Science, Service, Stewardship

Chinook Needs of Southern Resident Killer Whales & Ratios of Chinook Available : Whale Needs

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NOAA FISHERIES SERVICE

The Whales' Chinook Food Energy Needs

NMFS uses four pieces of scientific information to estimate the whales' energy needs from Chinook:

(1) Their estimated metabolic requirements,

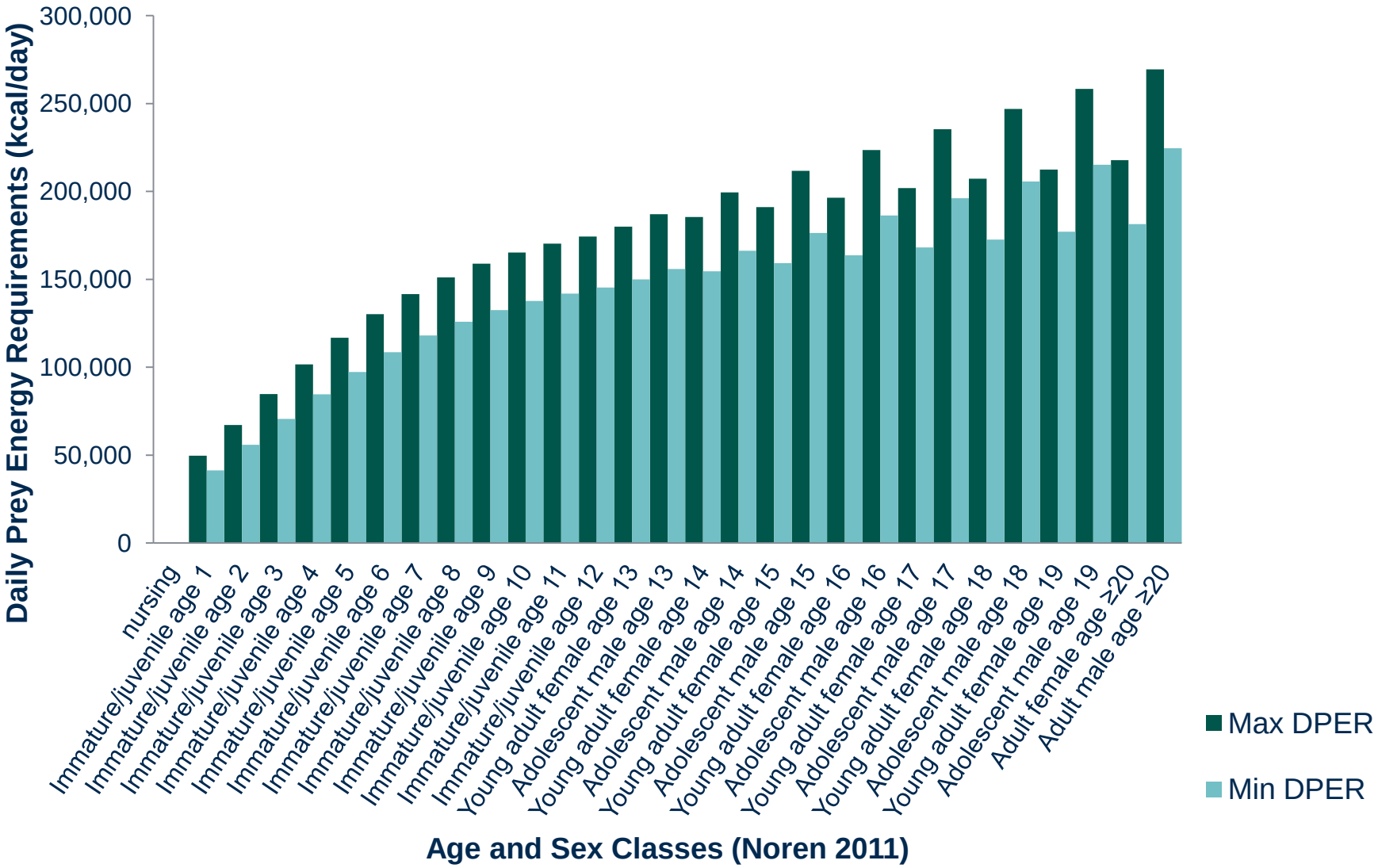
(2) The population age/sex structure and abundance,

(3) Estimated time spent in inland and coastal waters of their range, and

(4) How much of their metabolic requirements would ideally be met by Chinook, based on available data regarding percent Chinook in their diet.

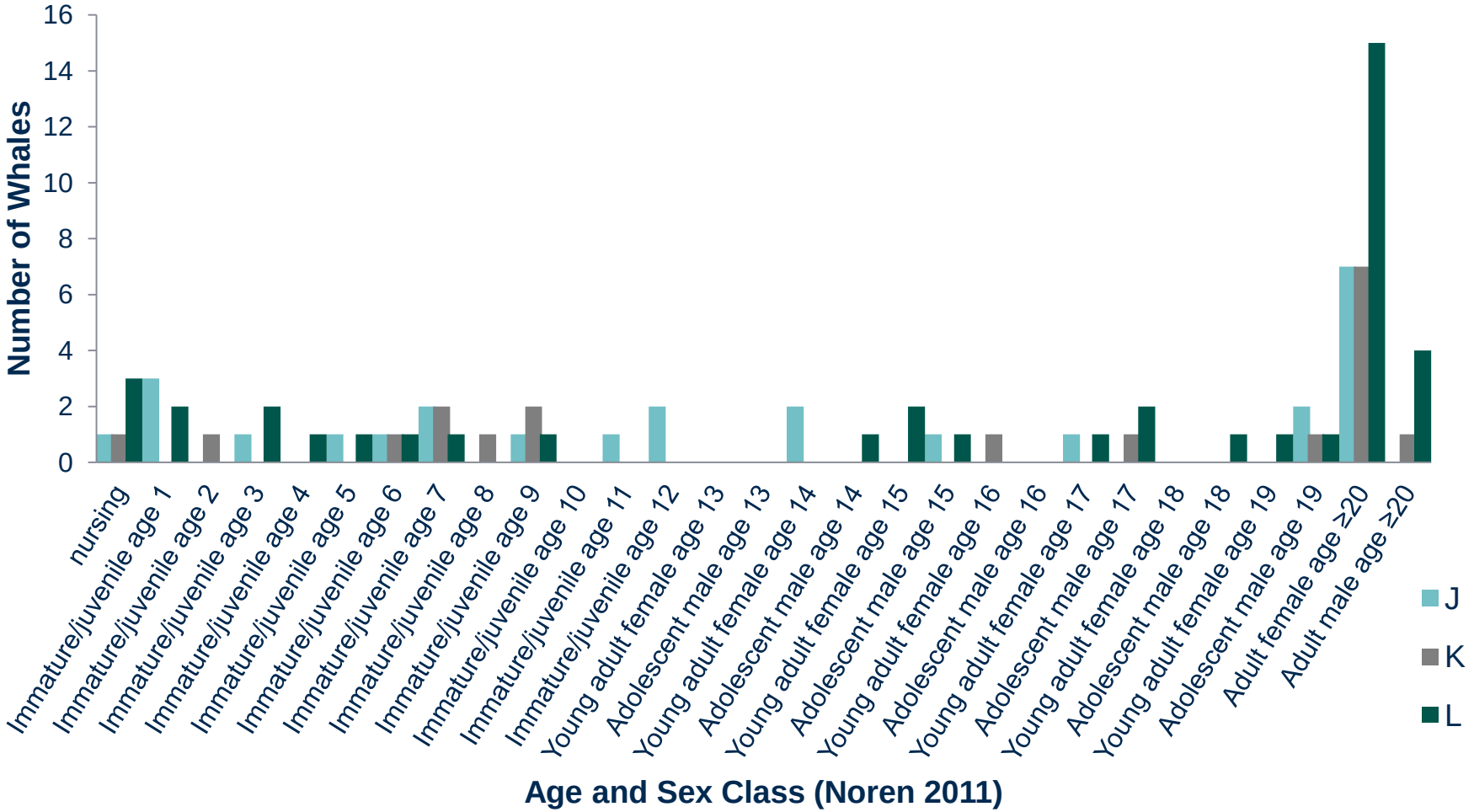
Estimated Metabolic Requirements

- Review Noren (2011) results:



Population Age/Sex Structure and Abundance

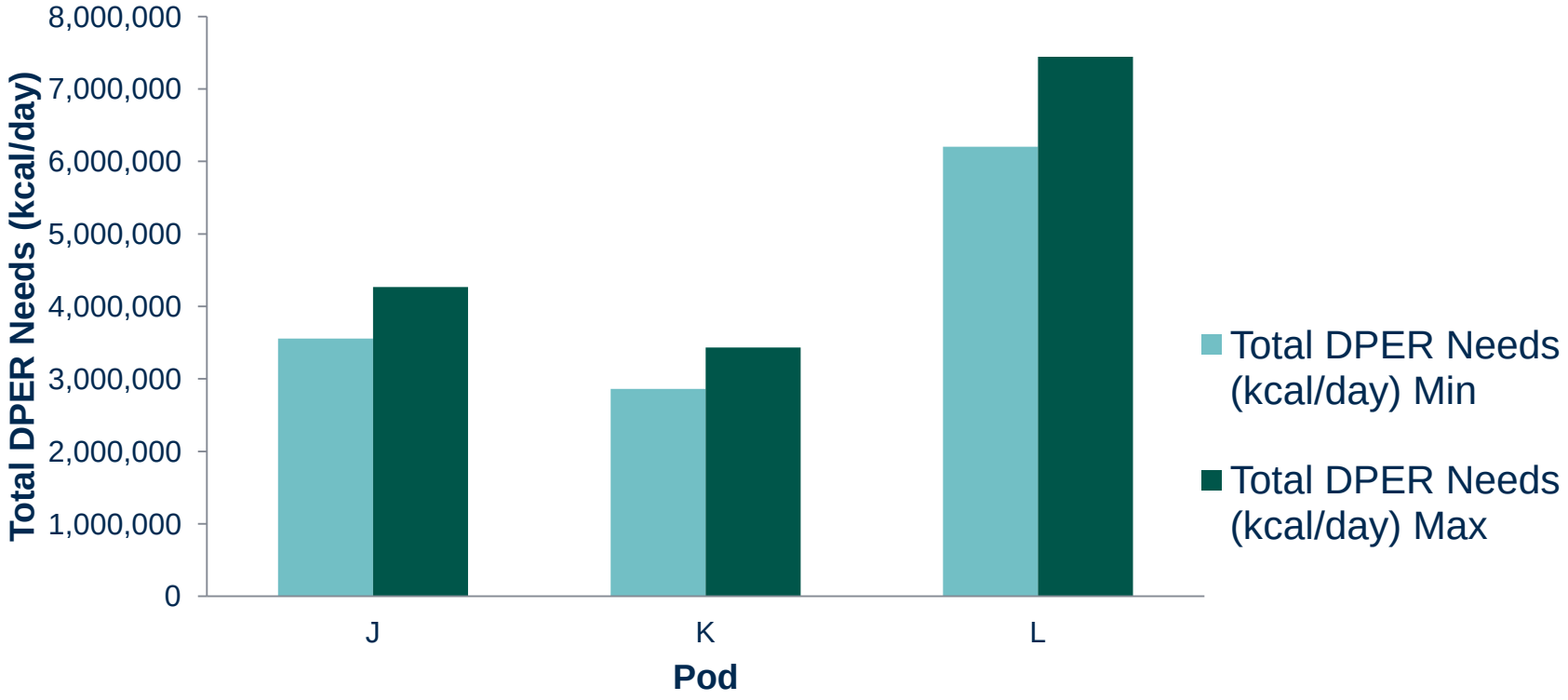
- Known age and sex of all individuals.*



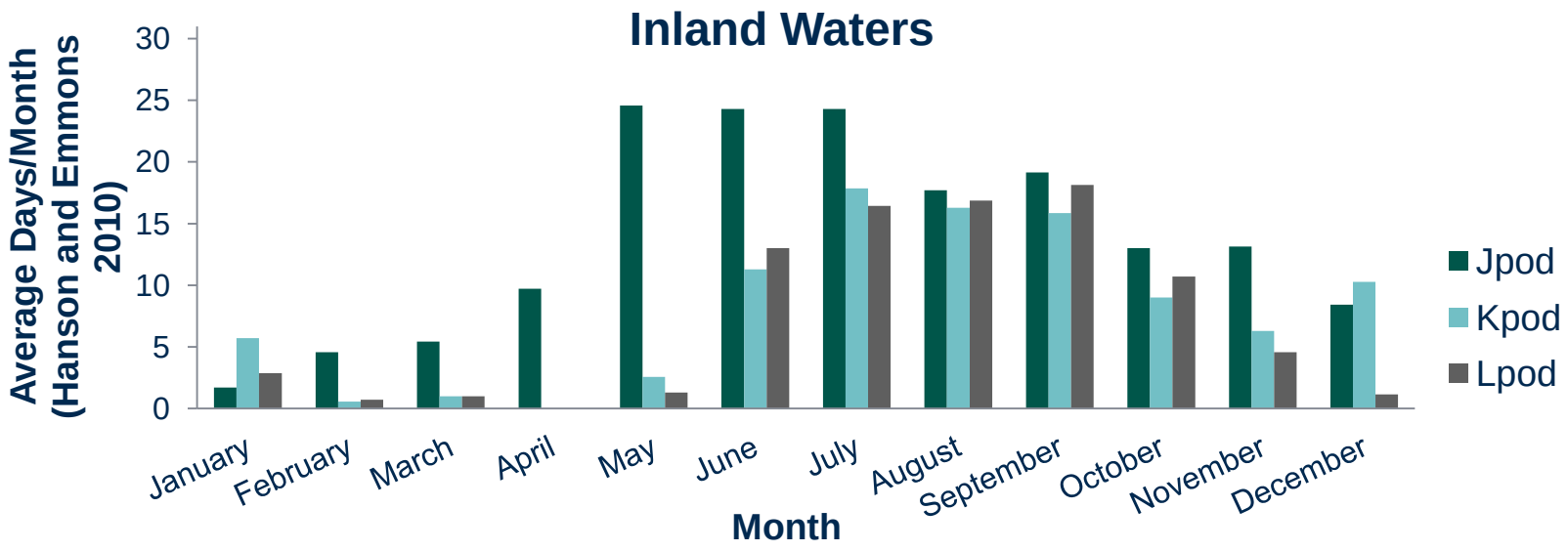
*Annual census by The Center for Whale Research

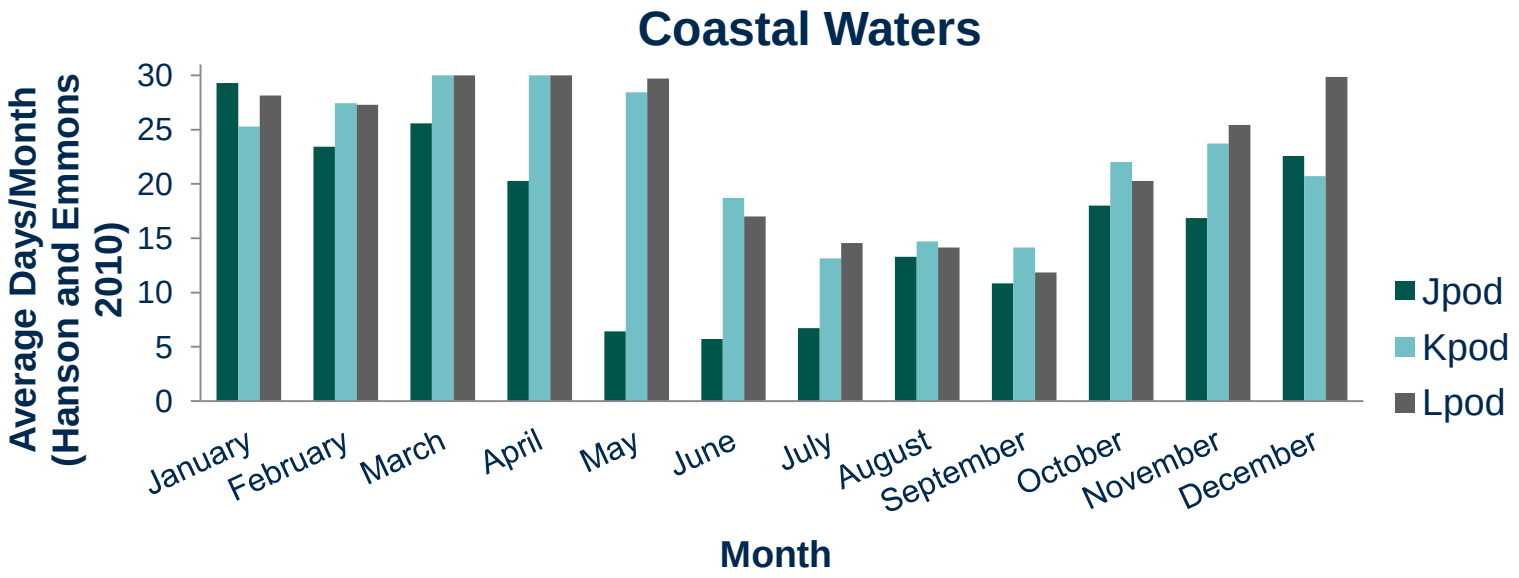
Daily Prey Energy Requirements by Pod

- Multiplied number of whales per pod and class by both Min and Max DPER.
- Summed the resulting DPER values across class categories per pod.



