Kuskokwim River Chinook Salmon Forecasting

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Forecasting

- Definition: to calculate or predict some *future event* or *condition*, usually as a result of study and analysis of available *pertinent data*.
  - Weather: Temperature & Precipitation
  - Economic: Inflation & Unemployment
  - Earthquake: Location & Magnitude
  - Politics: Winner of an election
  - Traffic: Location & Time of congestion

Why Forecast Weather

- I checked the Bethel weather before I packed for my trip here.
  - The forecast informed me of how cold it might be
    - How heavy of a coat do I need to bring?
  - It said 20° and it actually is __°.
  - I did/didn't wear my coat because the weather today is different/the same as the forecast.
- I used the forecast to inform my decision to bring a coat.

Why Forecast Salmon Returns

- Fishermen want to know what fishing opportunity to expect.
  - Should the boat be ready to go at breakup?
  - How good/bad will fishing be during these periods?
  - What management actions may take place?
    - Should I buy an 8” or <6” net?
- Managers want to know what management actions may be required.
  - Do we expect enough fish for escapement?
  - Do we expect to have enough fish for subsistence harvest?
    - Do we need to do anything?
    - Restrictions or closures?

Forecasting

- Definition: to calculate or predict some *future event* or condition, usually as a result of study and analysis of available *pertinent data*.

- Weather
  - Event: Temperature in the future
  - Pertinent Data:
    - Historical weather patterns
    - Recent temperatures

- Salmon
  - Event: Chinook salmon return in the future
  - Pertinent Data:
    - Historical sibling and/or production relationships
    - Recent returns and run composition

Pertinent Data

- Brood Table
  - Summarizes annual run, age composition, and brood year return.

Brood Table

January 8, 2014

Brood Year	Escapement	Return by Age Class												Return	Return per Spawner	Total Run
		0.2	1.1	1.2	2.1	1.3	2.2	1.4	2.3	1.5	2.4	1.6	2.5			
1976	143,420	5	685	45,301	7	129,032	26	113,427	78	7,813	270	80	0	296,724	2.07	236,600
1977	201,852	5	685	29,297	0	53,519	24	67,261	350	8,145	503	101	0	159,889	0.79	299,963
1978	180,853	0	913	11,960	0	59,692	313	65,360	491	6,014	43	5	0	144,790	0.8	268,495
1979	157,668	0	139	45,301	7	82,411	152	75,392	58	7,029	50	13	12	210,564	1.34	256,585
1980	203,605	5	685	30,686	32	62,372	170	48,479	68	7,813	270	7	0	150,587	0.74	305,814
1981	279,392	0	367	31,815	0	61,253	21	72,840	350	11,546	70	7	0	178,270	0.64	393,868
1982	80,353	0	318	11,508	0	59,307	313	69,437	95	7,410	1,045	10	0	149,444	1.86	188,449
1983	84,188	0	747	45,301	7	97,996	30	119,935	723	6,245	108	37	281	271,408	3.22	169,073
1984	99,062	5	685	28,540	0	73,040	1,568	73,672	146	5,617	841	8	0	184,122	1.86	190,618
1985	94,365	0	86	38,015	0	126,302	46	110,193	1,253	5,788	449	8	90	282,231	2.99	178,959
1986	58,556	0	99	55,236	0	72,342	1,939	100,040	253	10,399	745	10	0	241,062	4.12	130,978
1987	89,222	0	3016	26,034	0	94,115	942	99,770	768	5,912	1,432	9	0	231,998	2.6	198,713
1988	80,055	65	90	76,148	0	80,801	186	119,483	1,744	4,517	251	10	0	283,295	3.54	210,817
1989	115,704	0	7088	76,113	0	194,963	1,603	189,281	293	33,004	103	7	0	502,456	4.34	243,980
1990	100,614	0	409	39,167	170	103,957	43	110,564	615	3,623	79	8	0	258,635	2.57	267,906
1991	105,589	73	670	61,980	0	128,496	324	144,684	108	6,060	81	7	0	342,483	3.24	221,194
1992	153,573	0	163	29,341	0	70,580	34	85,749	110	3,787	72	6	0	189,842	1.24	290,249
1993	169,816	0	127	83,961	0	105,460	34	117,186	97	5,193	70	0	0	312,128	1.84	272,590
1994	242,616	0	97	16,062	0	53,331	236	55,960	95	11,520	2	0	0	137,304	0.57	371,651
1995	225,595	0	293	14,894	0	55,957	30	120,178	0	8,318	0	0	0	199,669	0.89	366,957
1996	197,092	0	317	19,163	0	67,457	0	97,481	0	9,395	0	0	0	193,813	0.98	308,320
1997	211,247	0	131	24,550	0	88,004	63	80,879	0	4,899	0	0	0	198,527	0.94	312,076
1998	113,627	0	0	52,214	0	107,444	0	112,376	0	4,917	172	0	0	277,124	2.44	217,853
1999	112,082	0	215	50,637	0	118,418	439	122,425	618	14,411	107	0	0	307,272	2.74	188,957
2000	65,180	0	434	150,604	0	170,004	10	121,781	161	6,204	814	0	0	450,011	6.9	138,057
2001	145,232	0	1398	67,655	0	92,751	54	97,738	294	5,190	198	0	0	265,278	1.83	223,930
2002	164,635	0	801	77,048	0	90,865	0	67,652	1,354	2,330	329	0	0	240,378	1.46	245,235
2003	180,687	0	996	76,950	0	115,515	70	86,835	300	3,268	43	61	0	284,036	1.57	250,635
2004	287,178	0	196	46,546	0	76,442	842	40,712	0	1,768	43	*7	*5	166,576	0.58	389,401
2005	275,598	0	542	37,652	0	49,730	67	42,194	340	*9,642	*245	**13	**12	138,634	0.5	365,339
2006	214,004	0	169	24,509	0	51,306	116	*22,930	*548	[redacted]						310,537
2007	174,943	0	178	36,998	0	*51,640	*153	[redacted]								272,978
2008	128,978	0	157	*22,874	*0	[redacted]										239,273
2009	118,478	*234	*48	[redacted]												206,672
2010	49,073		[redacted]													118,924
2011	72,097															131,896
*2012	*77,937															*99,143

Salmon Forecast Methods

- Definition: to *calculate* or predict some future event or condition, usually as a result of study and *analysis* of available pertinent data.

Forecasting Methods Overview

- Sibling Models
  - ***Average return***
  - ***Sibling***
  - ***Ln Sibling***
  - ***Half Ln Sibling***
  - ***Ln Spawner-Return Age***
  - ***Spawner-Recruit***
  - ***Averaging models***
  - Incorporation of environmental factors
  - Special transformations and data filters
  - Bayesian versions
  - Hybrids of all models
- Population
  - ***Spawner-Recruit***
  - ***Prior year total return***
  - Incorporation of environmental factors
  - ***Averaging models***
  - Special transformations and data filters
  - Bayesian versions
  - Hybrids of all models

