Science, Service, Stewardship

--Chinook abundance and food energy available to Southern Residents

--Which fisheries affect prey availability and to what extent?

--bonus: analysis since the PS Biop; look at Puget Sound terminal fisheries, VBGF averaging, size selectivity, Chinook natural mortality

September 26, 2011

NOAA FISHERIES SERVICE

Science, Service, Stewardship

--Chinook abundance and food energy available to Southern Residents

September 26, 2011

NOAA FISHERIES SERVICE

NOAA FISHERIES SERVICE

Why use the Fishery Regulation Assessment Model (FRAM)?

- ESA evaluation of 2008 PST Agreement and Puget Sound Harvest Plan on Chinook required specific stock and fishery strata.
- Assessment model needed the ability of evaluate the specific provisions or “actions” as described in each
- Some elements of FRAM (e.g. time strata and growth function) not found in other salmon fishery models, especially useful for SKRW Chinook prey analysis.
- Fishery season structure per the PST and PS harvest plans already derived for Chinook impact evaluation

NOAA FISHERIES SERVICE

Why FRAM? (part 2)

- Stock-specific abundance estimates for key prey stocks for SRKWs (e.g. Fraser Early, Late).
- Accepted fishery model used in number of management forums.
- In 2008, identified as a method by federal, state, tribal workgroup to evaluate SRKW-Chinook analysis for the 2008 PST Agreement Biological Opinion ("Biop"). Already used for fisheries effect on ESA listed Chinook stocks.
- Evaluate the Pgt. Snd RMP under the same lens as PST Agreement Biop.

NOAA
FISHERIES
SERVICE

Two types of FRAM-based Analysis

- Relationship of Chinook abundance from FRAM post season runs in 1983-2008 to SRKW population growth metrics—Eric Ward, NWFSC
- Effects of fisheries under “Harvest Plan” on Chinook kilocalories available to SRKWs—FRAM “Likely” Runs for 1994-2008

NOAA FISHERIES SERVICE

FRAM Overview

FRAM is a fishery simulation model used to predict the impacts on Chinook stocks from a variety of proposed fishery regulations in a single management year.

- Used for So. U.S. Chinook management since mid-1990's.
- Deterministic.
- Single-pool ('all fish in the sea'); does not provide abundance within region/area.
- Does provide stock, age, and time step specific abundances.
- Stock, age, fishery and time-step specific landed catch and non-landed mortalities.

NOAA FISHERIES SERVICE

FRAM Overview

38 Stocks:

- Alaska-none
- Canada-WCVI, lower Georgia Strait, Fraser Early, Fraser Late
- So. U.S.- Puget Sound, WA n. coast, Willapa, Columbia summer, fall, lower Col R. spring, OR n. coast, Sacramento.

71 Marine Area Fisheries (troll, net, sport):

SEAK, BC North-Central, WCVI, Georgia St. Juan de Fuca, Puget Sound preterminal and terminal, So. U.S. ocean- WA to CA.

NOAA FISHERIES SERVICE

Major Model Input Data

Historical Data

- Stock specific exploitation rates derived from recoveries of coded-wire tags during the base period (1974-1979 brood years); modified to account for stocks not tagged in the base period
- Non-landed mortality rates on fish released
- Natural mortality rates; constant by age (0.4; 0.3; 0.2;0.1 for ages 2-5 respectively)
- Maturation rates; % that matures each age
- Von Bertalanffy growth functions by stock and maturity type.

NOAA FISHERIES SERVICE

Major Model Input Data

Current Data (for year to be modeled)

- Stock abundances of age 3-5 Chinook (from independent forecasts).
- Fishery catch or effort by time (Oct-Apr, May-Jun, Jul-Sep) and fishery strata, nominal or scalars.
- Size limits by fishery.
- Non-retention data (eg encounters of Chinook that must be released because of regulation prohibiting retention).

NOAA FISHERIES SERVICE

Model Processes

- From starting FRAM cohort abundance for each stock and age:
  - Compute natural mortality
  - Split cohort into mature & immature components
  - For each fishery compute:
    - Legal and Sublegal Populations using VBGFs
    - Landed Catch
    - Release and Other Mortality
  - Compute escapement by subtracting terminal area fishing mortality from mature run

NOAA FISHERIES SERVICE

Chinook Food Energy Available: Methods Overview

We used FRAM to estimate abundance of Chinook food energy available to the whales with a five-step process (measure after natural mortality and marine area mixed stock "preterminal" fishing):

(1) Assign Chinook by stock, age and time period to a regional location (inland waters or coastal waters).

(2) Identify average Chinook lengths by stock, age and model time period (Von Bertalanffy growth functions),

(3) Apply the size-selectivity function and exclude Chinook that did not meet the size-selection criteria,

(4) Apply a length-to-kilocalorie model to estimate kilocalories of Chinook from the identified stock/age specific lengths,

(5) Multiply the stock/age-specific Chinook abundance from FRAM, modified by the size selective model, by kilocalories derived in (4).

NOAA FISHERIES SERVICE

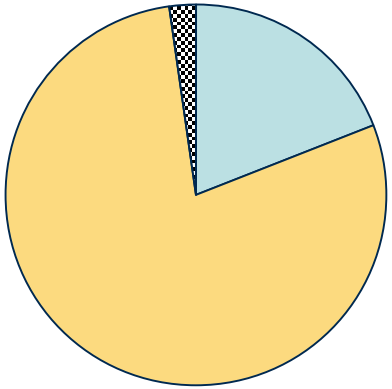
Step 1: Assign Chinook from single-pool to SRKW regional waters.

- Inland Chinook—Chinook caught in inland waters (Geo St, JDF, PS, HC) and Chinook with origin in Inland waters and expected to pass through.
    - Includes portion of non-inland origin Chinook stocks intercepted in inland waters (e.g. Col Tule caught in JDF)
- Coastal Chinook—Chinook caught in coastal waters (QCI to CA) and Chinook expected to pass through.
- Sum of Inland and Coastal Chinook abundances represents total available to SRKWs.
- FRAM Base Period catch and escapement distribution for each stock used to estimate proportion of stock that contributes to Inland or Coastal Chinook abundance.

NOAA FISHERIES SERVICE

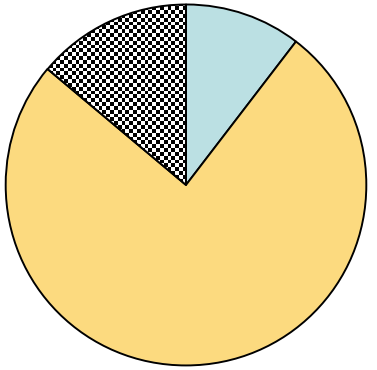
Contribution of stock cohort to Chinook prey in SRKW range

