# NWFSC Science to Inform SRKW Distribution and Diet

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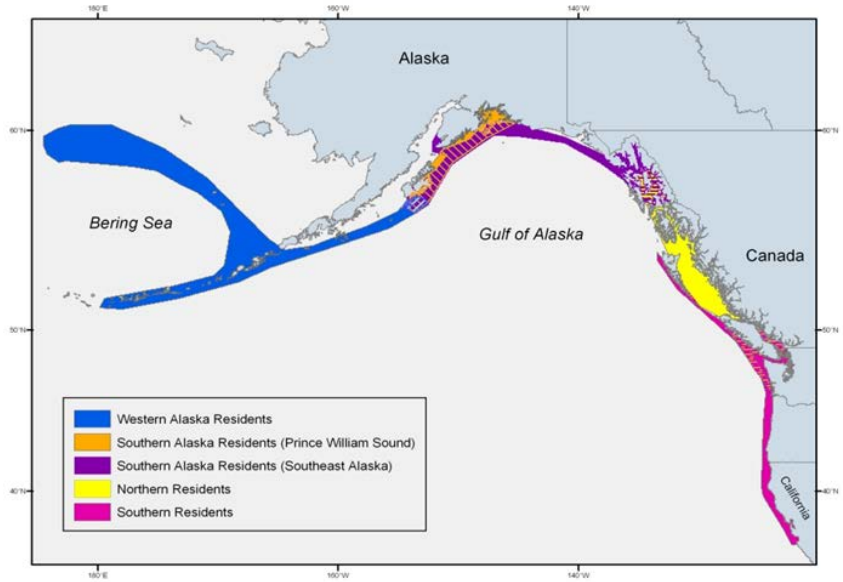
Northwest Fisheries Science Center

# What do we know about killer whale distribution?

# Background

Southern Resident Killer Whales (SRKW) are a small population of “piscivorus” killer whales that occurs primarily in the Pacific Northwest

Comprised of 3 pods, J, K, L

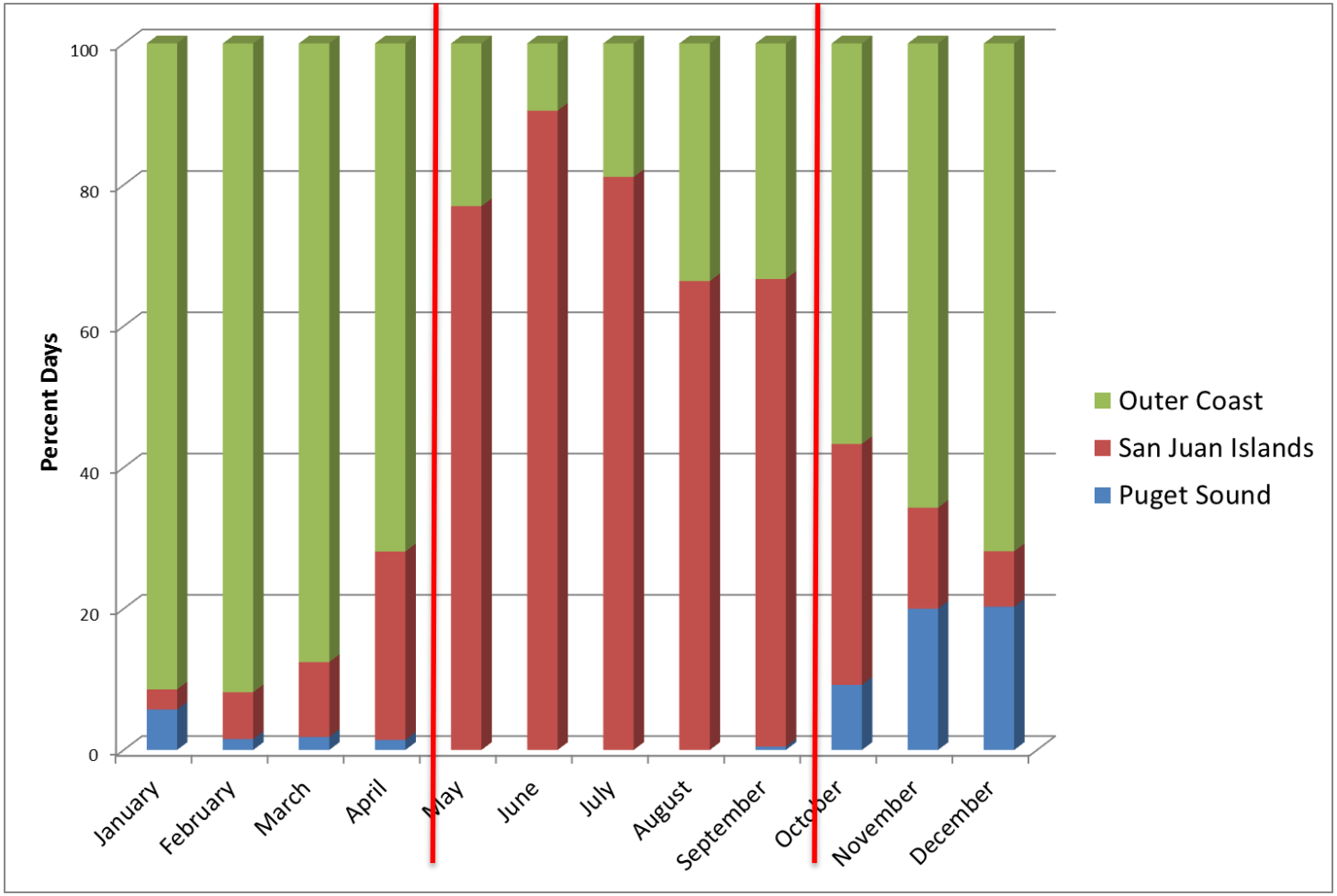



Estimated ranges of resident-type killer whales in the North Pacific Ocean

Photo by Astrid van Ginneken, Center for Whale Research

# Where do SRKWs occur?

*Percentage of time Southern resident killer whale pods were present in three main areas of their range*




*Three unique seasonal occurrence patterns for SRKWs*

*January – May* *June – September* *October - December*

# Occurrence varies by social group (pod)

- J pod (22 animals)
  - Salish Sea distribution, rarely on outer BC/WA coasts
- K/L pod (53 animals)
  - Salish Sea occurrence in summer months
  - Primarily coastal WA/OR in winter, sporadic late fall visits to Salish Sea

- Range is large
  - Monterey CA to Southeast Alaska

# Data that informs distribution

- Sightings / photographs
  - Vast majority in summer months in the Salish Sea (Hauser et al. 2006)
  - Only a handful of verified SRKW sightings on outer coast

- Coastal acoustic recorders (Hanson et al. 2013)
  - SRKW difficult to detect – density of recorders is low, and animals don't vocalize continuously (Hanson et al. unpublished)

- Satellite tags
  - Best source of information on distribution
  - Deployments concentrated in winter months (Hanson et al. unpublished)

# Satellite data (8 whales tagged 2012-2016)

- Coastal waters
- K25 (29 Dec. 2012, 96 days)
- L84 (17 Feb. 2015, 93 days)
- K33 (31 Dec. 2015, 48 days)

- Inland waters
- L87 (26 Dec. 2013, 31 days)
- J27 (28 Dec. 2014, 49 days)