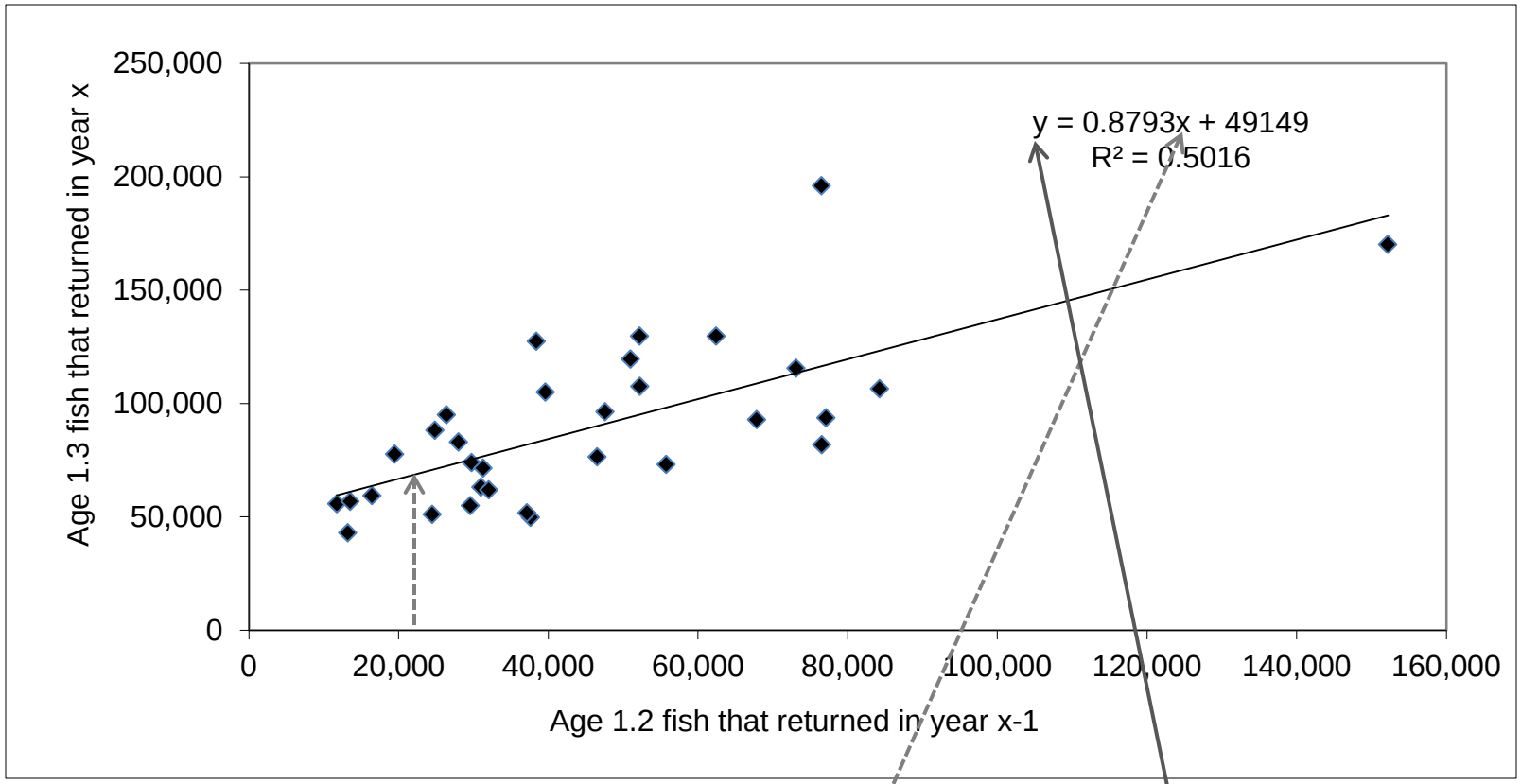
Kuskokwim Forecasting Methods

- Forecast each major age class individually
  - Add age class forecasts to get total forecast
- Several different forecast models are considered for each age class.
  - Average return
  - Sibling
  - Ln Sibling
  - Half Ln Sibling
  - Ln Spawner-Return Age
  - Spawner-Recruit

Sibling Models

- Return of prior year informs return of next year.
  - Age 1.2 fish that returned in 2012, inform how many age 1.3 fish should return in 2013
    - 1.3 in 2012 -> 1.4 in 2013
  - These fish come from the same brood year, so production should be similar.

Sibling Model



Age 1.2 fish returned in 2012 = 22,874

Age 1.3 fish forecasted to return in 2013 = 69,261

Model Selection

Age	Model	Forecast
1.3	Average return	68,846
1.3	Sibling	69,261
1.3	Ln Sibling	65,925
1.3	Half Ln Sibling	67,785
1.3	Ln Spawner-Return Age	87,062
1.3	Spawner-Recruit	96,963

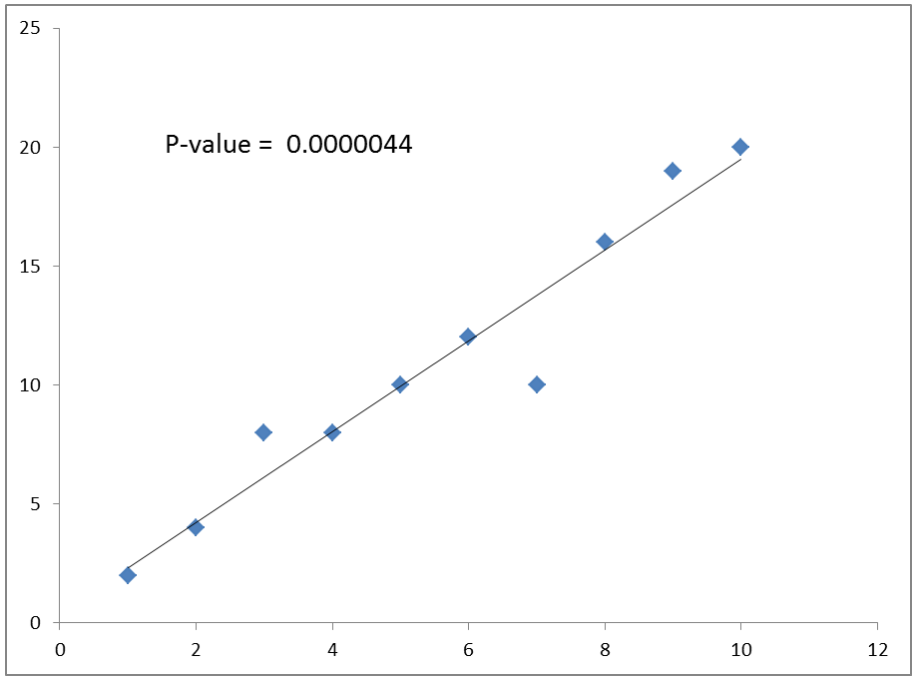
We have 6 different results for each age class from the various models.

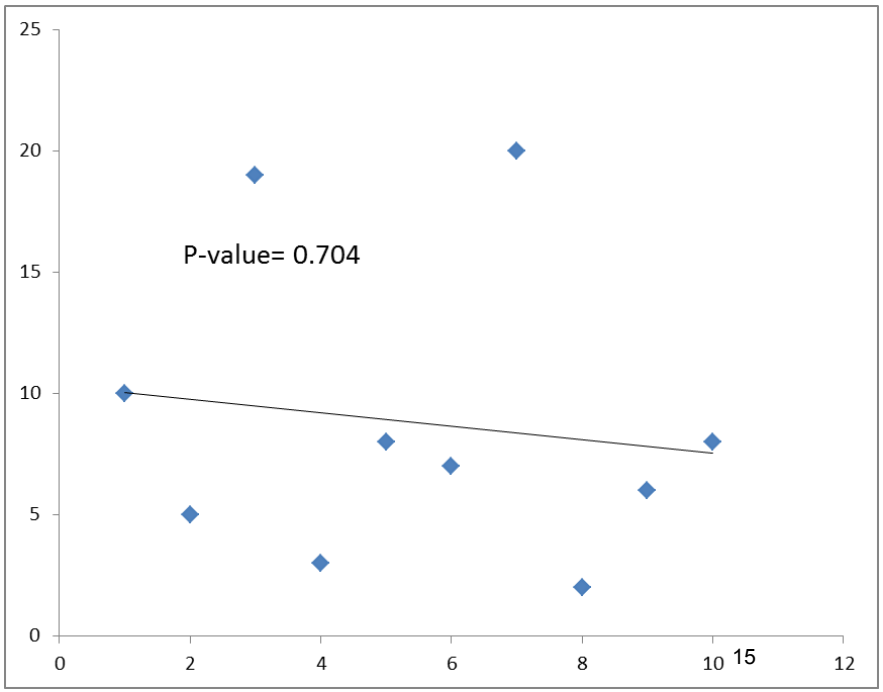
How do we select the model for each age class?

Model Selection

- We first test if the linear regression is statistically appropriate for each model.
  - If it is not, then the model will not be considered for selection.
  - P-value= probability that linear regression does NOT explain data variance
    - P-value < 0.05 is good
    - Less than 5% of the time linear regression doesn't explain

Significance of Linear Relationships





Model Selection

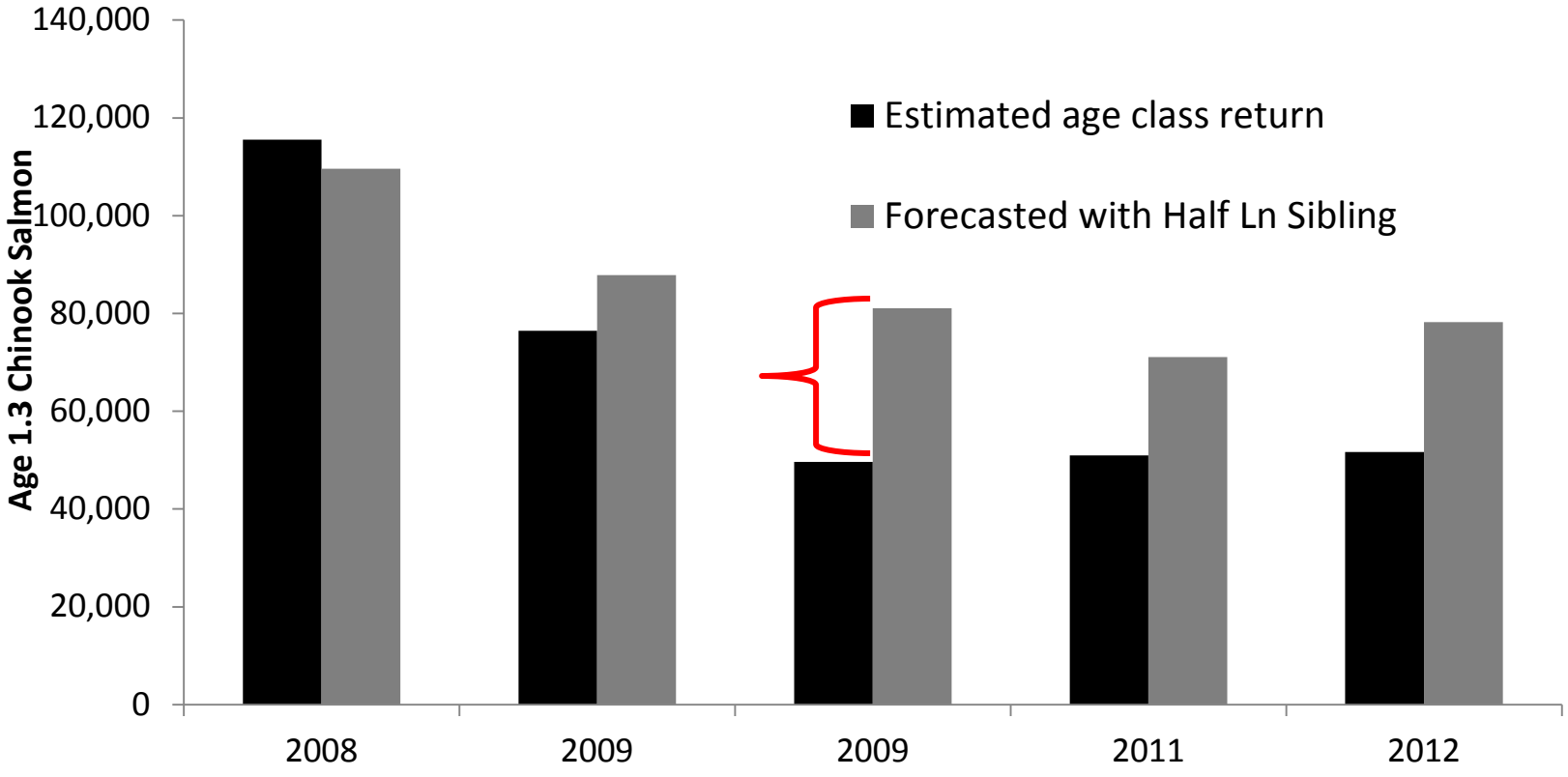
Age 1.3 Model	P-value (< 0.05 is good)	
5-year average	N/A	
Sibling	0.000006	
Ln Sibling	0.000003	
Half Ln Sibling	0.000000	
Ln Spawner-Return Age	0.003633	
Spawner-Recruit	0.000011	

All models are valid for this age class currently.