Fraser Late



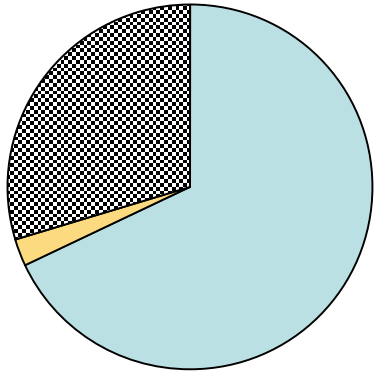
coastal inland out-of-range

Fraser Early



coastal inland out-of-range

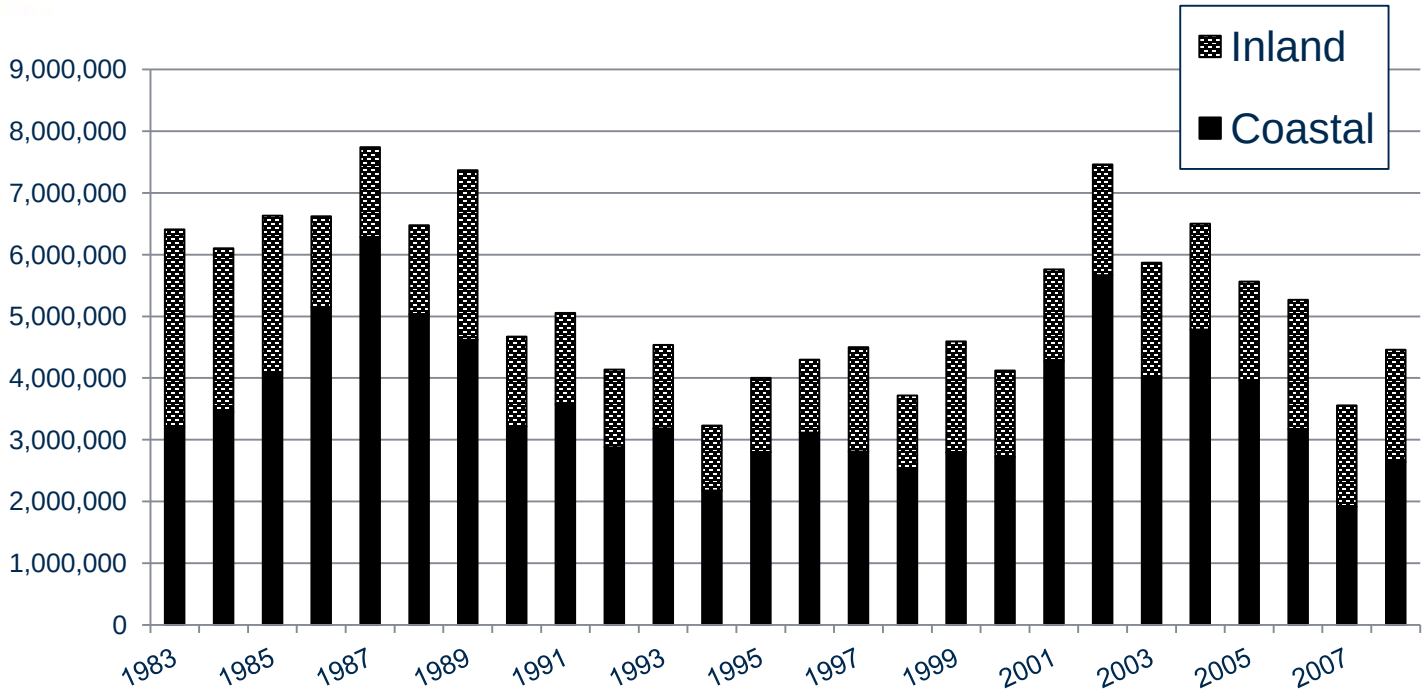
Col. Fall Bright



coastal inland out-of-range

NOAA FISHERIES SERVICE

Abundance of Age 3-5 Chinook in Inland and Coastal Waters, May-June



FRAM Post Season

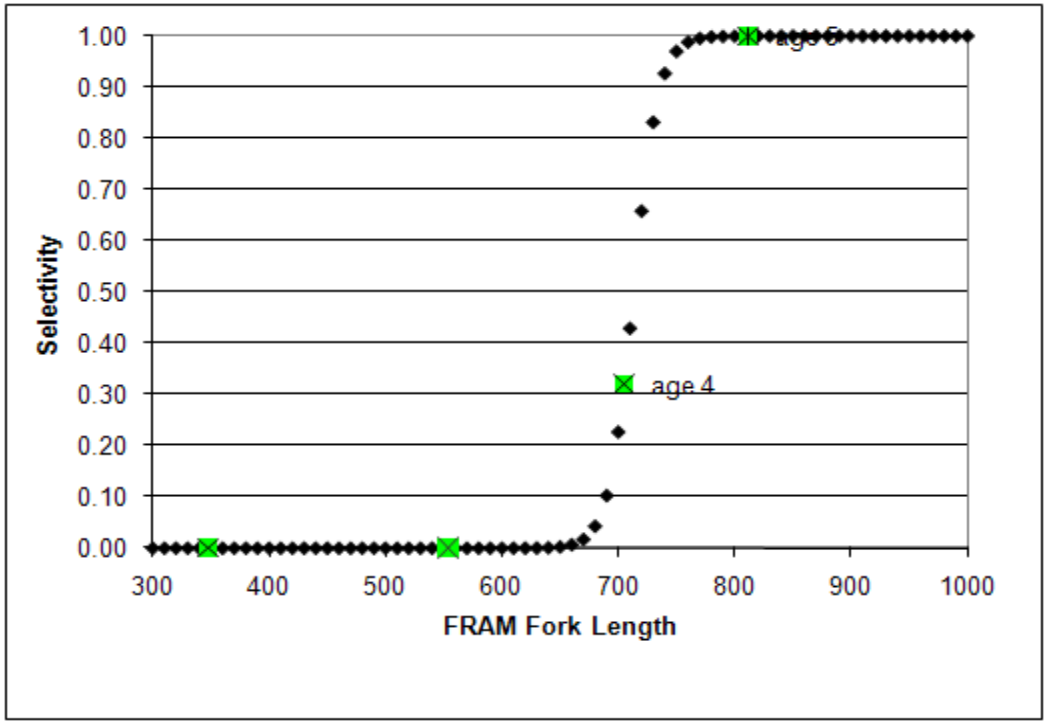
NOAA FISHERIES SERVICE

Step 2: Identify Average Lengths

Age	Hanson et. al. unpubl. data		
	FRAM lengths	Abundance (%)	Kills (%)
Age 2	347	59.0	3.6
Age 3	554	25.8	12.5
Age 4	705	13.4	48.2
Age 5	812	1.7	35.7

NOAA FISHERIES SERVICE

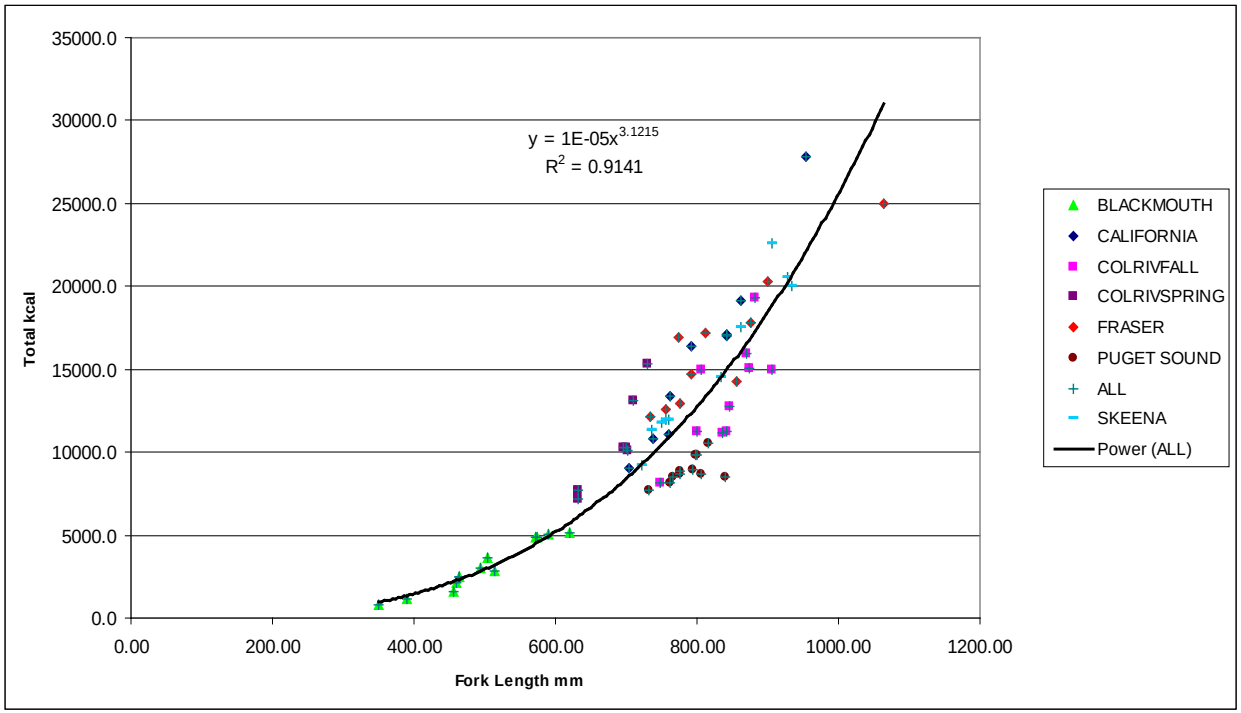
Step 3: Apply Size-Selective Model and Exclude Small Chinook



NOAA FISHERIES SERVICE

Step 4: Apply a Length-to-Kilocalorie Model

- O'Neil et al. (unpubl. data) created composite samples of dried Chinook tissue from Chinook collected in terminal areas.
- They used standard methods to derive caloric content and fit a regression of Chinook fork-length to kilocalories using this data: $y = 1\ E\text{-}05x^{3.1215}$, $R^2 = 0.9141$



NOAA FISHERIES SERVICE

Step 5: Multiply Abundance by Kilocalories

	Fork Length				Length-kcal	WL_a	1.11E-05
	Oct-Apr	May-Jun	Jul-Sep			WL_b	3.121511
age 2	251	340	385		341.44	884.74	1302.46
age 3	466	529	561		2356.39	3504.83	4202.95
age 4	618	662	684		5683.02	7065.24	7837.67
age 5	725	756	772		9364.77	10694.79	11407.96
	Oct-Apr	May-Jun	Jul-Sep		Oct-Apr	May-Jun	Jul-Sep
age 2	315	412	461		692.09	1605.40	2274.79
age 3	548	615	649		3904.36	5623.69	6649.67
age 4	710	757	781		8789.24	10752.24	11836.77
age 5	823	857	873		13957.65	15781.75	16751.57

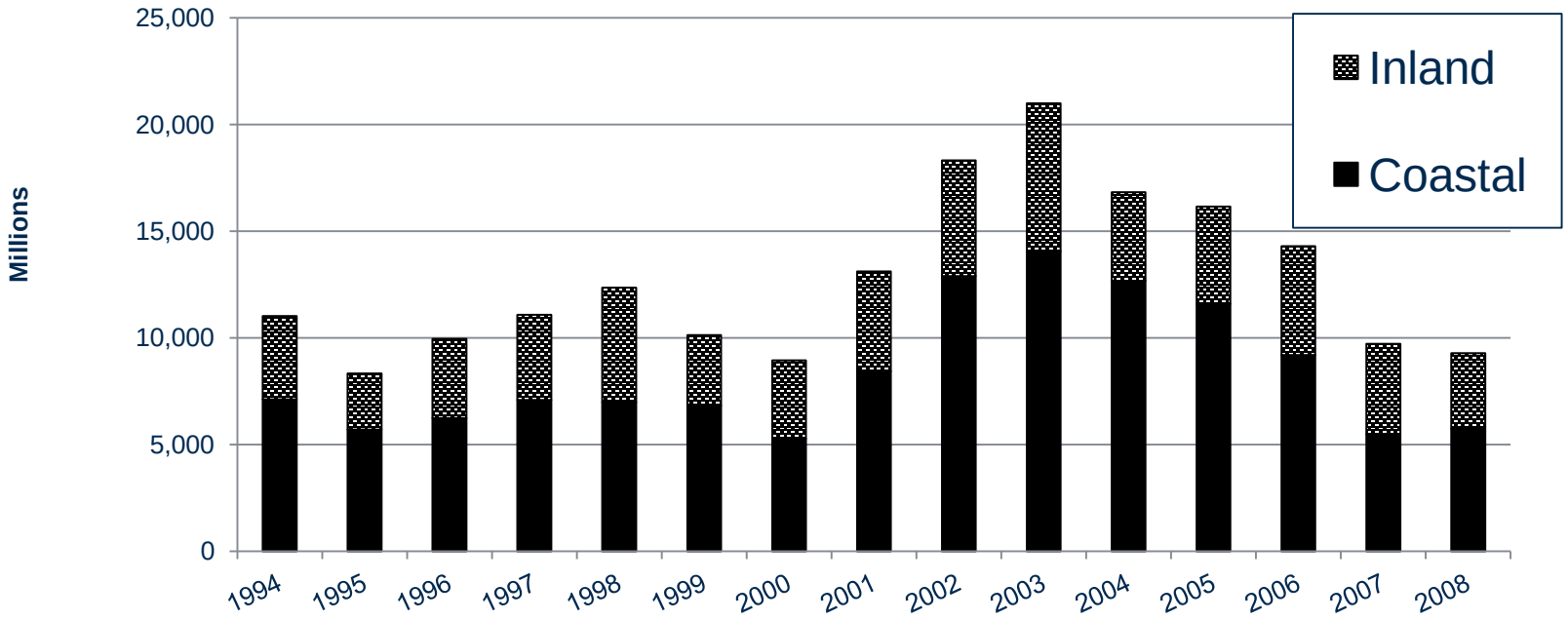
NOAA FISHERIES SERVICE

Results of steps 2-5

- Produces estimates of kilocalories of Chinook food energy available to SRKWs in inland and coastal waters that meet size selectivity criteria per FRAM time step.

