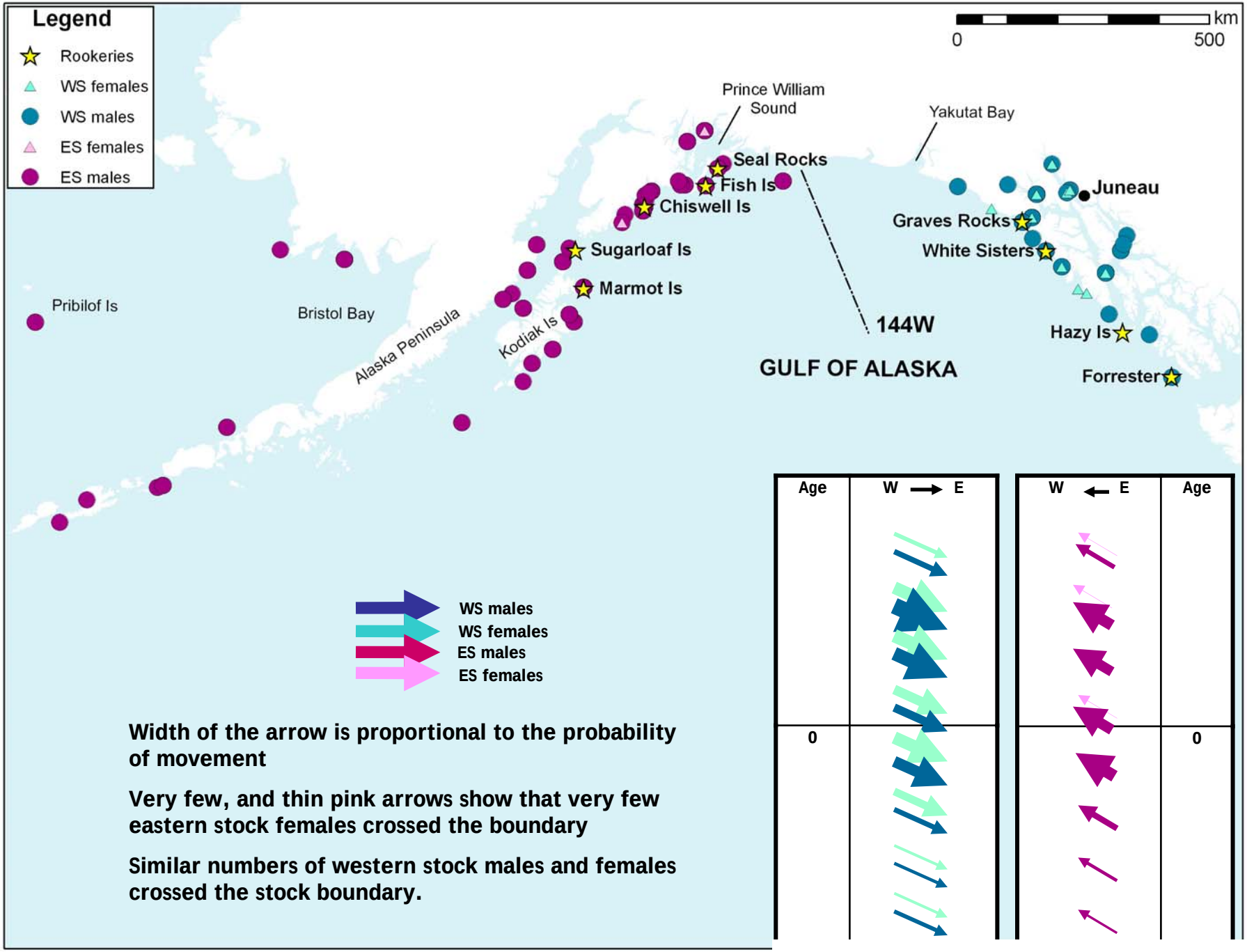
Steller sea lion rookeries in the Gulf of Alaska





Blue and turquoise symbols represent photo-confirmed movements of animals first branded in the western stock across the stock boundary, while purple and pink symbols represent presence of animals marked in the east at western stock haulouts.