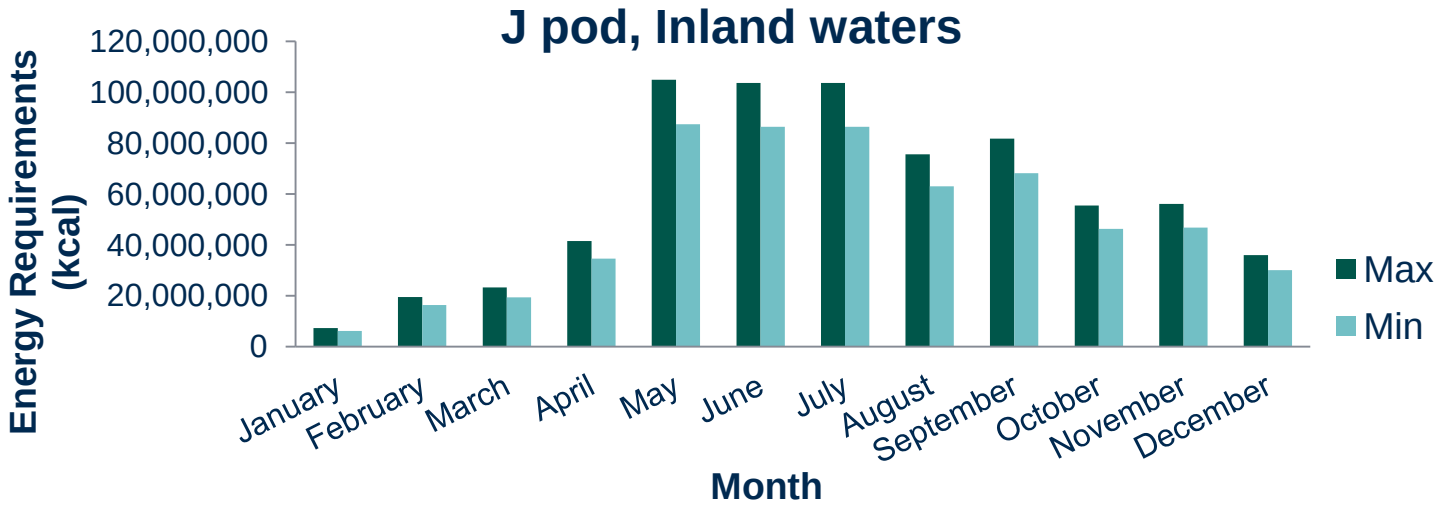
Estimated Time Spent in Inland and Costal Waters

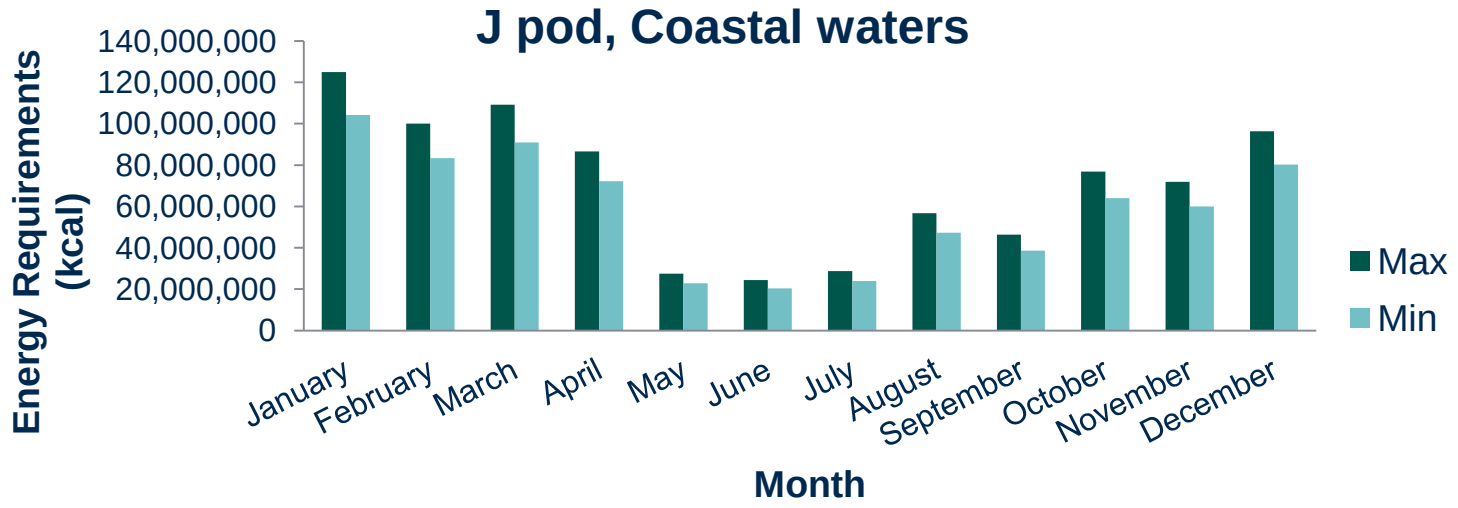




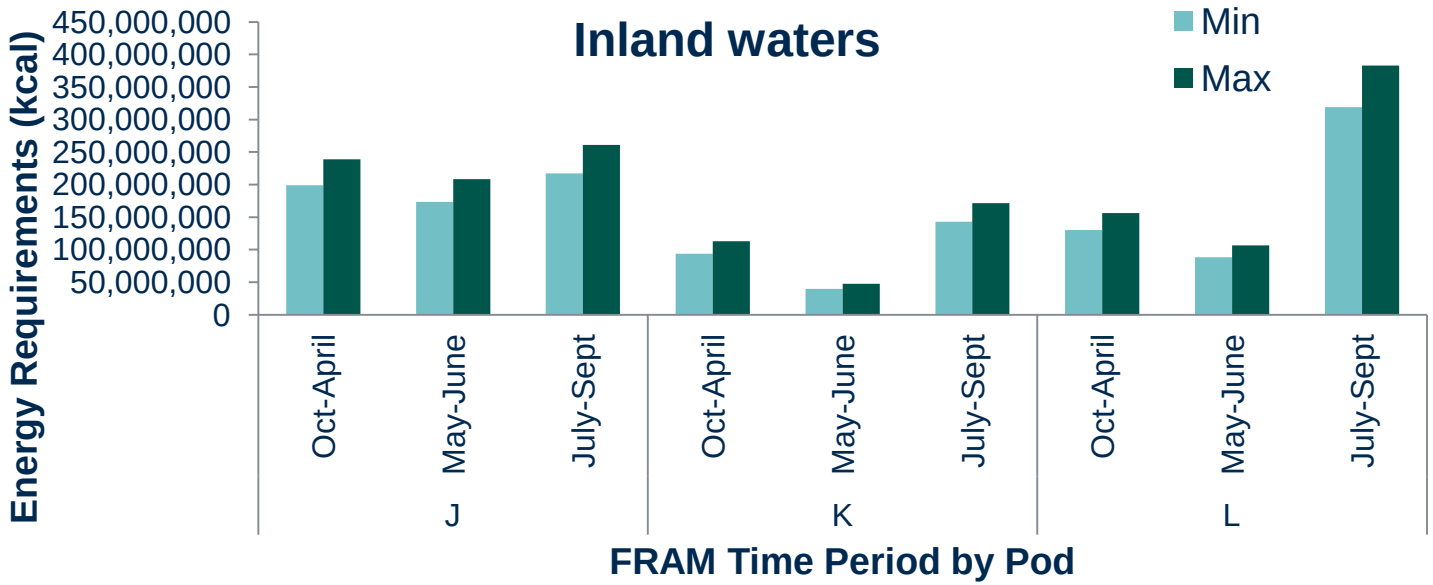
Monthly Energy Requirements by Pod & Location