NOAA FISHERIES SERVICE

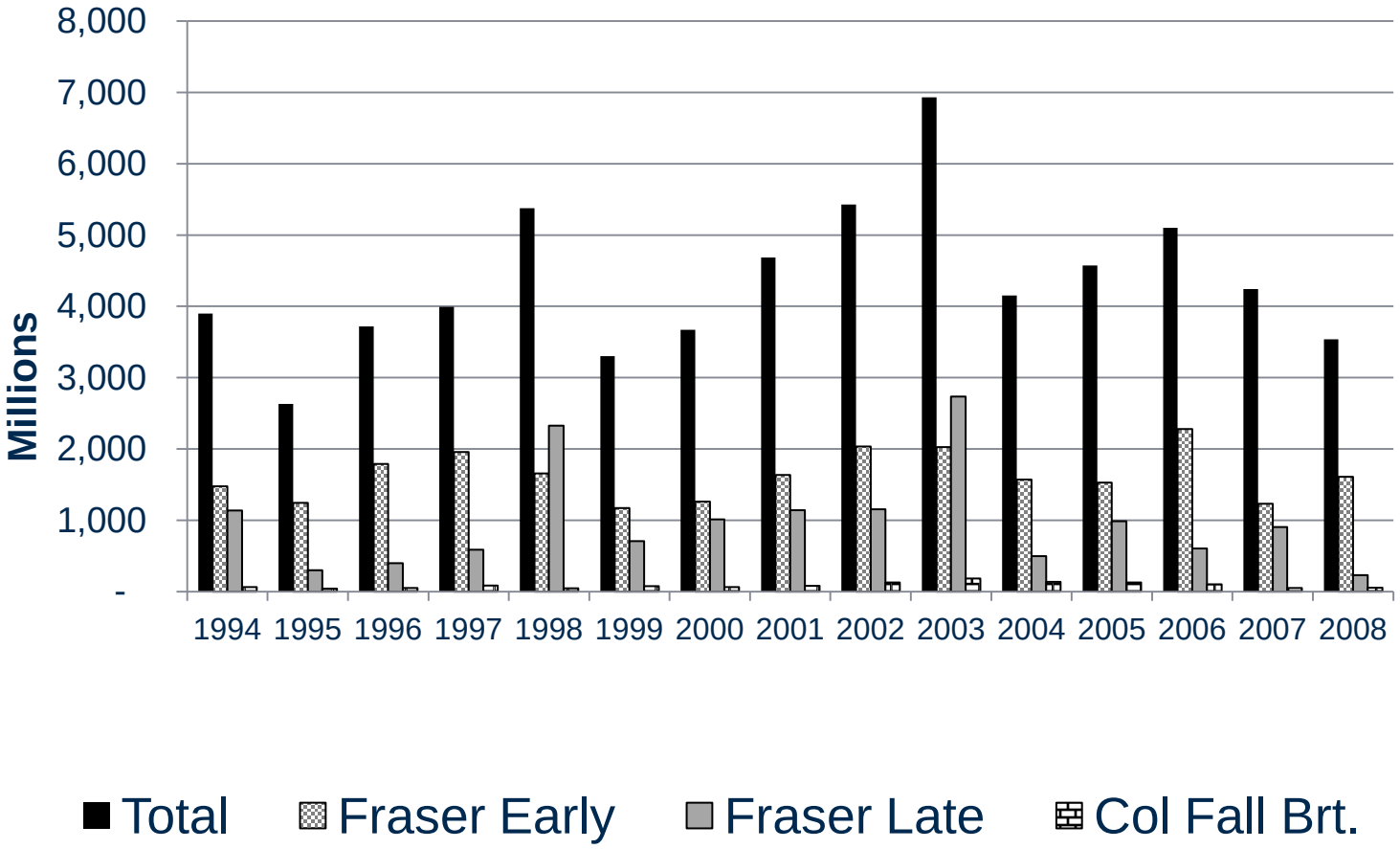
Kilocals $_{w/selectivity}$ of Age 3-5 Chinook in Inland and Coastal Waters, Jul-Sep



FRAM Likely Run

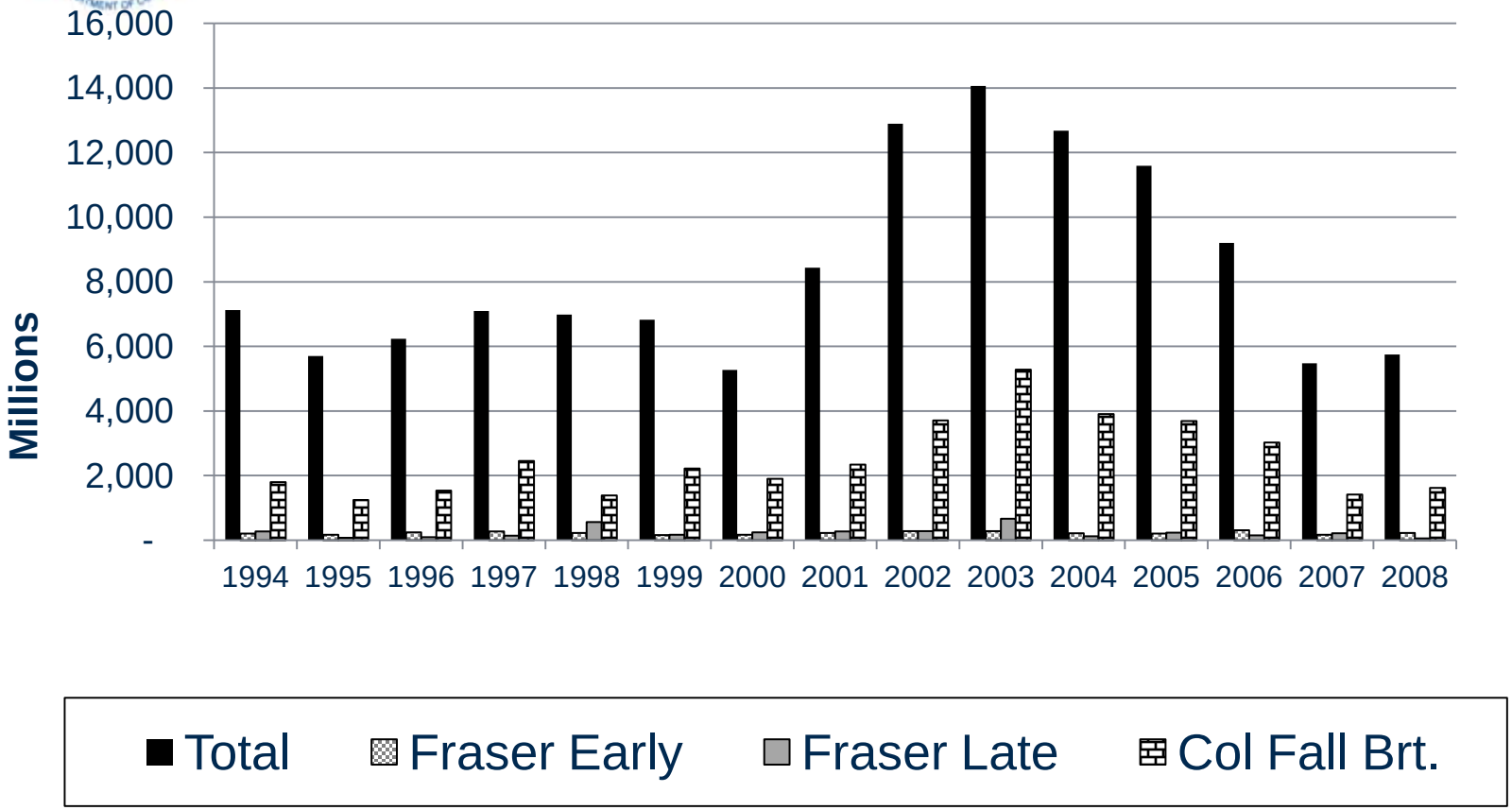
NOAA FISHERIES SERVICE

Kilocals of Chinook in inland waters, Jul-Sep



NOAA FISHERIES SERVICE

Kilocals of Chinook in coastal waters, Jul-Sep



Science, Service, Stewardship

Which fisheries affect prey availability and to what extent?

September 26, 2011

NOAA FISHERIES SERVICE

NOAA FISHERIES SERVICE

Percent reductions of Chinook in inland and coastal waters

- We estimated percent reduction in Chinook food energy available to SRKW from:

  (a) all fisheries,

  (b) Canada fisheries,

  (c) U.S. fisheries (Puget Sound fisheries for Pgt. Snd. RMP Biop).

- Percent reduction estimated from paired runs and comparison of kilocalories with fisheries open and kilocalories with fisheries closed.

