Ecological constraints, migratory pathways, and anthropogenic impacts on red-throated divers in the North Pacific

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Red-throated Divers - Research Foci

1) Ecological constraint

Food availability, quality, breeding success and variation in oceanographic conditions.

2) Population connections

Migration movements (telemetry) and genetic differentiation

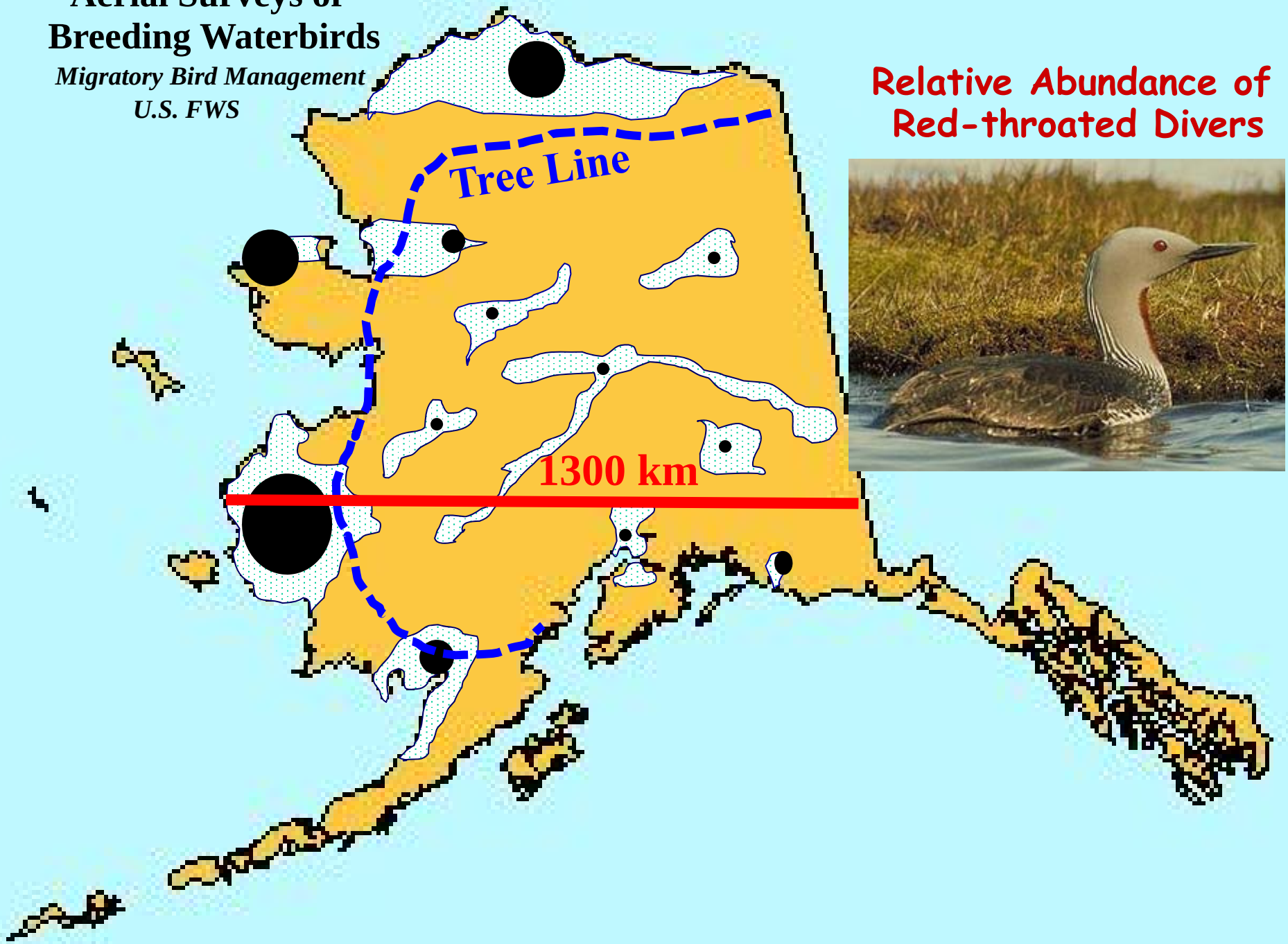
3) Anthropogenic impacts

Contaminants exposure

Aerial Surveys of Breeding Waterbirds

Migratory Bird Management

U.S. FWS



Relative Abundance of Red-throated Divers

Aerial Surveys of Breeding Waterbirds

Migratory Bird Management

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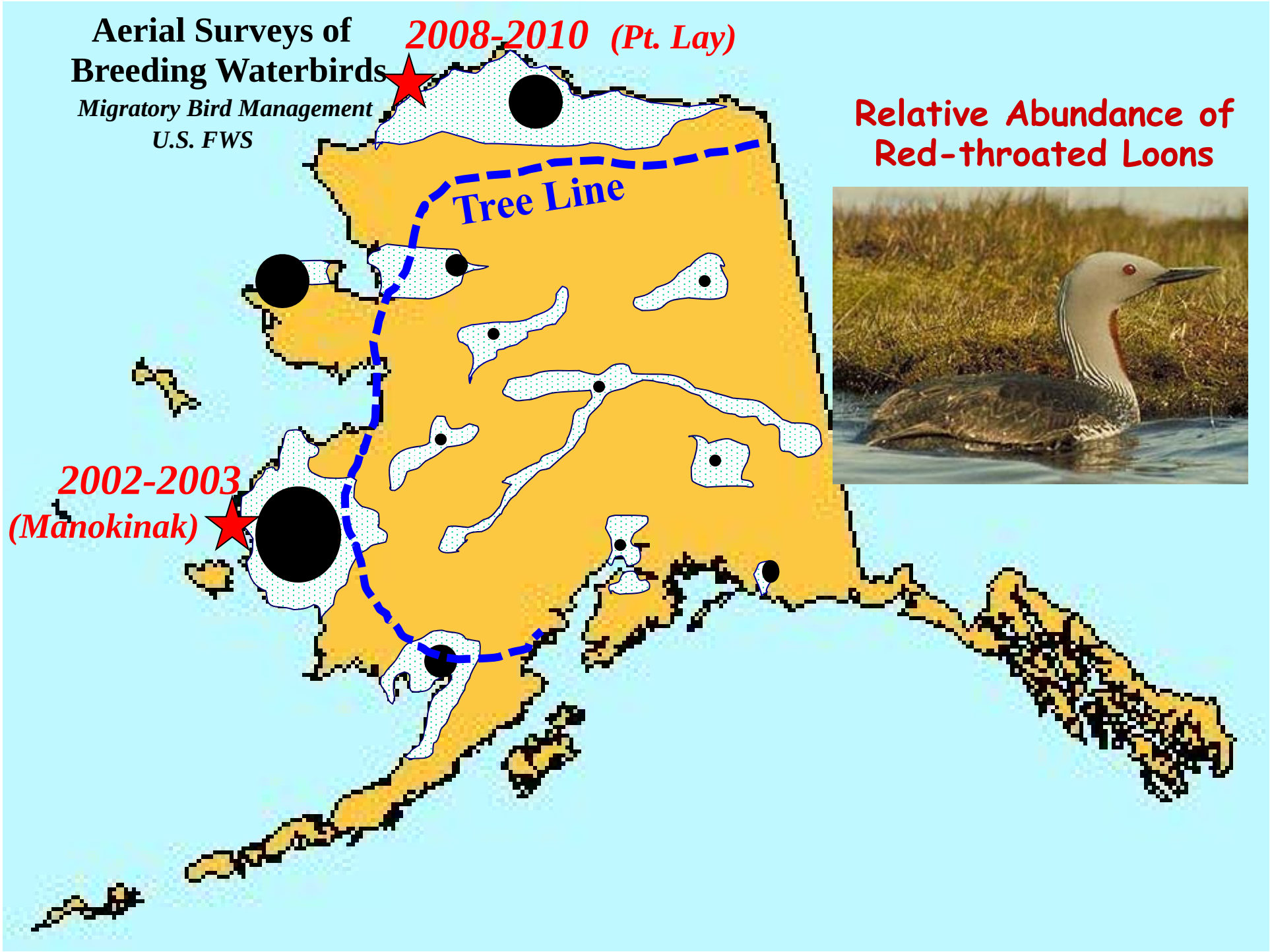
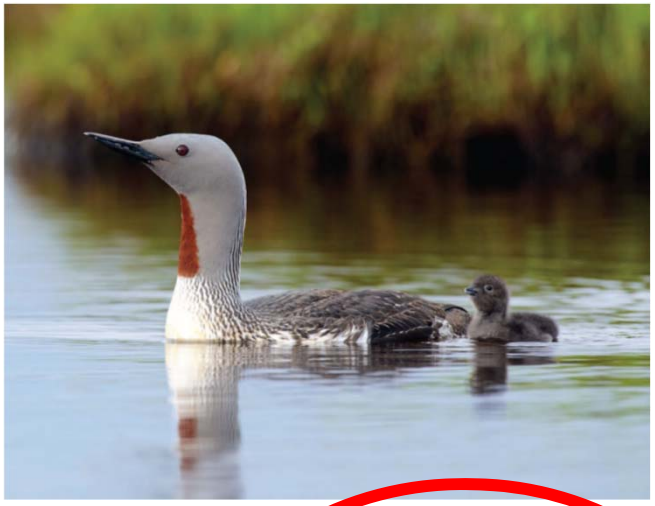
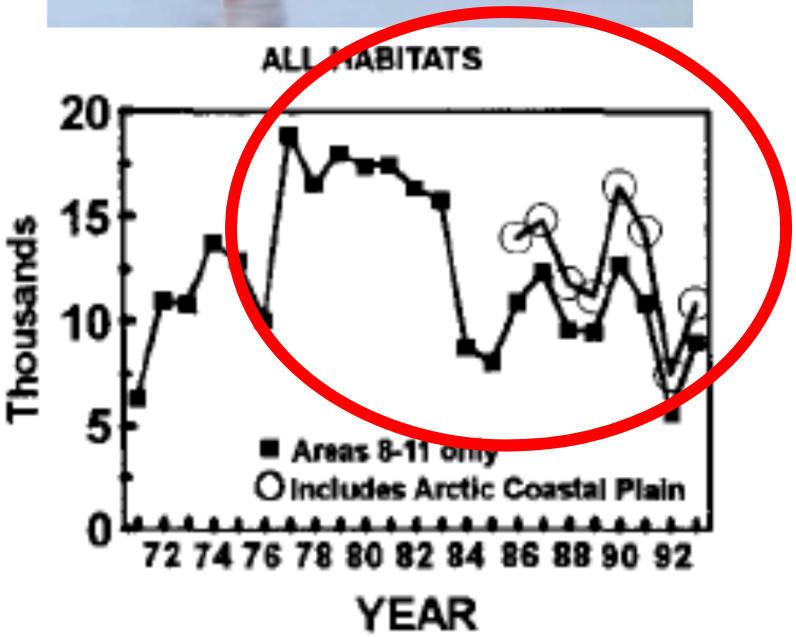


Relative Abundance of Red-throated Loons

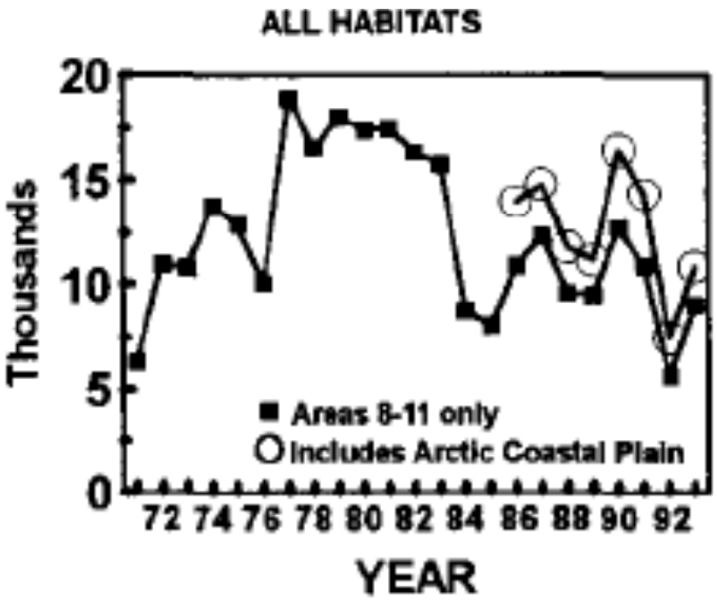
Groves et al. (1996) Status and trends of loon populations summering in Alaska, 1971-1993. *The Condor 98:189-195*.