- **Cross-boundary movements varied by sex, age, and natal stock**
- **100 eastern-born SSLs traveled west; only 2 were females**
- **76 western-born SSLs traveled east; nearly half were females**



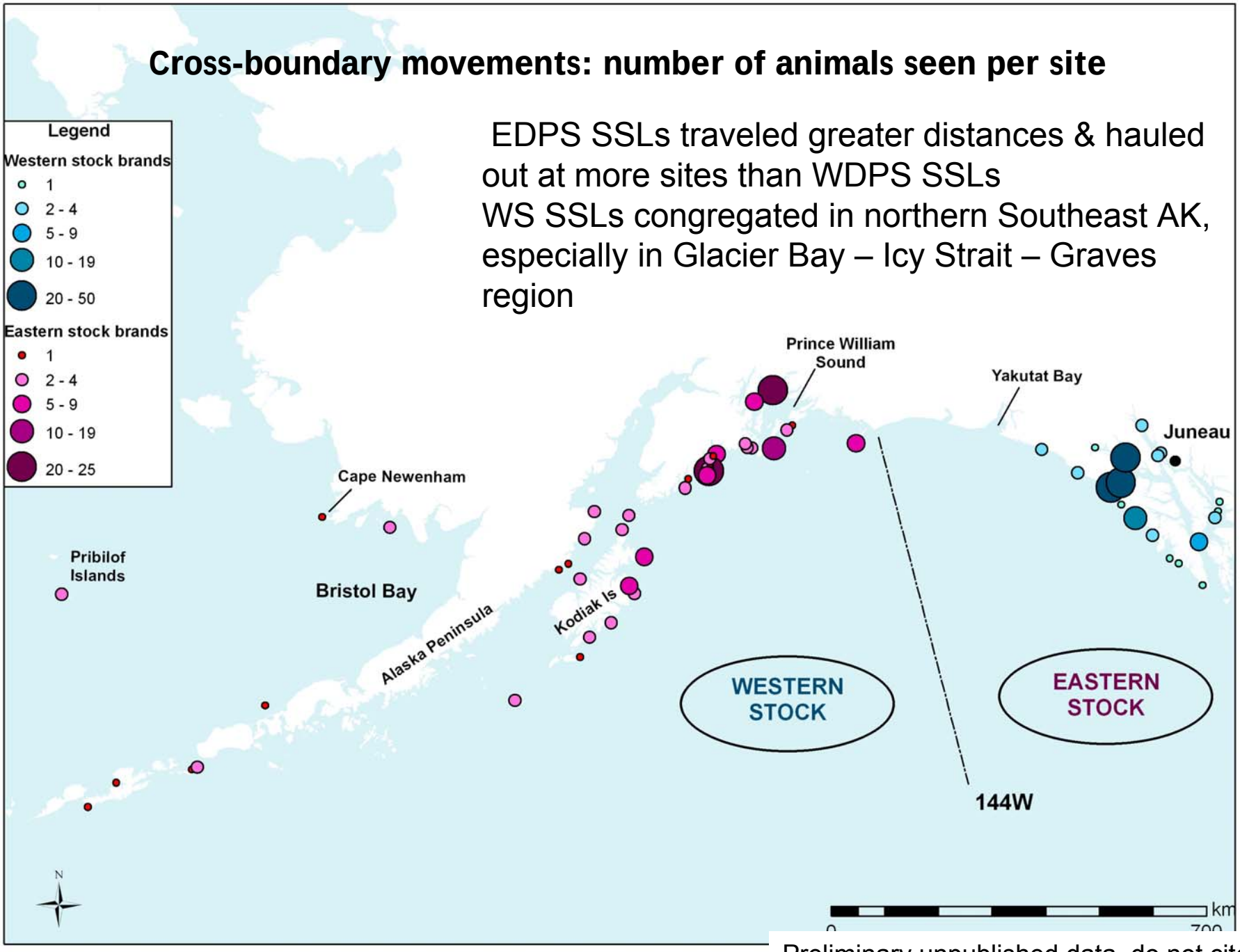
Proportion of branded animals that traveled to the opposite stock