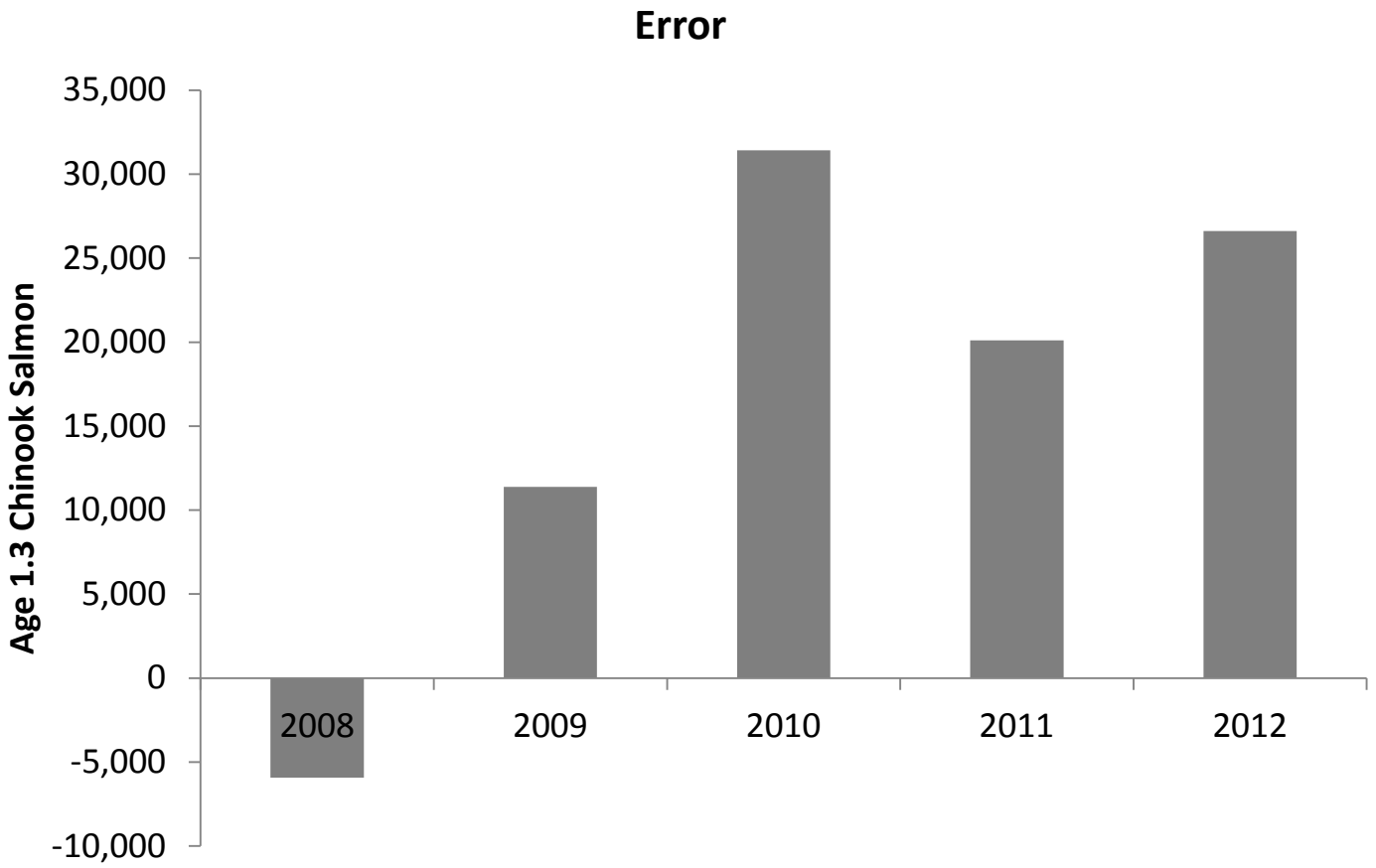
Model Selection

- We evaluate each model by comparing past forecasts with actual returns to identify the error in each forecast model for that age class.
  - Since we haven't been forecasting very long, we simulate forecasts for 5 years prior for each age class to estimate the error.

Age 1.3 Half Ln Sibling Model Precision



Age 1.3 Half Ln Sibling Model Precision

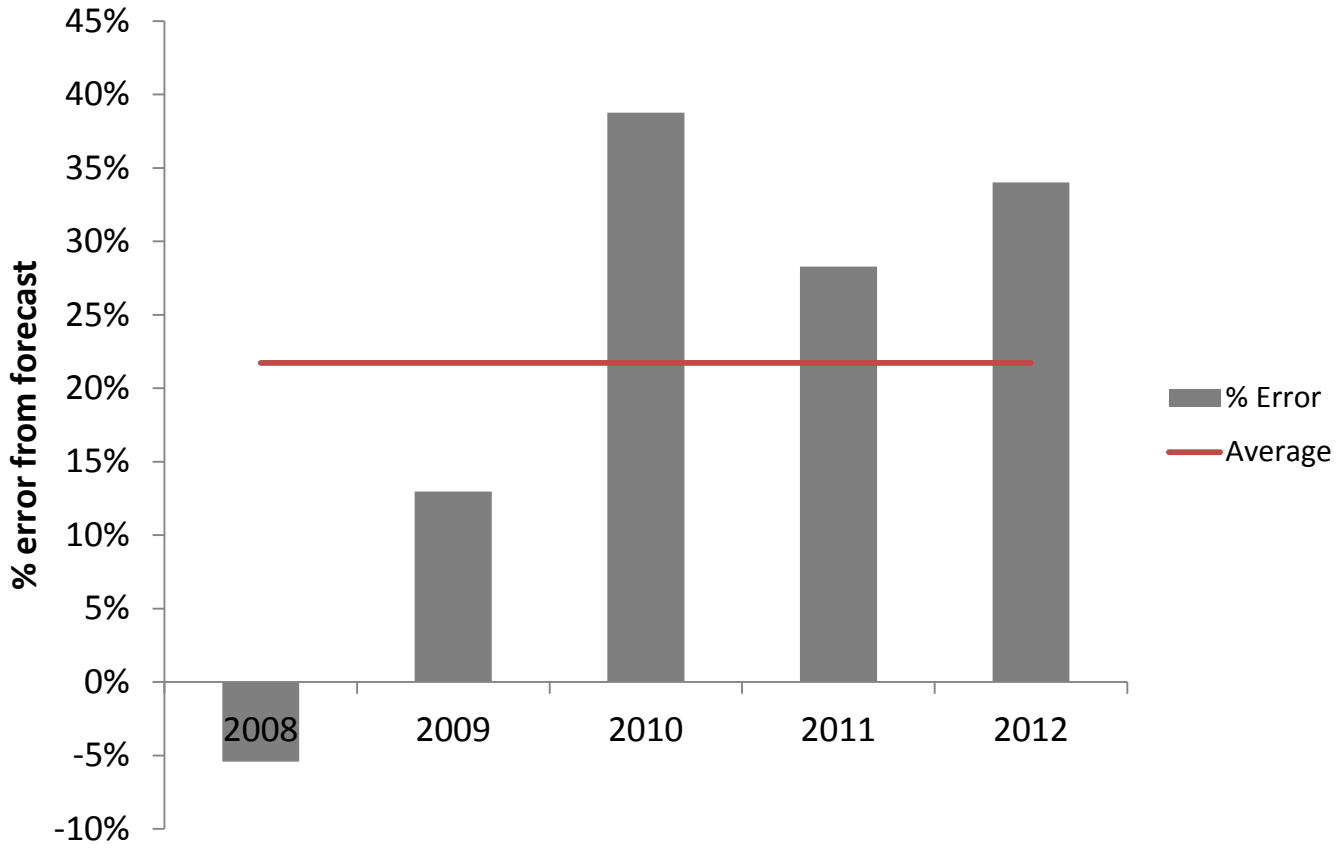


fish not the best for comparison

50,000 fish off in a year where 100,000 come back is 50% off.