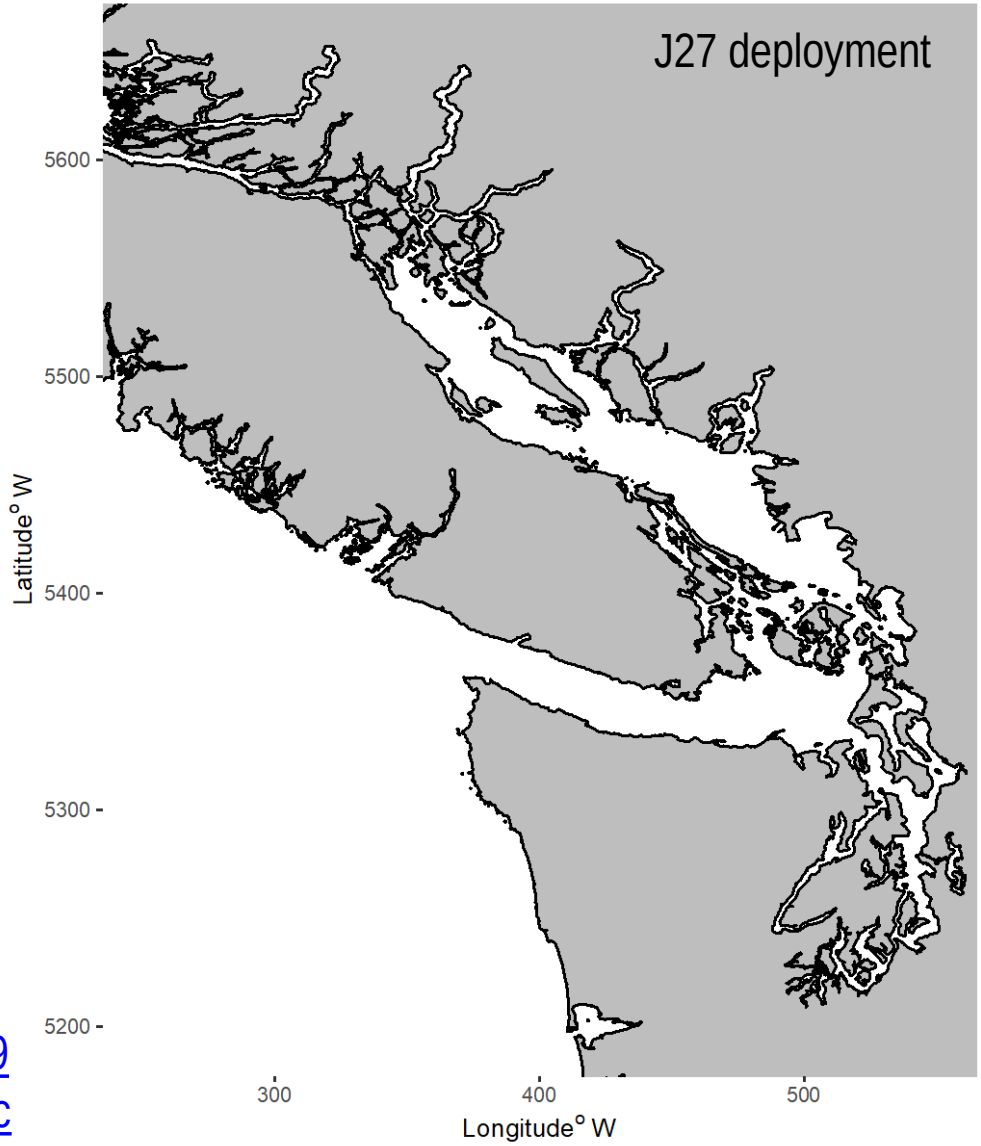
These represent the 5 longest deployments,
3 other tags lasted 8 days or less

# Analysis

- State space movement models
- Tags programmed to maximize duration
- Can't identify foraging events
- Estimated location at 10-min intervals

- More details in Hanson et al. (2018) report to Navy – link below

https://www.navymarinespeciesmonitoring.us/files/9315/3186/7492/Hanson_et_al_2018_Modeling_Occurrence_of_SRKW_in_NWTRC.pdf

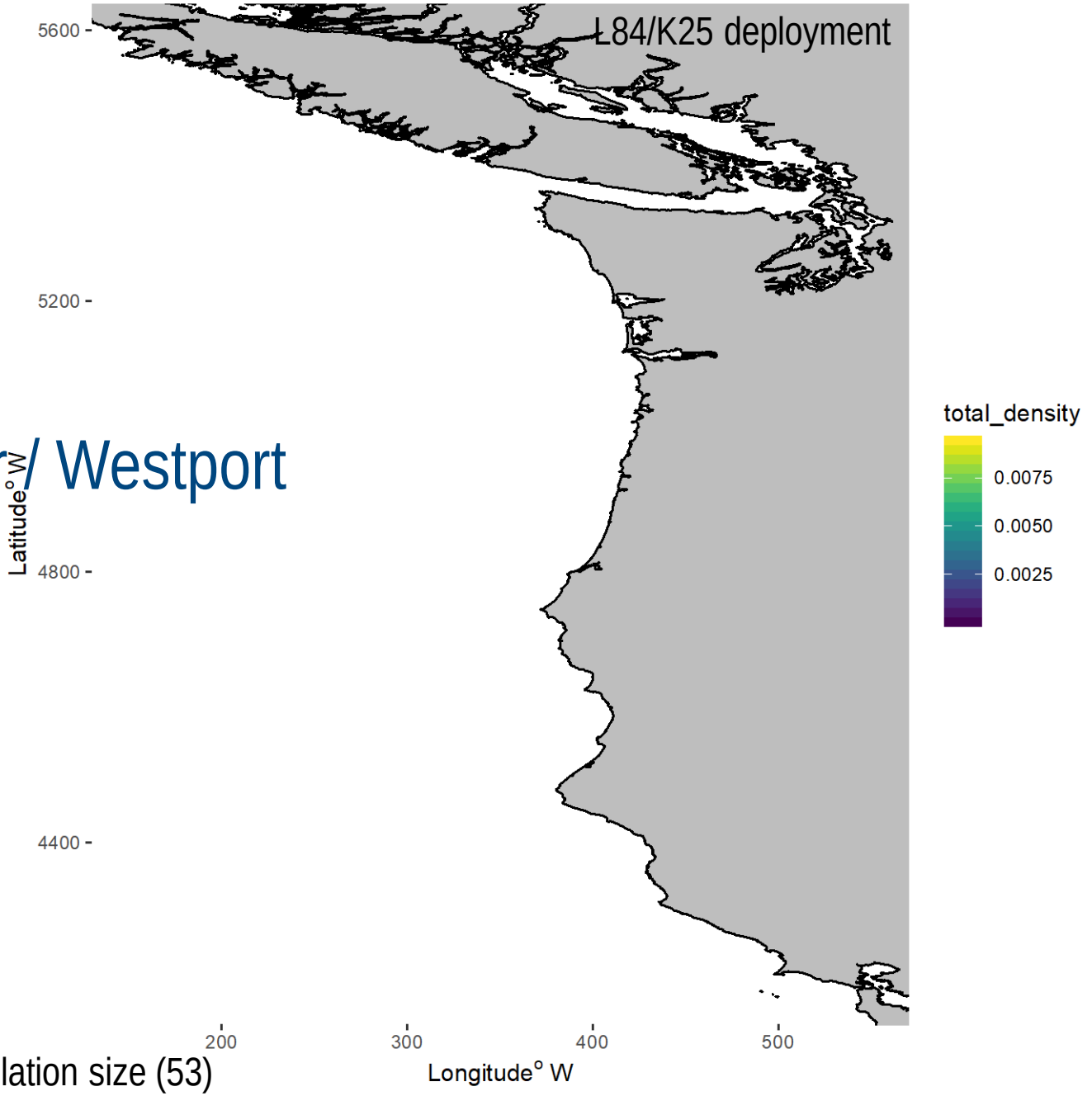


# Coastal distrib

## Hot spots:

Columbia River/ Westport

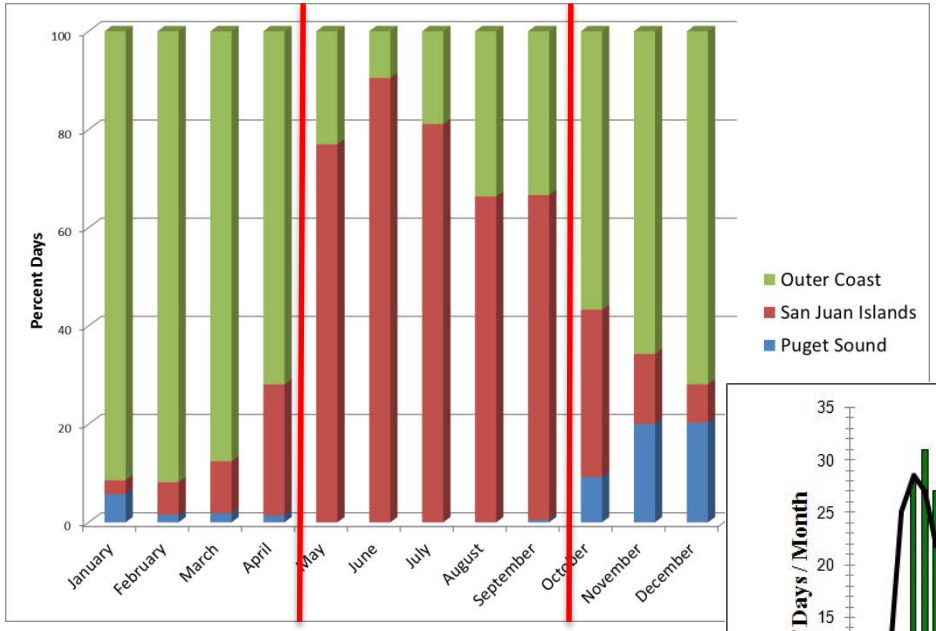
WA coast




Density = avg occurrence x population size (53)

