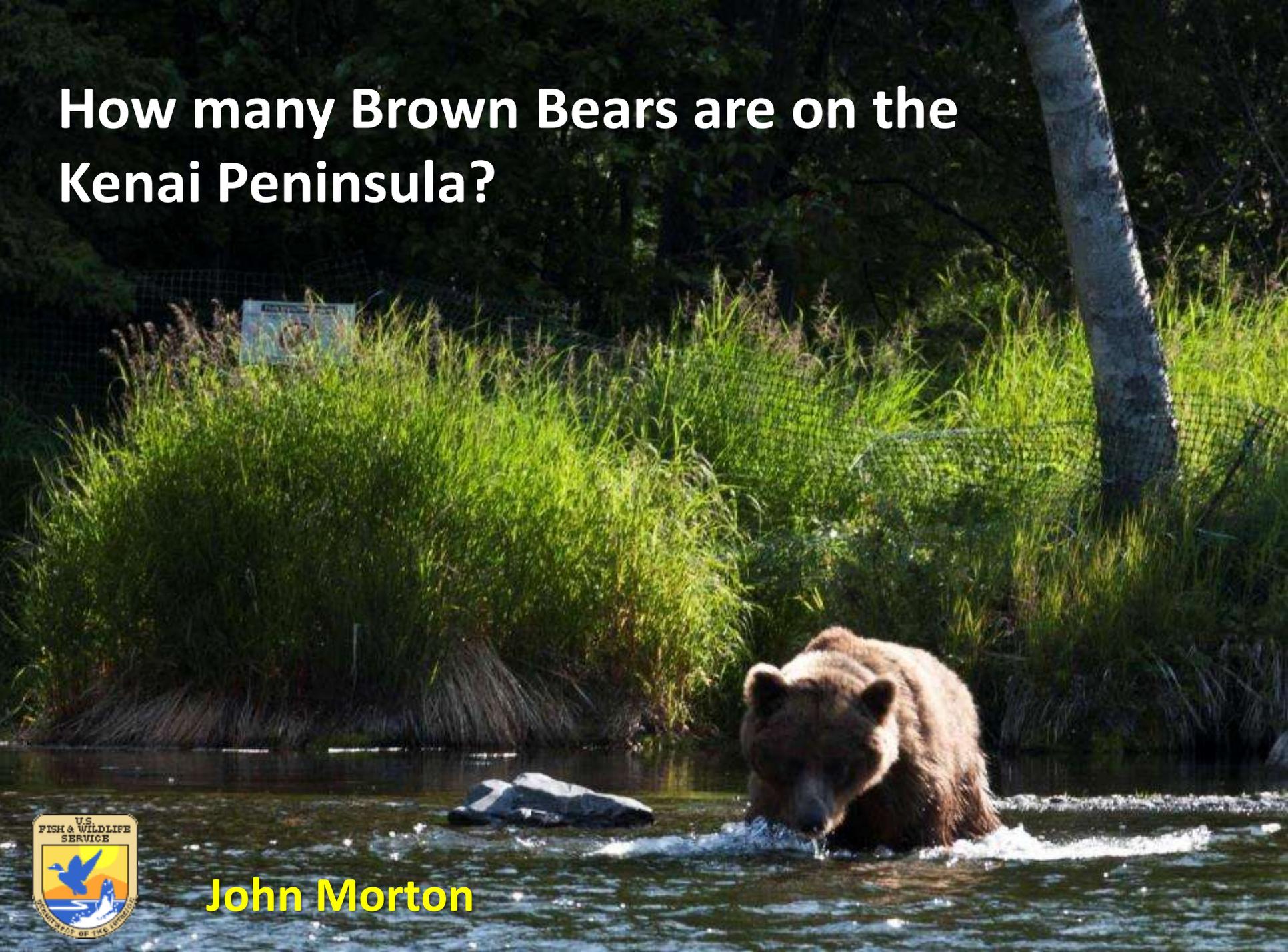
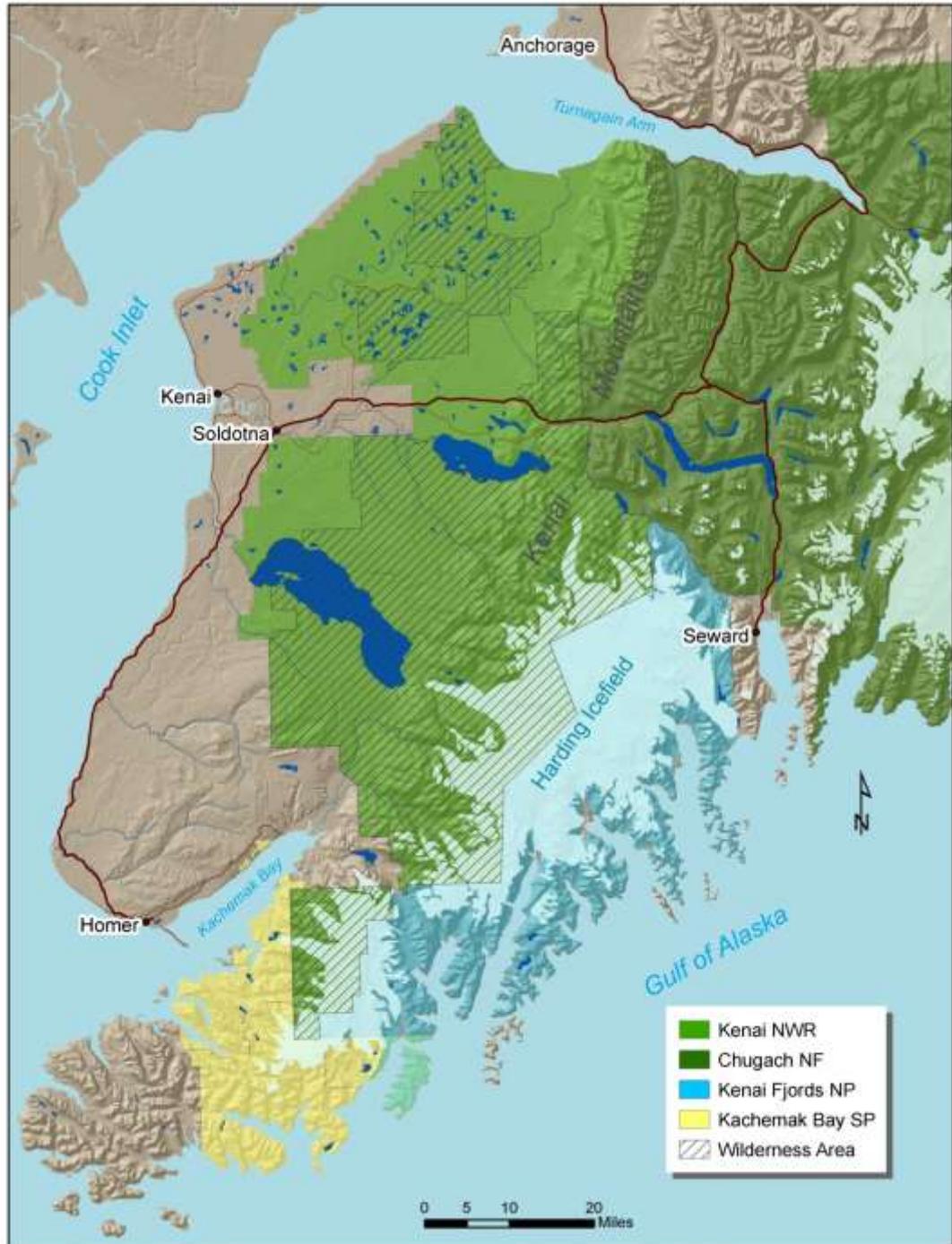