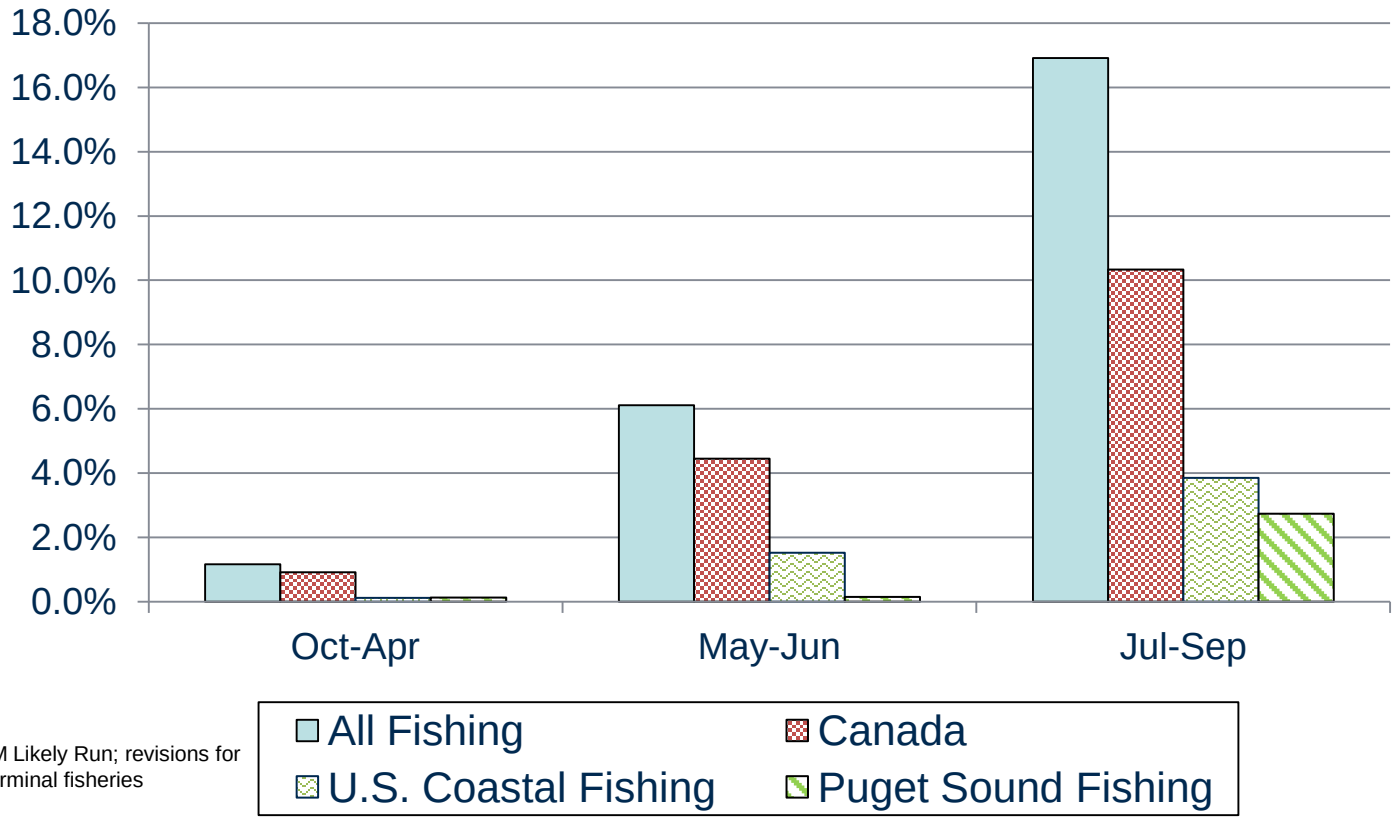
NOAA FISHERIES SERVICE

Which fisheries counted towards reduction in Chinook prey?

- Marine area fisheries only.
- Any salmon fisheries that could affect Chinook abundance passing through or destined for Inland waters. Same for coastal waters.
- For Pug. Snd. RMP Biop, nearly all PS marine area fisheries were counted except for a few subareas where SRKWs have not been observed (Area 8D, 10E, 12, most of Area 13).
- Since the PS Biop, PS marine terminal fishery catches discounted by percentage of years with sightings within fishery subareas (discounting ranges from 50% to 89%).

NOAA FISHERIES SERVICE

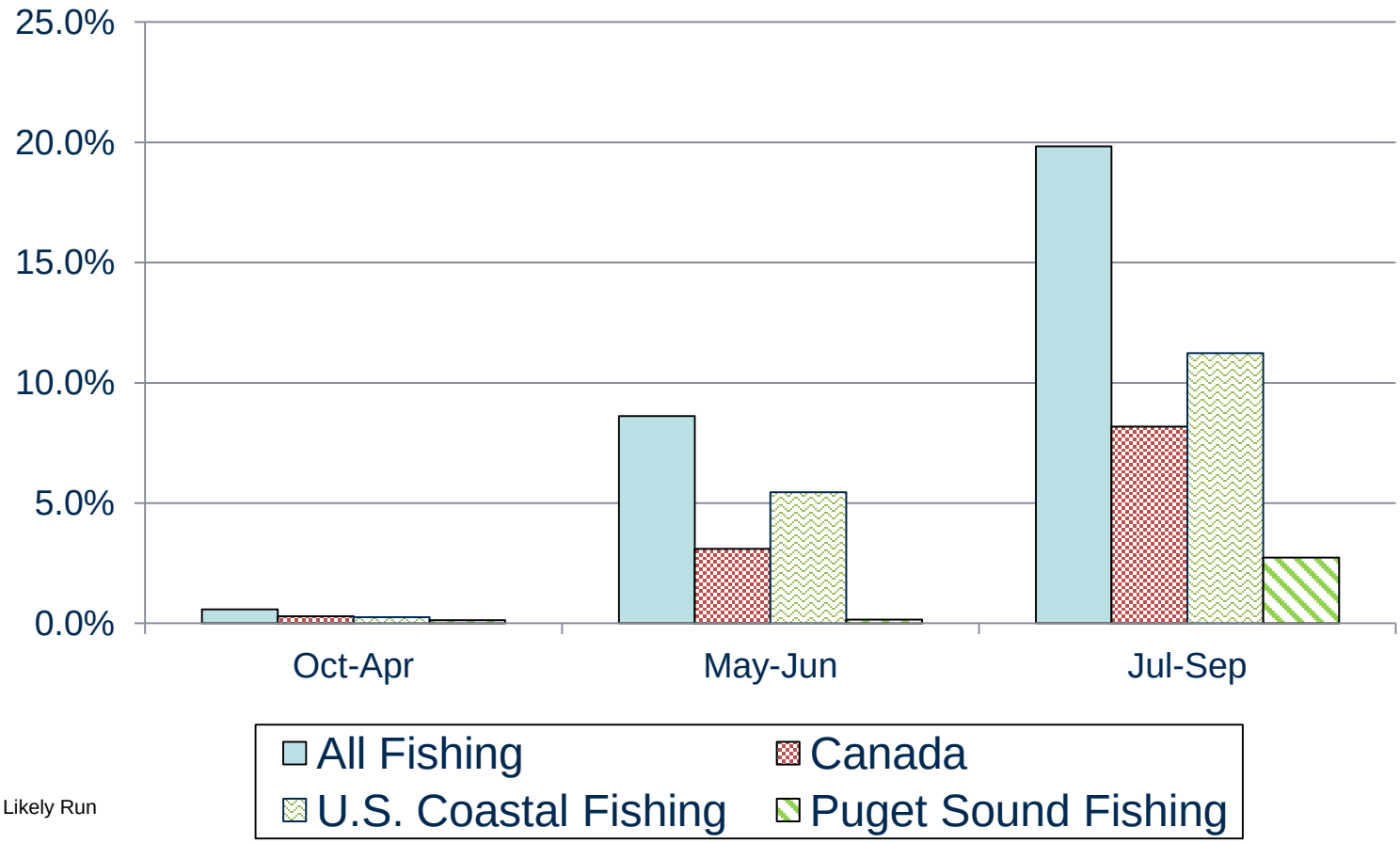
Reduction in kilocalories of Chinook in inland waters from salmon fishing (ave. 1994-2008)



FRAM Likely Run; revisions for PS terminal fisheries

NOAA FISHERIES SERVICE

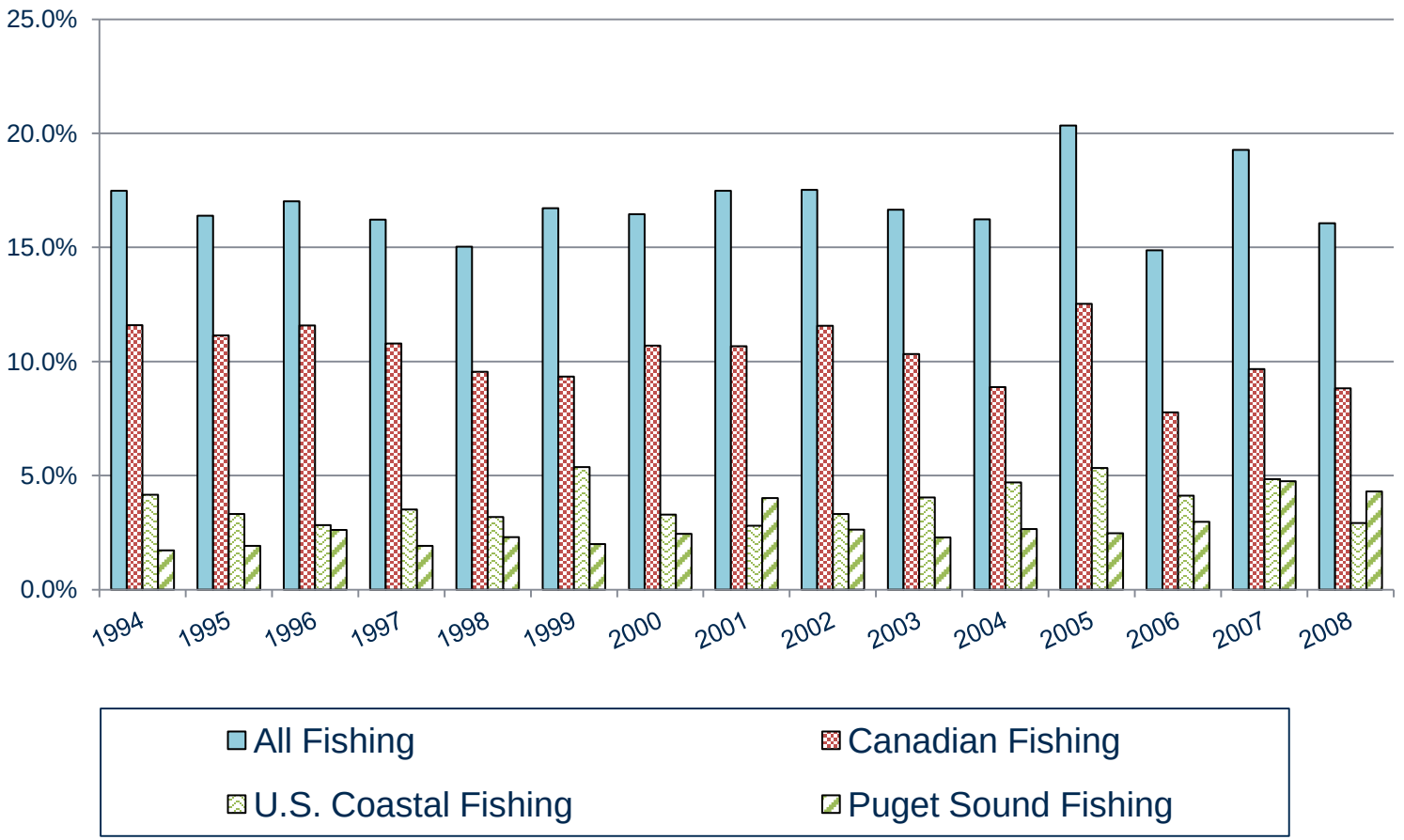
Reduction in kilocalories of Chinook in coastal waters from salmon fishing (ave. 1994-2008)