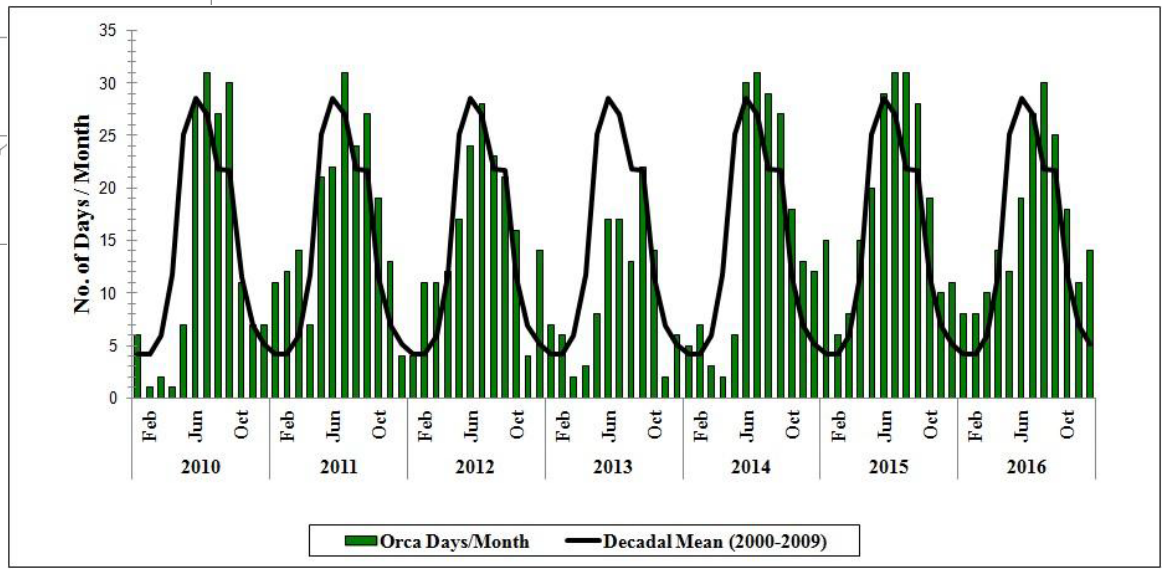
# Where do SRKWs occur?

*Percentage of days Southern resident killer whale pods were present in three main areas of their range*




Orcamaster Data from 2003-2009

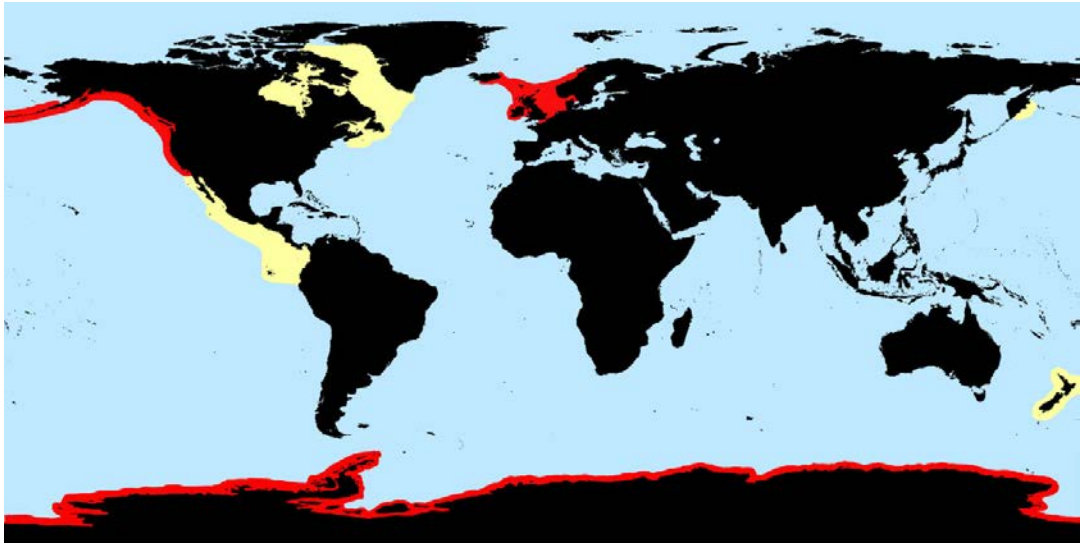
Orcamaster Data from 2010-2016




*SRKW occurrence in inland waters may be changing - recently present fewer days in each spring*
*Overall reduction in 2013 – In 2017 only occurred on 40 days*

# What do we know about killer whale diet?

# Globally diverse diet



- >100 prey species
- Marine mammals
- Birds
- Reptiles
- Invertebrates
- Fish
  - Salmon
  - Herring
  - Toothfish

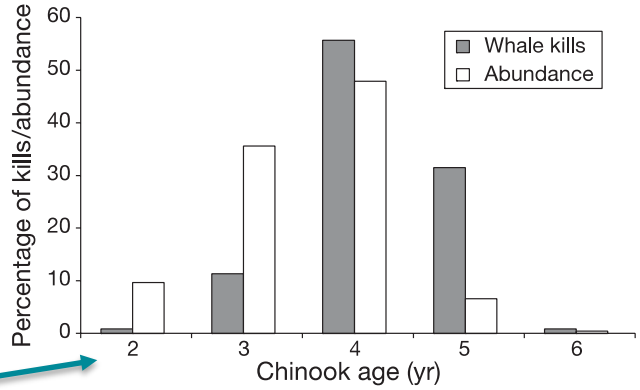
Reviewed by Riesch et al. 2012, Ford 2009

# Data that informs SRKW diet

- Stomach contents from killer whales (Ford et al. 1998)
- Stable isotope samples from skin biopsies
  - Reviewed by Hilborn et al. (2012), paper in prep.
- Prey collection (recovering samples of prey brought to surface)
  - Species ID, stock ID
  - Might be biased with respect to size/species
- Prey collection via fecal samples
  - Genetic species ID of prey (Ford et al. 2016)
  - ~ 10% of samples can be identified to stock
  - No age information

# Example of potential selectivity

- Size or age of scale samples may be affected by selectivity / prey sharing (Ford and Ellis 2006)
  - Follow up Hilborn et al. 2012
  - Estimating killer whale selectivity is difficult



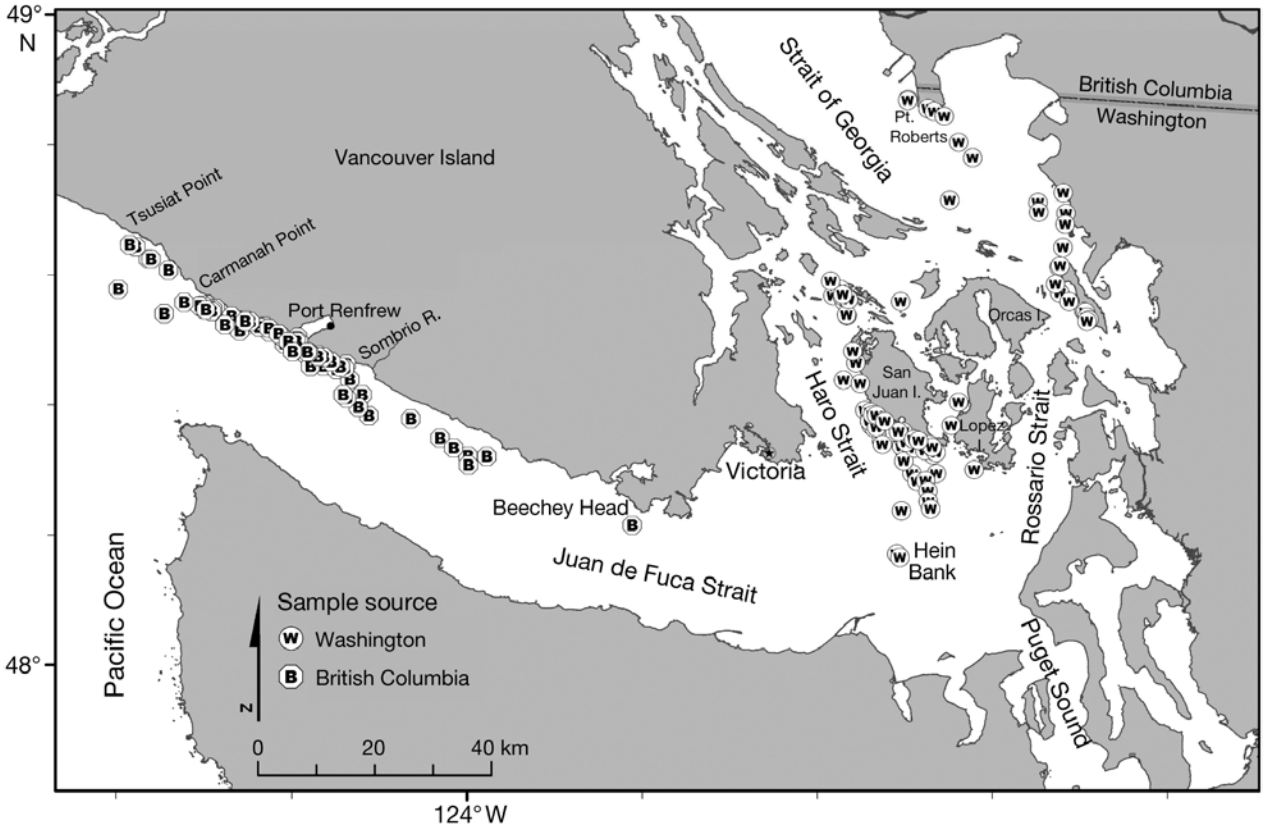

Age 2 fish represent a small contribution

istribution of available chinook was derived from cumulative abundance estimates of 976 212 fish over the 5 yr period (see Footnote 1 in 'Results')

# *SRKW summer diet: May - September*

## Focal Follow behavioral foraging study

Hanson, et al. 2010. Species and stock identification of prey consumed by endangered "southern resident" killer whales in their summer range. Endangered Species Research 11: 69–82.