How many Brown Bears are on the Kenai Peninsula?



John Morton



Why we estimated the Kenai brown bear population in 2010....

- ✓ Designated *Population of Special Concern* by State of Alaska in 1998 – 2010
- ✓ Genetically less diverse than (and distinct from) adjacent mainland Alaskan brown bears
- ✓ Only estimate of 250-300 brown bears based on multiplying the area of suitable habitat by mean bear density from other AK studies
- ✓ Population trend unknown ($\lambda = 0.9364 - 1.0588$)
- ✓ Low yearling survivorship and small proportion of subadult females suggested low recruitment
- ✓ Annual DLPs increased from <1 in 1960s to 5 in 1990s to >20 in 2000s



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DNA-based mark-recapture model to estimate population

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Research Article

Estimation of the Brown Bear Population on the Kenai Peninsula, Alaska

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ABSTRACT The brown bear population on the Kenai Peninsula, Alaska, has not been empirically estimated previously because conventional aerial methods over this heavily forested landscape were infeasible. We applied a rapid field protocol to a DNA-based mark-recapture approach on a large and highly buffered sample frame to estimate brown bear abundance. We used lure to attract bears to barbed wire stations deployed in 145 9-km × 9-km cells systematically distributed across 10,200 km² of available habitat on the Kenai National Wildlife Refuge and Chugach National Forest during 33 consecutive days in early summer 2010. Using 2 backpackers and 4 2-person field crews, we deployed the stations during a 6-day period and subsequently revisited these stations on 5 consecutive 5-day trap sessions. We extracted DNA to identify individual bears and developed capture histories as input to mark-recapture models. Combined with data from radio-telemetry bears, ≥245 brown bears were alive on the Kenai Peninsula in 2010, but we used only 99 females and 104 males in modeling. We used Akaike's Information Criterion selection and model averaging to estimate 428 (95% lognormal CI = 355–539) brown bears (including all age classes) on the study area. Despite low recaptures rates, we achieved reasonable precision by ensuring geographic and demographic population closure through a spatially comprehensive sample frame and very short sampling windows. We reduced bias by including information from sub-traps and telemetry females ($n = 1$, occasion 10). Extrapolating the density estimate of 42 bears/1,000 km² of available habitat on the study area to the Kenai Peninsula suggests a peninsula-wide population of 582 brown bears (95% lognormal CI = 469–739). Demographic data estimate that is low, compared to other coastal brown bear populations in Alaska and genetic evidence that suggests this peninsula population is isolated, harvest management has been liberalized since 2012. We recommend this population estimate serve as the benchmark for future management. PUBLISHED 2015. This article is a U.S. Government work and, as such, is in the public domain in the USA.

KEY WORDS Alaska, brown bear, genetics, hair DNA, Kenai Peninsula, mark-recapture, population, Poisson model, *Ursus arctos*.

The density of brown bear (*Ursus arctos*) population on the Kenai Peninsula in south-central Alaska is a keystone species (Interagency Brown Bear Study Team [IBBST] 2003). Brown bears on the Kenai Peninsula influence plant distribution and abundance through seed dispersal in feces, transport marine-derived nutrients into terrestrial ecosystems through salmon consumption (Hilkebrandt et al. 1999a), and possibly regulate ungulate populations through natural predation under certain conditions (Zager and Beedars 2006). Brown bears are recognized as a source of enjoyment by visitors and hunters, as a source of revenue for commercial wildlife viewing and hunting charters, and as a wilderness icon (Alaska Department of Fish and Game [ADF&G] 2000).