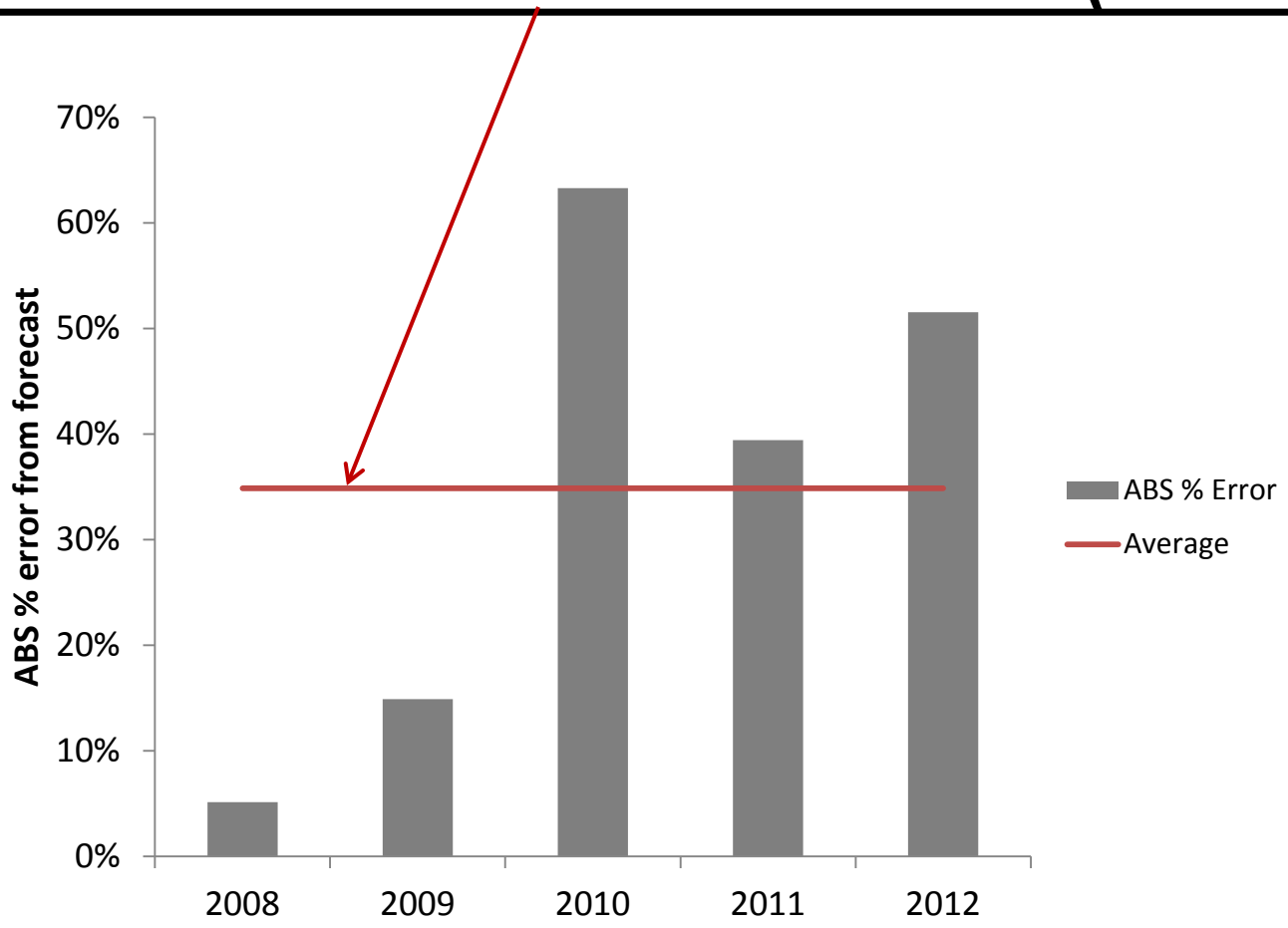
50,000 fish off in a year where 500,000 come back is 10% off.

Age 1.3 Half Ln Sibling Model Precision



At this point we are not concerned about the forecast being high or low, just how far off. Average of 5 and -5 is 0; but both are actually 5 off.

Mean Absolute Percent Error (MAPE)



This model has produced forecasts that have been this percent off in the past five years.

Model Selection

Age 1.3 Model	P-Value (< 0.05 is good)	MAPE
5-year average	N/A	59%
Sibling	0.000006	40%
Ln Sibling	0.000003	39%
Half Ln Sibling	0.000000	35%
Ln Spawner-Return Age	0.003633	36%
Spawner-Recruit	0.000011	38%

2013 Kuskokwim River Chinook salmon Age Class Forecasts and Model Selection

Age 1.1

Model	P-value	MAPE	2013
3-year average	0.00000	1.98	169
Spawner-Recruit	0.04921	2.04	210

Age 1.2

Model	P-value	MAPE	2013
4-year average	0.00000	0.79	30,545
~~Sibling~~	~~**0.30742**~~	~~0.44~~	~~42,515~~
~~Ln Sibling~~	~~**0.26762**~~	~~0.28~~	~~31,719~~
Spawner-Recruit	0.00000	0.50	45,270
Ln Spawner-Return Age	0.04277	0.38	41,504
~~Half Ln Sibling~~	~~**0.273914**~~	~~0.27~~	~~35,390~~

Age 1.3

Model	P-value	MAPE	2013
5-year average		0.59	68,846
Sibling	5.768E-06	0.40	69,261
Ln Sibling	3.17E-06	0.39	65,925
Spawner-Recruit	5.455E-12	0.38	96,963
Ln Spawner-Return Age	0.0036328	0.36	87,062
Half Ln Sibling	1.126E-05	0.35	67,785

Age 1.4

Model	P-value	MAPE	2013
6-year average	0.00000	1.13	59,828
Sibling	0.00000	0.95	63,515
Ln Sibling	0.00001	0.83	57,401
Spawner-Recruit	0.00000	0.72	85,693
Ln Spawner-Return Age	0.00107	0.81	76,486
Half Ln Sibling	0.00107	0.86	62,209

Age 1.5

Model	P-value	MAPE	2013
7-year average	0.00000	0.14	4,901
Sibling	0.00019	0.54	(1,415)
Ln Sibling	0.00017	0.33	1,150
Spawner-Recruit	0.00001	0.14	4,833
~~Ln Spawner-Return Age~~	~~**0.15601**~~	~~0.20~~	~~4,751~~
Half Ln Sibling	0.00019	0.30	2,207

2013 Total Kuskokwim River Chinook Salmon Forecast

Age Class	Forecast
1.1	169
1.2	41,504
1.3	67,785
1.4	85,693
1.5	4,833
Total	199,984
UCI (+20%)	159,987
LCI (-20%)	239,981

2013 Season Review

- Pre-season
  - Forecast:160,000–240,000
    - SEG 65,000 – 120,000
    - Avg. Subsistence Harvest – 85,000
  - Management Strategy
    - Tributary restrictions
    - Mainstem Unrestricted
      - Inseason indicators used to implement restriction

Lower Drainage Wide Goal			65,000
	Lower Bound	Midpoint	Upper Bound
2013 Forecast	159,988	199,985	239,981
Surplus beyond escapement	94,988	134,985	174,981
Projected Sub. Harvest (Avg)	85,000	85,000	85,000
Surplus beyond Sub.	9,988	49,985	89,981

Mid Point Drainage Wide Goal			92,500
	Lower Bound	Midpoint	Upper Bound
2013 Forecast	159,988	199,985	239,981
Surplus beyond escapement	67,488	107,485	147,481
Projected Sub. Harvest (Avg)	85,000	85,000	85,000
Surplus beyond Sub.	-17,512	22,485	62,481

Upper Drainage Wide Goal			120,000
	Lower Bound	Midpoint	Upper Bound
2013 Forecast	159,988	199,985	239,981
Surplus beyond escapement	39,988	79,985	119,981
Projected Sub. Harvest (Avg)	85,000	85,000	85,000
Surplus beyond Sub.	-45,012	-5,015	34,981

2013 Season Review

- June 11

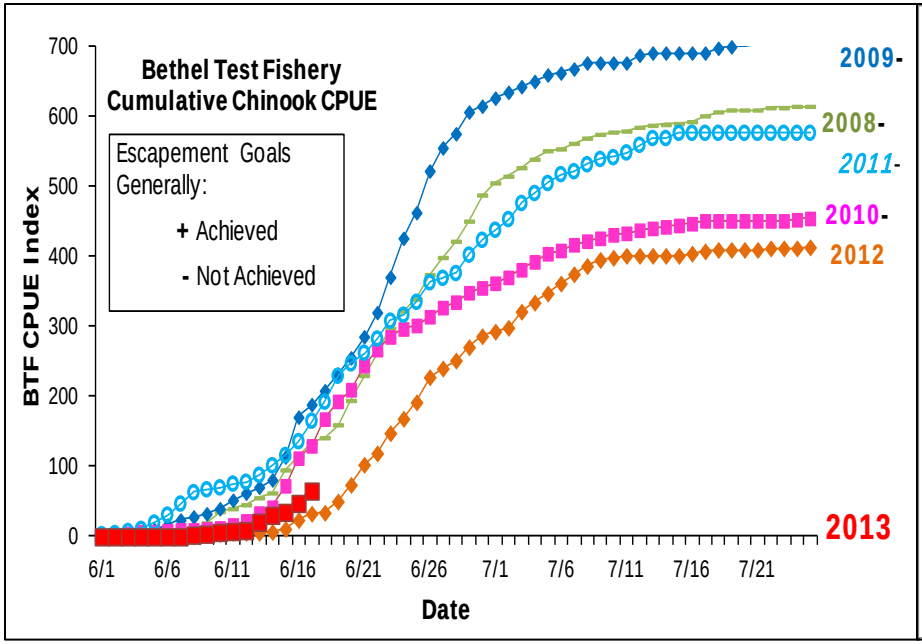
Bethel Test Fishery
Chinook Salmon Cumulative CPUE Index
(UNCORRECTED)