San Juan Islands

N=159 Scale/tissue samples
N=69 fecal samples

Juan De Fuca Strait

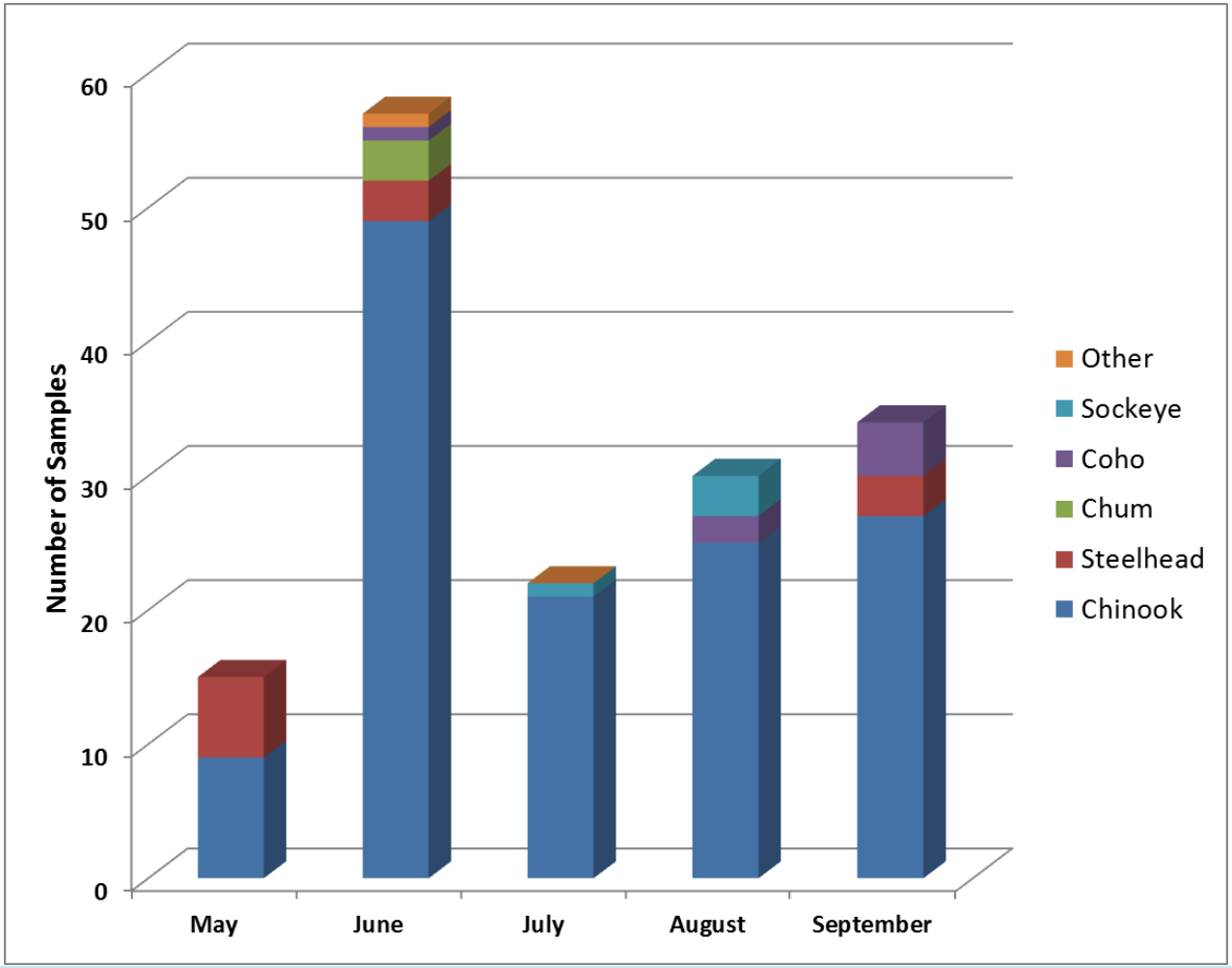
N=75 Scale samples

*SRKW summer diet: May - September*

# SRKW Focal Follow behavioral foraging study

*Based on Scales and Tissues the summer prey were mostly salmon*

Number of Prey identified from scales and genetic analyses of fish Scales, or Tissue




- *Chinook > 80% in all months except May*
- *Few Sockeye and no Pink salmon in sample*
- *Only one non-salmonid fish*