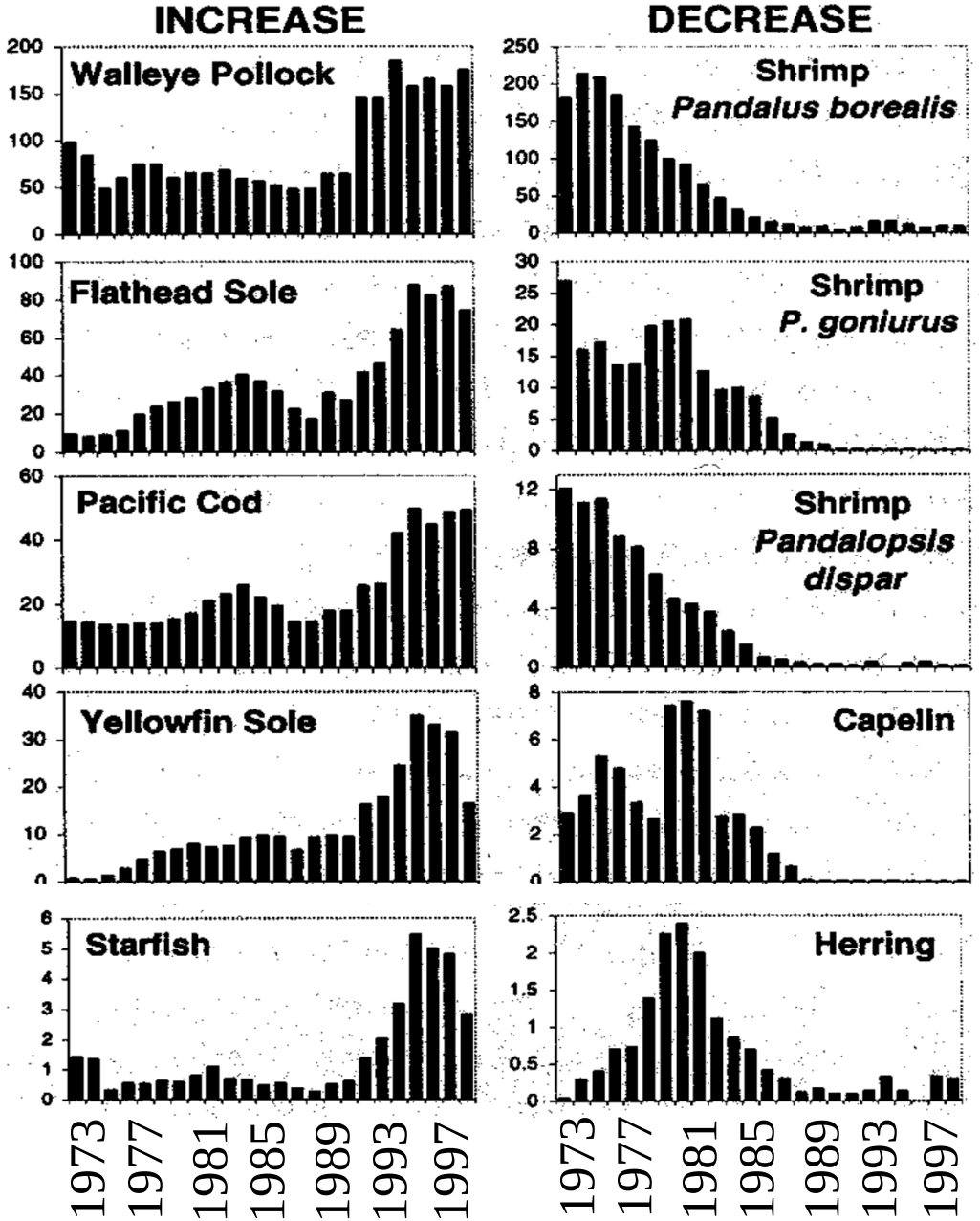


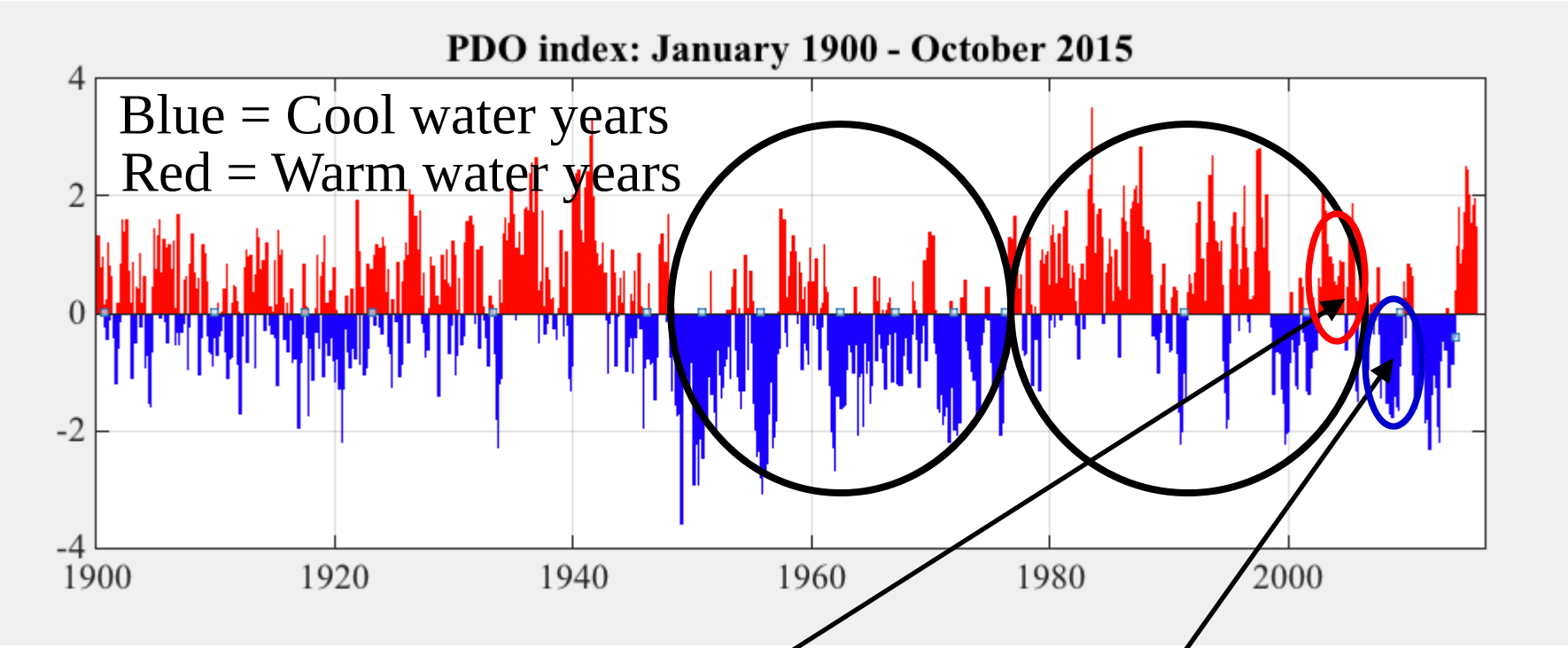


53% decline in abundance
in less than 20 years

Anderson, P.J., and J.F. Piatt. 1999. Community reorganization in the Gulf of Alaska following ocean climate regime shift. Marine Ecology Progress Series 189:117-123.







Jeff Ball thesis (Manokinak)

No 2-chick broods

Both parents frequently away foraging

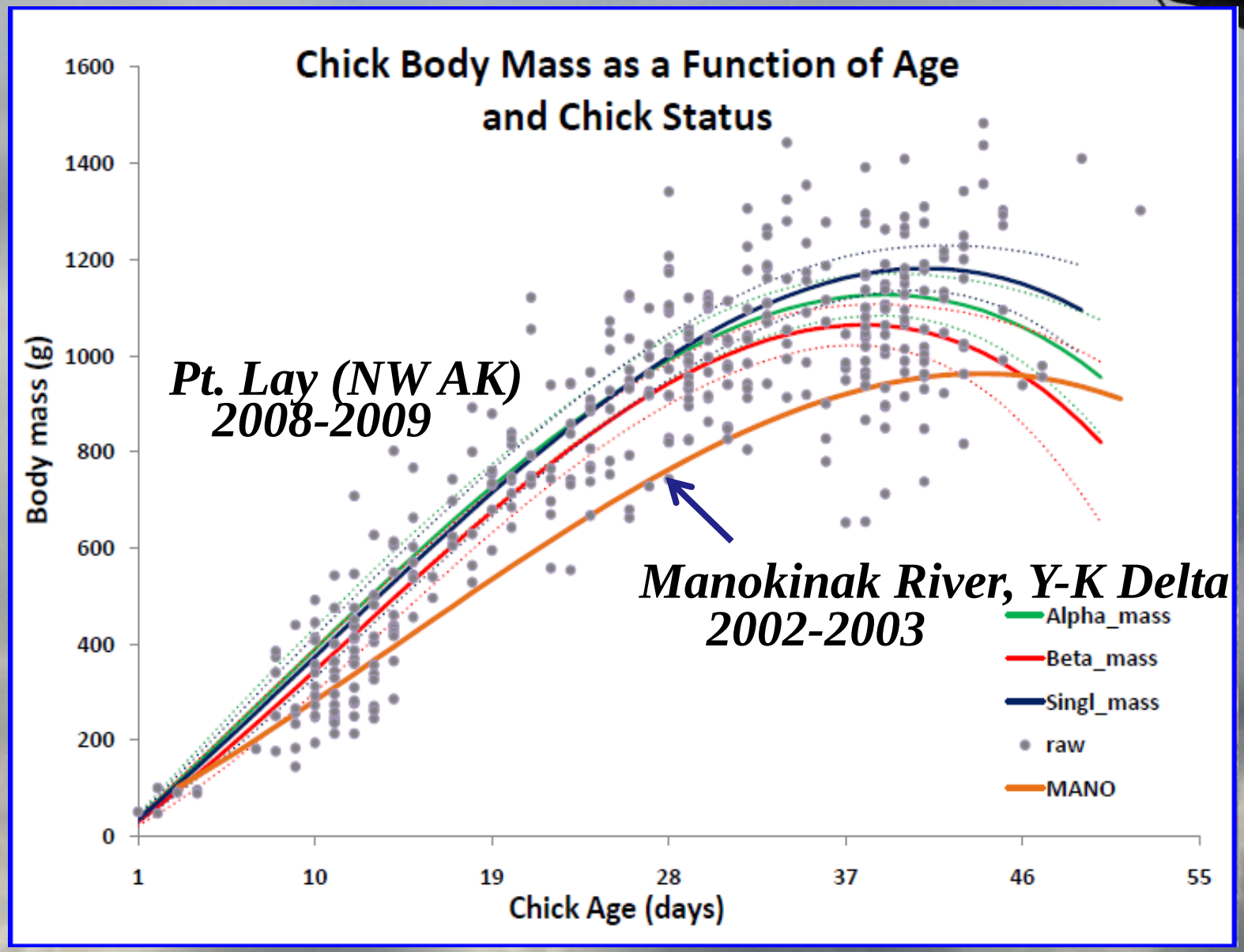
Low energy density prey

Dan Rizzolo thesis (Pt. Lay)