FRAM Likely Run

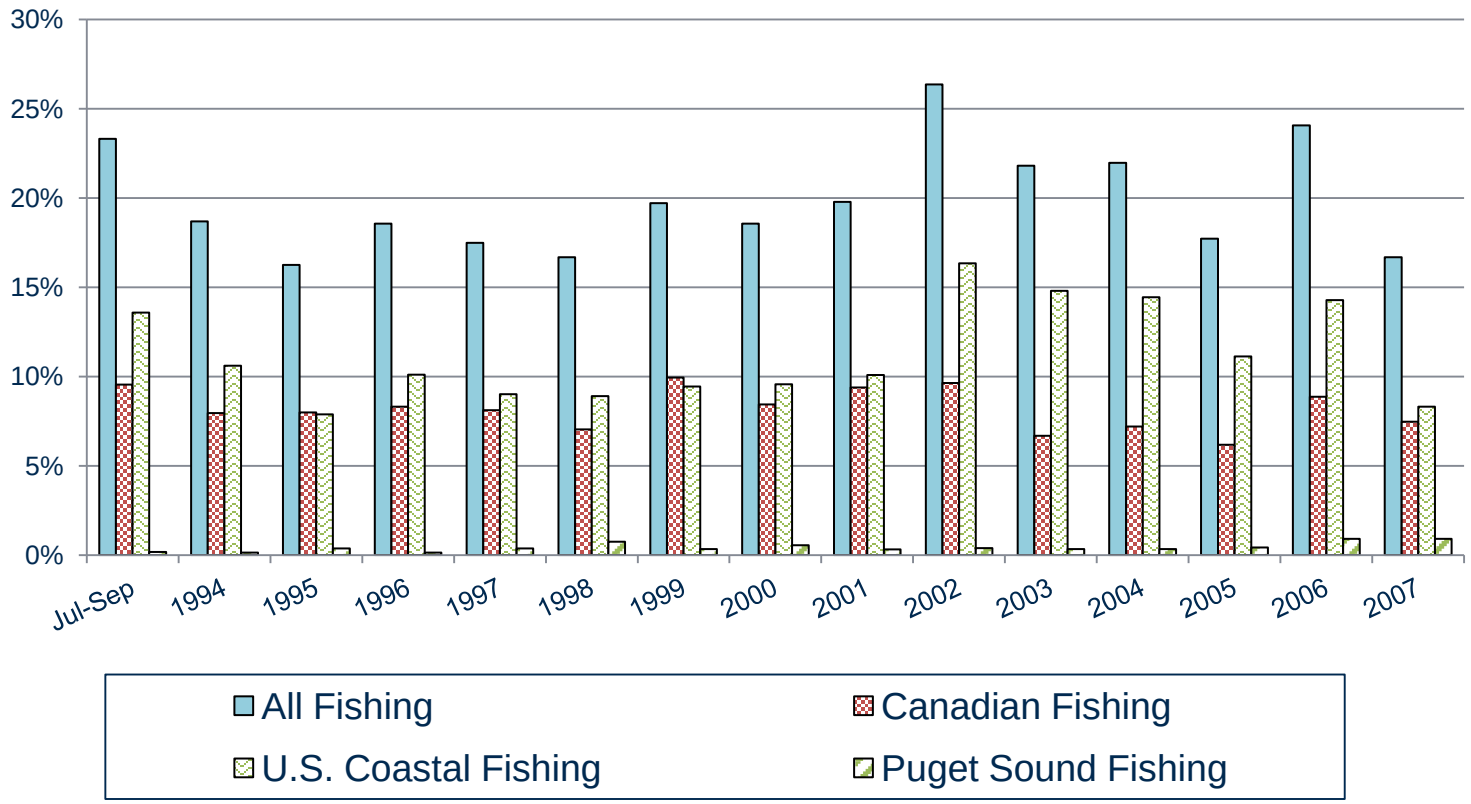
NOAA FISHERIES SERVICE

Reduction in kilocalories of inland waters Chinook from salmon fishing, Jul-Sep



NOAA FISHERIES SERVICE

Reduction in kilocalories of coastal waters Chinook from salmon fishing, Jul-Sep



Science, Service, Stewardship

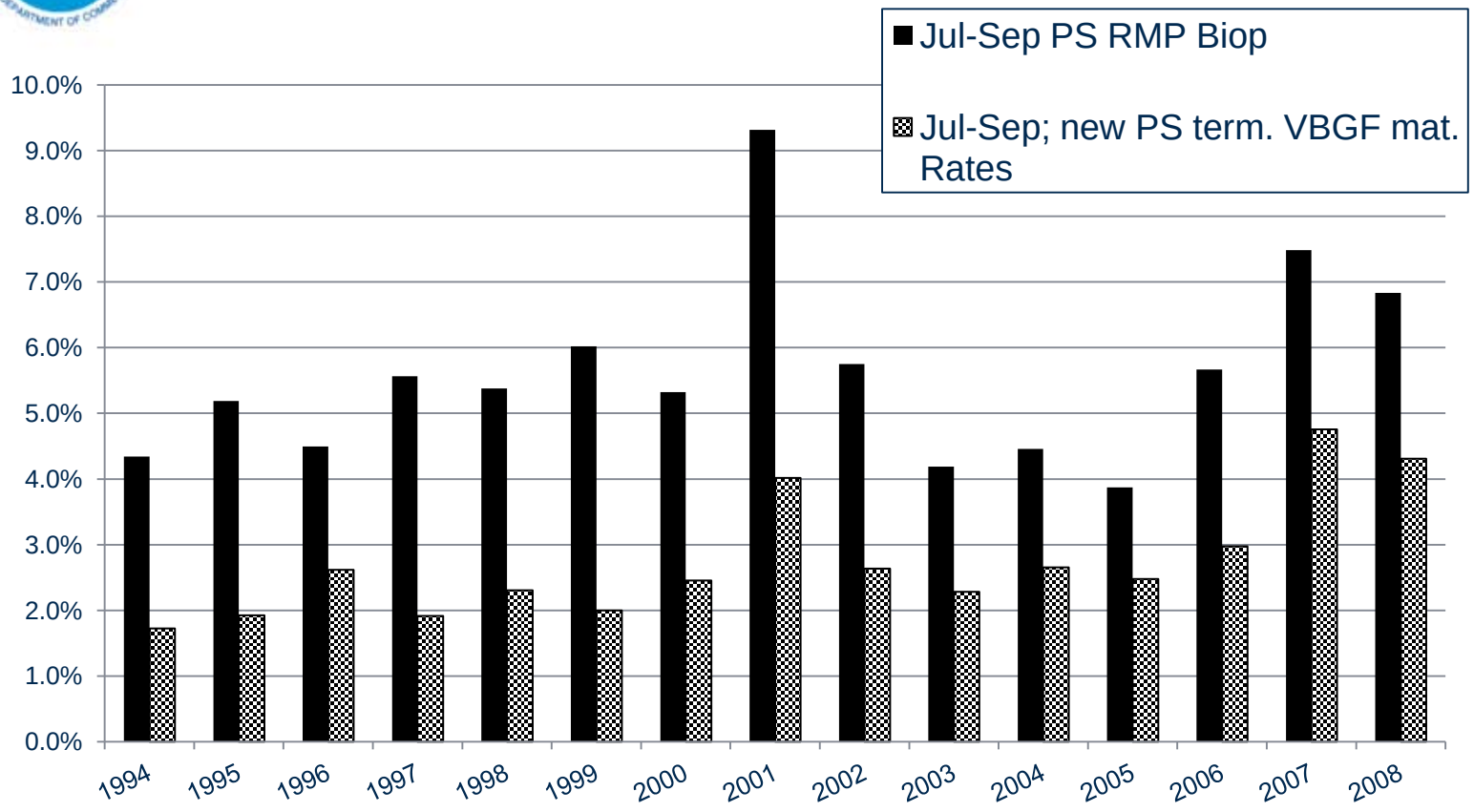
Bonus Stuff on PS Terminal Fisheries, Size Selectivity, Natural Mortality