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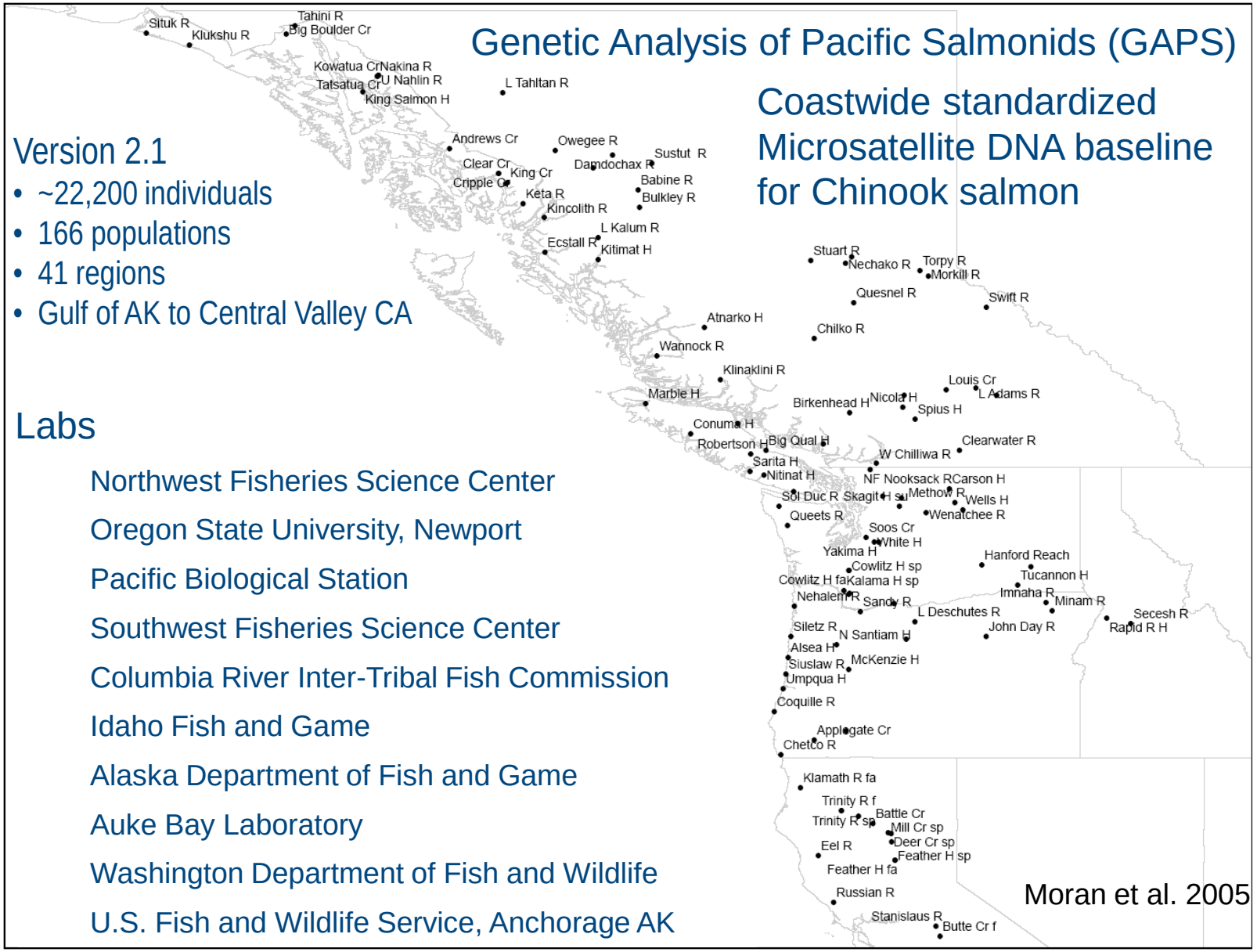
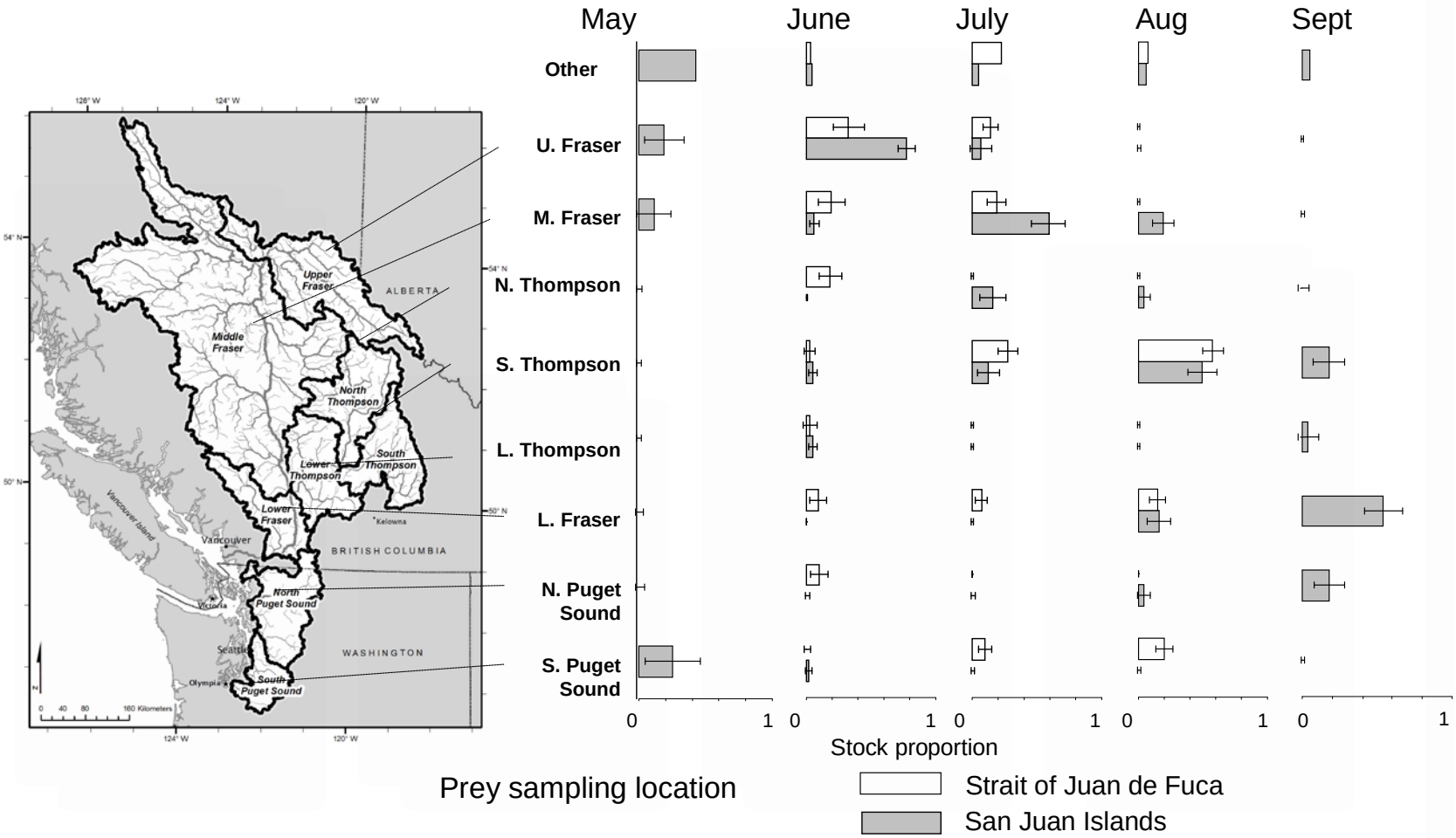
# SRKW summer diet: May - September



# SRKW summer diet: May - September

## SRKW Focal Follow behavioral foraging study

*Fraser River has highest occurrence*




*Upper, Middle, and Lower Fraser, and South Thompson are seasonally important*

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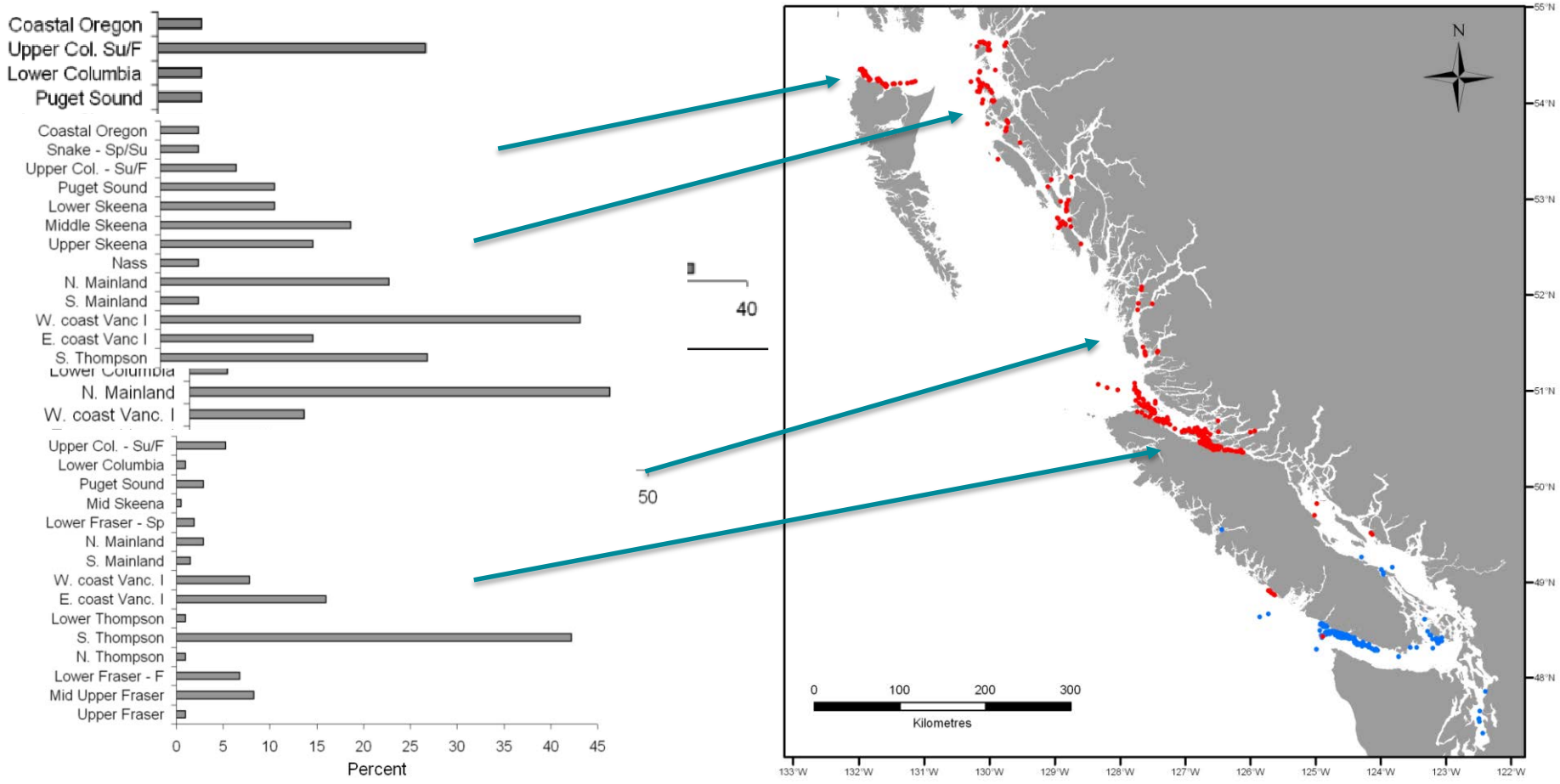
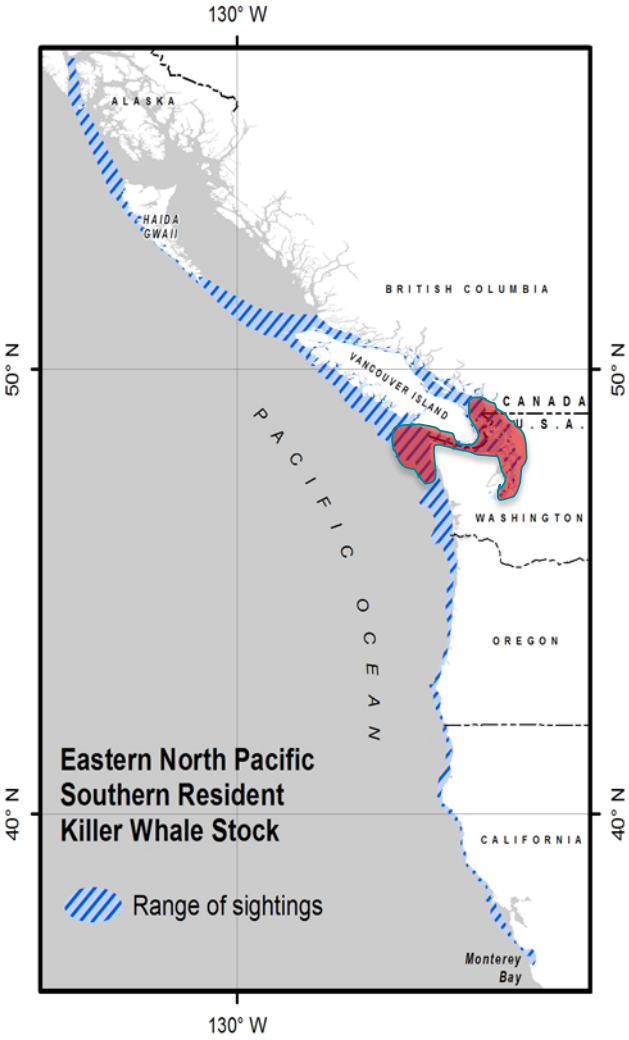
Hanson, et al. 2010. Species and stock identification of prey consumed by endangered "southern resident" killer whales in their summer range. Endangered Species Research 11: 69–82.