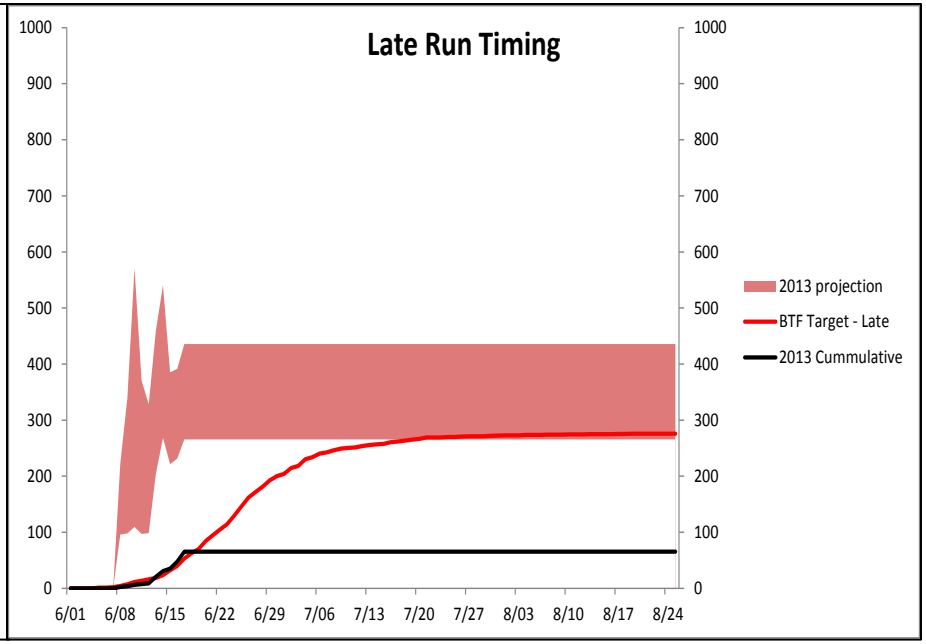
	2008	2009	2010	2011	2012	2013
6/01	0	0	0	3	0	0
6/02	3	0	3	5	0	0
6/03	3	1	4	8	0	0
6/04	3	4	7	11	1	0
6/05	3	10	7	20	1	0
6/06	4	17	8	31	1	0
6/07	4	24	10	47	1	0
6/08	10	28	10	63	1	2
6/09	20	33	11	67	3	1
6/10	36	40	13	70	4	
6/11	40	52	17	75	6	
6/12	46	62	23	78	6	
6/13	56	71	34	88	6	
6/14	63	81	42	102	7	
6/15	96	114	73	116	11	
6/16	115	171	112	136	24	
6/17	135	189	130	165	33	
6/18	142	209	168	192	34	
6/19	160	232	193	229	50	
6/20	195	255	210	247	74	
6/21	230	286	244	262	103	
6/22	262	320	267	283	119	
6/23	298	371	285	308	148	
6/24	323	426	297	317	168	
6/25	339	463	302	335	192	
6/26	374	522	314	363	228	
6/27	399	555	327	369	240	
6/28	422	575	335	376	252	
6/29	451	606	349	402	271	
6/30	488	615	355	423	286	

- Subsistence fishermen in the lower Kuskokwim River were reporting good catches.
- Maintain the existing subsistence salmon fishing restrictions on the tributaries and keep subsistence salmon fishing open in the mainstem to all gear types and unrestricted gillnet mesh size.

2013 Season Review

- June 19

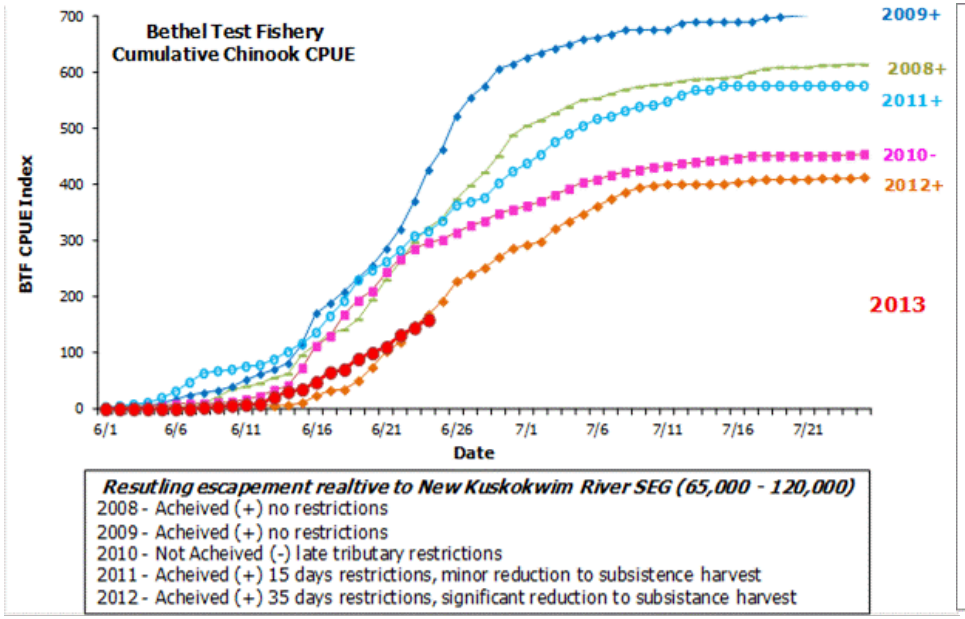


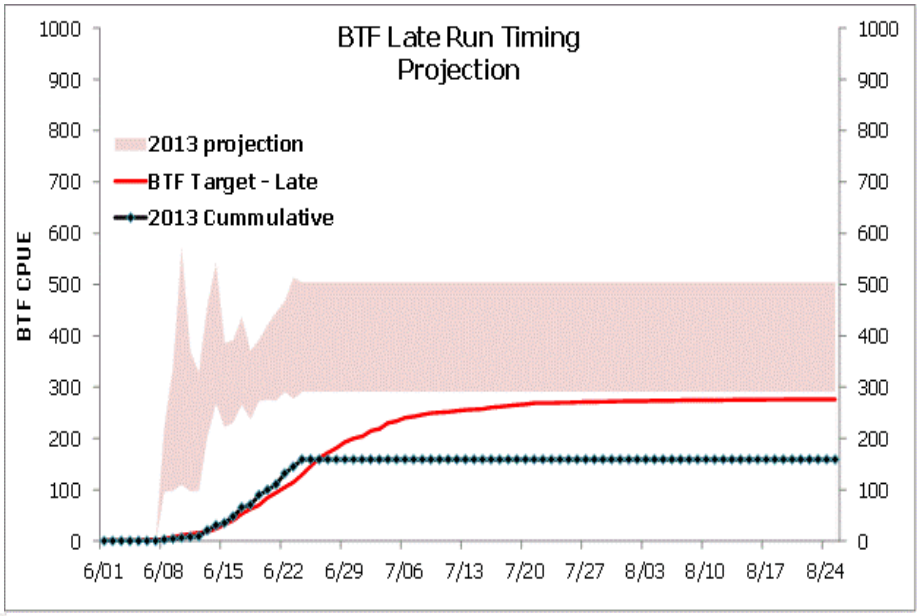


- Lower river reported people were slowing down on targeting Chinook salmon as they were close to meeting their Chinook salmon harvest goals.
- A few lower river fishermen reported they were waiting to start fishing until the densities of salmon increased to achieve harvest goals more efficiently
- Middle river fishermen indicated Chinook salmon run was beginning to show, however catch rates were still fairly low
- Keep subsistence salmon fishing open in the mainstem to all gear types and unrestricted gillnet mesh size