NATAL ROOKERY	SEX	PROP'N
Forrester + Hazy	F	0.00
Forrester + Hazy	M	0.09
White Sisters + Graves	F	0.01
White Sisters + Graves	M	0.07
PWS	F	0.13
PWS	M	0.11
Marmot + Sugarloaf	F	0.04
Marmot + Sugarloaf	M	0.06

Females from southern EDPS rookeries were not seen in ‘opposite’ stock
Females from PWS were most likely to cross stock boundary

Cross-boundary movements: number of animals seen per site

EDPS SSLs traveled greater distances & hauled out at more sites than WDPS SSLs
WS SSLs congregated in northern Southeast AK, especially in Glacier Bay – Icy Strait – Graves region



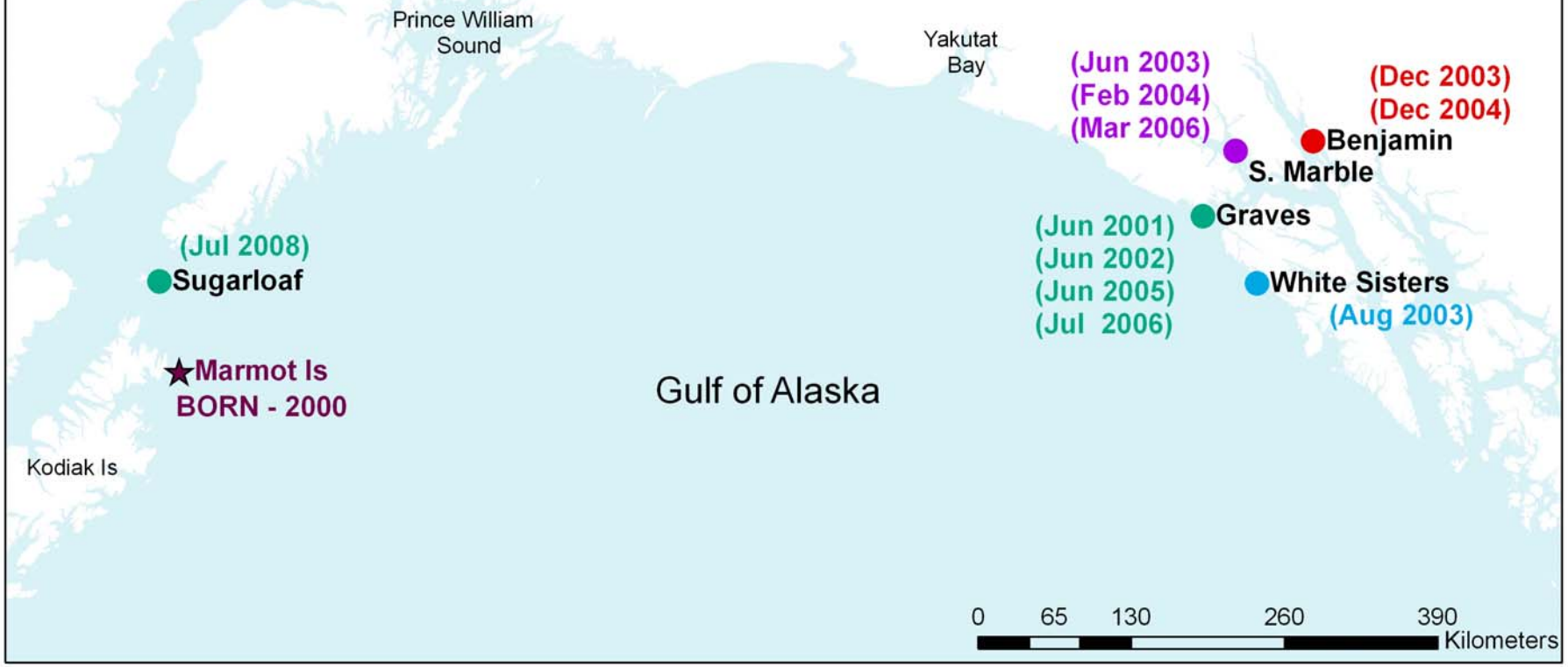
Preliminary unpublished data, do not cite

Summary of female cross boundary movements

- 7 western-born females had a pup in the east (at Graves or White Sisters)
- 6 of these 7 were 5 years of age when they first pupped in EDPS
- 1 female born in Oregon had a pup at Graves Rock
- 1 of the 2 EDPS females that traveled to the WDPSS returned to her natal rookery at age 5

Emigration??