# Comparison to Northern Resident killer whale Chinook consumption (summer)



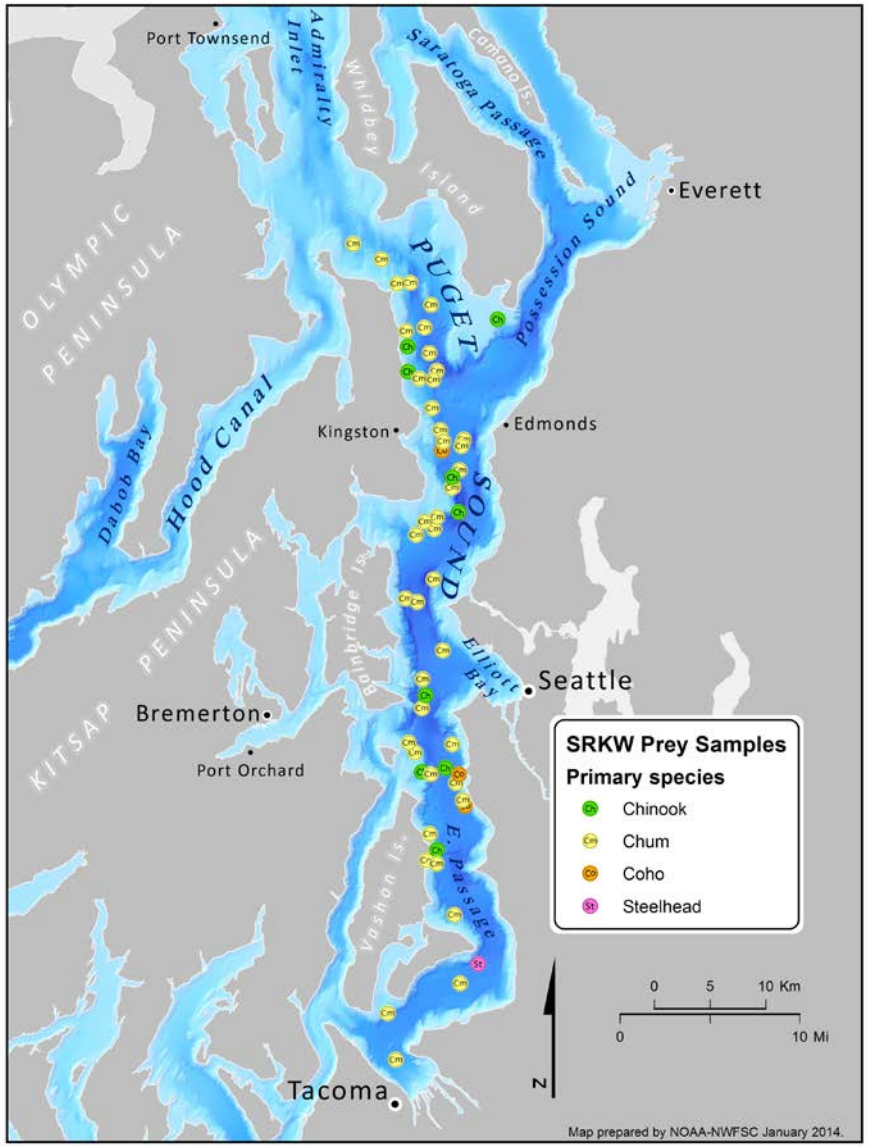

Ford, J.K.B, Wright, B.M., Ellis, G.M., and Candy, J.R. 2010. Chinook salmon predation by resident killer whales: seasonal and regional selectivity, stock identity of prey, and consumption rates. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/101. iv + 43 p.