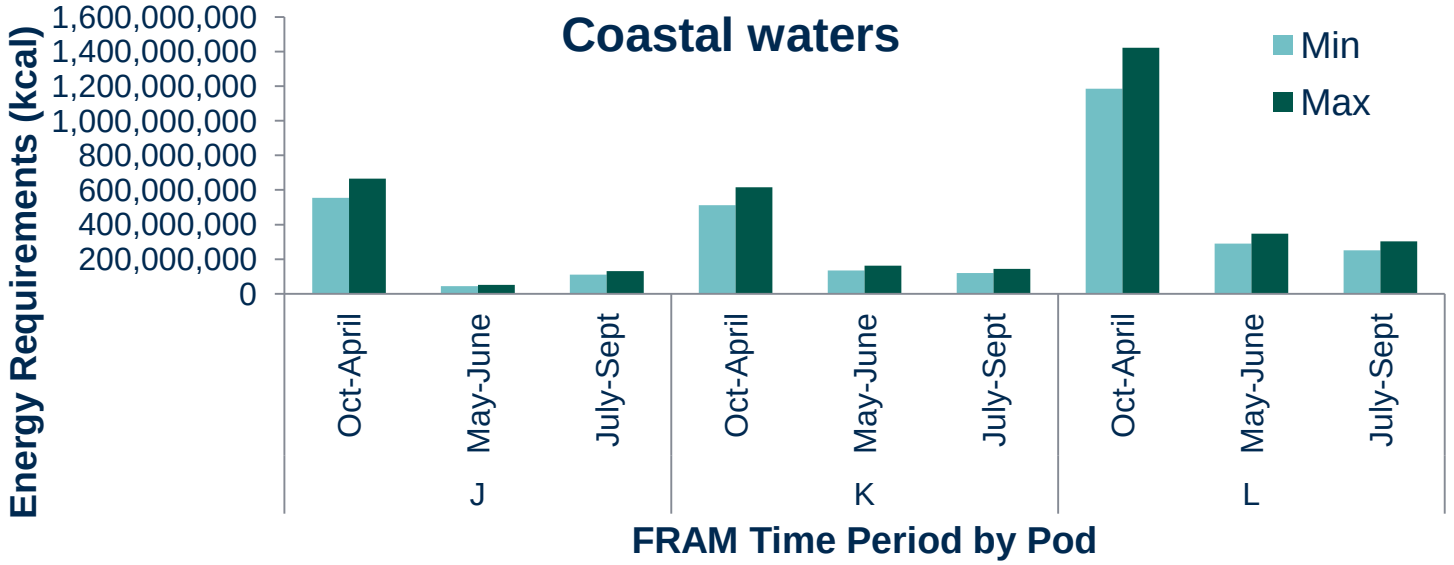
- Multiplied total pod DPER by number of days per month and location.