T23 was born at Marmot Is (WDPS) in 2000, had a pup at Graves (EDPS) in 2005, then at Sugarloaf (WDPS) in 2008. So, if we see a female pupping in ES, at what point do we consider it a permanent move?

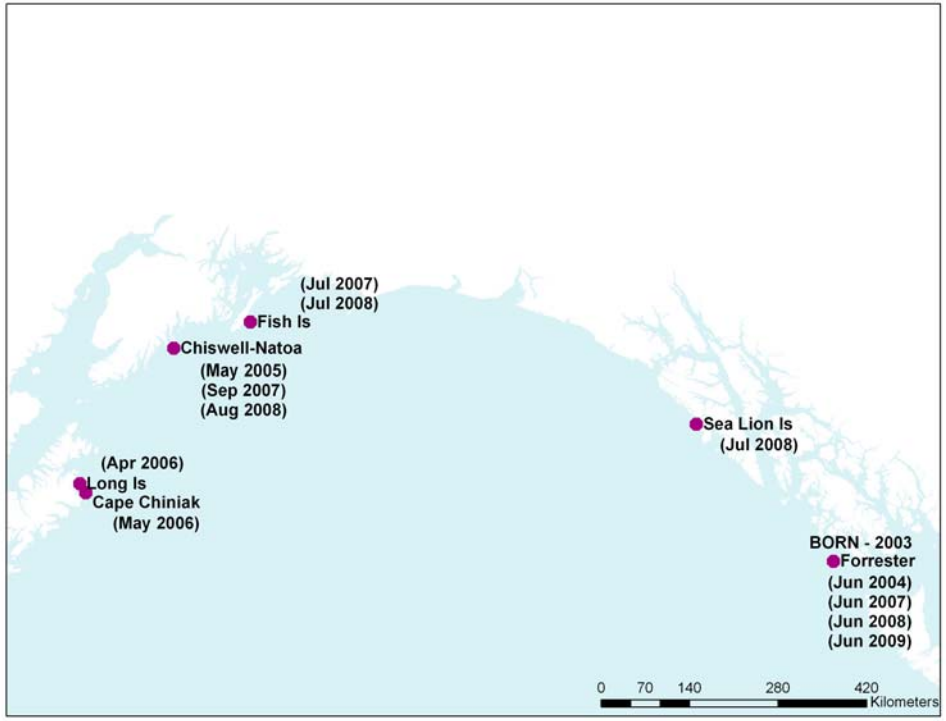


Movements by males

- **SSLs seen in the 'opposite' stock often return to their natal stock, even after several years; this appears to be especially true of males, making 'permanent' emigration somewhat difficult to detect**

- **12 ES males branded in 1994-1995 traveled west; 9 returned to establish territories in their natal stock; we have not documented a male holding a territory in the 'opposite' stock**

This figure shows the repeated cross-boundary movement by a Forrester male, born in 2003 (F115). We don't know if these back-and-forth movements will continue once the male is of breeding age. Based on photo-confirmed 94-95 brand data, the majority of males that traveled west returned to establish territories in their natal stock.