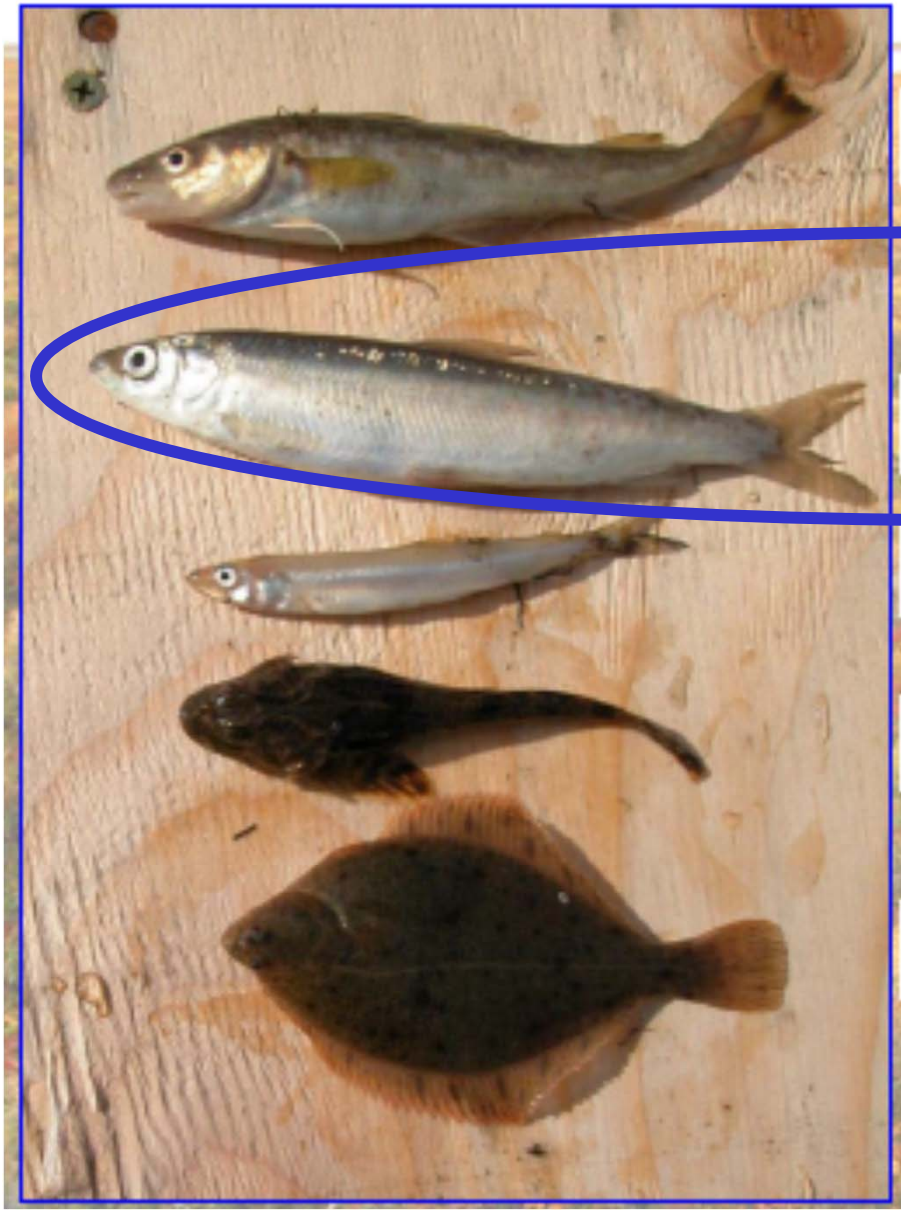
66% of broods w/ 2 chicks

One parent always attending

High energy density prey


Chick Body Mass as a Function of Age and Chick Status
Body mass (g)
1600
1400
1200
1000
800
600
400
200
0
1
10
19
28
37
46
55
Chick Age (days)
Pt. Lay (NW AK) 2008-2009
Manokinak River, Y-K Delta 2002-2003
Alpha_mass
Beta_mass
Singl_mass
raw
MANO