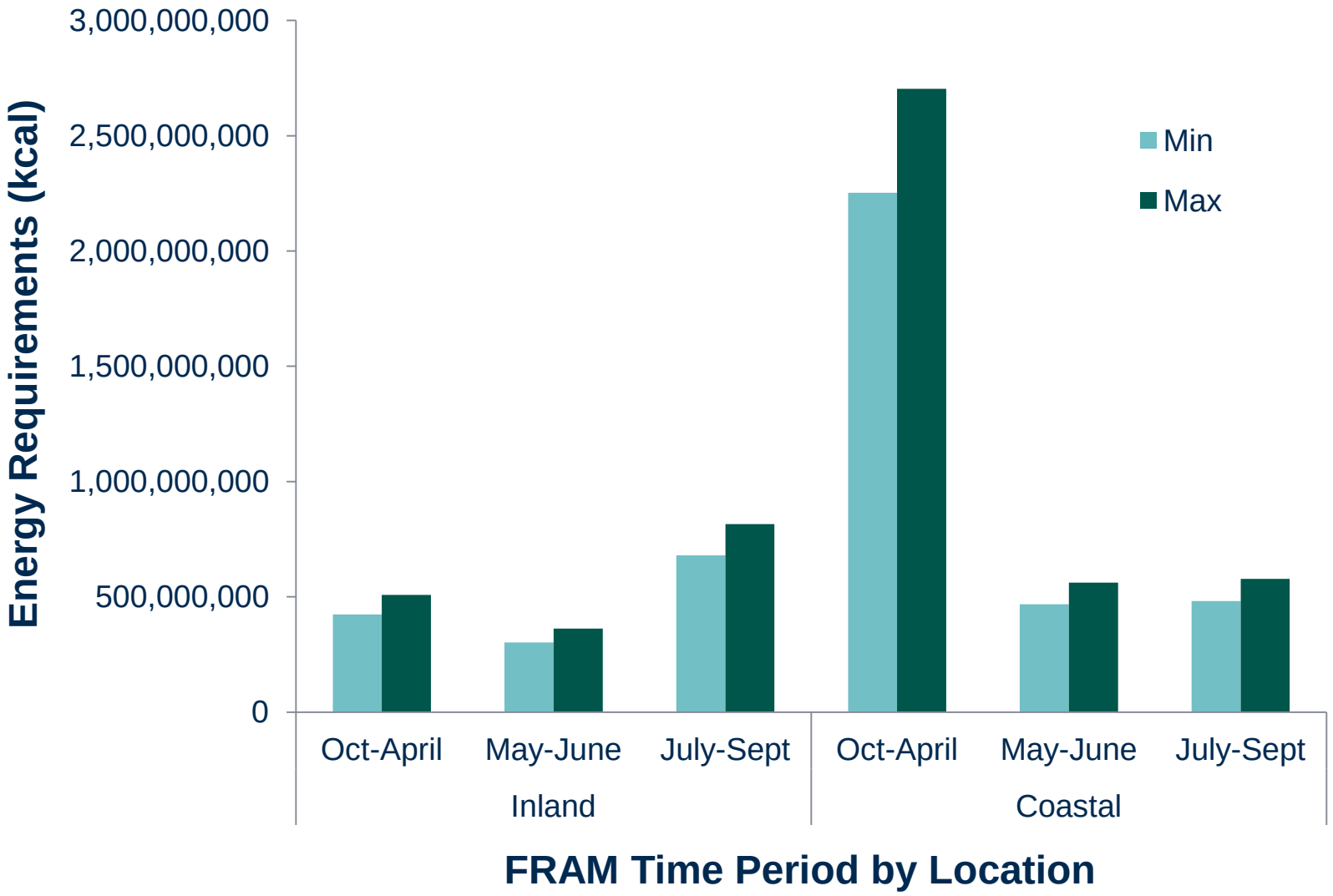


Summarized by Pod and FRAM Time Periods





Summarized for the Whole Population



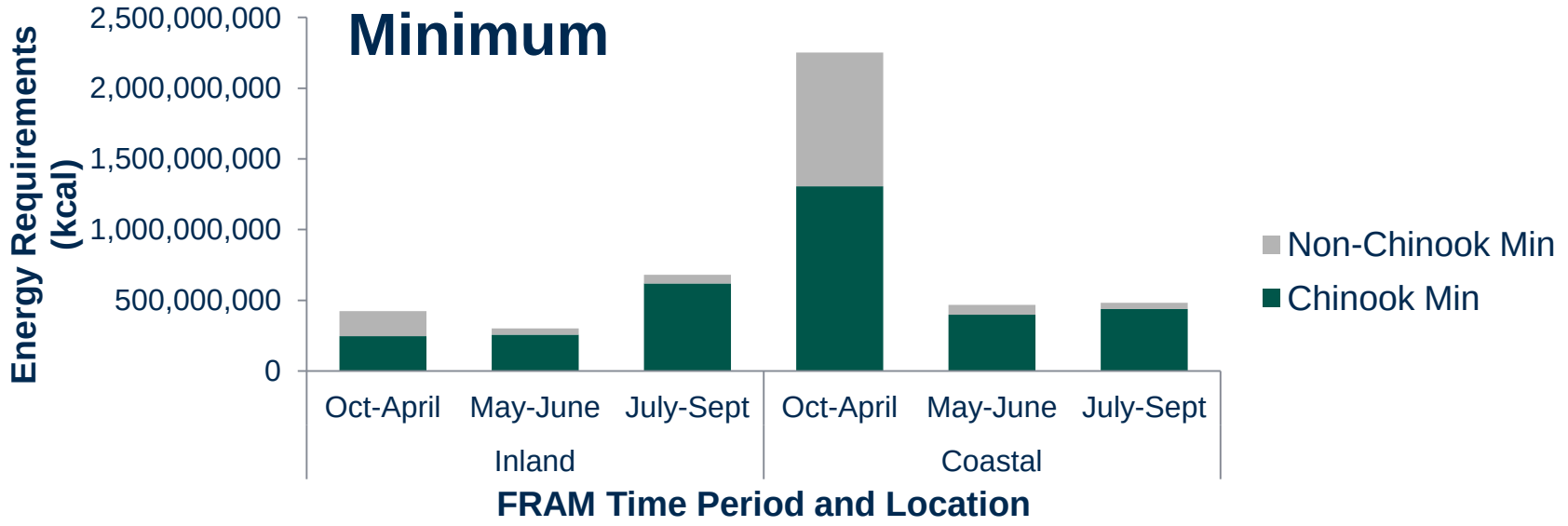
Metabolic Requirements Ideally Met by Chinook - Methods

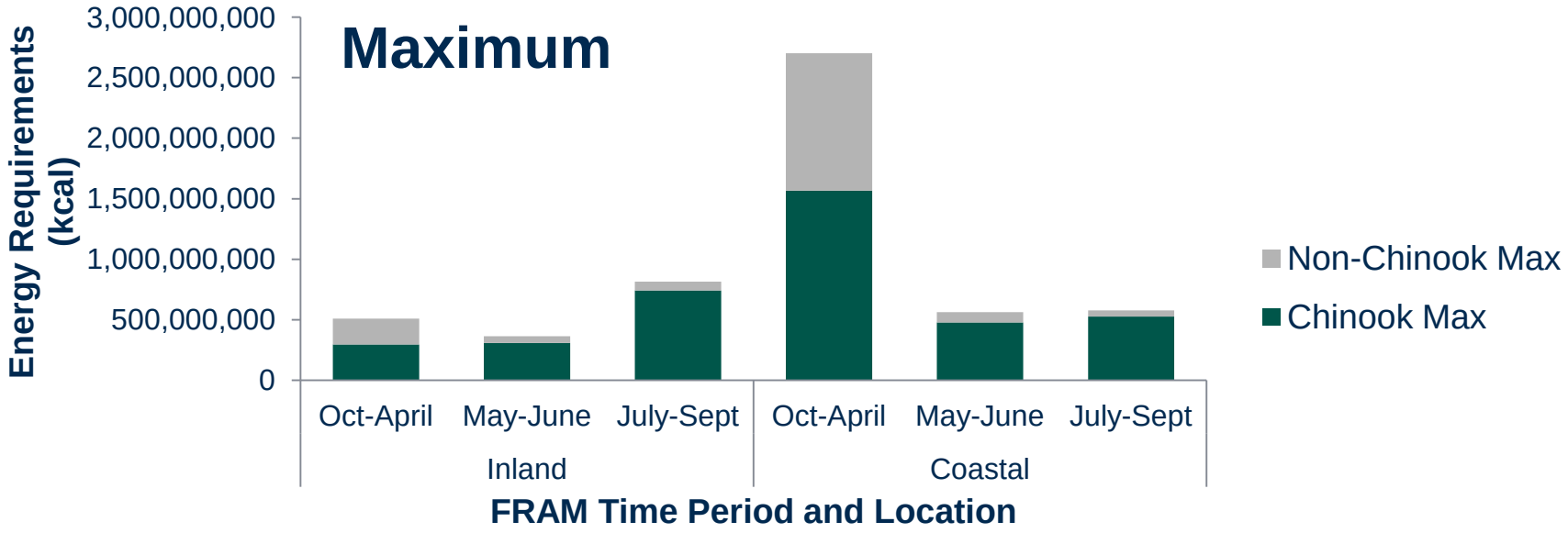
Methods: Multiplied % Chinook by the population energy-requirements for each FRAM time period and location.

- **% Chinook:** Used scale and tissue samples from Hanson et al. 2010 to compute % Chinook in diet per FRAM time period.
- **Oct-April estimate:** no data from Feb-April. Used a weighted mean of months with data (Oct-Jan; 24%*4) and months without data (represented Feb-April with next available data from May-June; 85%*3).
- **Assumption:** Same % Chinook per FRAM time period in both inland and coastal waters.