F1135 – male, born at Forrester in 2001

Last seen Aug 2007
Glacier Bay

Juneau

BERING SEA

2005

May 2007

2003

Jul 2007

Sitka

2006

2002

Bristol Bay

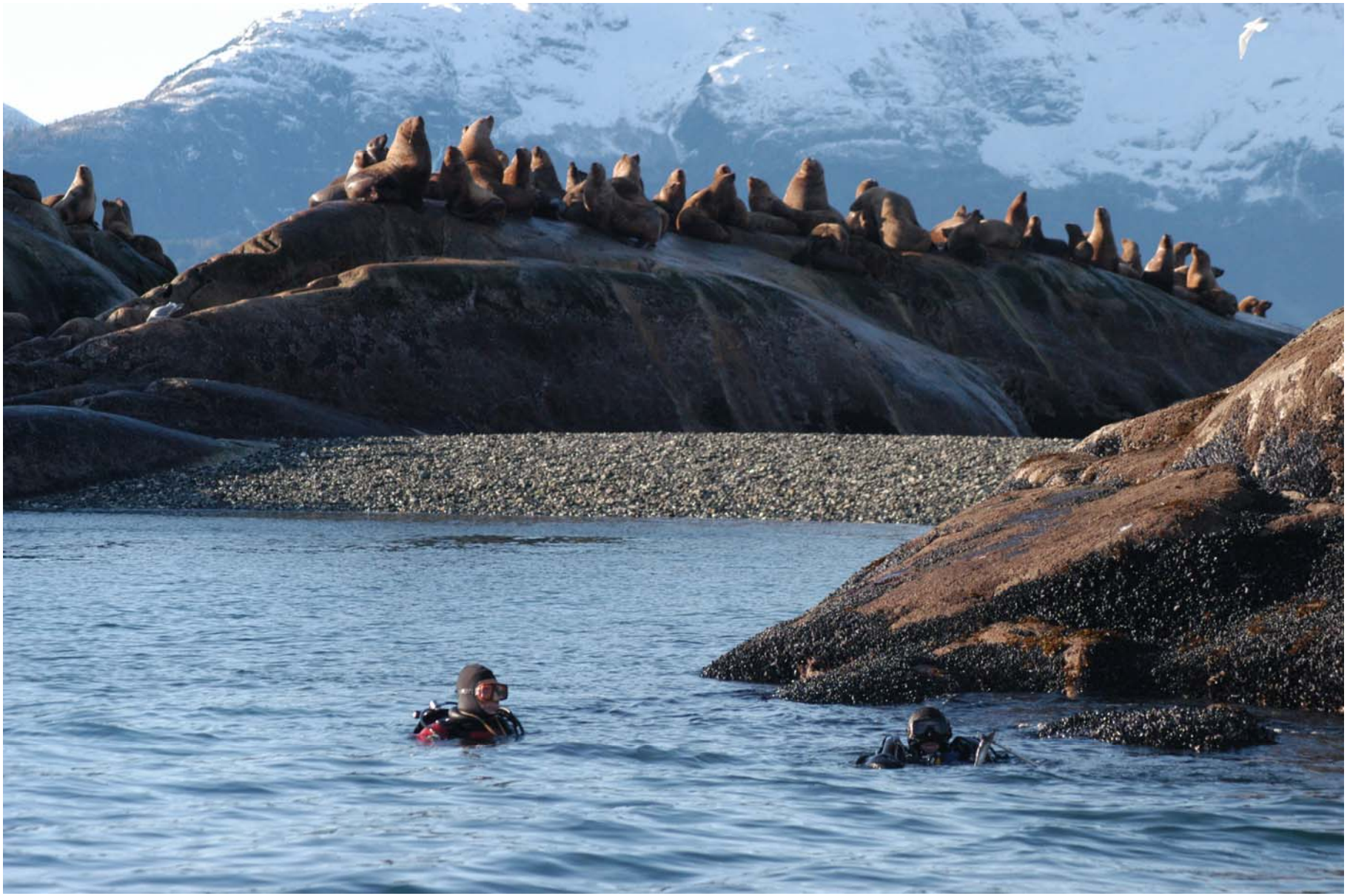
Mar 2007

Kodiak Is

2002 = Biali
2003 = South Marble Island (SMI)
2005 = Round Is
2006 = Marmot Is
2007 = Mar: St. George, May: Chiswell, July: White Sisters (with Flasher), Aug: SMI