The 16-km wide isthmus that separates the 24,000 km² Kenai Peninsula from the adjacent mainland restricts brown bear emigration and immigration (Jackson et al. 2009). Using mitochondrial and mitochondrial DNA (mtDNA), Jackson et al. (2006) verified that the Kenai brown bear population is isolated, reporting lower mtDNA haplotype diversity than most other brown bear populations on mainland Alaska but similar to other peninsula populations.

The Kenai Peninsula is also one of the fastest urbanizing areas in Alaska, with approximately 10,000 new residents added every decade since 1960 (<http://www.kenai.gov/population/popcount/041300000.txt>, accessed 23 Sep 2015). Over these same 5 decades, brown bears killed in defense of life or property (DL/P) on the Peninsula have increased from < 1/year in the 1960s, to 5/year in the 1990s, and to 16/year since 2000 (Staring and Del Fran 2002, Zahara 2012). Legal harvest of brown bears has varied with hunting regulations over this same period, ranging from 0/year during much of the past decade to 60 individuals in 2014. In 2011, the year of

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Simple Lincoln-Petersen Estimator

$$N = MC/R$$

N = Estimate of total population size

M = Total number of animals captured and marked on the first visit

C = Total number of animals captured on the second visit

R = Number of animals captured on the first visit that were then recaptured on the second visit



**How many double-crested cormorants
in the Skilak Lake colony?**



“Mark” 16 birds with
red leg-bands



**“Re-capture” 5 birds, of which 3 have
red leg-bands**



27 cormorants

$$N/16 = 5/3$$

Simple Lincoln-Petersen Estimator

$$N = MC/R$$

N = Estimate of total population size

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C = Total number of animals captured on the second visit

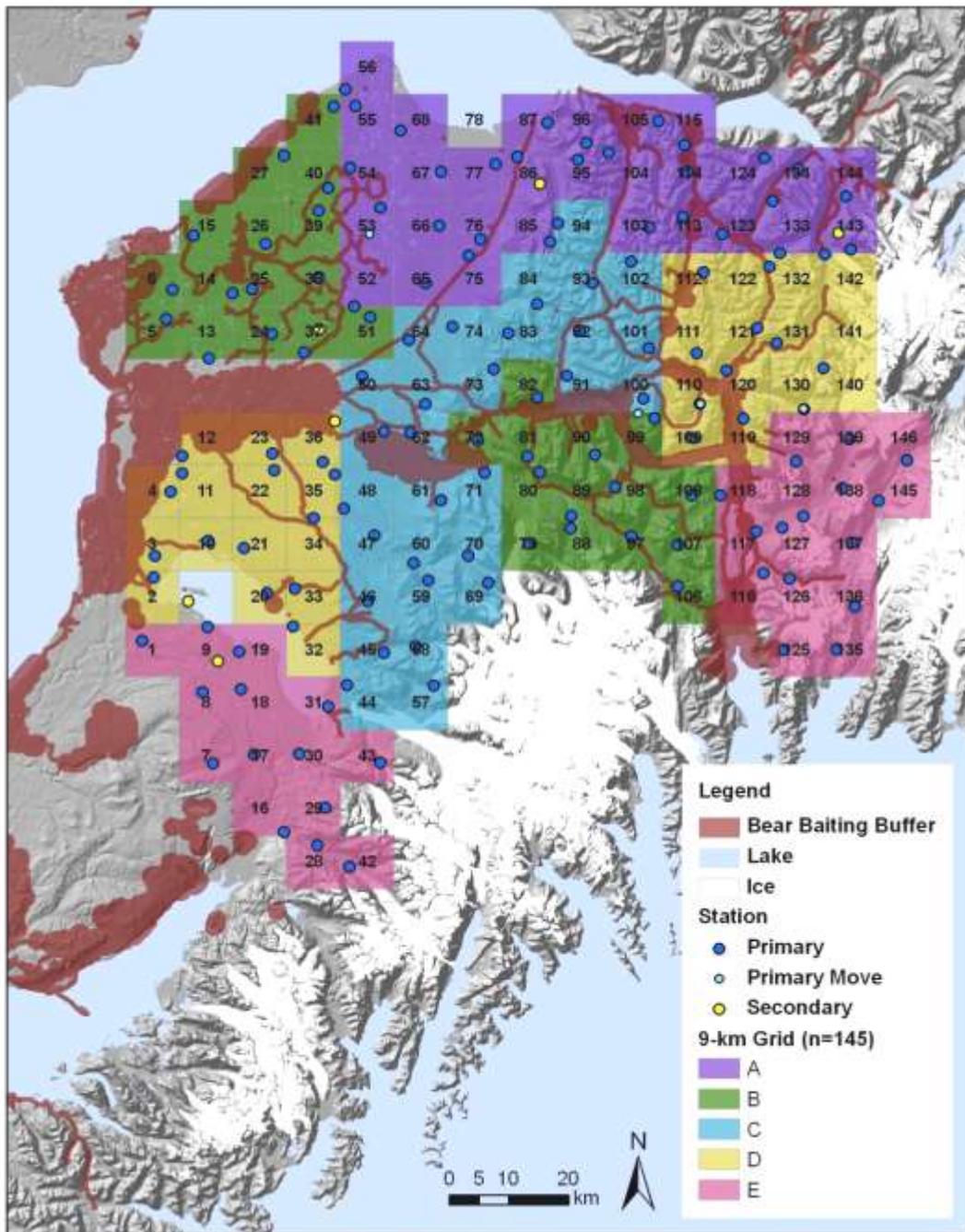
R = Number of animals captured on the first visit that were then recaptured on the second visit