The Menu



Saffron Cod 3.0 kJ g^{-1} wet mass

Least Cisco 5.2 kJ g^{-1} wet mass

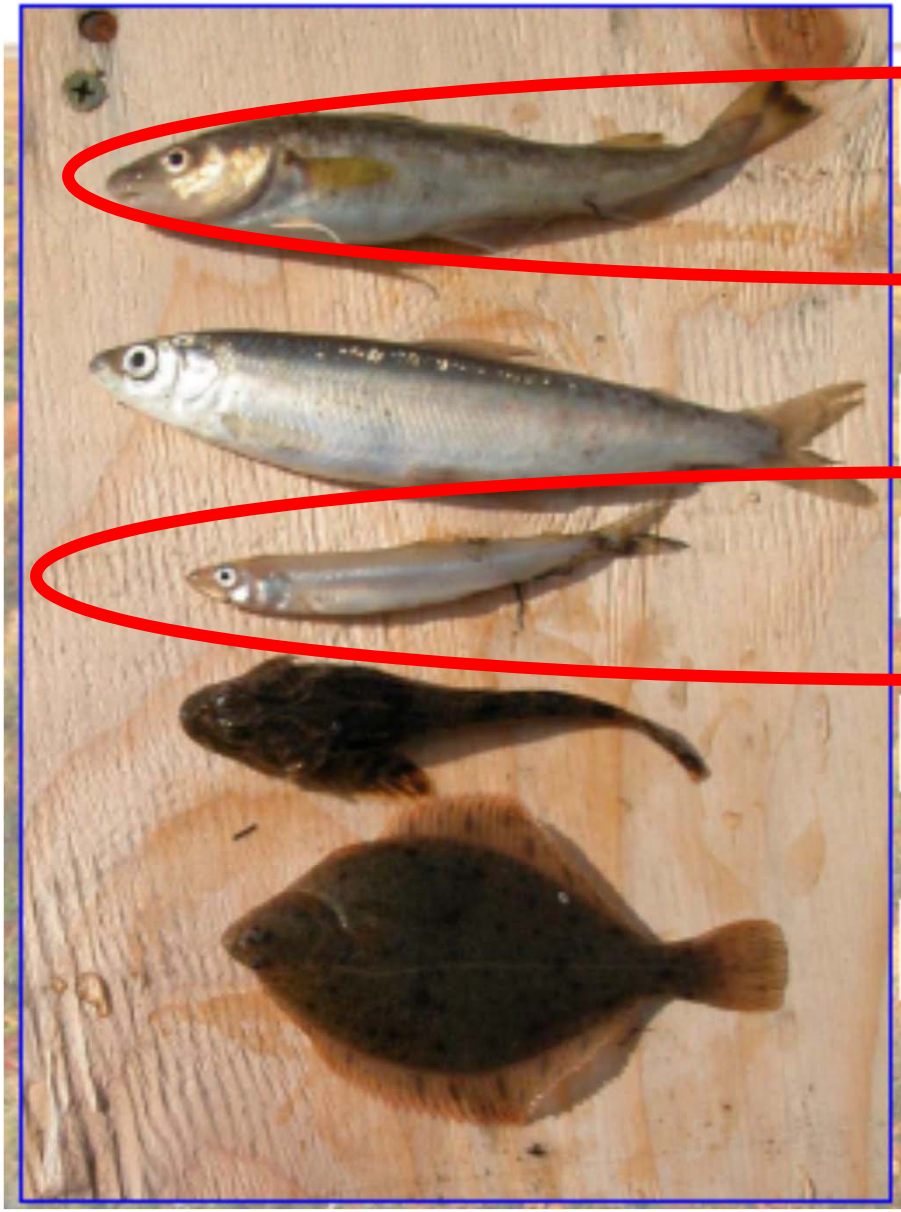
Rainbow Smelt 3.5 kJ g^{-1} wet mass

4-horn Sculpin ? kJ g^{-1} wet mass

Arctic Flounder 3.1 kJ g^{-1} wet mass

*Energy values from Ball et al. 2007

The Menu



Saffron Cod 3.0 kJ g^{-1} wet mass

Least Cisco 5.2 kJ g^{-1} wet mass

Rainbow Smelt 3.5 kJ g^{-1} wet mass

4-horn Sculpin ? kJ g^{-1} wet mass

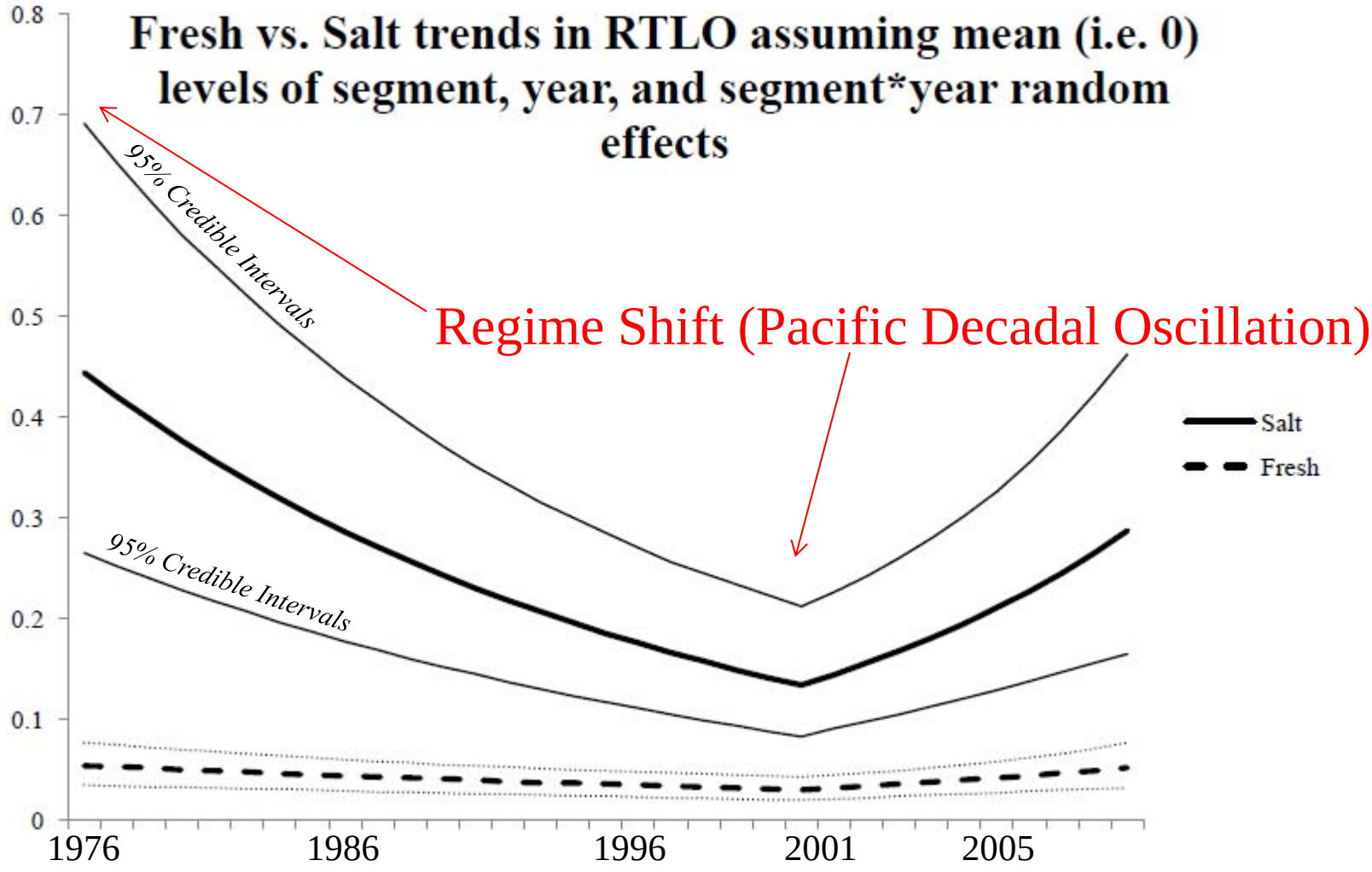
Arctic Flounder 3.1 kJ g^{-1} wet mass

*Energy values from Ball et al. 2007

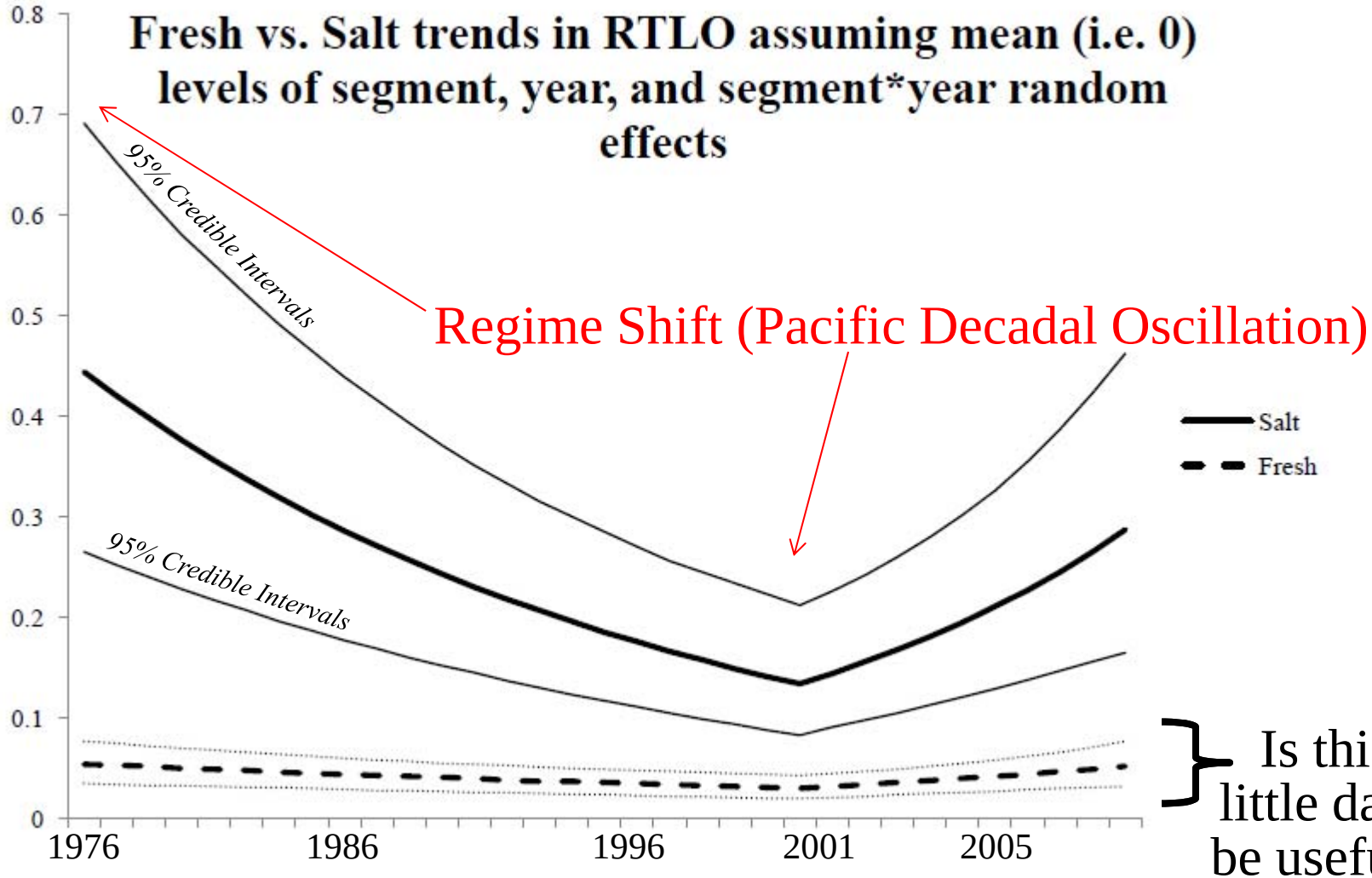
G. pacifica typically feeds young Notostraca (tadpole shrimp)
Low energetic value, but very abundant.

Thus, *G. pacifica* has constantly moderately low productivity.

And, *G. stellata* has years of very high and very low productivity.



salt trend 1976-1999	0.947	(0.933 – 0.960)
salt trend 2000-2009	1.079	(1.040 – 1.112)
fresh trend 1976-1999	0.974	(0.955 – 0.989)
fresh trend 2000-2009	1.013	(1.013 – 1.096)



Is this too little data to be useful; or this implies foraging on freshwater lakes lacks booms and busts.

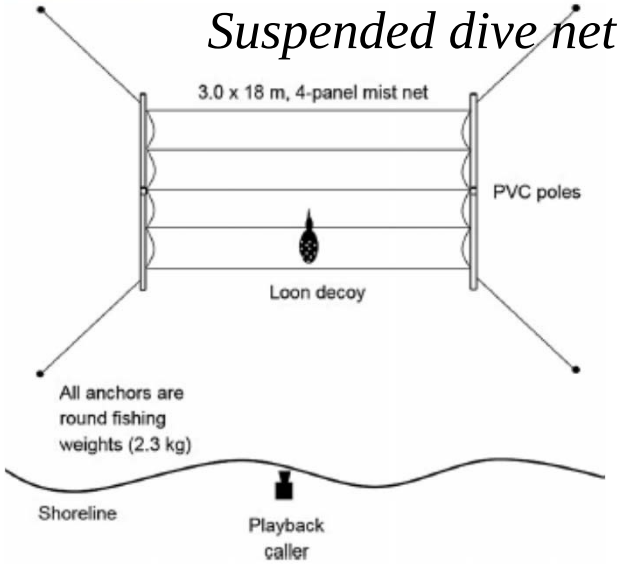
salt trend 1976-1999	0.947	(0.933 – 0.960)
salt trend 2000-2009	1.079	(1.040 – 1.112)
fresh trend 1976-1999	0.974	(0.955 – 0.989)
fresh trend 2000-2009	1.013	(1.013 – 1.096)

Survival of Adult Red-Throated Loons (*Gavia stellata*) May be Linked to Marine Conditions (Waterbirds 2014:118-124)

Table 1. Seven different models of variation in the survival of adult Red-throated Loons marked in Alaska.

		Analysis with Two Mortalities		Analysis with Four Mortalities		Average of Two Analyses
Model of Survival Variation	Number of Parameters	ΔAIC_c	AIC_c weight	ΔAIC_c	AIC_c weight	AIC_c weight
Early vs. late years	2	0.60	0.194	0	0.439	0.317
Breeding vs. nonbreeding seasons	2	1.48	0.126	1.76	0.182	0.154
Invariant	1	0.52	0.203	1.86	0.173	0.188
Migration vs. non-migration seasons	2	0	0.263	3.06	0.095	0.179
Breed/molt vs. other seasons	2	0.95	0.164	3.76	0.067	0.115
All four seasons differ	4	3.31	0.050	4.62	0.043	0.047

Satellite Telemetry: Capture and Marking



Uher-Koch et al. 2016.
Ringing and Migration
(Nesting or early chick rearing)

USGS
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Satellite Telemetry: Capture and Marking

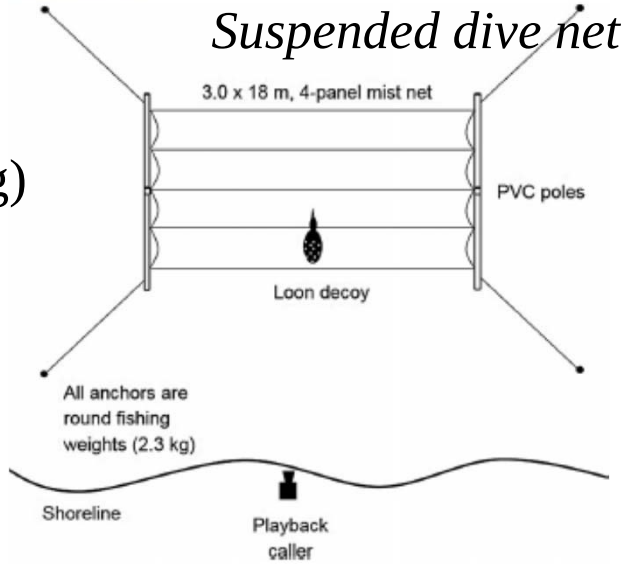
Transmitter

(abdominal implant; ~ 42 g)

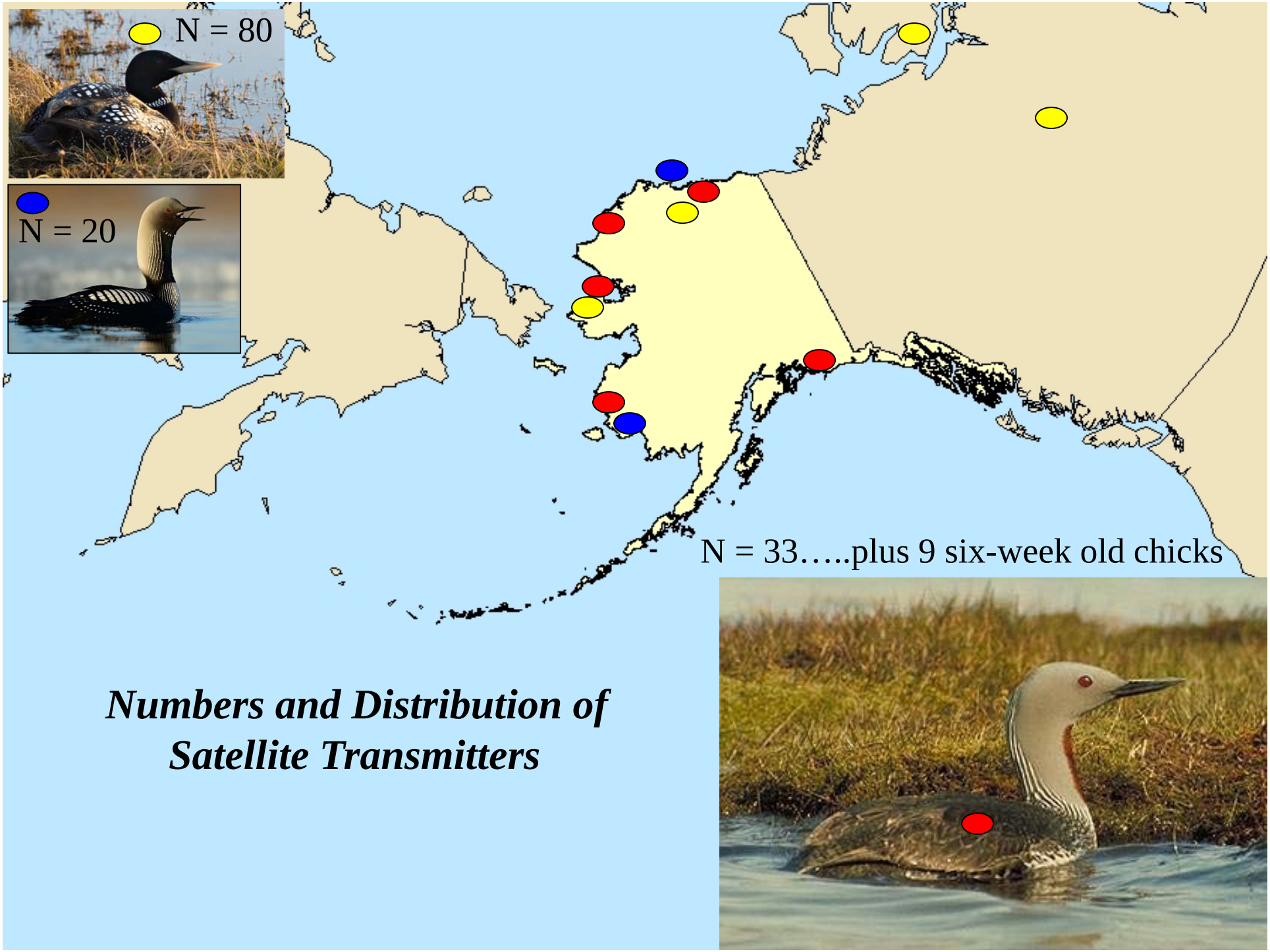
Antenna

Mulcahy and Esler. 1999. J. Zoo and Wildlife Medicine 30:397-401.