# SRKW fall diet: October- December




## Fish scales

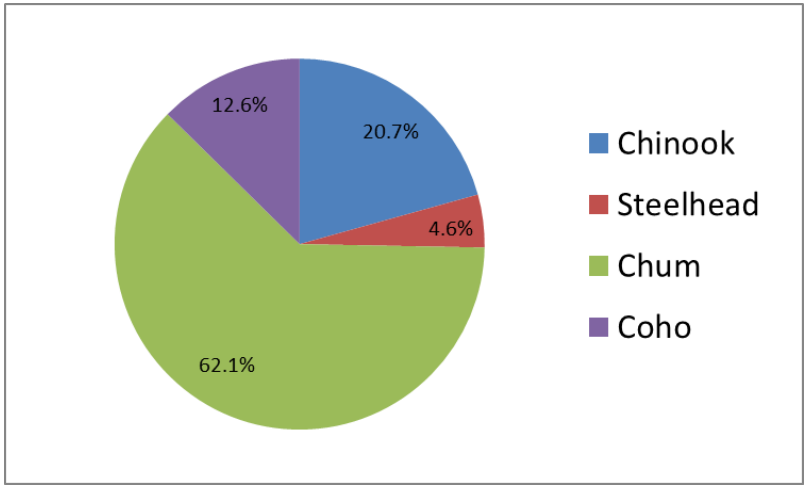
## Feces



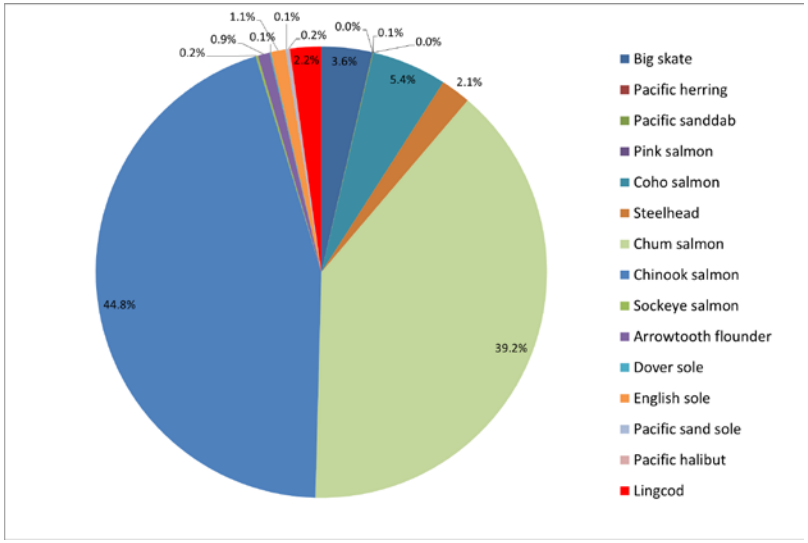

Locations of SRKW predation events by prey species in Puget Sound

Data from 2007-2012

## Scale and tissue samples N = 92




## Quantitative fecal DNA N = 54




**Feces show more Chinook than Chum**

**Feces shows more prey diversity**

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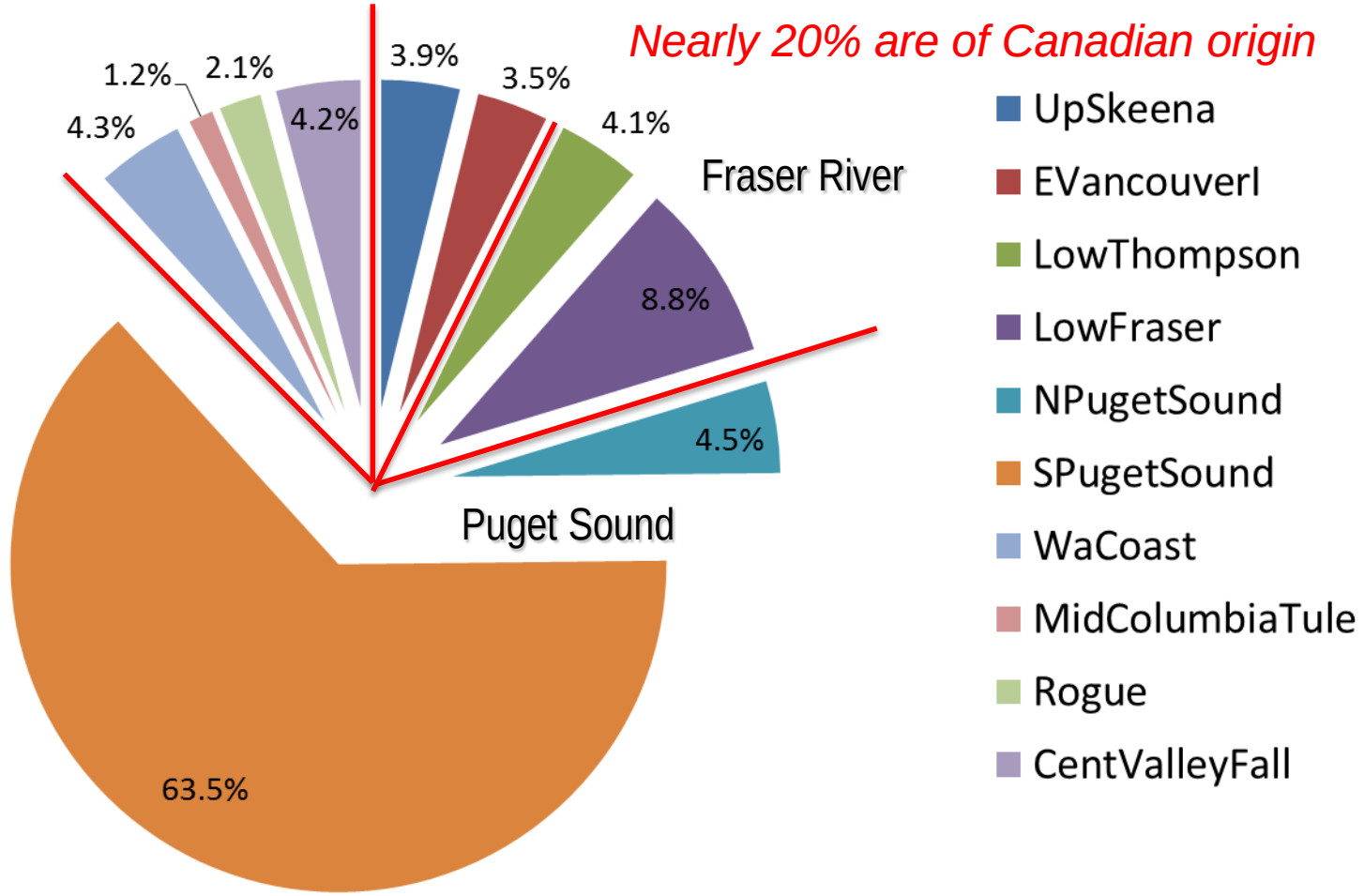
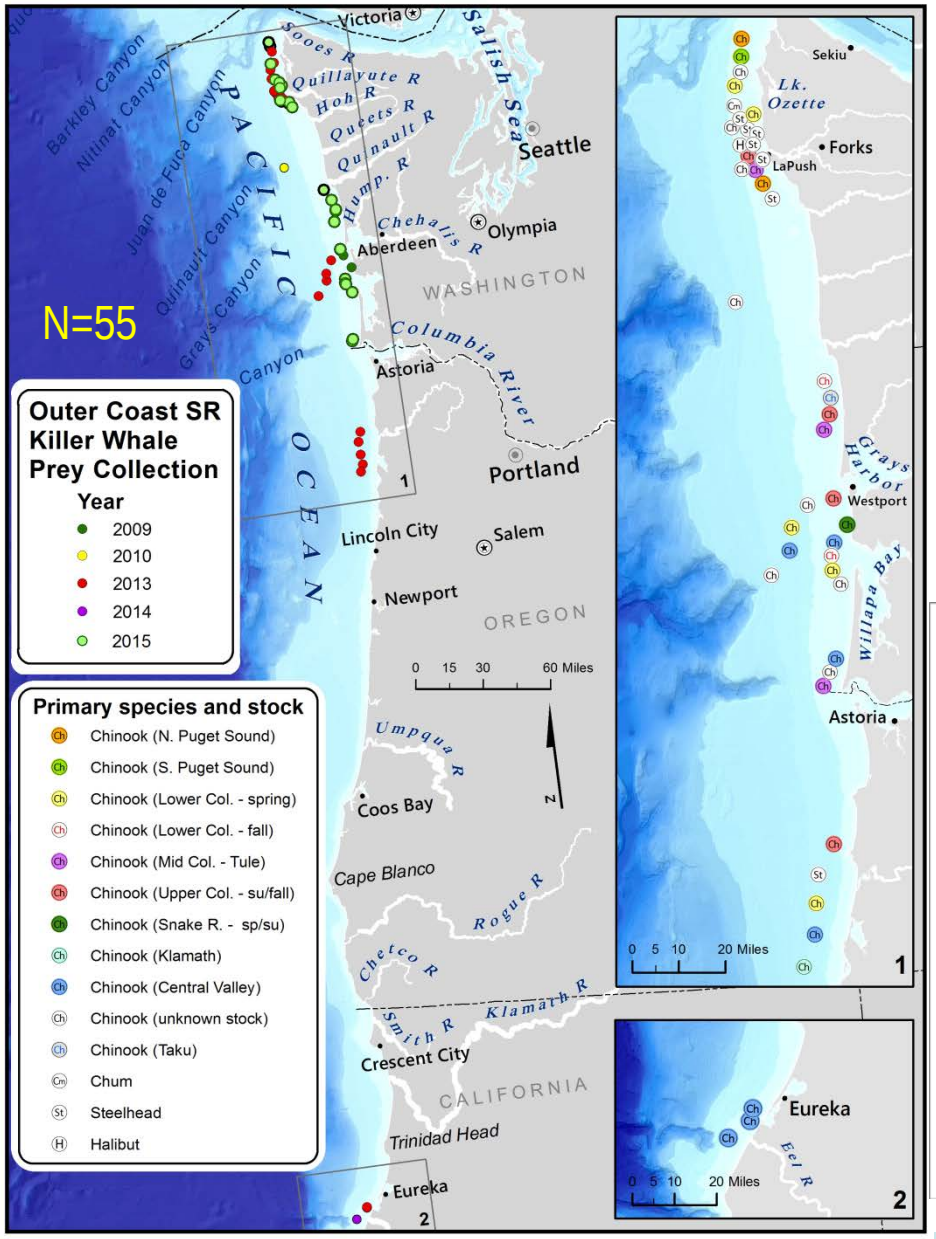
*SRKW fall diet: October- December*

# SRKW Focal Follow behavioral foraging study

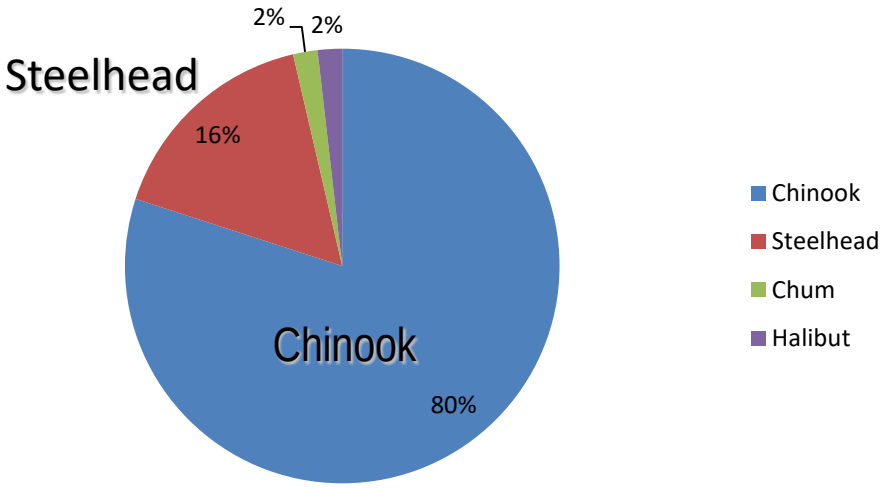
*Puget Sound stocks have greatest occurrence*