...estimate is not based on the number of individuals marked (i.e., genotypes) but on their recapture rates

Assumptions of Mark-Recapture Model

- ✓ No individuals die, are born, move into the study area (immigrate) or move out of the study area (emigrate) between visits
- ✓ No marks fall off animals between visits, and that the researcher correctly records all marks
- ✓ Equal capture probability of individuals





**145 primary hair stations
subjectively placed within 81-
km² cells systematically
distributed over 11,700 km²
study area**

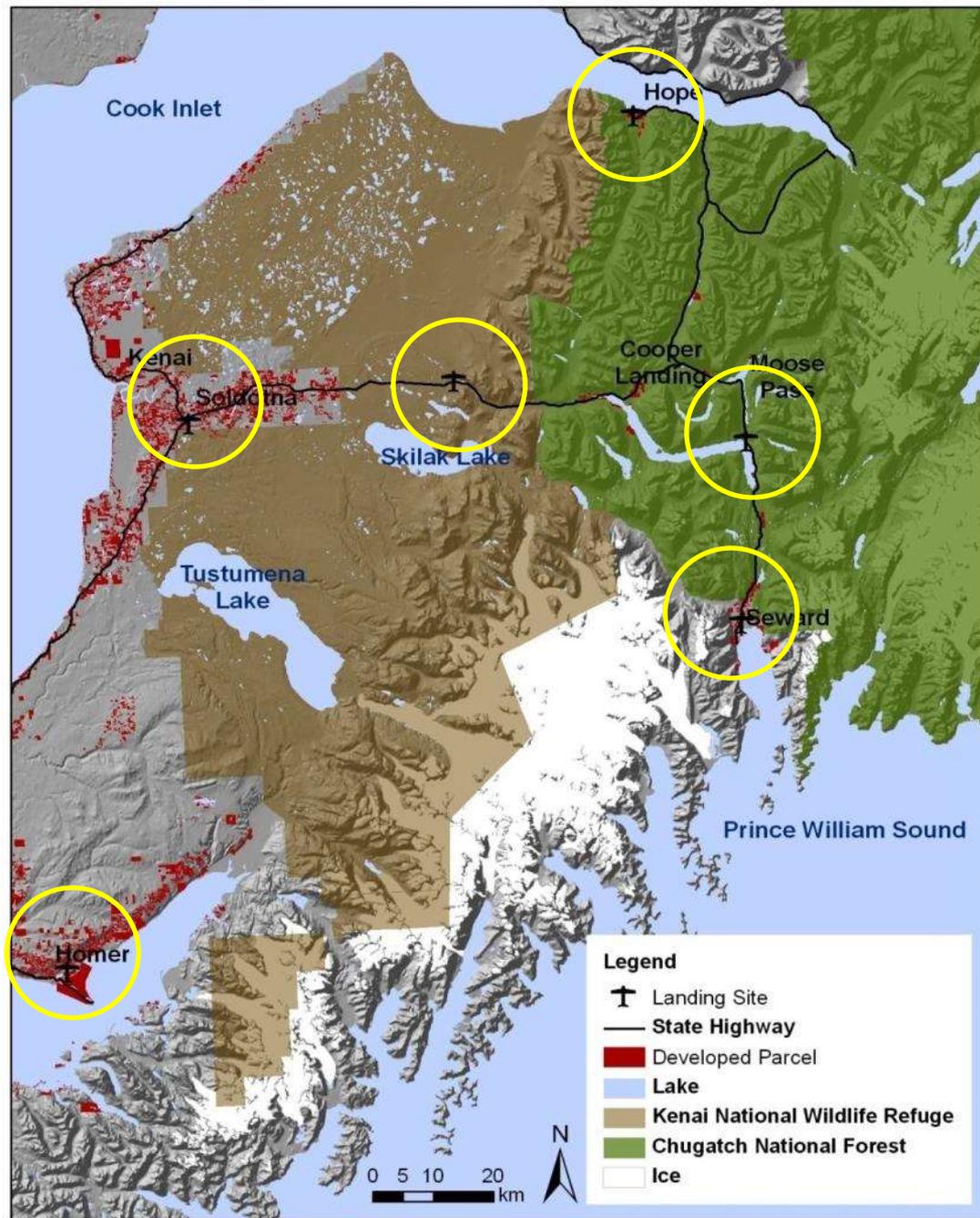
**29 stations sampled daily over
five 5-day trap sessions using
rotating panel design**

Selection criteria for hair stations

- ✓ adequate space for helicopter access
- ✓ > 400m from trails, cabins, roads
- ✓ riparian/wetland corridors
- ✓ other travel corridors (ridges, shoulders, chutes)
- ✓ OTBE, ensure good spatial separation among sites within a cell







Four sets of 2-person field crews operated out of Moose Pass and Soldotna for 31 consecutive days





N204PA

2000 GAL



FLAMMABLE

NO SMOKING













1MINUTE

13

JUN.10,10 09:48 PM



1MINUTE

13

JUN.10,10 09:49 PM



1MINUTE

13

JUN.10,10 09:50 PM



1MINUTE

13

JUN.10,10 09:53 PM



1MINUTE

07

JUN.19,10 08:00 AM



1MINUTE

07

JUN.19,10 08:01 AM



1MINUTE

07

JUN.19,10 08:04 AM



1MINUTE

07

JUN.19,10 08:05 AM



1MINUTE

07

JUN.19,10 08:06 AM



1MINUTE

07

JUN.19,10 08:09 AM



1MINUTE

07

JUN.19,10 08:10 AM



1MINUTE

07

JUN.19,10 08:11 AM



Hair station: _____ Barb # _____ Session # _____

Date: June ____, 2010

3 hairs or less? Y / N

Hair Location: Upper strand / Lower strand

Probable Species: Brown bear / Black bear / unknown

Comments: _____



106624



106624



11,175 hair samples (grid) + 91 hair samples (rub tree)