Time period	% Chinook
Oct-April	58
May-June	85
July-Sept	91

Metabolic Requirements Ideally Met by Chinook-Results

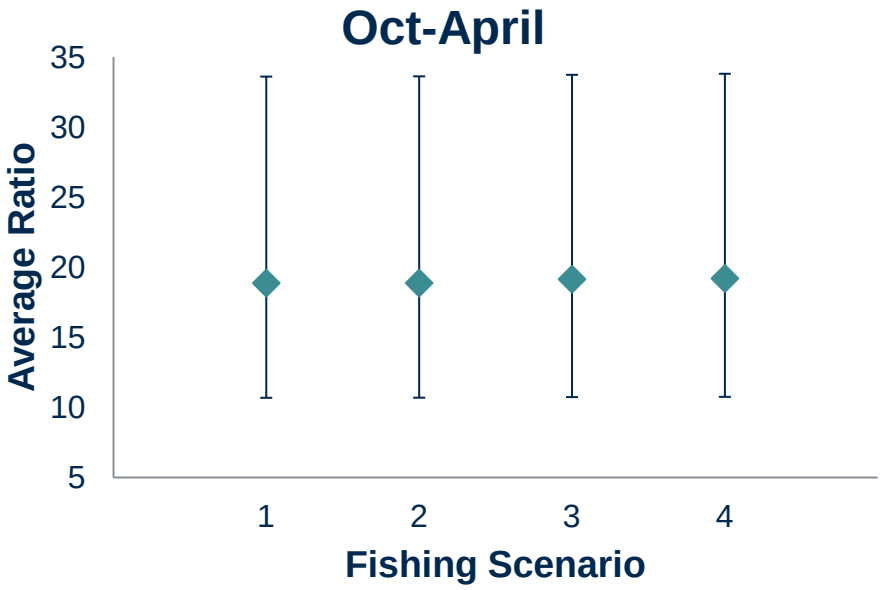


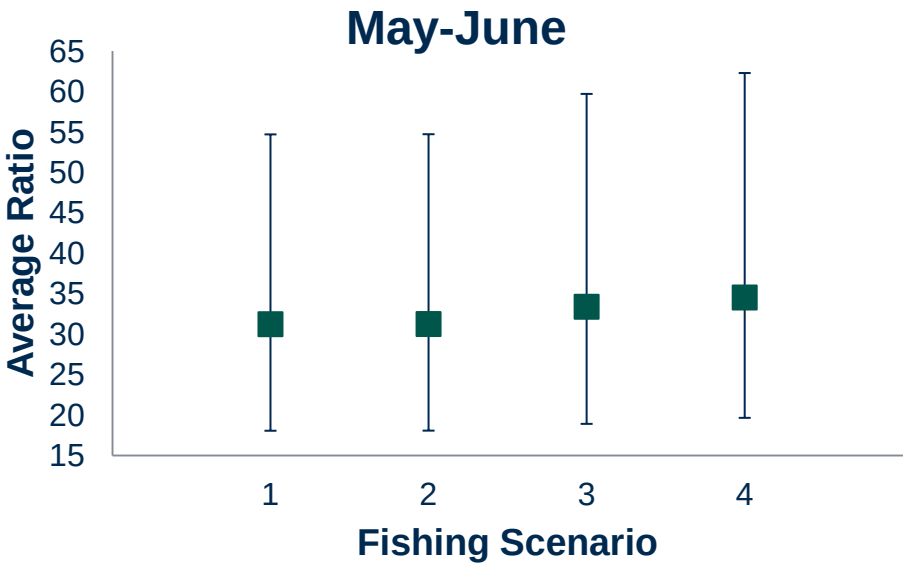


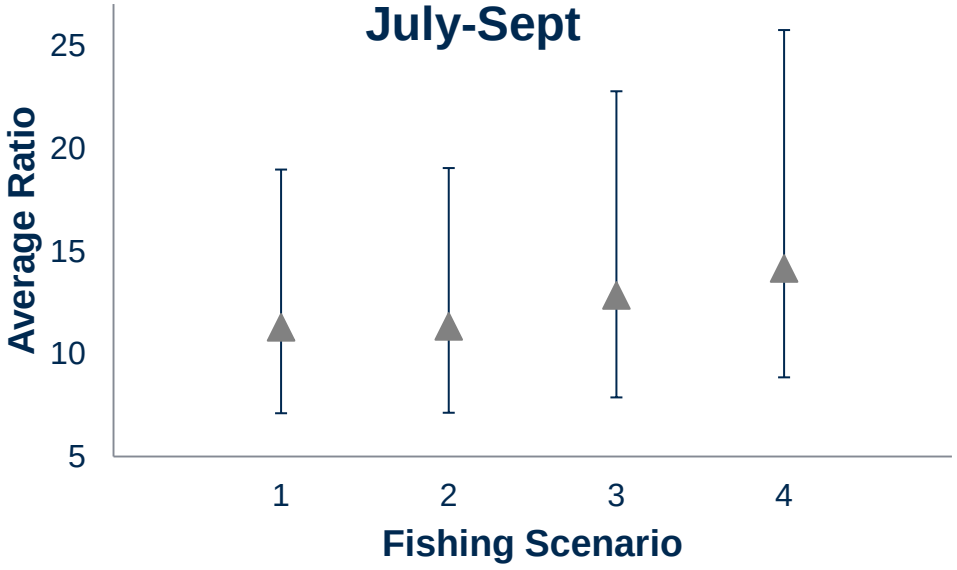
Ratios of Chinook Available Compared to the Whales Needs - Methods

- Ratio = Prey Available (kcal) / Whale Needs (kcal)
- Specific to FRAM time period and location.
  - Indicate that Chinook available is greater than the whales' needs by the magnitude of the value.
- Computed ratios where fisheries are closed and open for comparative purposes.
  - All U.S. and Canadian Fishing Open
  - All Open Except Puget Sound Fishing
  - Only Canadian Fishing Open
  - All U.S. and Canadian Fishing Closed
- Considered ratios for other marine predators and systems to provide context.
- New: Consider the relative influence of select parameters on the ratio estimates to highlight model sensitivities.

Ratios of Chinook Available Compared to the Whales Needs – Coastal Results







Fishing Scenario:

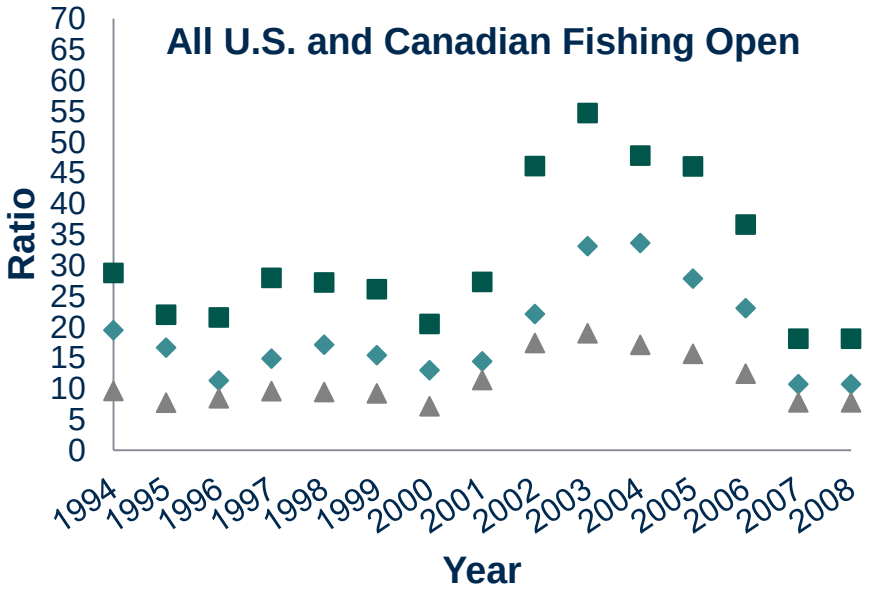
1 = All U.S, and Canadian Fishing Open

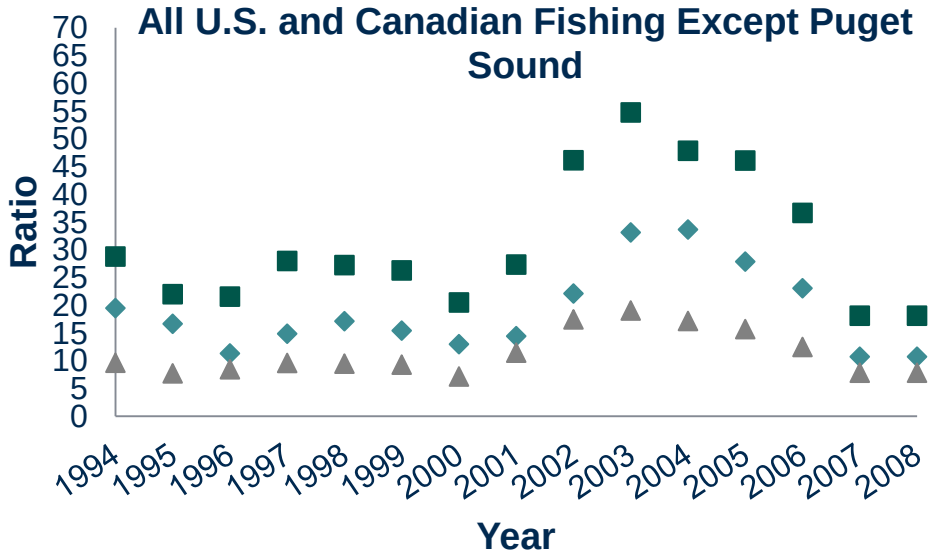
2 = All U.S. and Canadian Fishing Open Except Puget Sound