2013 Season Review

- June 26

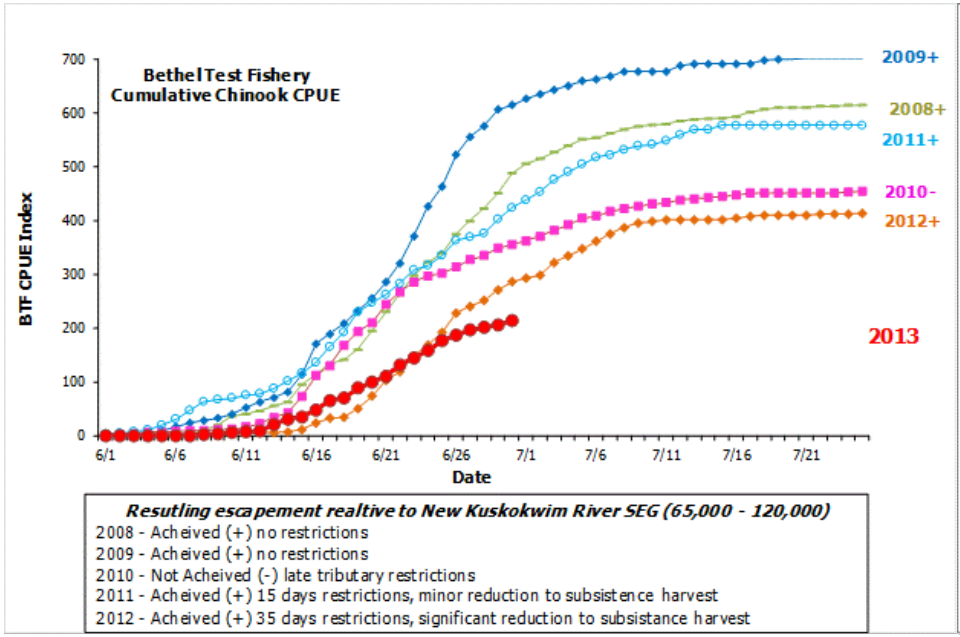


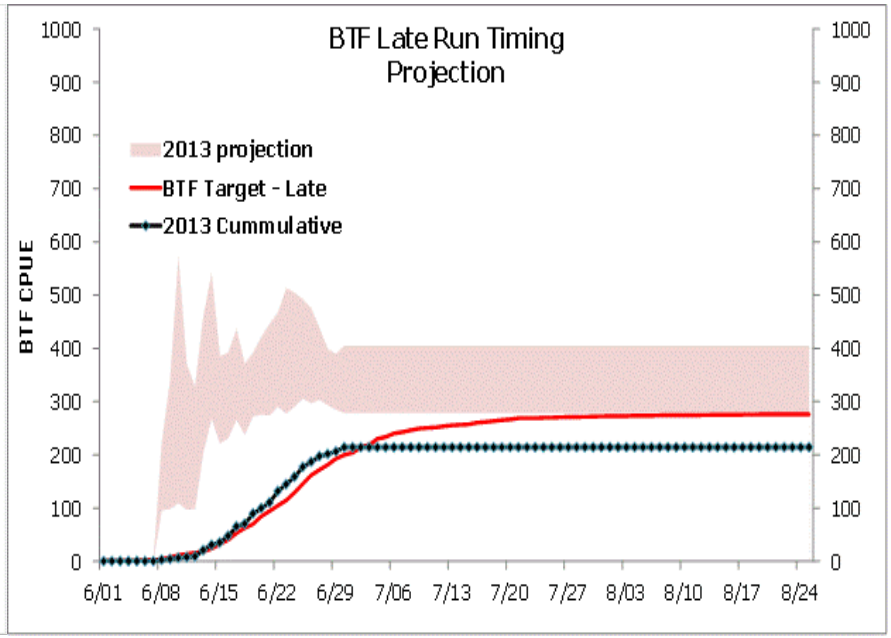


- Escapement data minimal – 2-3 days of passage at GEO & TAT, none at other weirs
- Lower river reported slowing down on targeting Chinook salmon as they had met or were close to meeting their Chinook salmon harvest goals.
- Middle river subsistence fishermen indicated that the Chinook salmon run was beginning to build in that section of river, however catch rates were still fairly low
- Mainstem restriction to <6”

2013 Season Review

- July 2



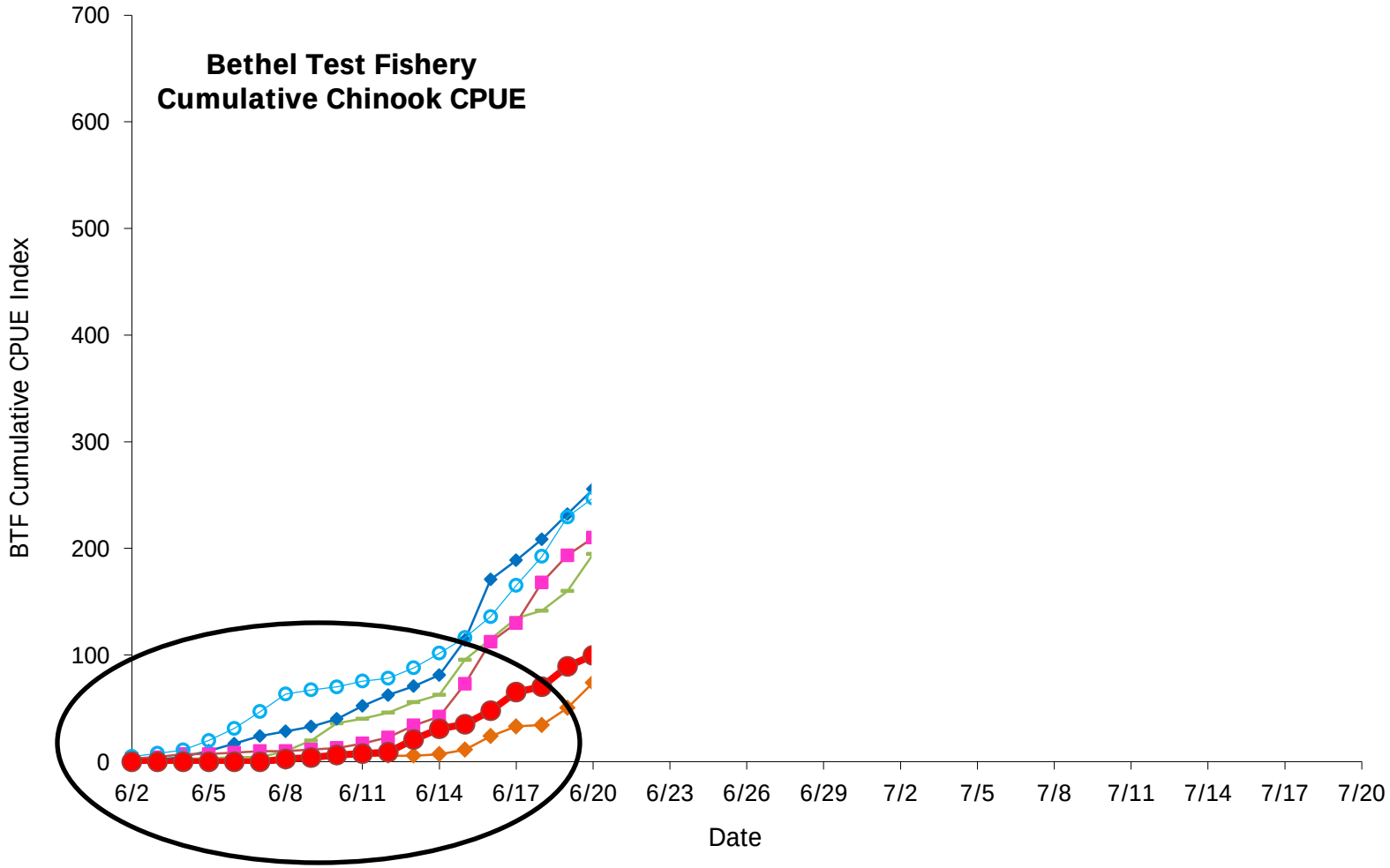


- Escapement data: TAT-highest passage since 2006; GEO-Higher than 4 of 5 recent; Others minimal data (4 days or less of passage)
- Subsistence fishermen from the lower and middle Kuskokwim River reported that people were mostly finished with subsistence fishing until coho salmon fishing begins.
- Extended <6” restriction for 6 additional days