11,266 hair samples

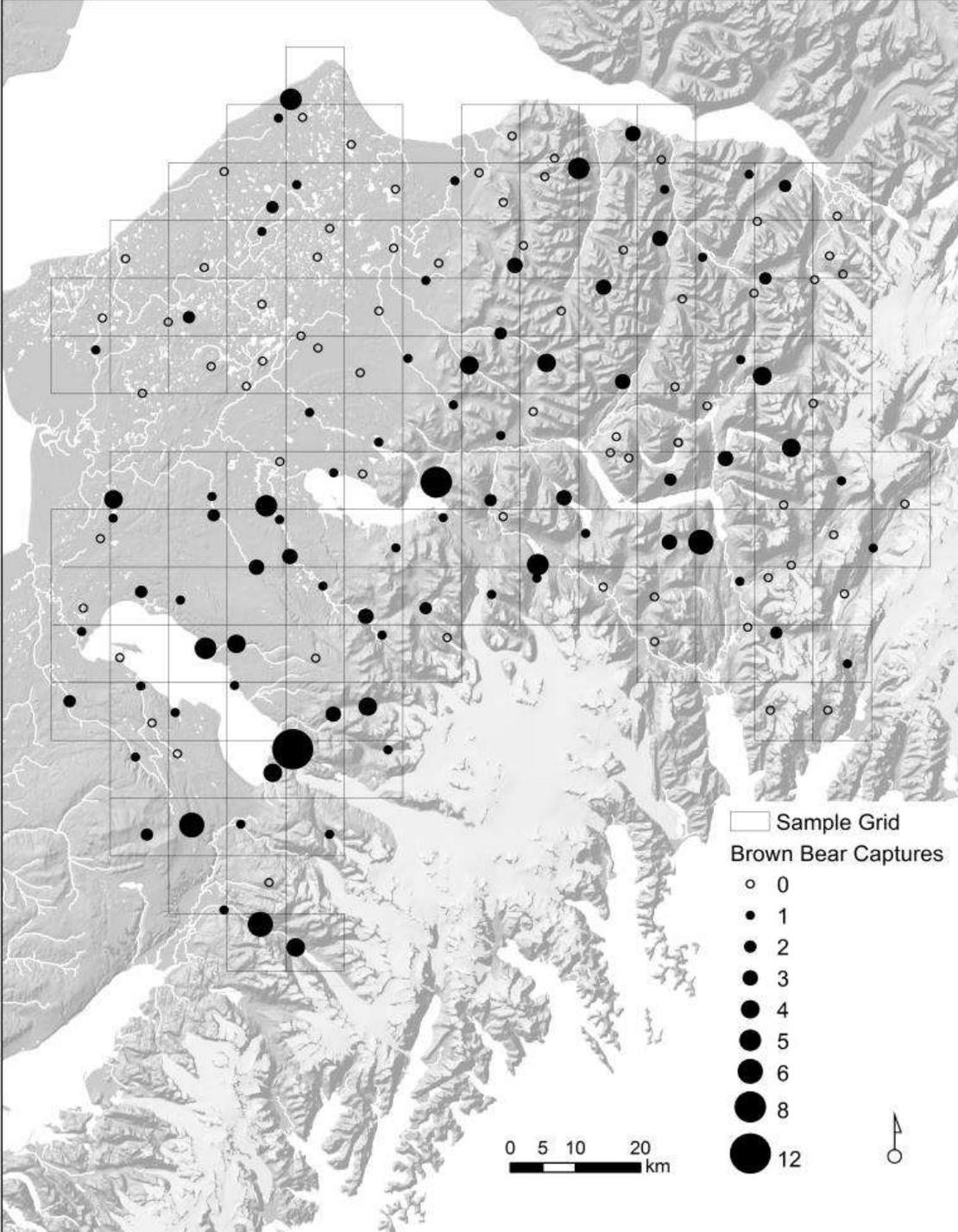
2,671 DNA samples

1,034 brown bear samples

211 unique genotypes

104 males + 99 females (n = 203)





Distribution of 211 brown bear captures at 145 primary + 7 secondary hair stations