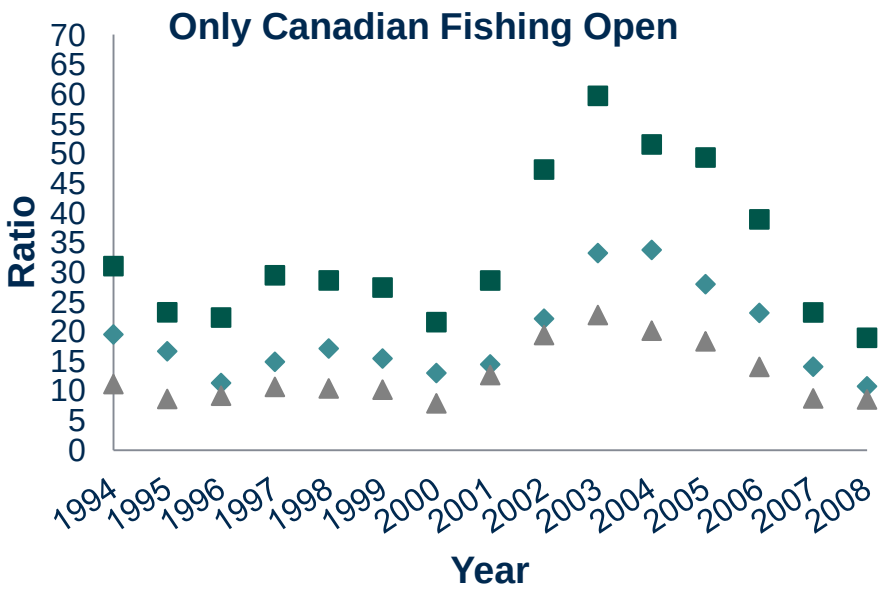
3 = Only Canadian Fishing Open

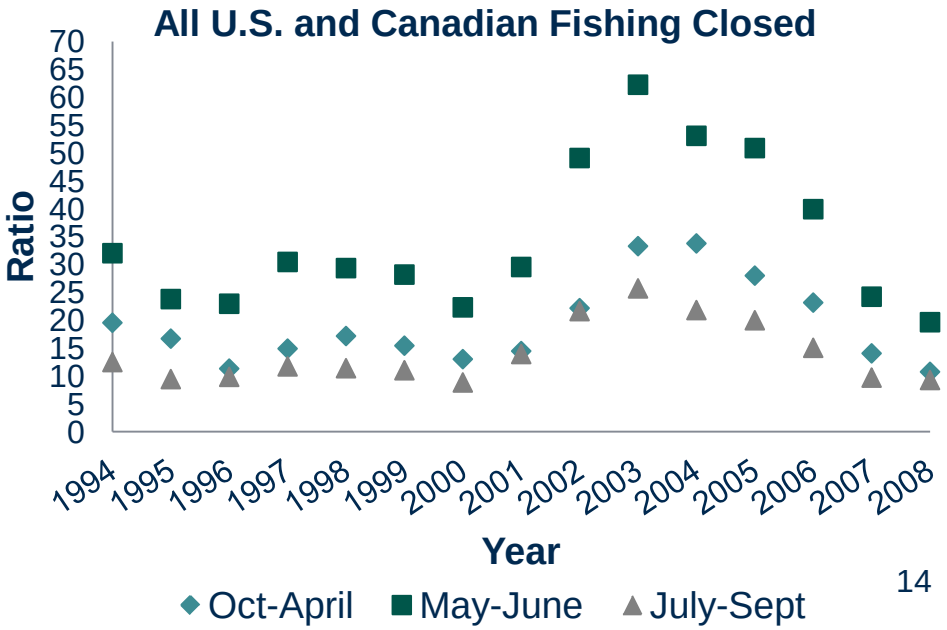
4 = All U.S. and Canadian Fishing Closed

Ratios of Chinook Available Compared to the Whales Needs – Coastal Results, Cont.