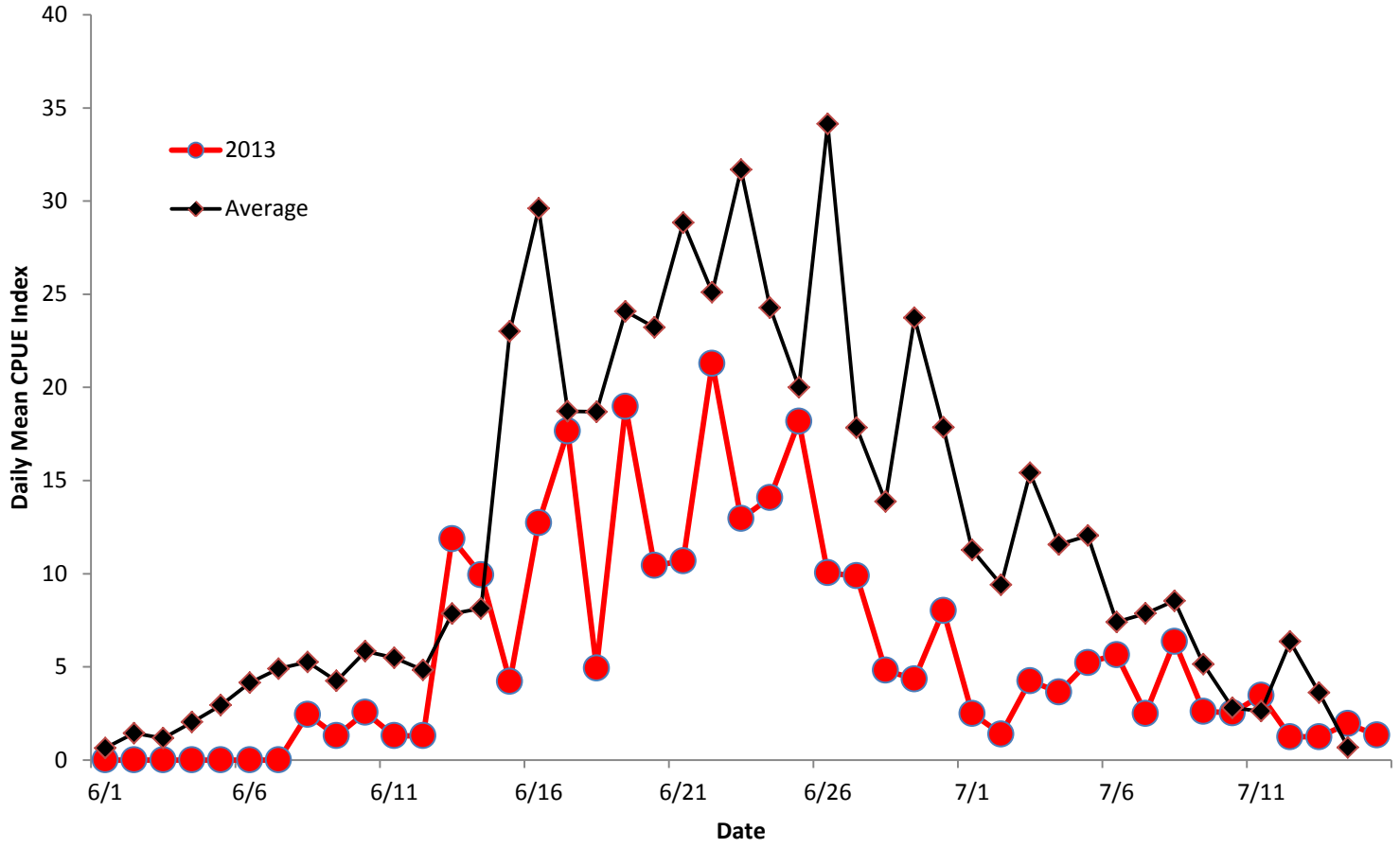
2013 Issues

- Low Abundance
- BTF Tool indicated we should be close to meeting goals
  - 2013 total was 261 (target 276), and we didn't come close to meeting tributary goals
  - Target too low?
- Inseason data not powerful enough to indicate restrictions on time
- Inseason run timing assignment for projections is difficult
  - Run timing assignment inseason is based on when the run arrives.
  - Run timing after the season can be interpreted based on the actual peak and 50% point of passage.
- Subsistence harvest status
  - How much harvest has occurred on day X?
  - How much harvest will occur after day X?
  - Below Bethel and above Bethel
  - Are inseason oral reports based on fish abundance or effort?

Inseason Run Timing Assessment



Post Season Run Timing Assessment



2008-2012 Average - 50% point on June 23

2013 - 50% point on June 22

Preparing for 2014

- BTF Tool utility
  - Run timing assessment can significantly affect outcome
  - Expectation of restrictions will alter assumptions of average subsistence harvest
  - Tool with projections will not be utilized
- BTF CPUE will be compared with years with positive escapement outcomes (2008-2009, 2012 (similar management strategy, and achieved escapement))
- Forecast methods evaluation (Hindcasting)
- 2014 Forecast description
- Management expectations

Hindcasting

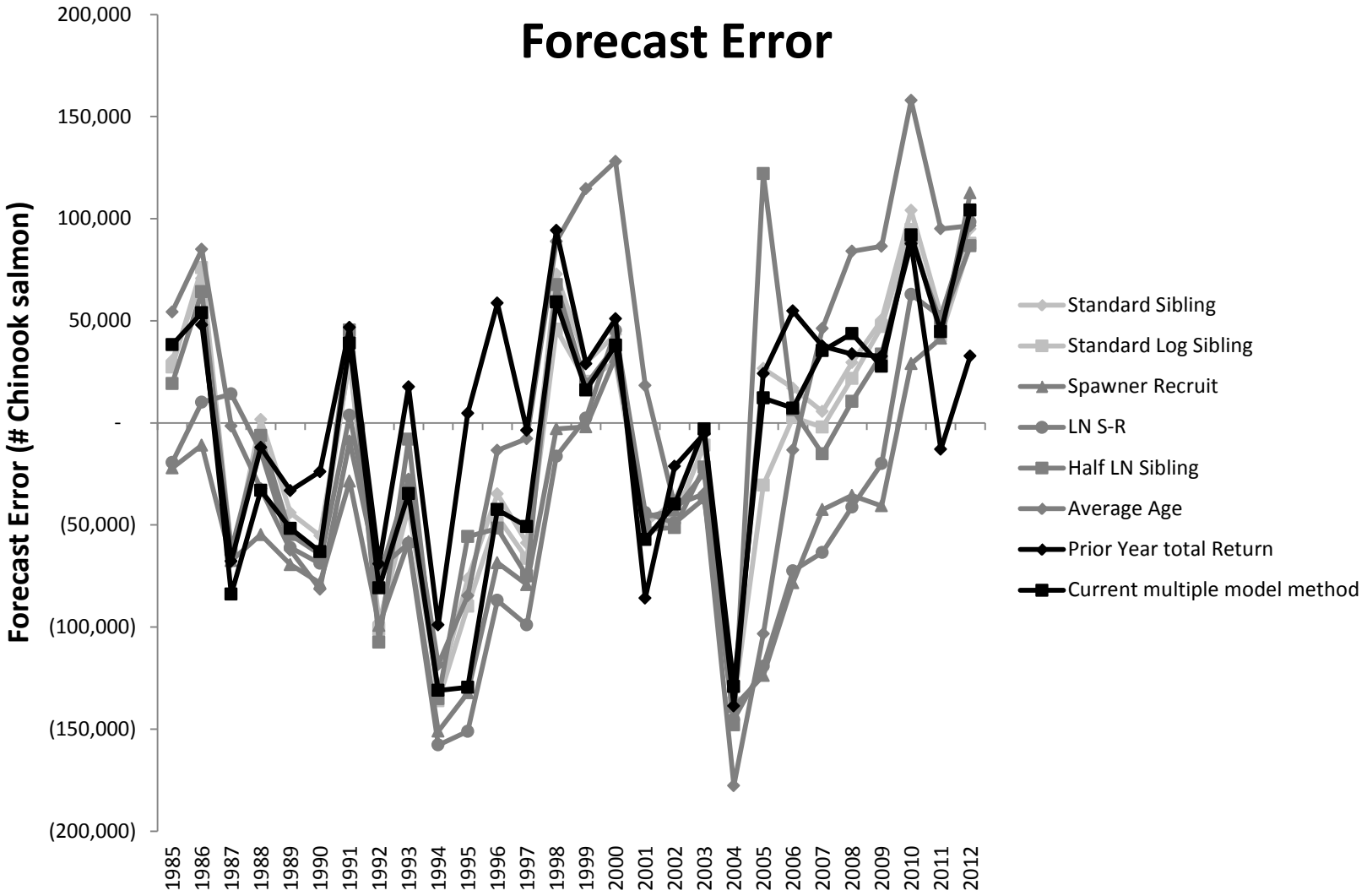
- Evaluate precision and accuracy of different forecast models over time
  - Similar to model selection for forecasts
- Consider different models from literature as well as currently used models
- Identify if there is a “best” model for Kuskokwim River Chinook salmon
- If model error is consistent, we could apply error to adjust forecast to become more precise.

Hindcasting Methods

- Evaluate 16 individual models
  - More than 100 different combinations of models
- Create forecasts for each model/combination for past 28 years
- ID annual error of model
- Adjust each model by error
  - Re-evaluate adjusted models

Models Evaluated

- Sibling
  - Average return
  - Sibling
  - Ln Sibling
  - Half Ln Sibling
  - Ln Spawner-Return Age
  - Spawner-Recruit
  - Sibling models w/ prior year return control
  - Combinations of all Sibling models
- Population
  - Spawner-Recruit
  - Prior year return
  - Spawner-Recruit w/ Escapement control
  - Spawner-Recruit w/ prior year return control
- All models adjusted by prior year and 7-yr average error