September 26, 2011

NOAA FISHERIES SERVICE

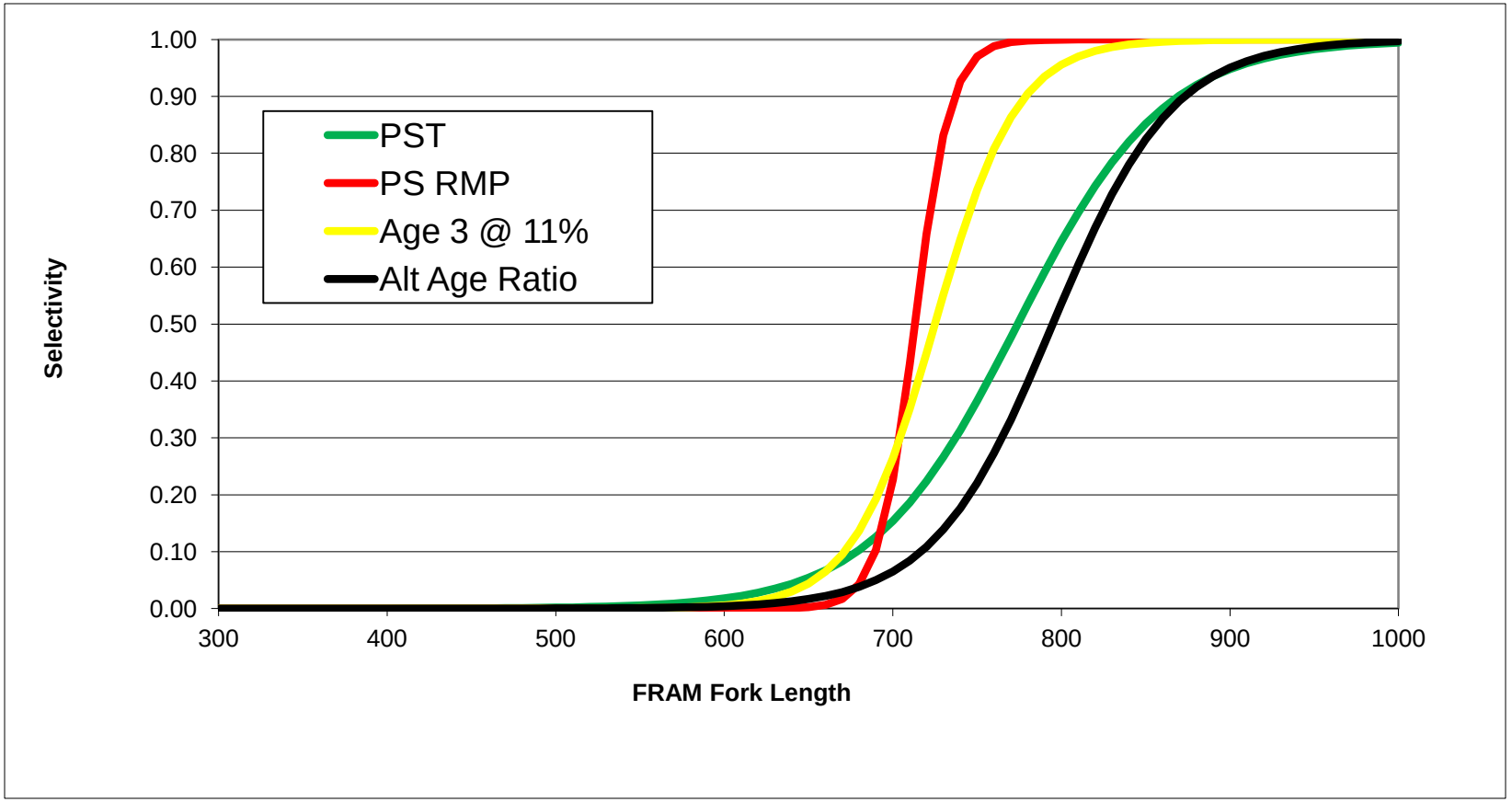
NOAA FISHERIES SERVICE

Reduction in kilocals of Chinook in inland waters from Pgt. Snd. fisheries under PS RMP Biop and revised PS terminal fishery effect and VBGF ave. via maturation rates



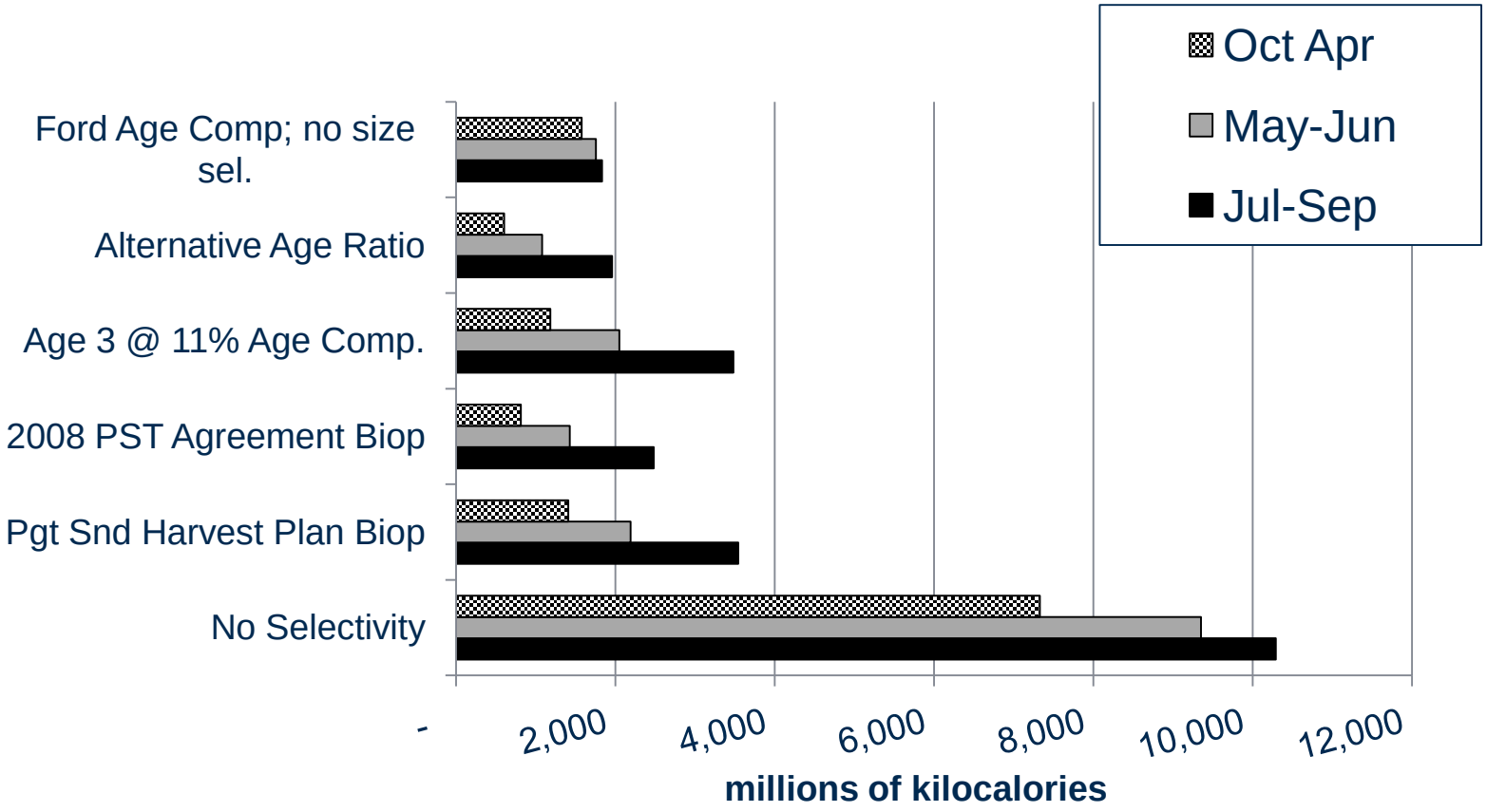
NOAA FISHERIES SERVICE

Size selectivity effect on kilocals

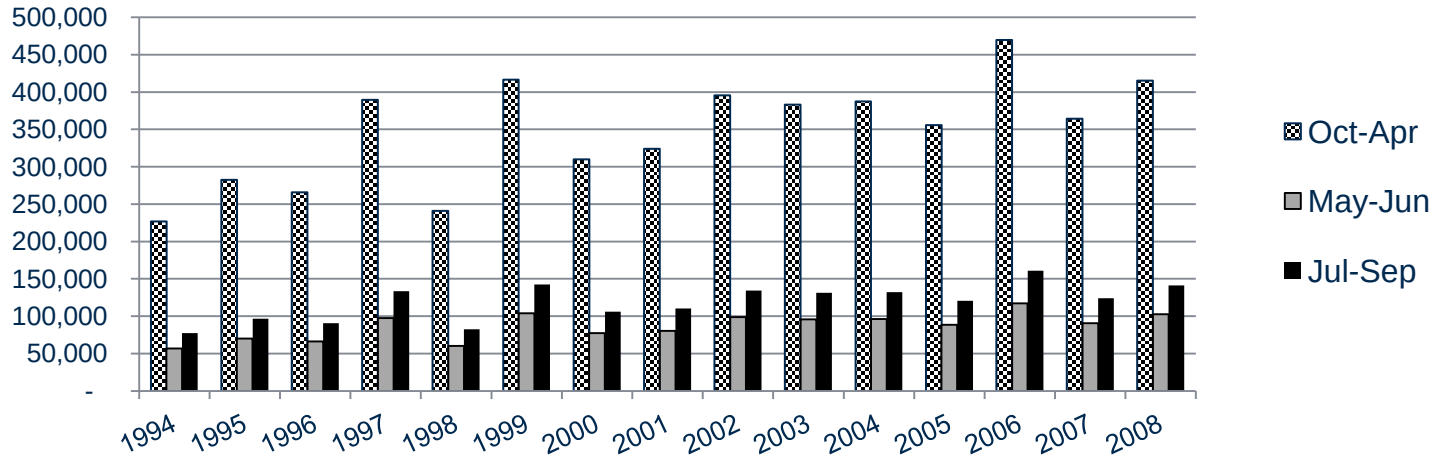


NOAA FISHERIES SERVICE

Kilocalories of Chinook in inland waters for 2008 under different size selectivities