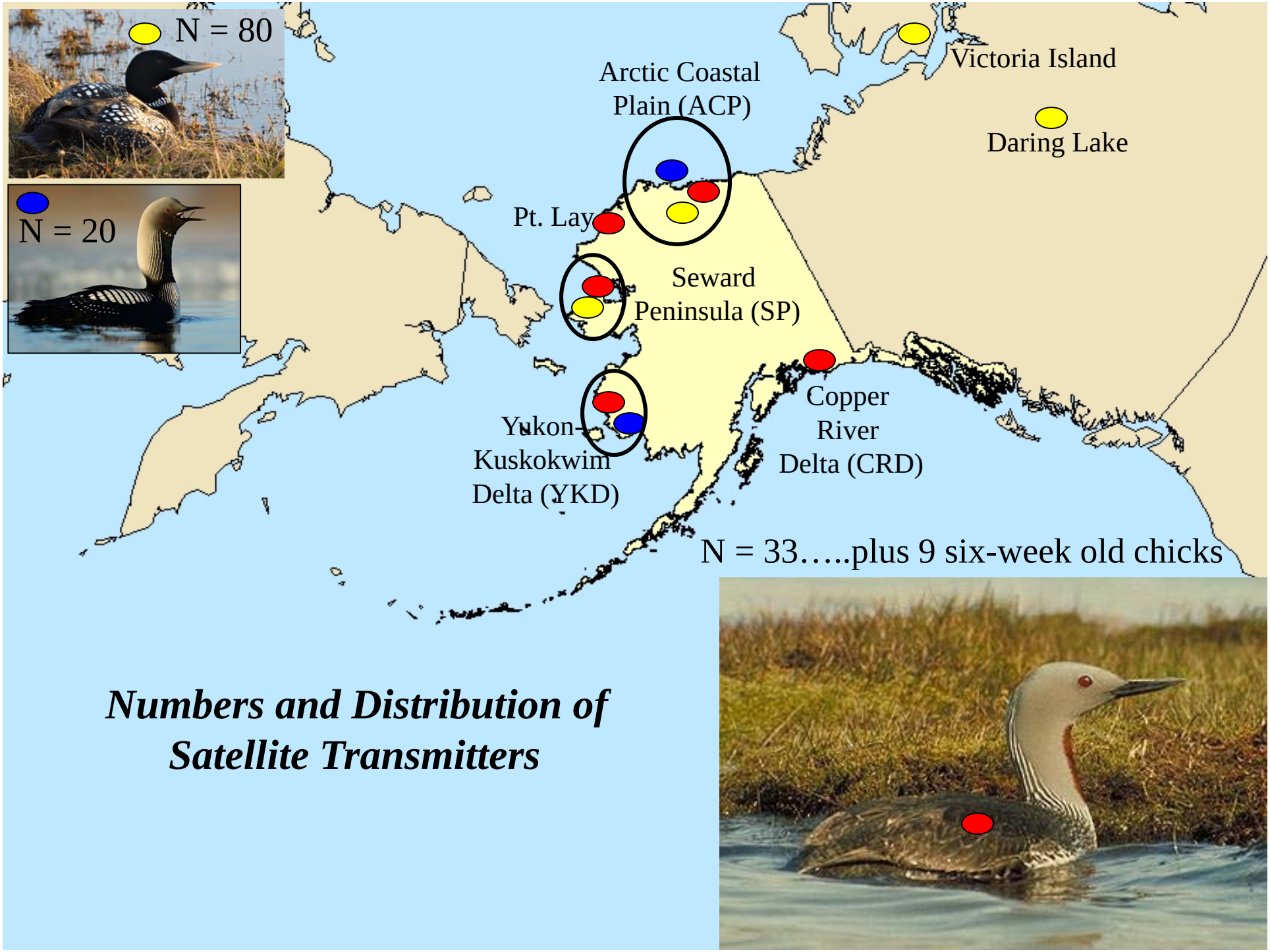
Suspended dive net



Uher-Koch et al. 2016. Ringing and Migration *(Nesting or early chick rearing)*



Numbers and Distribution of Satellite Transmitters


N = 80
N = 20
Arctic Coastal Plain (ACP)
Victoria Island
Daring Lake
Pt. Lay
Seward Peninsula (SP)
Copper River Delta (CRD)
Yukon-Kuskokwim Delta (YKD)
N = 33…..plus 9 six-week old chicks
Numbers and Distribution of Satellite Transmitters

Diver Genetics:

G. adamsii

Genetic distinctions among populations
Low levels of genetic variability

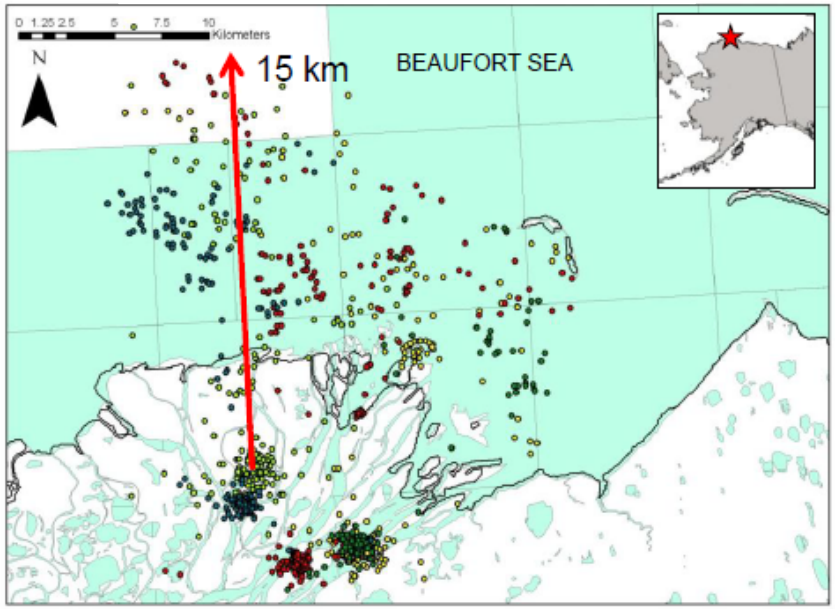
G. stellata

Evaluation of genetic distinctions ongoing
Low levels of genetic variability

G. pacifica *and* ***G. immer***

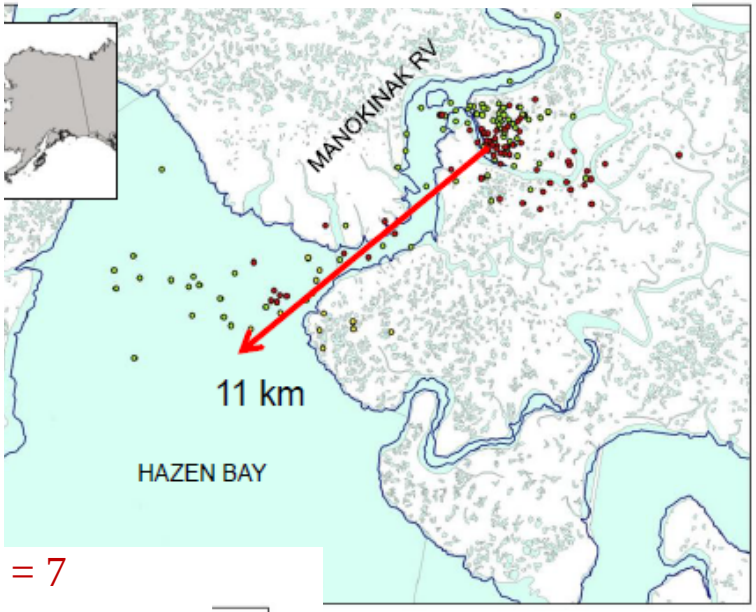
Are both more genetically variable than G. adamsii or G. pacifica