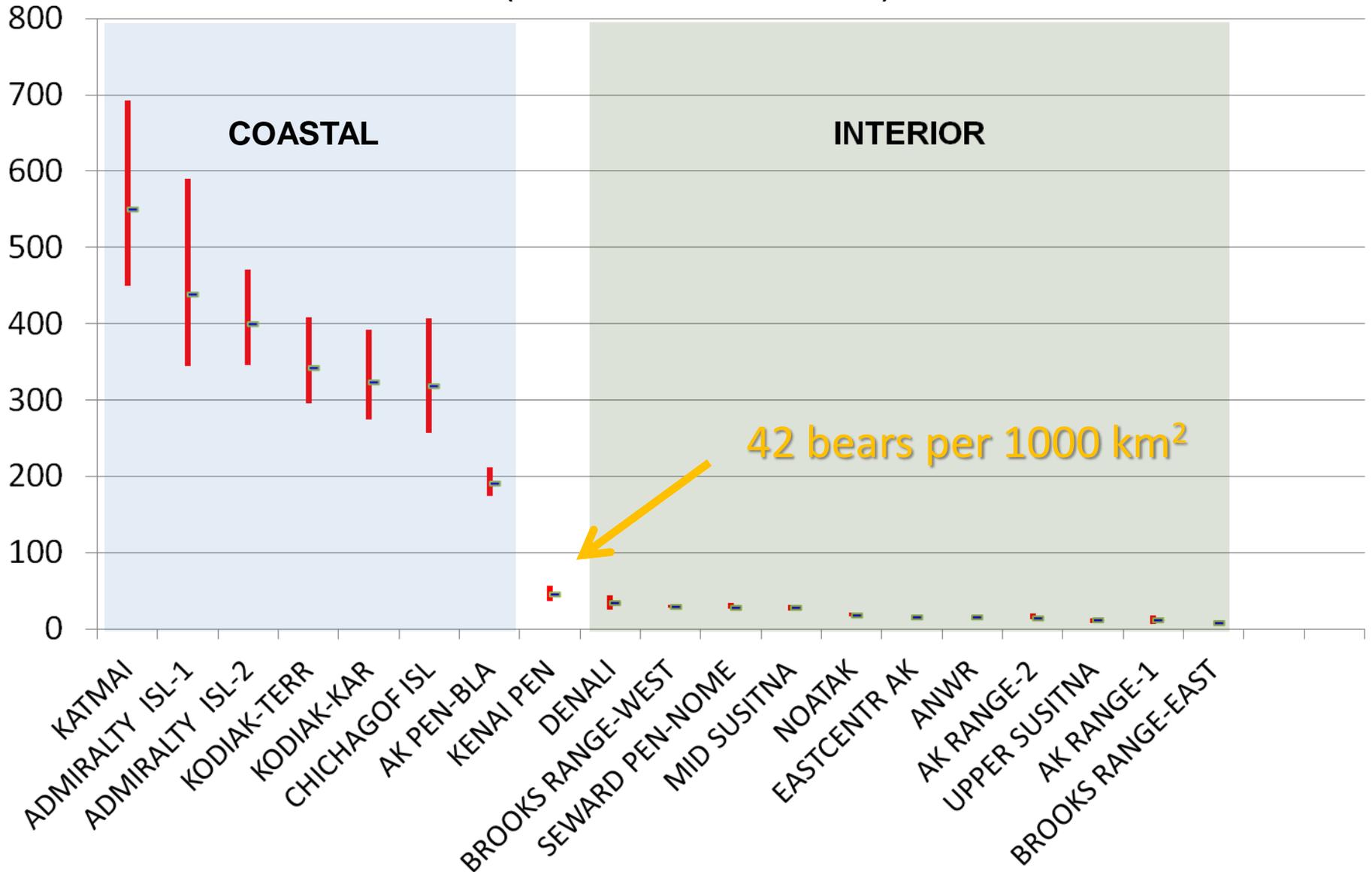
Brown bear population estimate (all ages) on 11,700 km² sample frame

GRID + telemetry data + rub trees

Sex	Estimate	SE	$M(t + 1)$	95% Lognormal CI	
				LCI	UCI
Females	214.6	33.7	99	165.0	301.3
Males	213.1	30.9	104	167.2	292.2
Combined	427.6	46.7	203	353.2	539.1

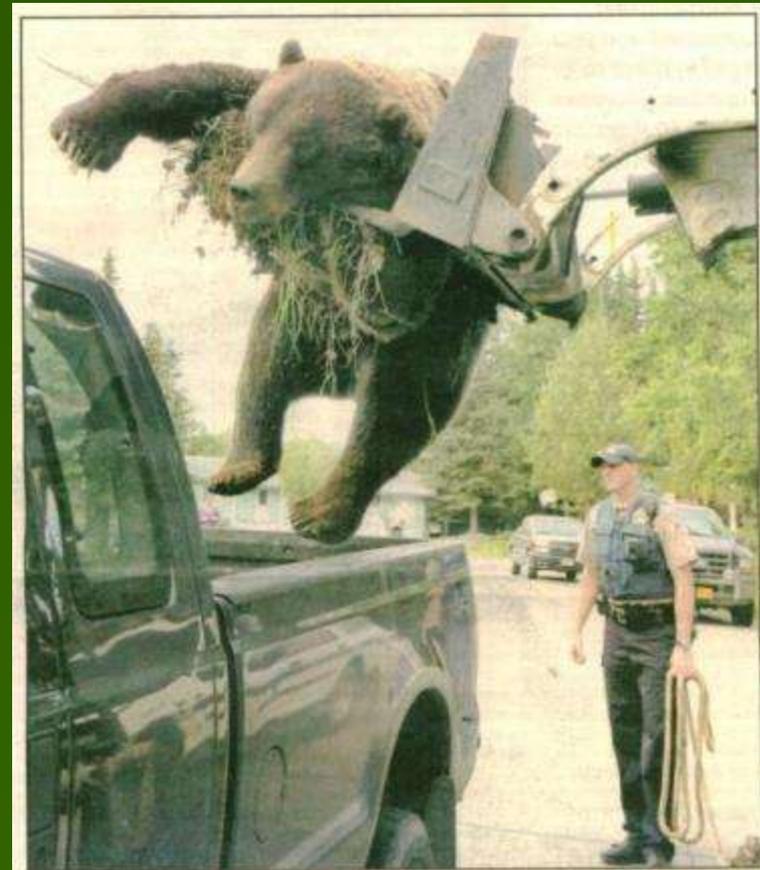
ALASKA BROWN BEAR DENSITIES (PER 1000 KM²)

(after Miller et al. 1997)



What are the management implications for Kenai brown bears?