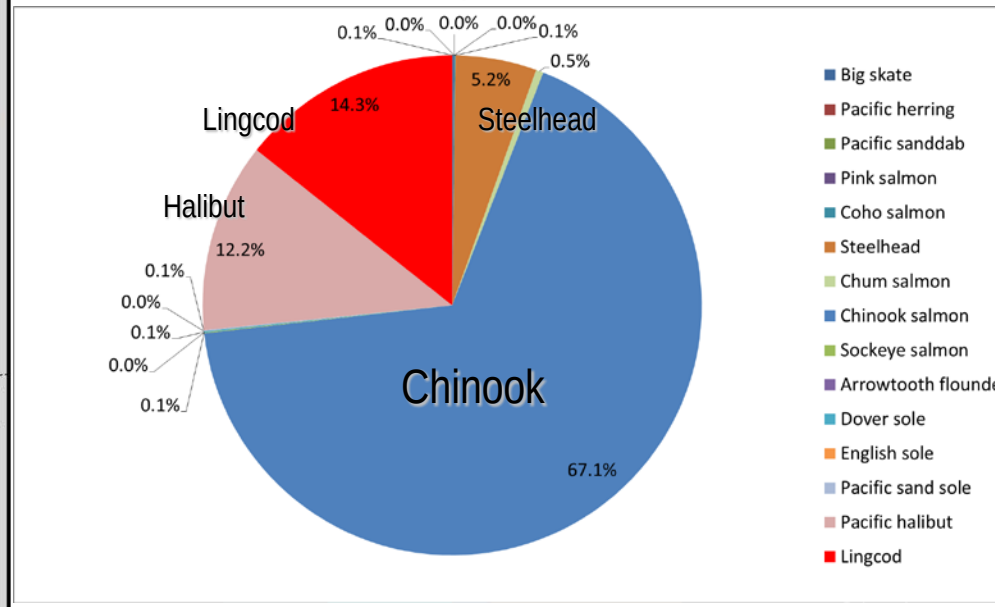
# SRKW fall diet: Winter samples




## Scales/tissues N=55




## Fecal samples N=29

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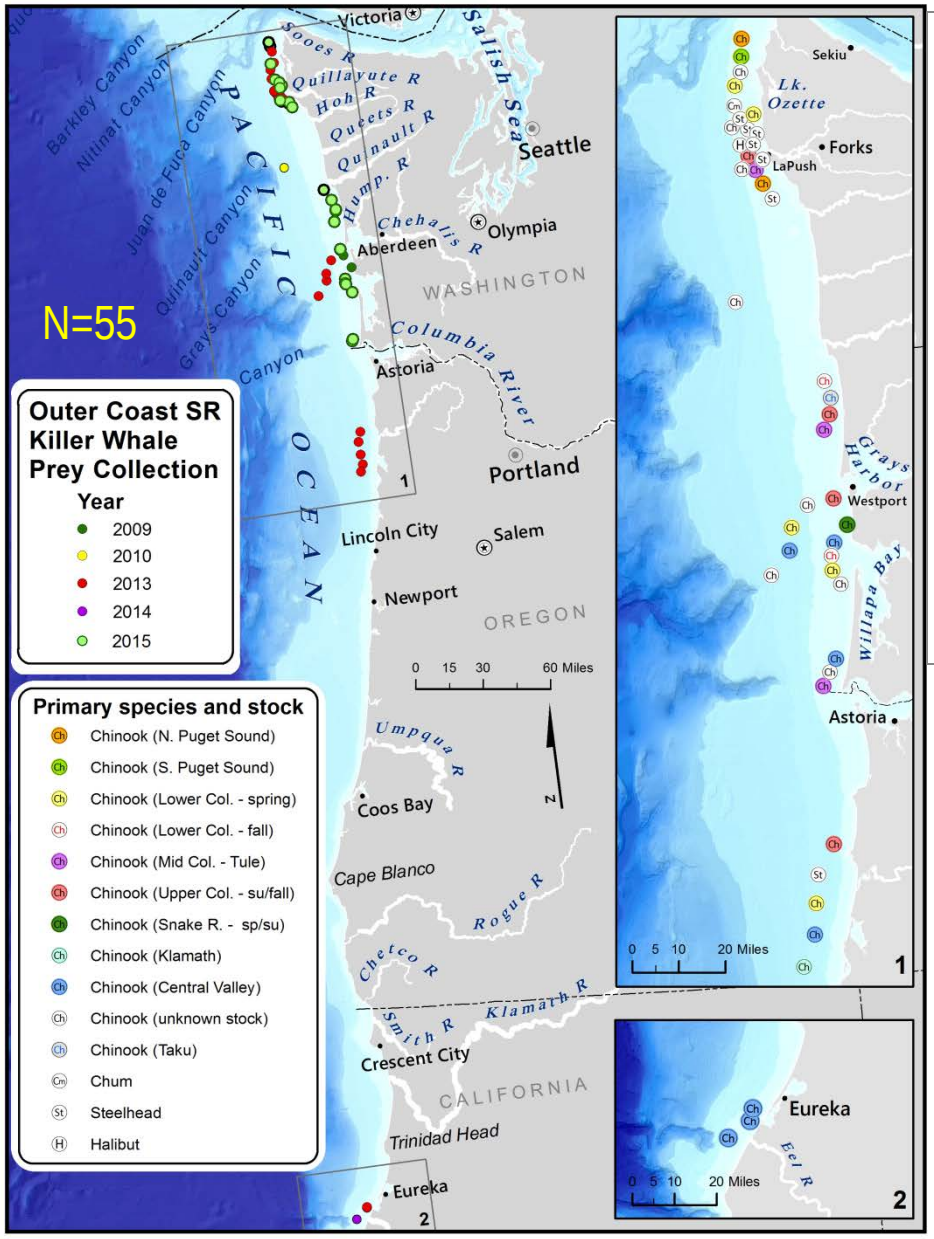
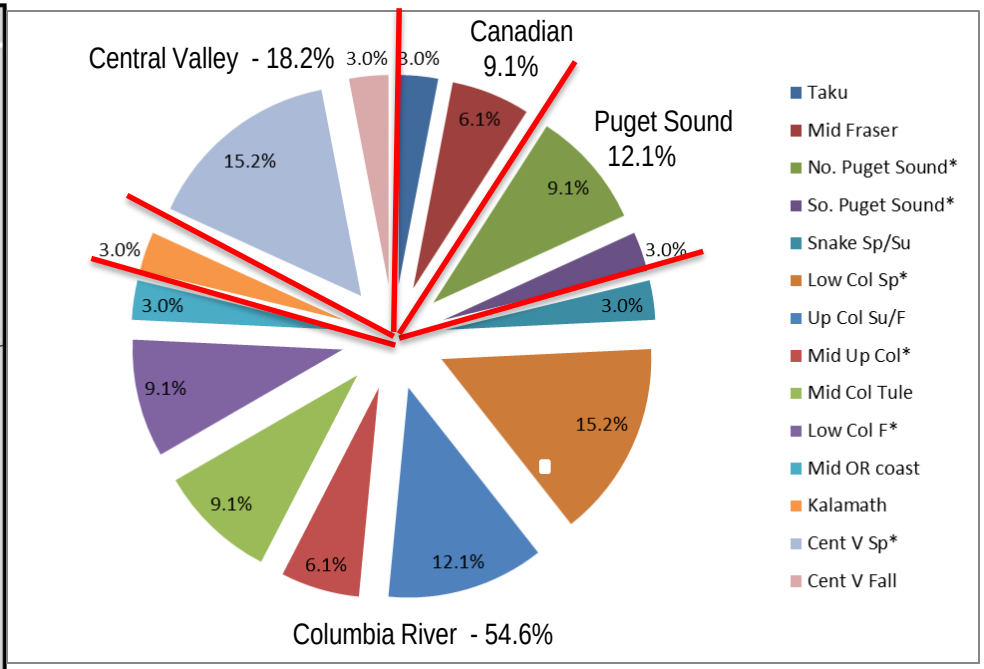
*Feces showed a more varied diet*

# SRKW fall diet: Winter samples




*Chinook Genetic Stock Identification included 12 U.S. west coast stocks - 6 of the 12 Chinook stocks are ESA listed*

*Over half the Chinook consumed originated in the Columbia River*

*Columbia R, Central Valley, Puget Sound, and Fraser comprise over 90% winter prey for K/L pods*

*Columbia R. stocks comprised of spring, summer, and fall runs – majority where from summer and fall runs*

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# Summary

- Diet dominated by Chinook, especially in summer
  - Coho, chum contribute more to prey in fall / early winter (Ford et al. 2006)

- Genetic estimation (fecal samples) more variable than prey samples
  - Might reflect selectivity in what's brought to the surface or shared

- All prey / fecal samples opportunistic, and difficult to collect
  - Confounding of space – season
  - Virtually no diet samples in Winter Salish Sea

- Samples reflect stocks available in collection location
  - e.g. lots of Fraser River samples in summer in the Salish Sea, Columbia River on outer coast near the mouth of the Columbia River

- Current stocks might not reflect optimum or historic prey

- Which stocks will benefit the whales the most in what seasons?