Arctic Coastal Plain, n = 5



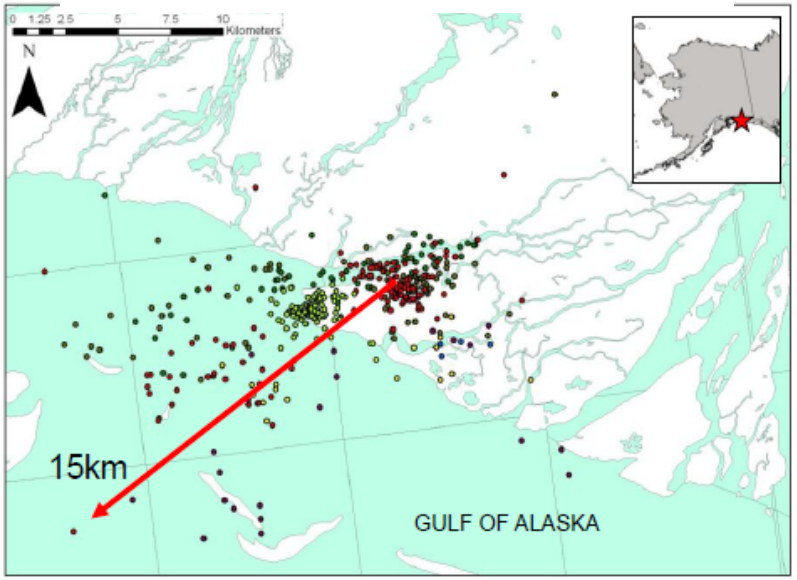
All LC 1-3 locations, June-August

Yukon-Kuskokwim Delta, n = 3



tions, June-August

Copper River Delta, n = 7



All LC 1-3 locations, June-August

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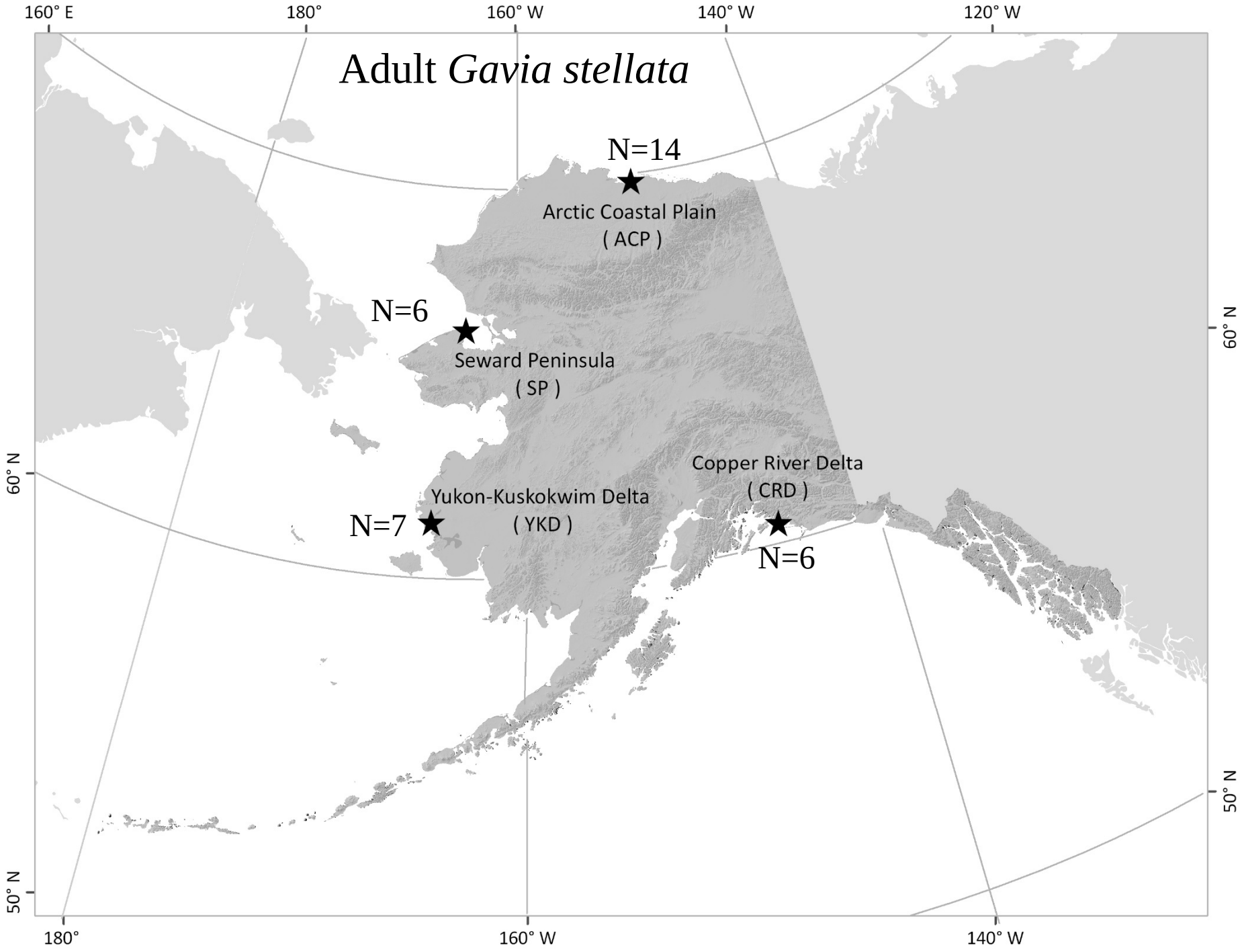
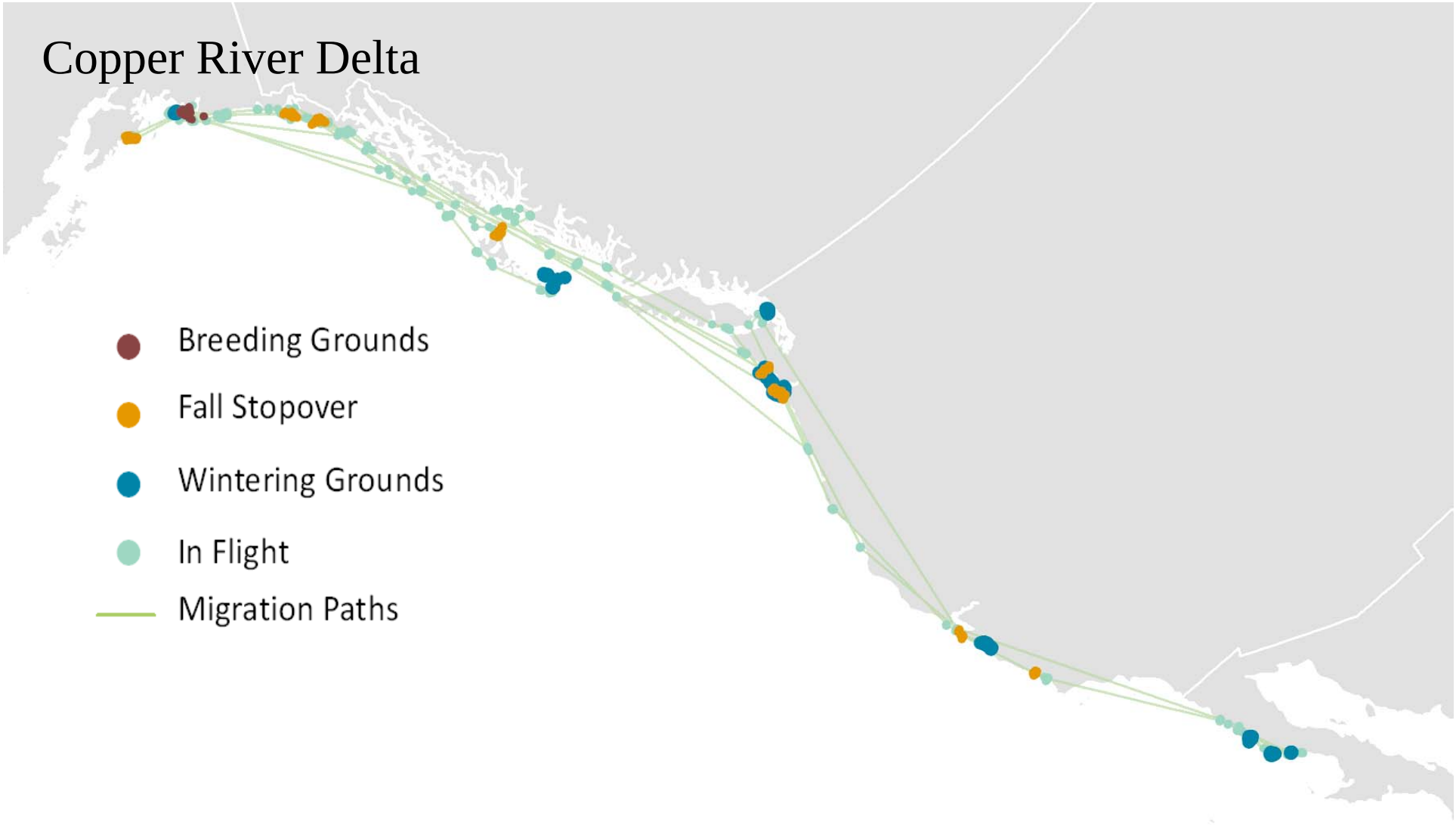
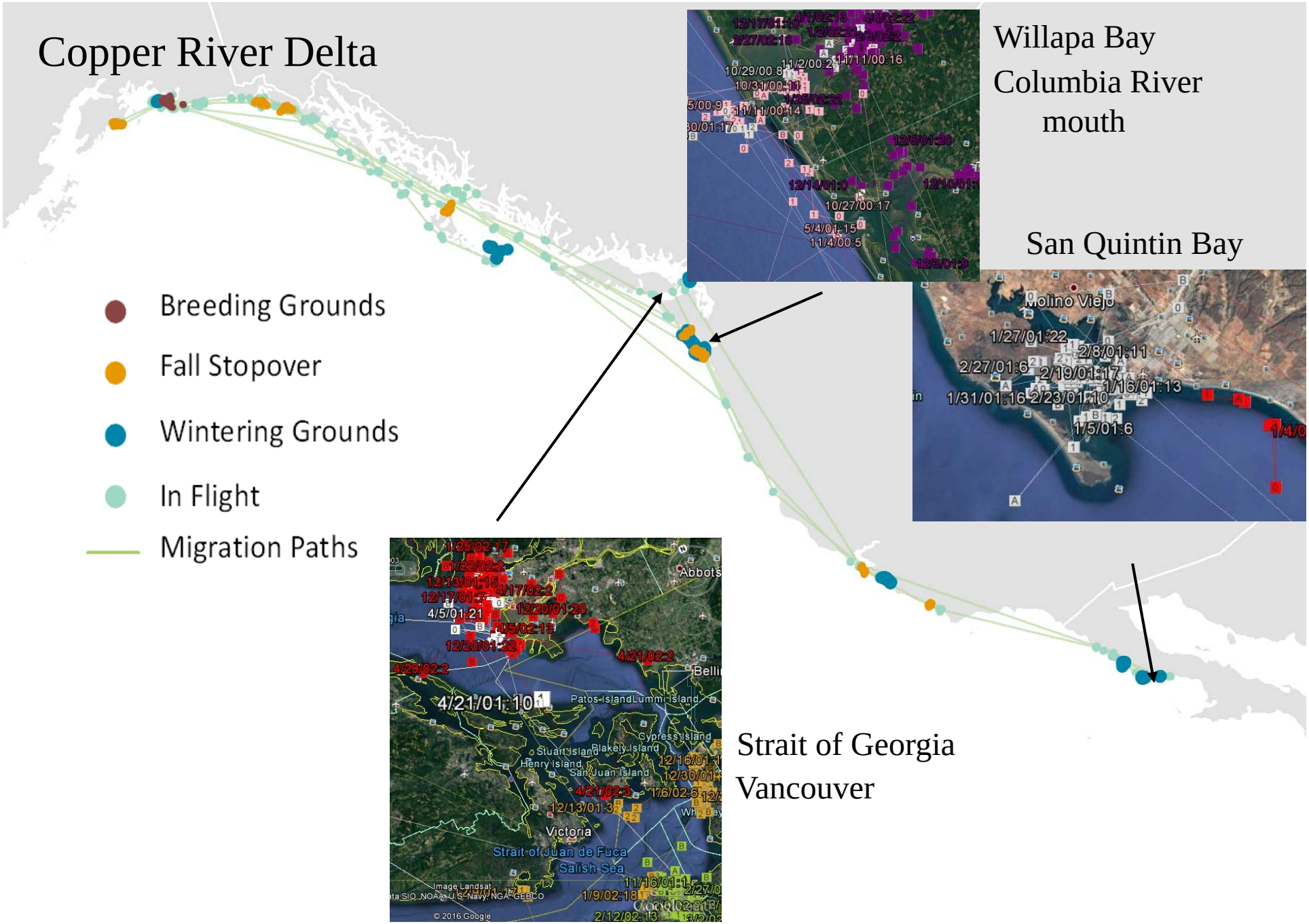

Adult *Gavia stellata*
160° E
180°
160° W
140° W
120° W
N=14
Arctic Coastal Plain
(ACP)
N=6
Seward Peninsula
(SP)
Copper River Delta
(CRD)
Yukon-Kuskokwim Delta
(YKD)
N=7
N=6
60° N
50° N
180°
160° W
140° W

Copper River Delta



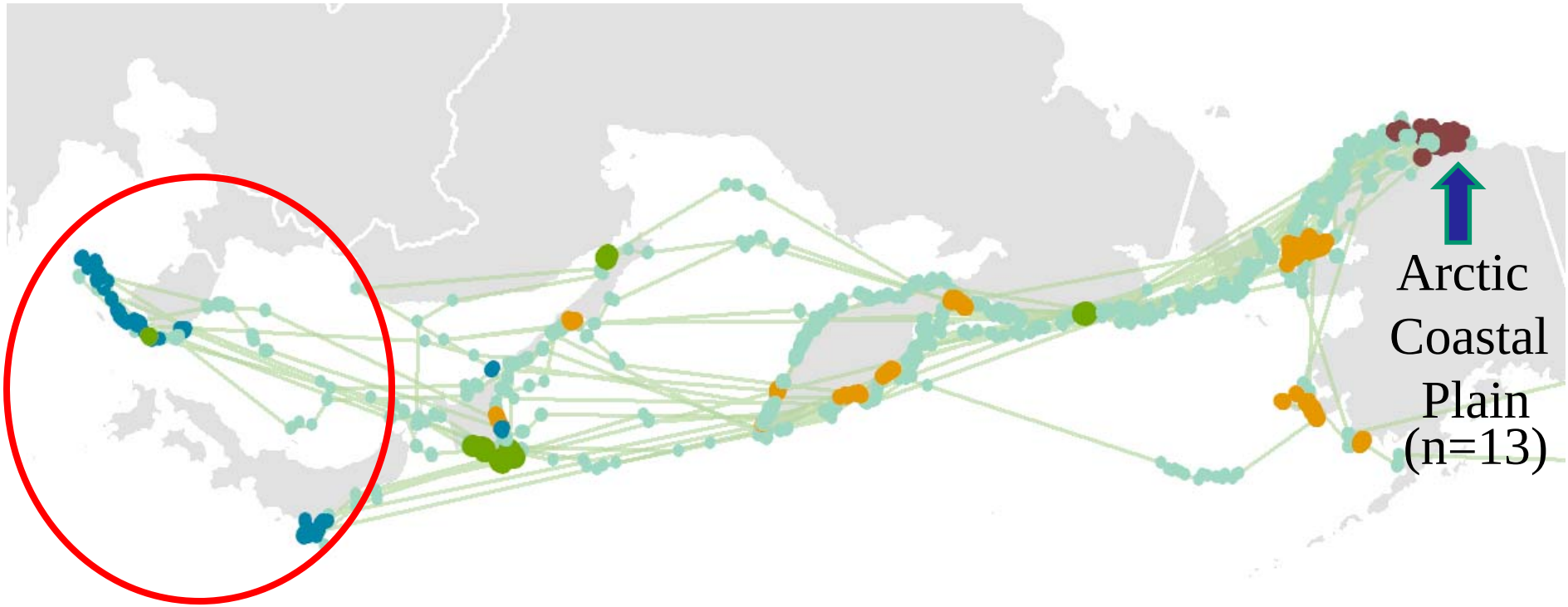

Copper River Delta
Breeding Grounds
Fall Stopover
Wintering Grounds
In Flight
Migration Paths
Willapa Bay
Columbia River
mouth
San Quintin Bay
Molino Viejo
Strait of Georgia
Vancouver
Victoria
Strait of Juan de Fuca
Salish Sea
Patos Island
Lummi Island
Cypress Island
Blakely Island
Stuart Island
Henry Island
San Juan Island
Abbotsford