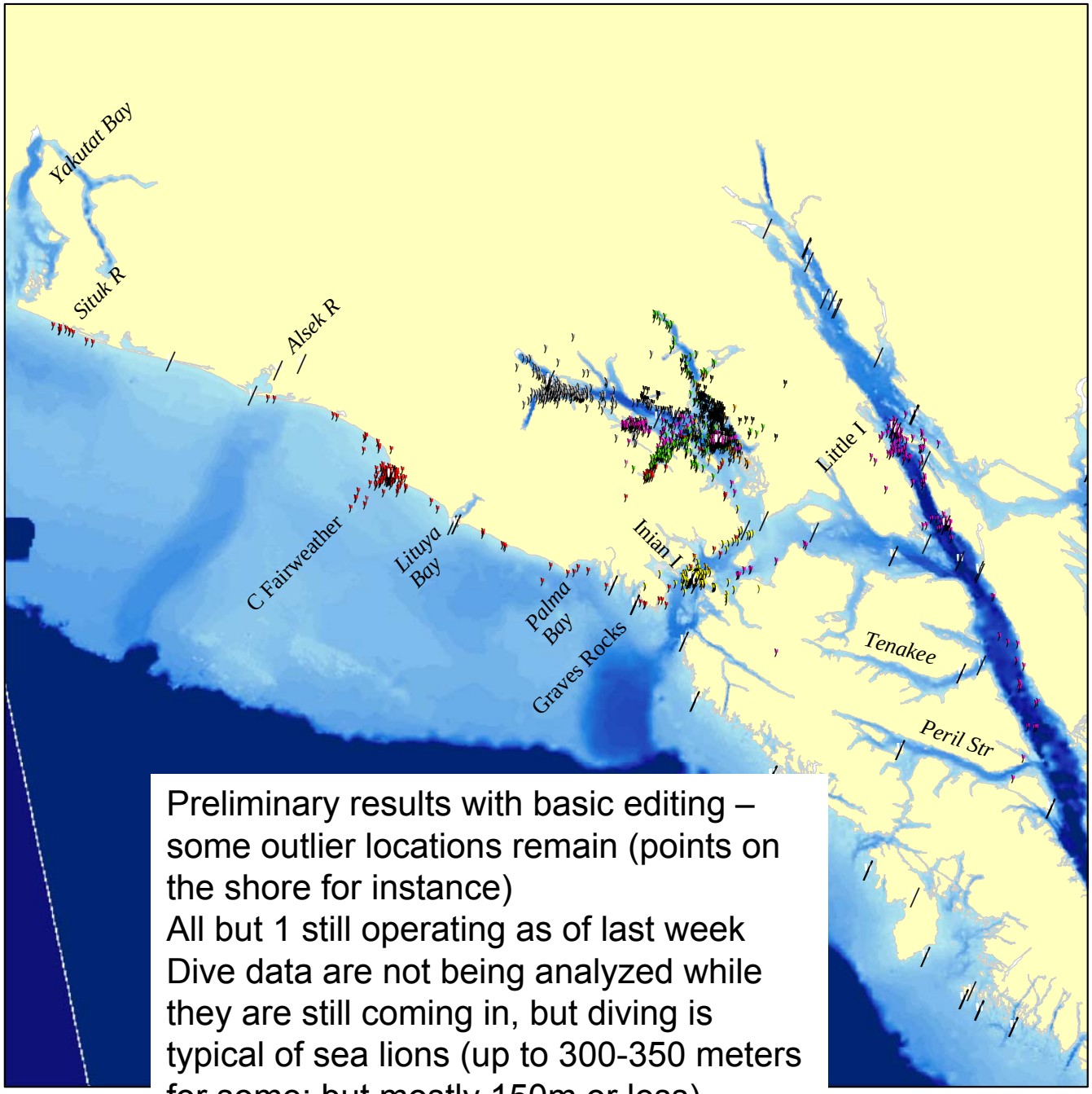
Summary

- The probability of WDPS SSLs being seen within EDPS is similar between sexes
- EDPS males regularly travel to the west but EDPS females very rarely do
- Some WDPS females were seen within the EDPS annually since a young age, eventually pupping in EDPS, suggesting permanent emigration; however, one sea lion following this pattern returned to WS and pupped there
- Concentration of WS animals in northern Southeast, especially reproductive females, suggests this region favorable for SSLs, also indicated by vital rates studies
- Growth of the SSL population in eastern GOA (WS) likely is not a result of immigrant females from the east pupping in the west; however, immigration from west to east likely contributes to population growth in ES, especially in northern Southeast