- ✓ Represents 1st empirically-based estimate of the Kenai brown bear population
- ✓ Puts human-caused mortality (legal harvest, illegal take, vehicle collisions, agency kills and DLPs) into better demographic context
- ✓ Helps determine sustainable harvest



Human-caused mortality of Kenai brown bears in past 4 years 3 times more than 1995-2011 annual average

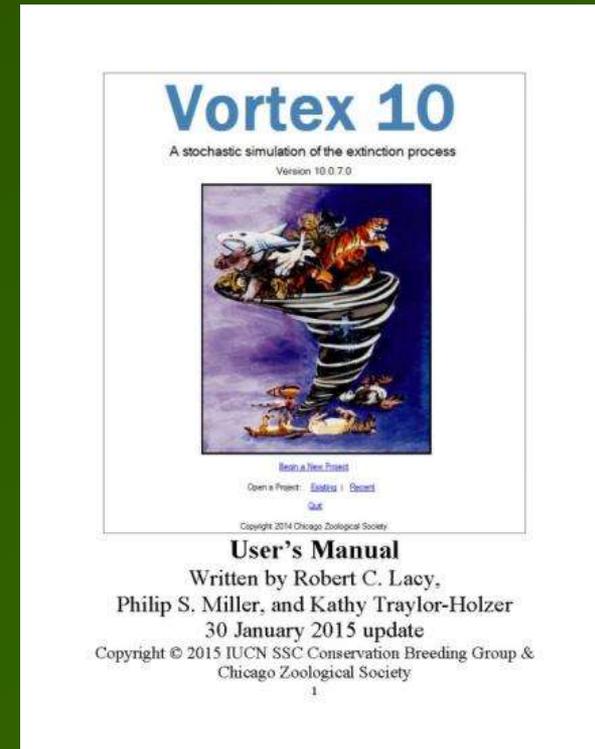
Year	Total HCM	Adult females	% on KENWR
2012	44	13	30%
2013	71	23	35%
2014	69	6	3%
2015	29	6	21%
TOTAL	213	48	22%

- ✓ Human-caused mortality of adult female bears averaged 4 per year during 1995-2011 but increased to 14 per year in 2012-14
- ✓ Total brown bears killed by humans averaged 20 annually during 1995-2011 but increased to 61 bears annually during 2012-14