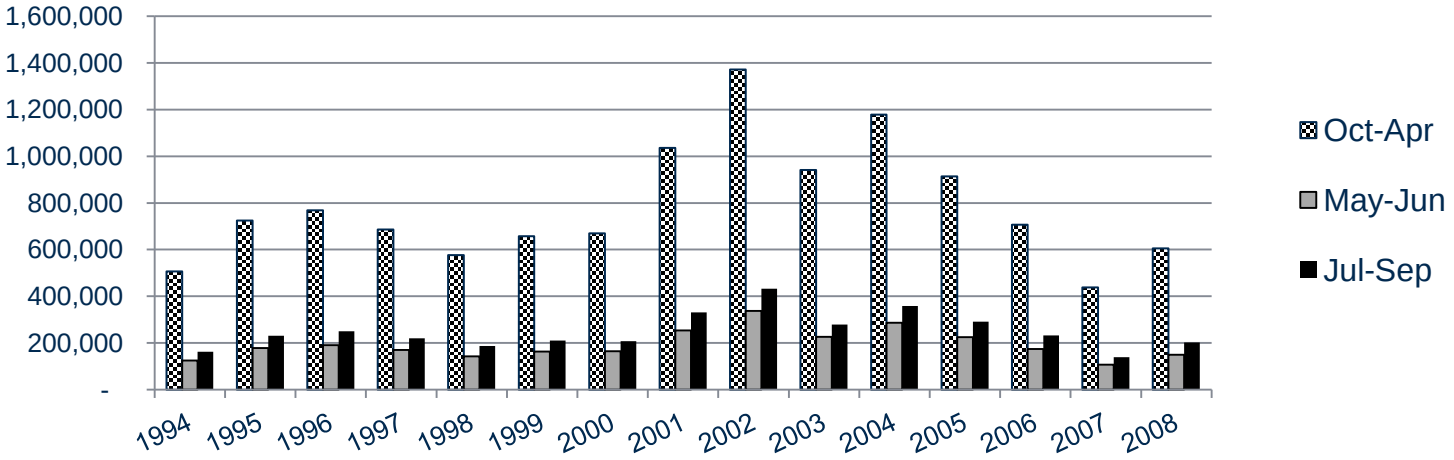


Natural mortality of age 3-5 inland Chinook



FRAM Likely Run

Natural mortality of age 3-5 coastal Chinook



FRAM Likely Run

NOAA FISHERIES SERVICE

Parting shots on fishery modeling

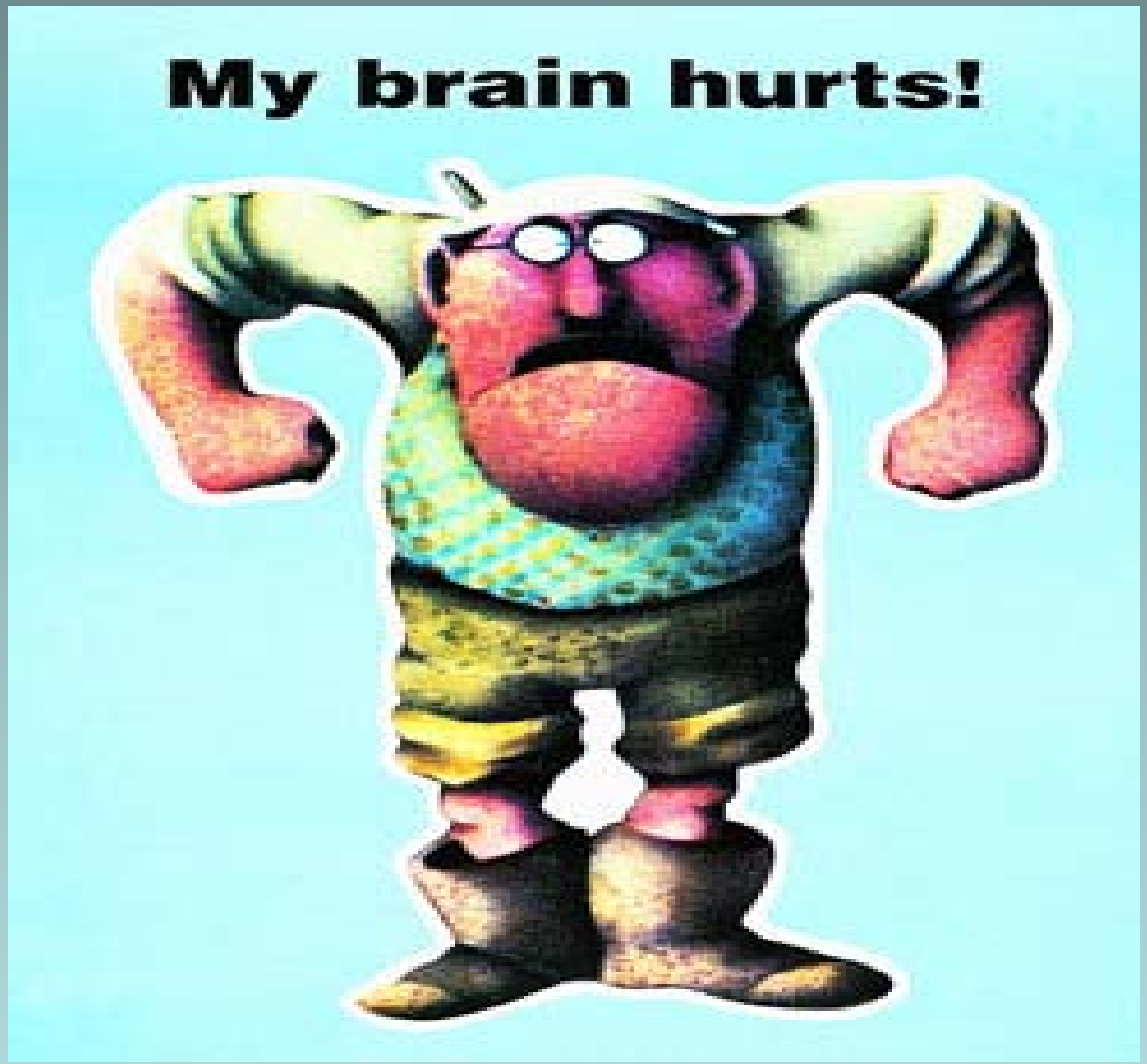
- Current Chinook fishery simulation models can provide broad scale information on prey abundance and fishery effects.
- Estimates of small scale (local) Chinook prey available to SRKW and effects of these fisheries difficult to estimate with single-pool models.
- Food energy estimates from Chinook prey sensitive to size (age) selectivity.
- FRAM and Chinook Model continuously improved and updated for better estimates of fishery impacts; related to estimates of Chinook prey too (e.g. FRAM VBGF compared to recent CWT analysis).
- Comments and feedback we have received have been helpful and have provided ideas for further analysis of key assumptions and analytical methods.
- To develop a new model to estimate effects on Chinook prey from fishery management decisions will take at least 3 times longer than you think it should.

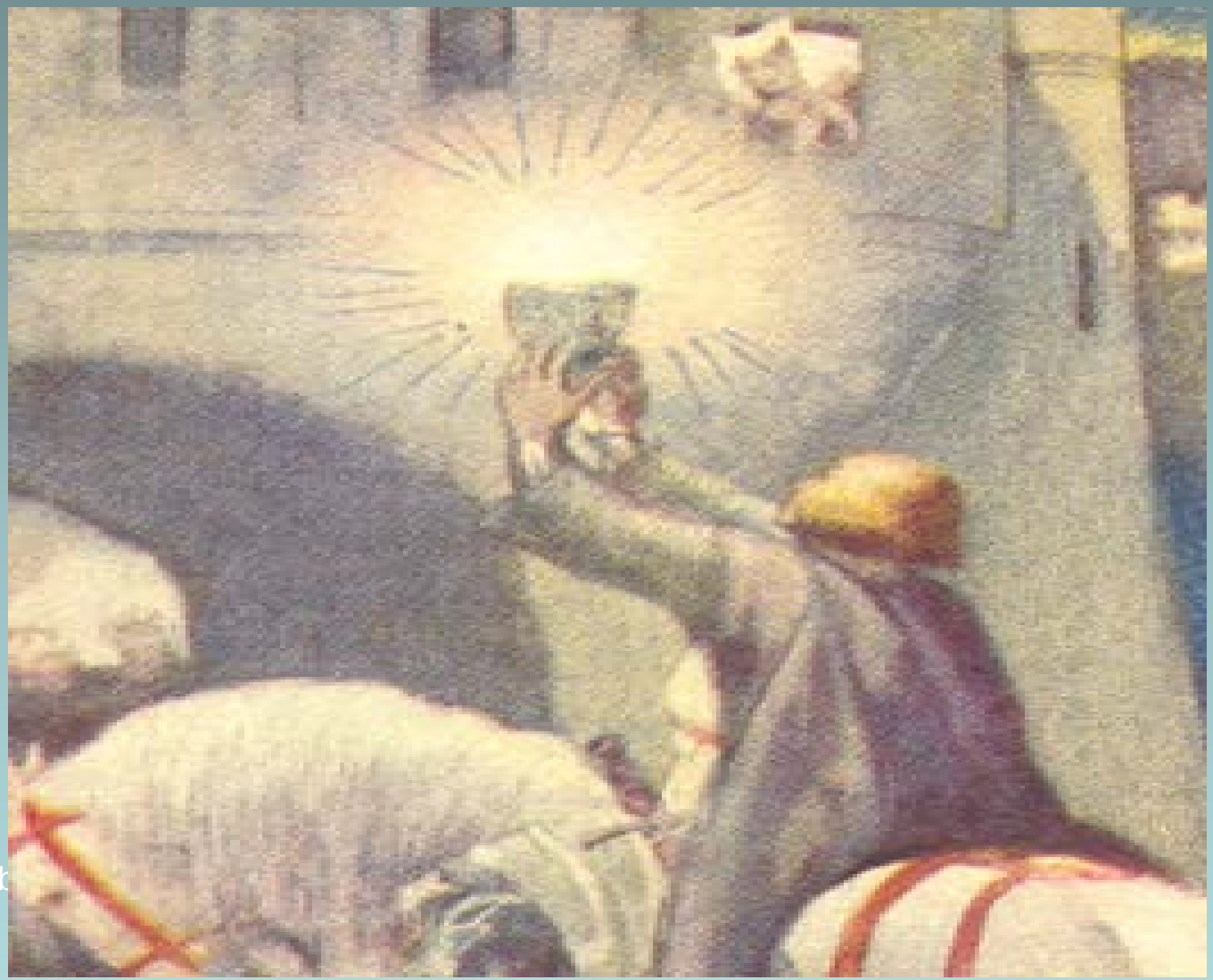

FRAM
259125

NOAA
FISHERIES
SERVICE


© Original Artist
Reproduction rights obtainable from
www.CartoonStock.com
Well- it sounds like lions to me
searchlabbum3

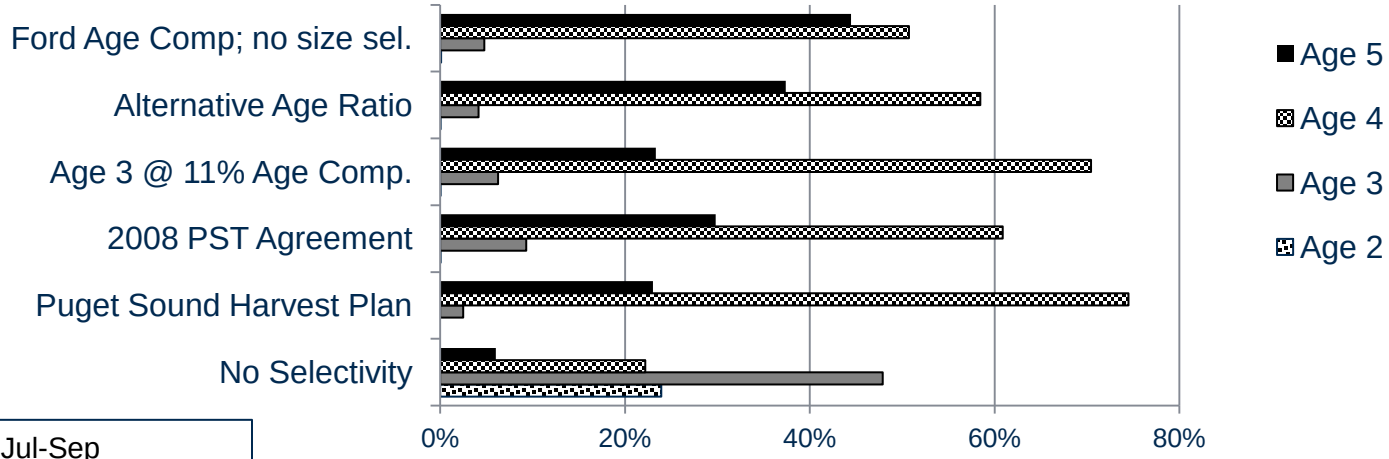

Elio


My brain hurts!