Dive captures at South Marble Island, November 2009

Dive captures at South Marble Island, November 2009



Steller Sea Lion Movements

Glacier Bay Deployment
Alaska Dept of Fish and Game

Nov 15, 2009 - Jan 15, 2010
Juveniles

Legend

Animal ID / Sex / Age Class

- SSL 719 M Juv
- SSL 720 M Juv
- SSL 722 M Juv
- SSL 724 M Juv
- SSL 725 F Juv
- SSL 727 F Juv
- SSL 742 M Juv

/ Haulout

> 600 m — 300 m — 0 m

Nautical Miles
0 10 20 30 40

Alaska Albers Projection / WGS84 Datum

Haulouts: ADFG Steller Sea Lion Project
Shoreline: Smith & Wessel GSHHS
Bathymetry: ADFG Alaska Coastal Bathymetry Project

These data are preliminary. Do not cite.

NOAA Permit 14325

25 January 2010
Michael Rehberg (michael.rehberg@alaska.gov)

Preliminary results with basic editing – some outlier locations remain (points on the shore for instance)
All but 1 still operating as of last week
Dive data are not being analyzed while they are still coming in, but diving is typical of sea lions (up to 300-350 meters for some; but mostly 150m or less)

wDPS location telemetry not included in NMML 2006 analysis:

Agency	Location	Dates	Age	n	Citation
ADFG	PWS	Nov-Dec	pup	7	unpub.
UAA	Kodiak	Mar-May	pup	5	#1
(Burns)	C. Aleutians	Apr-Jun	pup	6	#1
	C. Aleutians	Apr-Jun	juv	2	#1
	PWS	Nov-Mar	juv	11	#1 & 2
	PWS	Feb/Mar-May/Jun	juv	8	#1 & 2

#1 Rehberg and Burns 2008

#2 Frid et al. 2008

Age of Weaning

• needed to model productivity in SSL populations

•mark-resight models to estimate the probability of young SSL being weaned during their first, second or third years
•accounts for misclassification of weaned status

Estimates of the probability that a juvenile sea lion was weaned, that it would be sighted, and that it would be observed suckling if still dependent. Benjamin Island, SEA 2003-2004

Age (yrs)	Probability weaned	95% C.I.	Sighting probability	Probability observe suckling
0	**0.103**	0-0.285	0-0.81[1]	0.11-0.50*
1	**0.153**	0-0.389	0-1[2]	0.303
2	**0.910**	0.775-1	0.47-1.0[3]	0.14-0.56

[1]Varies with time
[2]Varies with weaning status & time, poorly estimated
[3]Varies with weaning status