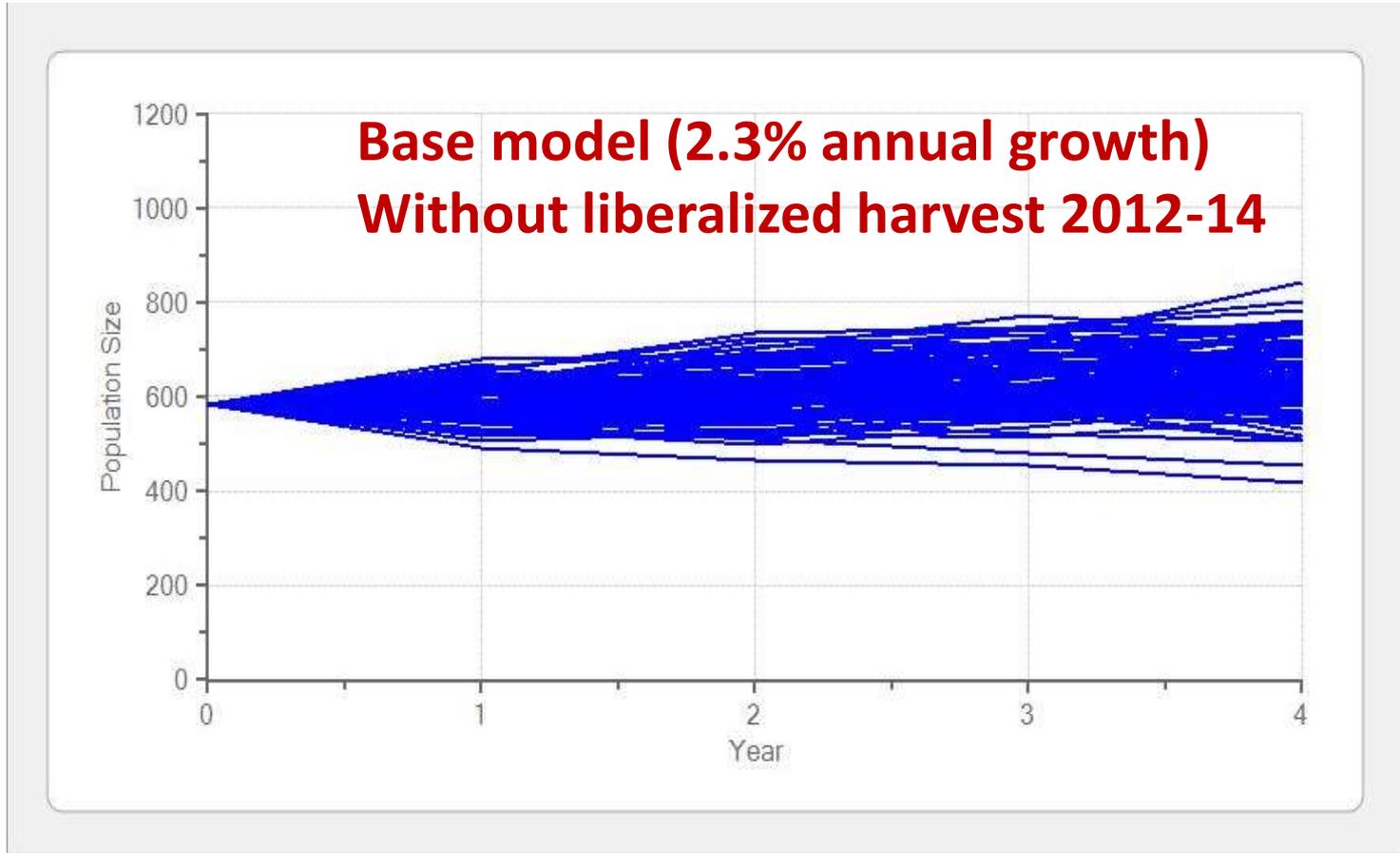
Population demographics used in VORTEX

- ✓ Based on data 1995-2014
- ✓ Polygynous system with 100% of adult males breeding
- ✓ Reproductive age = 6 years
- ✓ Maximum breeding age = 26 years
- ✓ 50% males, 50% females
- ✓ Adult females breeding = 34%
- ✓ Initial population of 582
- ✓ Assumes telemetered population of adult females is representative of peninsula-wide population
- ✓ Assumes stable age distribution, no density-dependent mortality

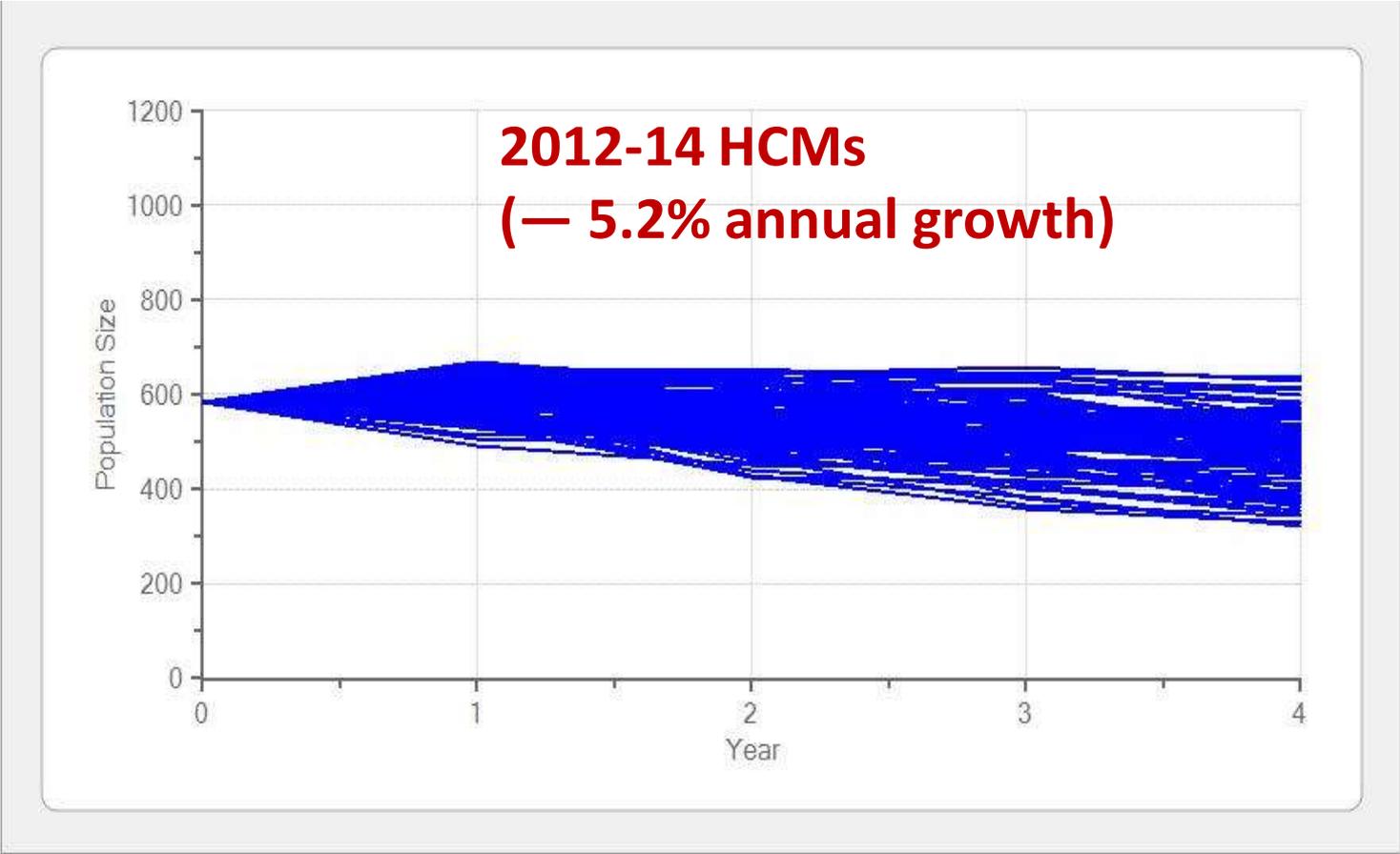
Based on Farley 2013, Morton et al. 2014,
ADF&G harvest data 2012-14 (revised with teeth ages)



$$N_t = N_0 e^{rt}$$



Kenai brown bear population would have grown to 643 by 2014 if harvest had not been liberalized in 2012-14



2012-14 harvest (n = 184) depressed the Kenai brown bear population by **18%** (478 bears) from 2010 to 2014



582 brown bears in 2010
478 brown bears in 2014

Questions????