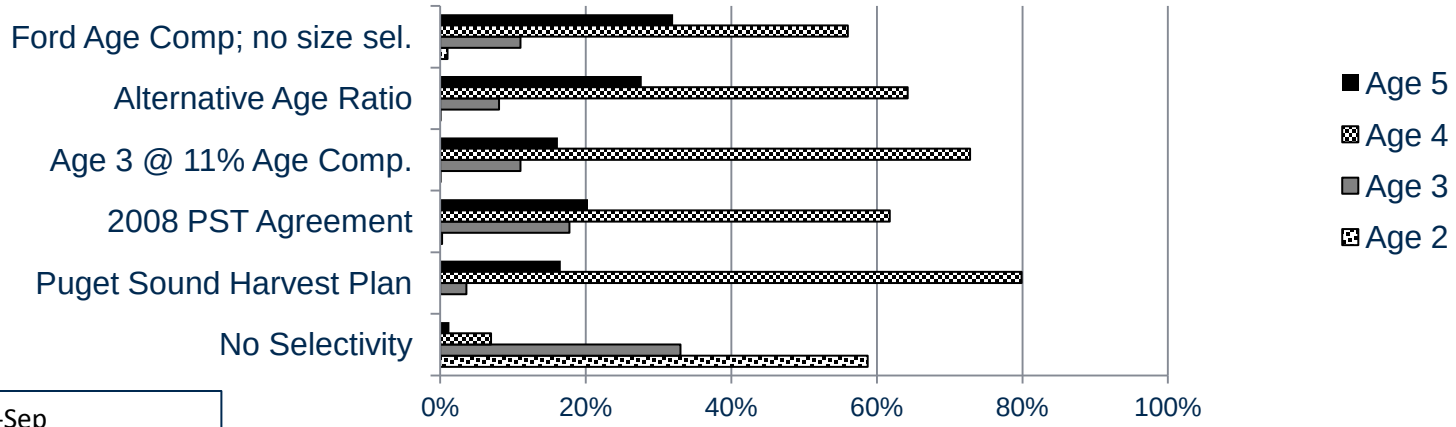
Septemb

Percent kilocals by age for inland Chinook under different size-age selectivity



2008 Jul-Sep

Age composition of inland Chinook contributing to kilocalories ("age comp of kills")

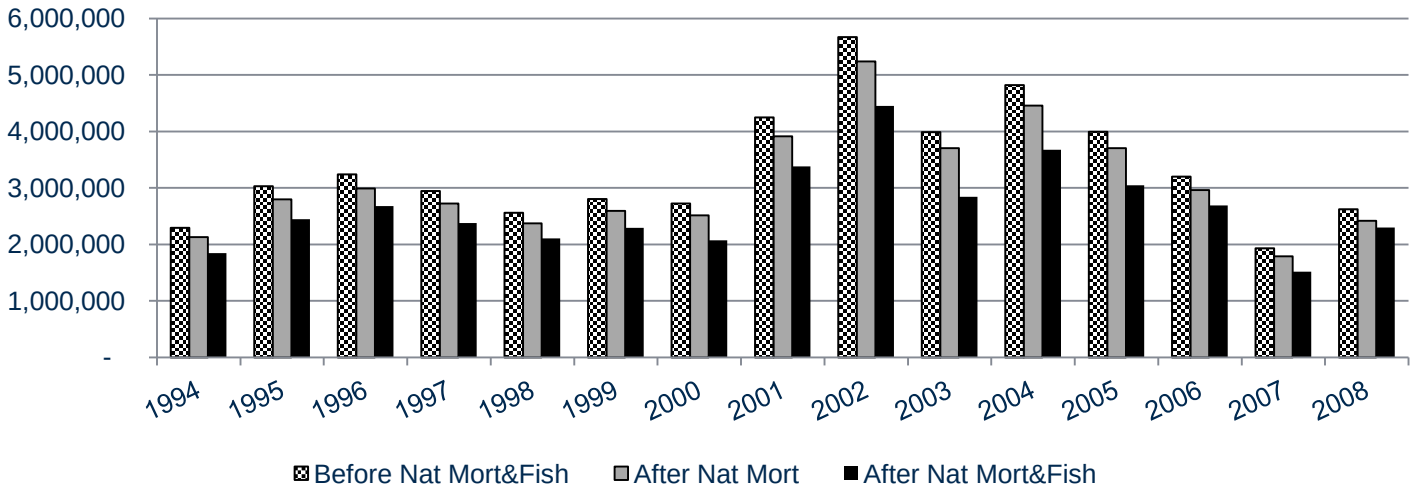


2008 Jul-Sep

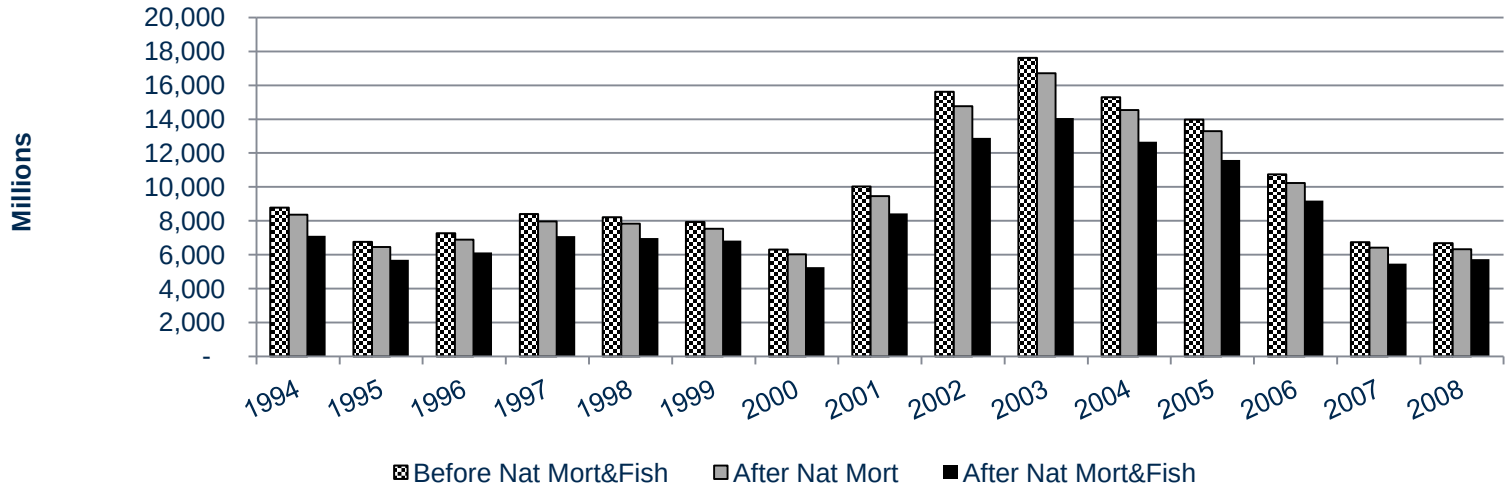
NOAA
FISHERIES
SERVICE

Fig. Geographic Range (light shading)

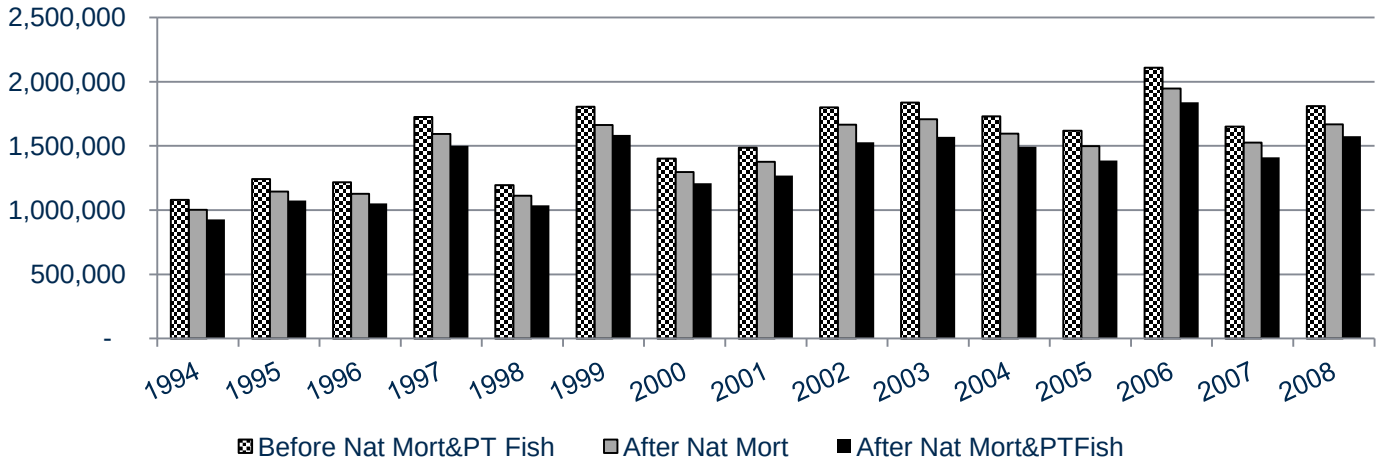
Abundance of age 3-5 coastal Chinook, Jul-Sep



Kilocals of age 3-5 coastal Chinook, Jul-Sep



Abundance of age 3-5 inland Chinook, Jul-Sep



Kilocals of age 3-5 inland Chinook, Jul-Sep