Preliminary unpublished data, do not cite

Age of Weaning in Southeast Alaska

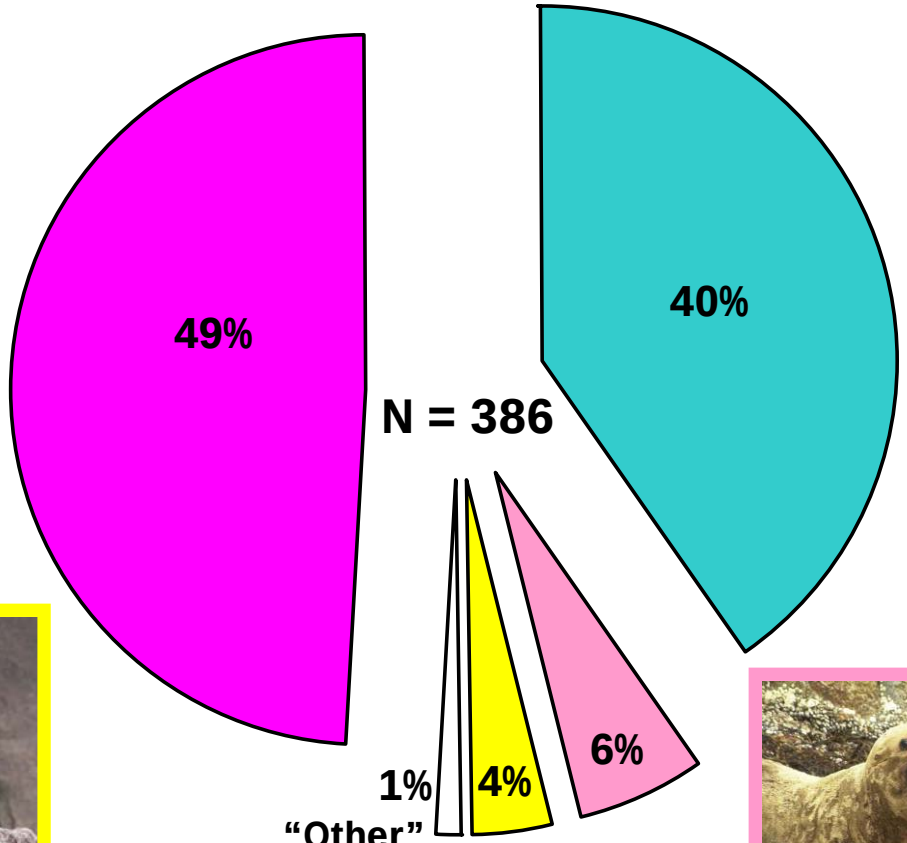
- Many juvenile SSL are suckling into their second year
- Study expanded to multiple sites in SEA in 04-05 and 05-06
- Similar patterns, possible high annual variability in proportion of juveniles weaned in their 3rd winter

- Reproduction in this population might be reduced from potential if all females were producing surviving pups annually
- Might enhance the survival of the juvenile during periods of suboptimal environmental conditions
- Life history strategy called “bet-hedging”

2000 – 2007

A *minimum* of 386 Steller sea lions entangled in marine debris in Southeast AK & northern BC

Neck Entanglement



Flasher

Hook and Line

Longline Gangion

Raum-Suryan, Jemison and Pitcher, 2009. Entanglement of Steller sea lions in marine debris: identifying causes and finding solutions.

NECK ENTANGLEMENTS

Neck entanglements: 189

Material unidentifiable: 77% of time

Material ID'd on 44 animals

PACKING BANDS (54%): bait boxes

RUBBER BANDS (30%): Crab pots, etc.

Unknown material (deeply embedded)

OTHER:

-net, rope, monofilament line

HOOK/MOUTH ENTANGLEMENTS

193 hook/mouth entanglements

Primarily fishing gear

Most (92%) flashers or longline gangion

Entanglement of branded Steller sea lions 2000-2009

BRAND	SEX	AGE ENTANGLED	ENTANGLEMENT TYPE
H445	F	0.8	Neck
W249	F	1.1	Hook/mouth w/ hanging flash
1Y	M	1.1	Flasher
201F	M	1.1	Hook/mouth
F47	M	1.8	Neck
W39	M	4.1	Flasher
F65	M	4.1	Neck
W235	M	5.1	Flasher
=437	F	5.8	Head/muzzle
=171	M	6.1	Flasher
H193	M	6.1	Flasher
F1135	M	6.1	Flasher
H330	M	6.1	Flasher
H80	M	6.2	Neck
W102	M	7.1	Flasher
F754	M	8.1	Neck
F805	M	9	Head

Acknowledgments:

We would like to thank the field research teams of both the Alaska Department of Fish and Game and the National Marine Mammal Laboratory (NMFS/NOAA) as well as the crews of the R/V Medeia, R/V Curlew, P/V Stimson, P/V Wolstad, R/V Tiglax, R/V Resolution, M/V Pacific Star and the R/V Norseman I and II.

Funding provided through NOAA Cooperative Agreements NA17FX1079,NA04NMF4390170 and NA08NMF4390544. ADFG research conducted under MMPA permit #358-1564, 358-1769 and 358-1888 and ADFG ACUC #03-002 and 06-07.