Yukon-Kuskokwim Delta
Breeding Grounds
Fall Stopover
Wintering Grounds
In Flight
Migration Paths


Yukon-Kuskokwim Delta
Yakutat Bay
Mouth of the
Kuskokwim River
Strait of Georgia
SanFrancisco Bay
Breeding Grounds
Fall Stopover
Wintering Grounds
In Flight
Migration Paths


Seward Peninsula
Breeding Grounds
Fall Stopover
Wintering Grounds
In Flight
Migration Paths


Seward Peninsula
Copper River and
Yakutat Bay
Mouth of the
Kuskokwim River
Breeding Grounds
Fall Stopover
Wintering Grounds
In Flight
Migration Paths



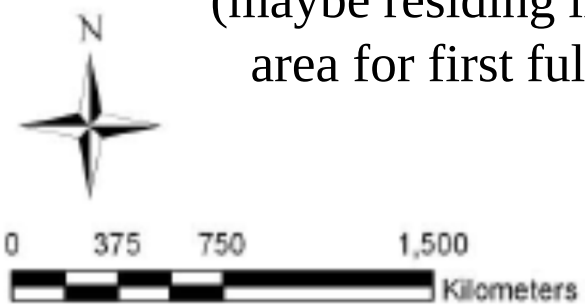
After 2005, we did not obtain any more locations west of Tokyo; suspected signal interference.

- Breeding Grounds
- Fall Stopover
- Wintering Grounds
- Spring Stopover
- In Flight


Arctic
Coastal
Plain
(n=1)
Breeding Grounds
Fall Stopover
Wintering Grounds
Spring Stopover
In Flight

Last location June 26, 2009

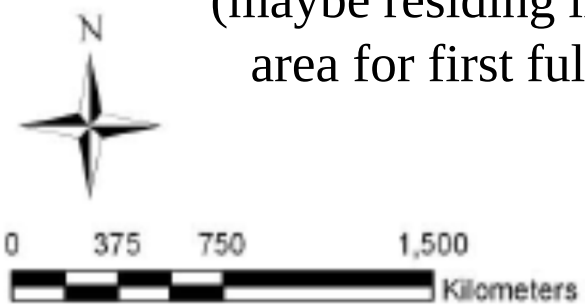
(maybe residing in wintering area for first full summer?)



Red-throated Loon, juvenile
PTT 81241
Deployed 2008

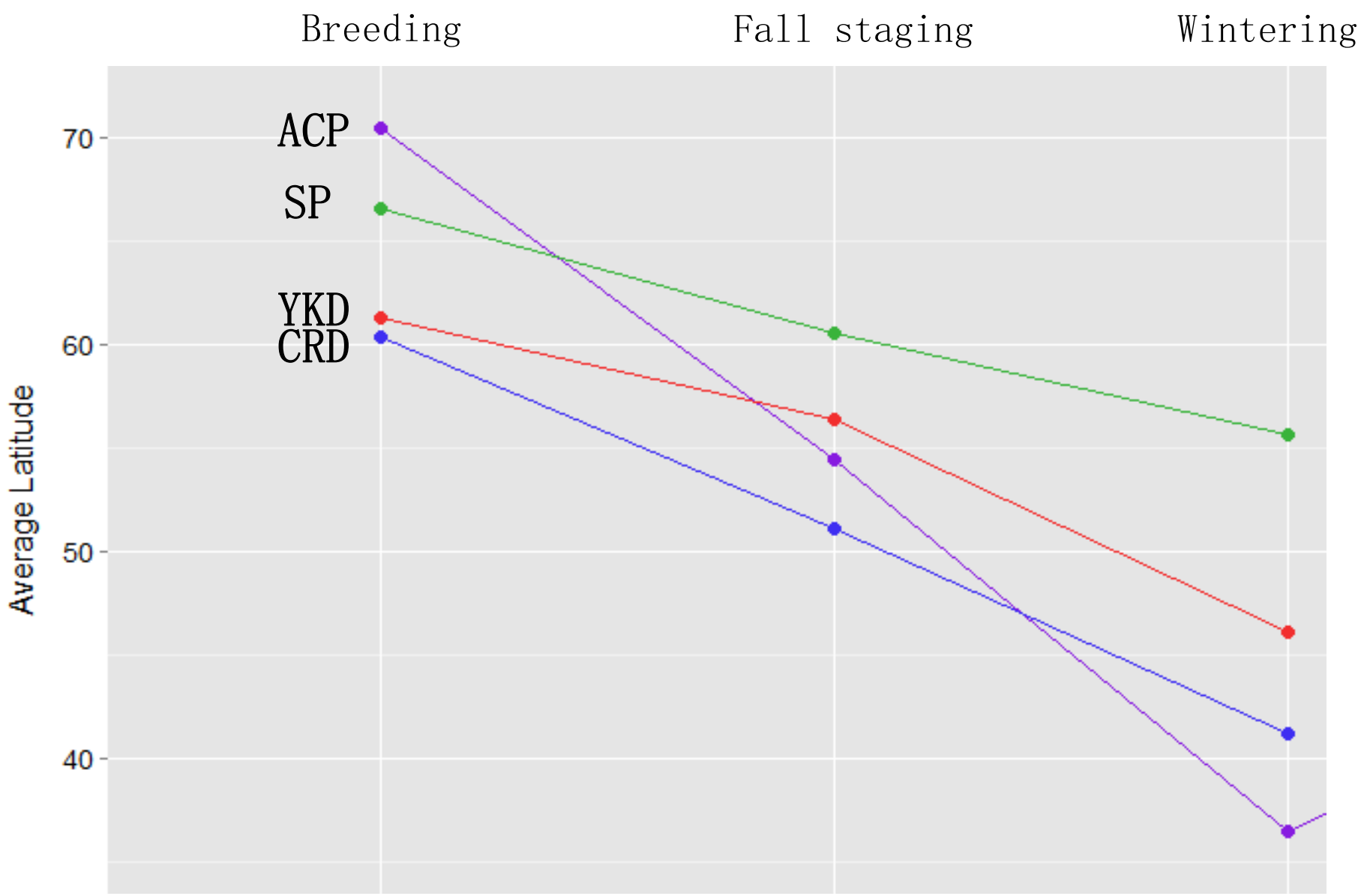
Last location June 26, 2009

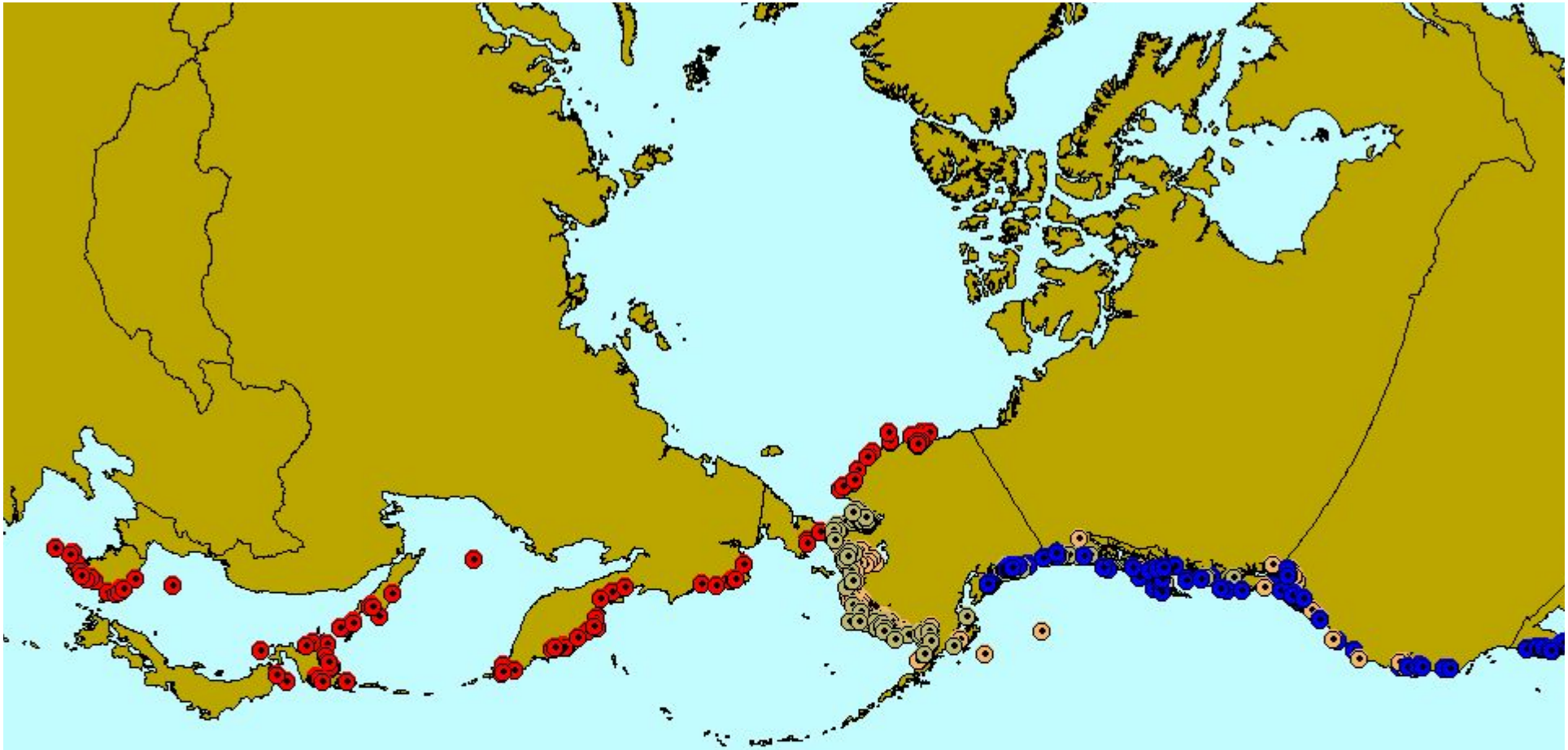
(maybe residing in wintering area for first full summer?)