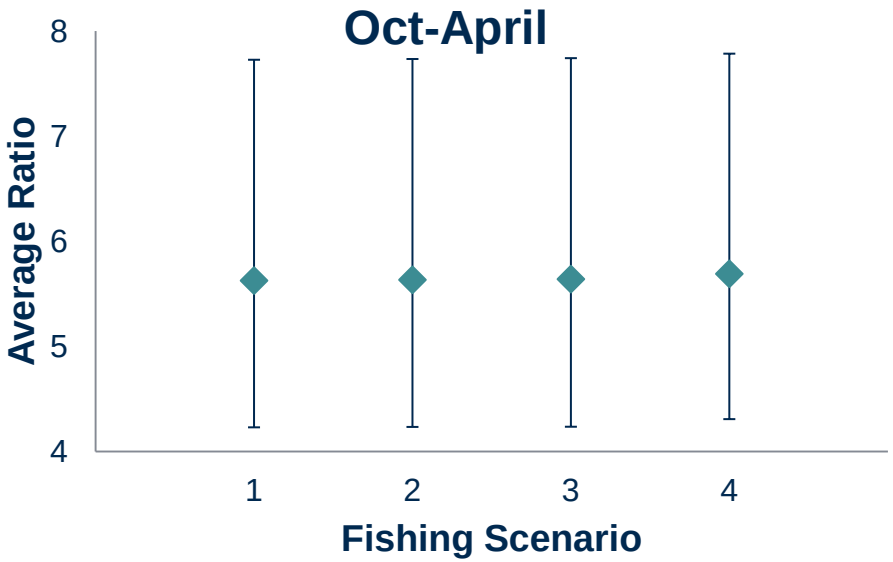


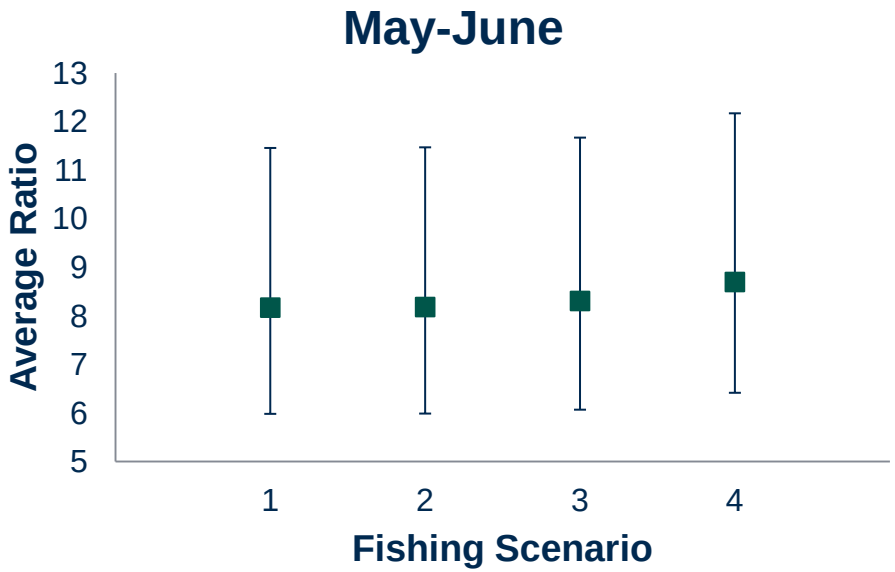


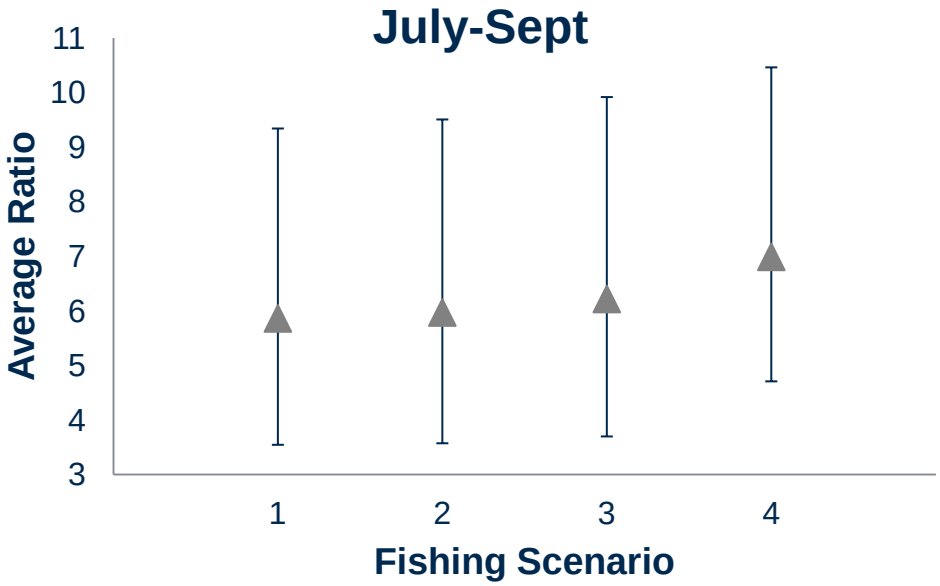




Ratios of Chinook Available Compared to the Whales Needs – Inland Results







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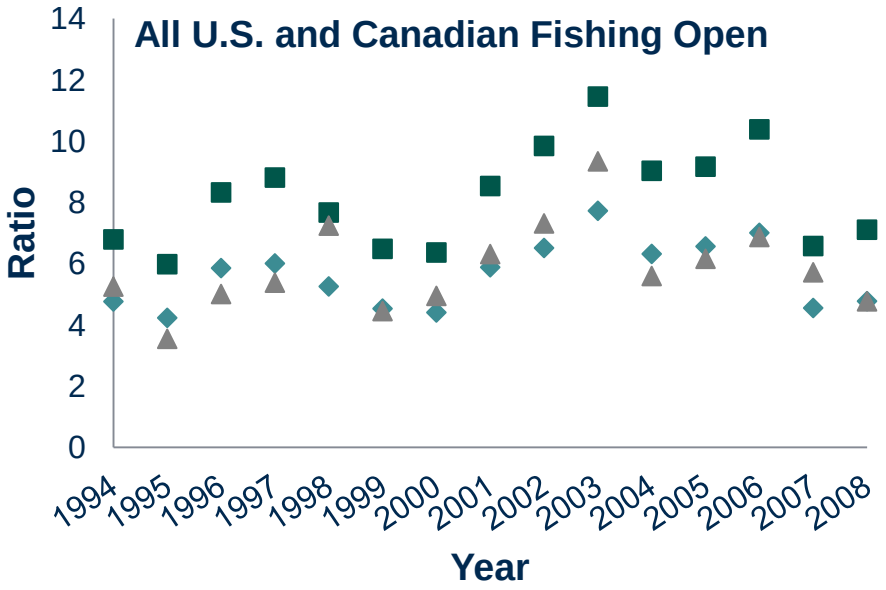
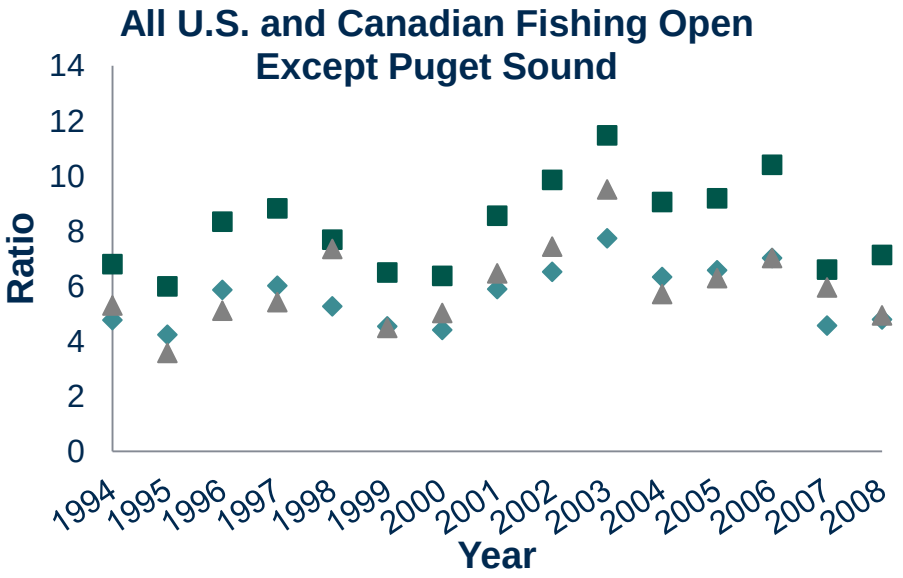
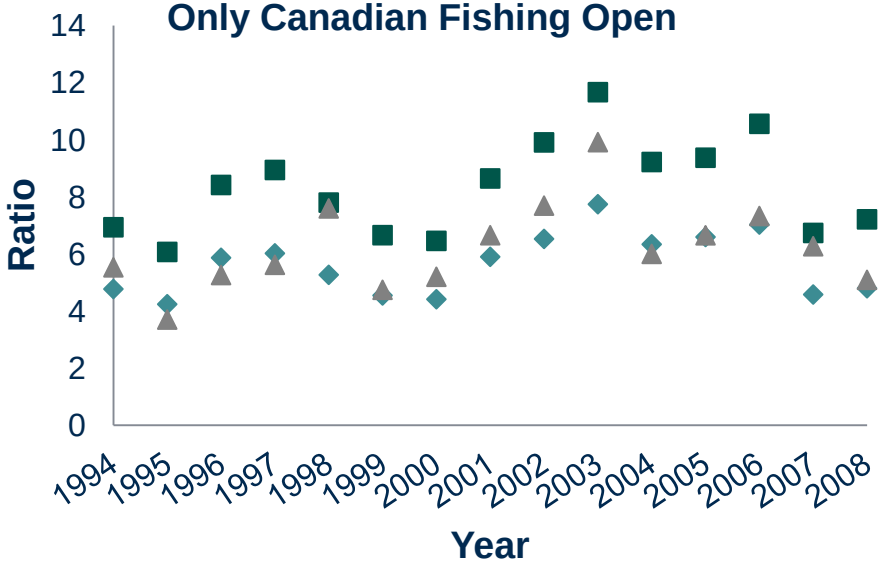
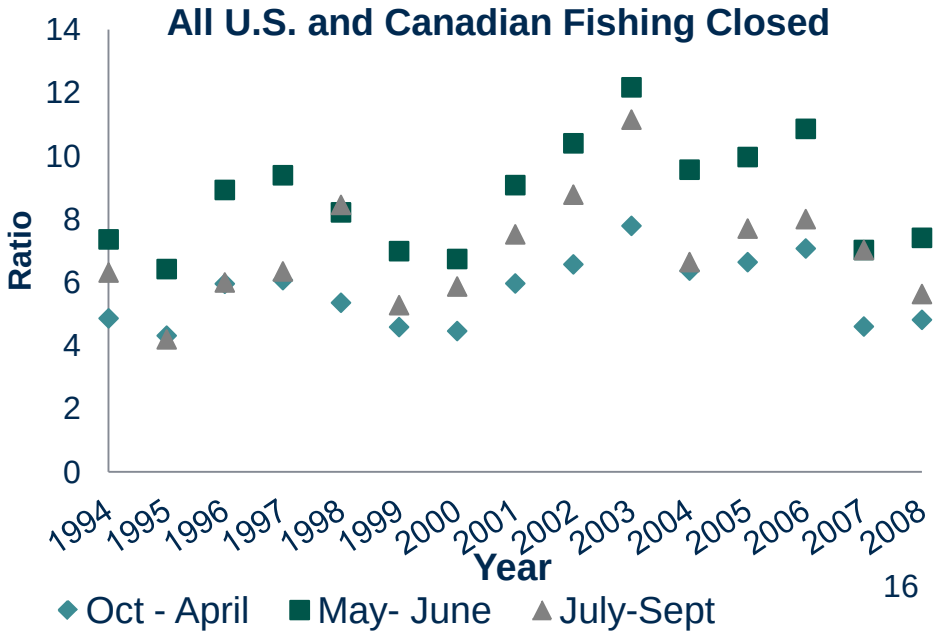
Ratios of Chinook Available Compared to the Whales Needs – Inland Results, Cont.









Ratios for Other Marine Predators and Systems

Ratios of prey to predators in four North Pacific ecosystem models. Predators included are cetaceans with fish comprising more than 25% of their diet (Kaplan 2011).

		Weighted Prey Ratios		
		by diet composition	only most abundant prey items that collectively sum to 95% of diet	excluding individual prey items <5% of diets
Region	**Predator**			
Northern California Current	baleen whales[a]	24.2	23.9	23.9
Northern California Current	orcas[b]	124.4	122.2	119.6
Northern California Current	sperm whales[c]	20.0	19.5	19.0
Northern California Current	toothed whales[d]	14.3	14.3	14.1
Northern British Columbia	toothed whales[e]	3.1	3.1	2.9
Eastern Bering Sea	toothed whales[f]	30.3	30.1	21.6
Western Bering Sea	toothed whales[g]	6.0	6.0	5.8

Relative Influence of Parameters on the Ratio Estimates

Example: 2008, All U.S. and Canadian Fishing Open, Inland Waters, July – Sept

- Start with set values for 2 parameters and a model decision-rule –
  - DPER level (Max); Selectivity Function (NOAA-FRAM model); and After Natural Mortality step of FRAM
  - Ratio = 4.77
- Vary DPER level (Min)
  - Ratio = 5.73
- Vary Selectivity Function
  - Ford-FRAM, Ratio = 3.34
  - No Selectivity, Ratio = 18.22
- Vary decision rule for natural mortality
  - Before natural mortality, Ratio = 5.56

Relative Influence of Parameters on the Ratio Estimates, Cont.

- **Whale Needs:**
  - Number of whales in the population
  - Age/Sex distribution
  - Days spent in each location
  - DPER level
  - % Chinook in diet

- **Chinook Availability:**
  - Selectivity function
  - Inclusion/exclusion of FRAM-estimated natural mortality
  - Assumptions about the contribution of coastal-origin stocks to inland availability and visa versa (i.e., only those caught were available)

Potential New Approaches for Consideration

- Use a Monte Carlo approach to estimate ratios - incorporate variability in each parameter and decision-rule and test parameter sensitivity.
- Further investigate ratios for other predators and systems.
- Other thoughts?