Red-throated Loon, juvenile
PTT 81241
Deployed 2008

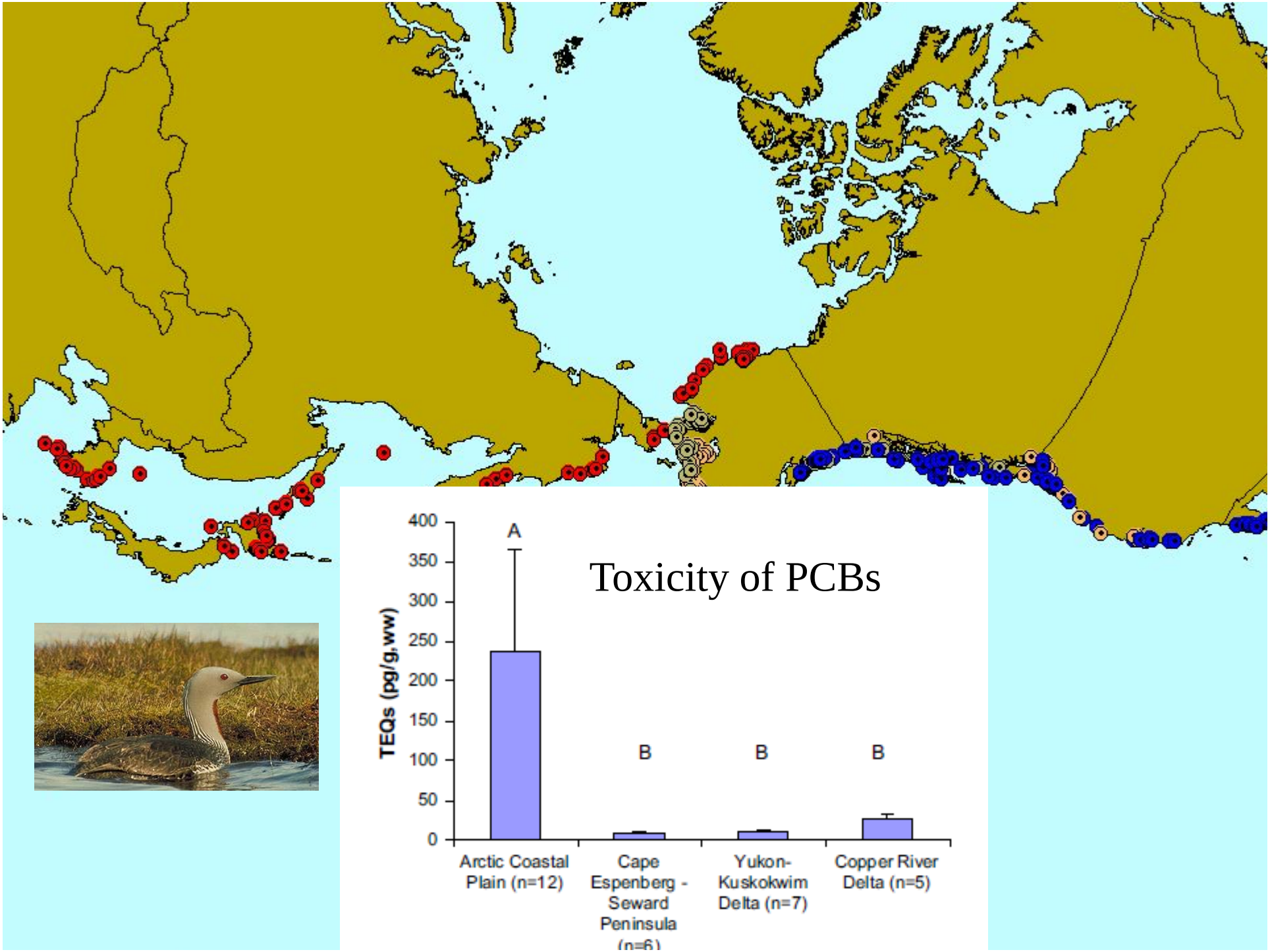
Dispersal may affect genetic distinctions among populations


Breeding
Fall staging
Wintering
ACP
SP
YKD
CRD
70
60
50
40
Average Latitude

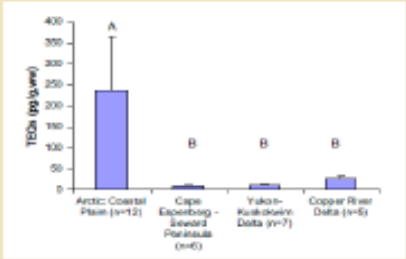


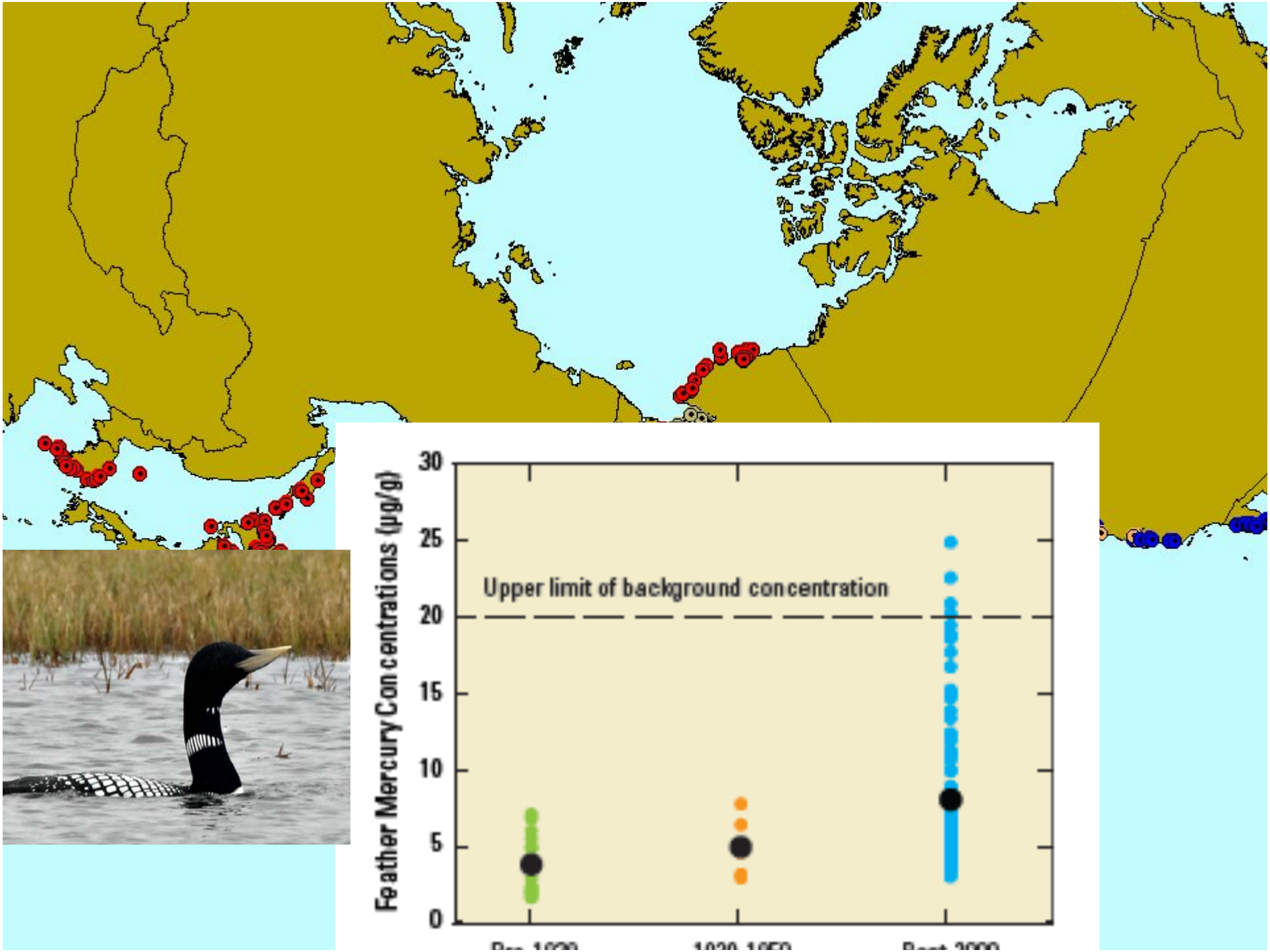
Red-throated Divers

(All high quality locations for all individuals)


Toxicity of PCBs
TEQs (pg/g,ww)
400
350
300
250
200
150
100
50
0
A
B
B
B
Arctic Coastal Plain (n=12)
Cape Espenberg - Seward Peninsula (n=6)
Yukon-Kuskokwim Delta (n=7)
Copper River Delta (n=5)

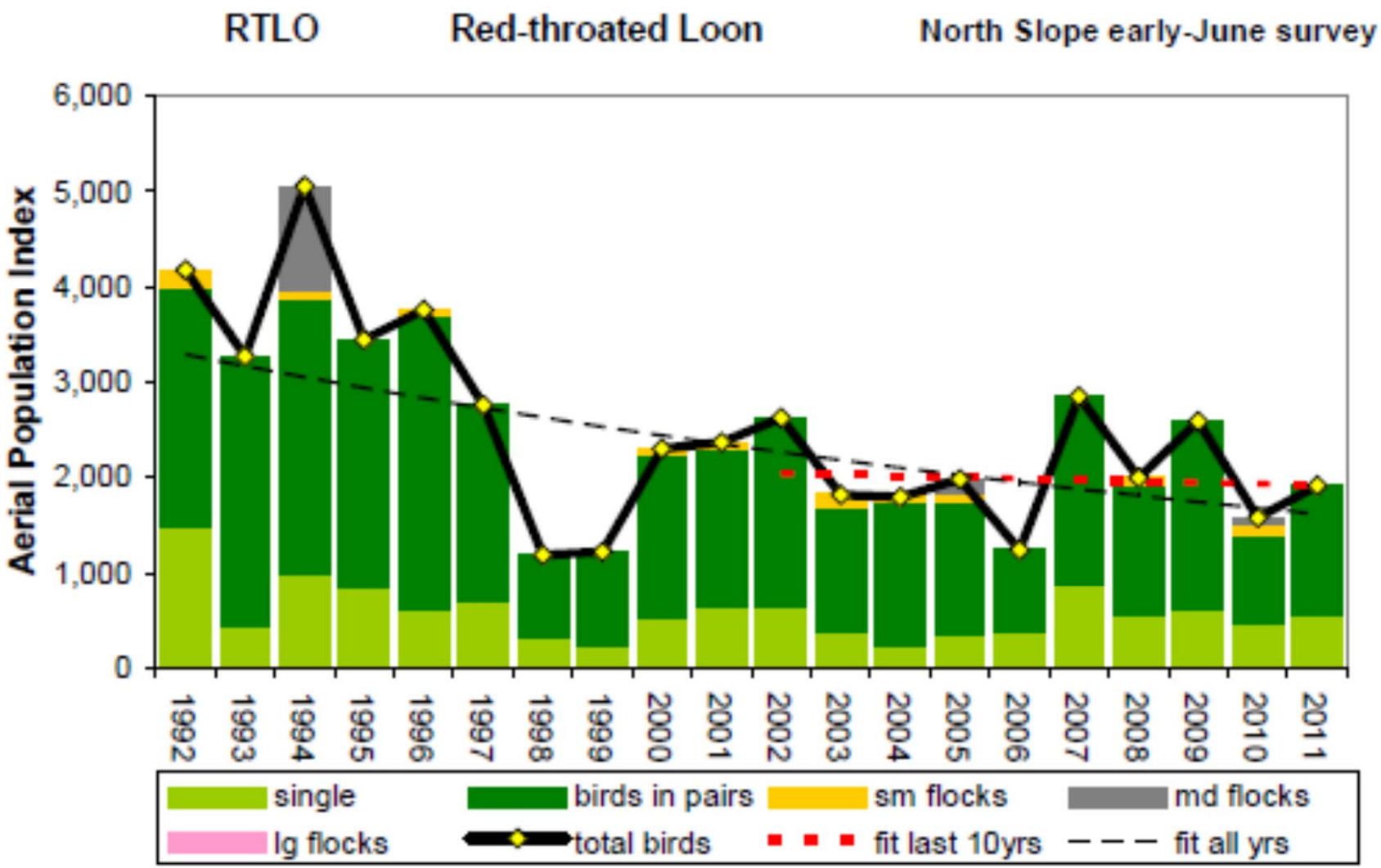
YBLOs farther offshore than RTLOs




Feather Mercury Concentrations (µg/g)
30
25
20
15
10
5
0
Upper limit of background concentration

Recent population declines in northern Alaska:

Changes in marine prey? Coastal erosion? Contaminants?




Thank You! Any Questions ??
Photo by R. Askren