Forecast Error
Forecast Error (# Chinook salmon)
200,000
150,000
100,000
50,000
-
(50,000)
(100,000)
(150,000)
(200,000)
1985
1986
1987
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2005
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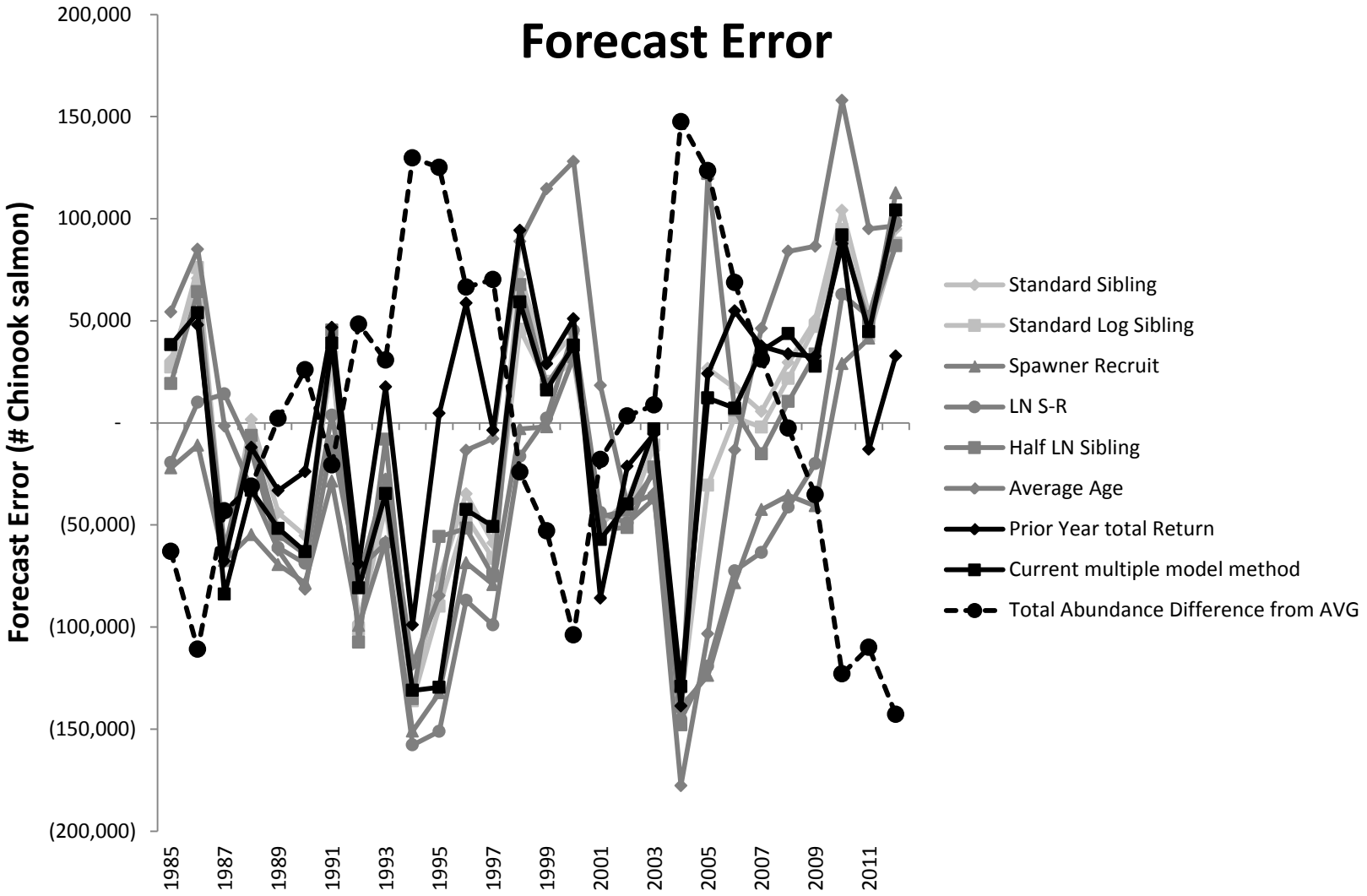
2007
2008
2009
2010
2011
2012
Standard Sibling
Standard Log Sibling
Spawner Recruit
LN S-R
Half LN Sibling
Average Age
Prior Year total Return
Current multiple model method


Forecast Error
Forecast Error (# Chinook salmon)
200,000
150,000
100,000
50,000
-
(50,000)
(100,000)
(150,000)
(200,000)
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
Standard Sibling
Standard Log Sibling
Spawner Recruit
LN S-R
Half LN Sibling
Average Age
Prior Year total Return
Current multiple model method
Total Abundance Difference from AVG

Absolute % Error of Select Forecast Methods

		Sibling Based Models							Population Level	
Return Year	Total Return	Standard Sibling	Ln Sibling	Spawner - Recruit	Ln S v Ln R	Half Ln sibling	Age AVG	Current method	Spawner-Recruit	Prior Year Method
1985	178,959	17%	15%	12%	11%	11%	30%	21%	23%	
1986	130,978	54%	58%	8%	8%	49%	65%	41%	76%	37%
1987	198,713	34%	31%	34%	7%	31%	1%	42%	29%	34%
1988	210,817	1%	6%	26%	7%	3%	15%	16%	69%	6%
1989	243,980	18%	21%	28%	25%	22%	26%	21%	32%	14%
1990	267,906	21%	24%	29%	26%	24%	30%	24%	41%	9%
1991	221,194	14%	15%	13%	2%	21%	4%	18%	10%	21%
1992	290,249	34%	35%	34%	25%	37%	26%	28%	33%	24%
1993	272,590	15%	10%	21%	22%	3%	10%	13%	37%	6%
1994	371,651	35%	37%	41%	42%	36%	32%	35%	41%	27%
1995	366,957	21%	24%	36%	41%	15%	23%	35%	42%	1%
1996	308,320	11%	15%	22%	28%	17%	4%	14%	24%	19%
1997	312,076	19%	21%	25%	32%	24%	2%	16%	21%	1%
1998	217,853	33%	21%	1%	8%	31%	41%	27%	14%	43%
1999	188,957	16%	11%	1%	1%	10%	61%	8%	25%	15%
2000	138,057	31%	22%	23%	33%	27%	93%	28%	60%	37%
2001	223,930	22%	25%	21%	20%	23%	8%	26%	26%	38%
2002	245,235	16%	19%	17%	20%	21%	17%	16%	29%	9%
2003	250,635	2%	4%	10%	15%	9%	14%	1%	19%	2%
2004	389,401	34%	35%	36%	37%	38%	46%	33%	51%	36%
2005	365,339	7%	8%	34%	33%	33%	28%	3%	30%	7%
2006	310,537	5%	1%	25%	23%	2%	4%	2%	17%	18%
2007	272,978	2%	1%	16%	23%	6%	17%	13%	14%	14%
2008	239,273	12%	9%	15%	17%	4%	35%	18%	5%	14%
2009	206,672	24%	23%	20%	10%	16%	42%	13%	14%	16%
2010	118,924	88%	80%	24%	53%	76%	133%	77%	85%	74%
2011	131,896	40%	32%	31%	39%	37%	72%	34%	7%	10%
2012	99,143	96%	89%	114%	99%	87%	97%	105%	42%	33%
7-yr Average		38%	33%	35%	38%	33%	57%	38%	26%	25%
10-yr Average		31%	28%	32%	35%	31%	49%	30%	28%	22%

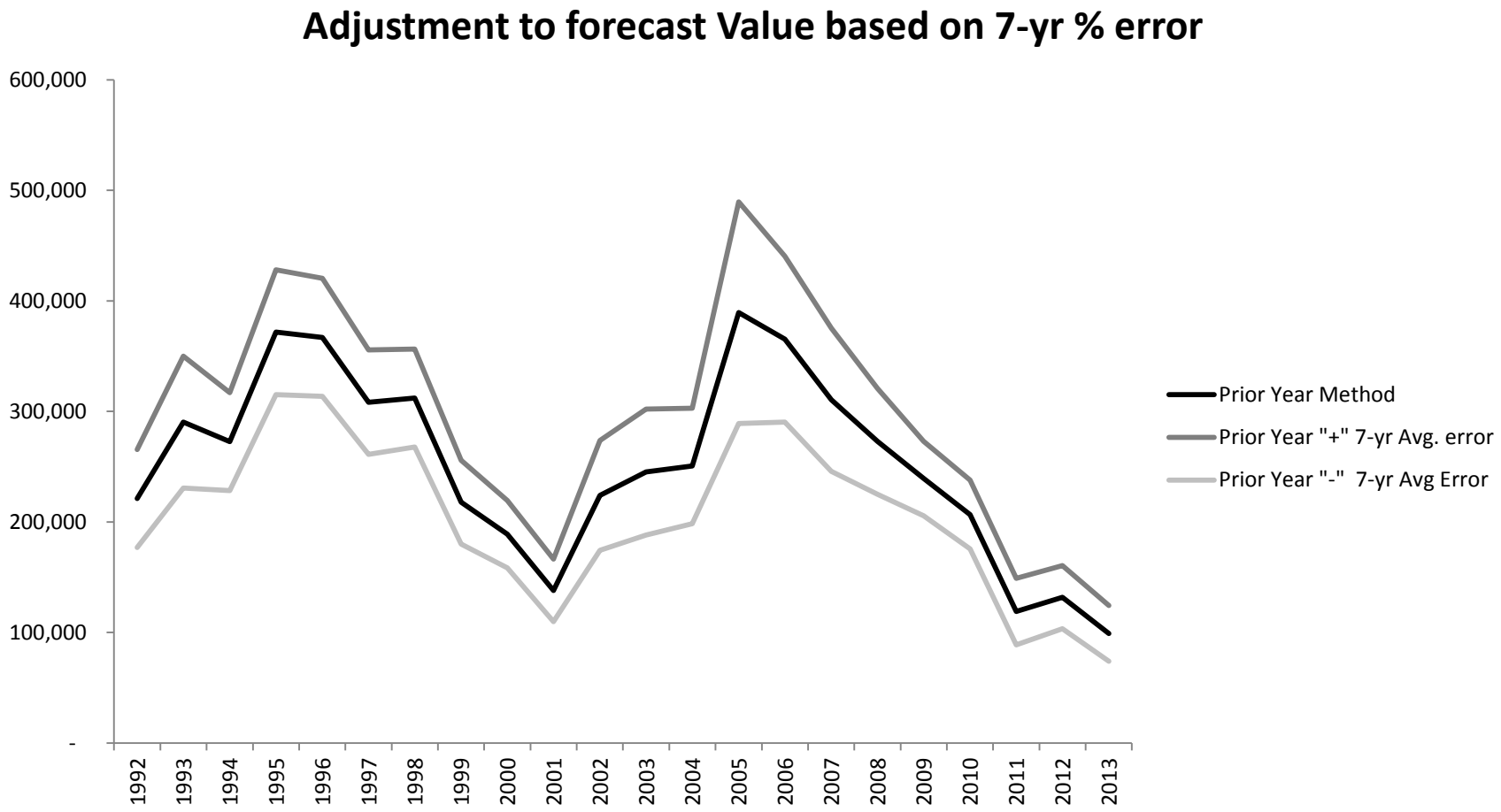
Hindcast Summary (no error adjustment)

- All models have + and – error
  - This error is directional and typically associated with Abundance level
  - Most Forecast models estimate towards average
- In some years models work well (1-10% error)
- On average most models are ~30-40% off

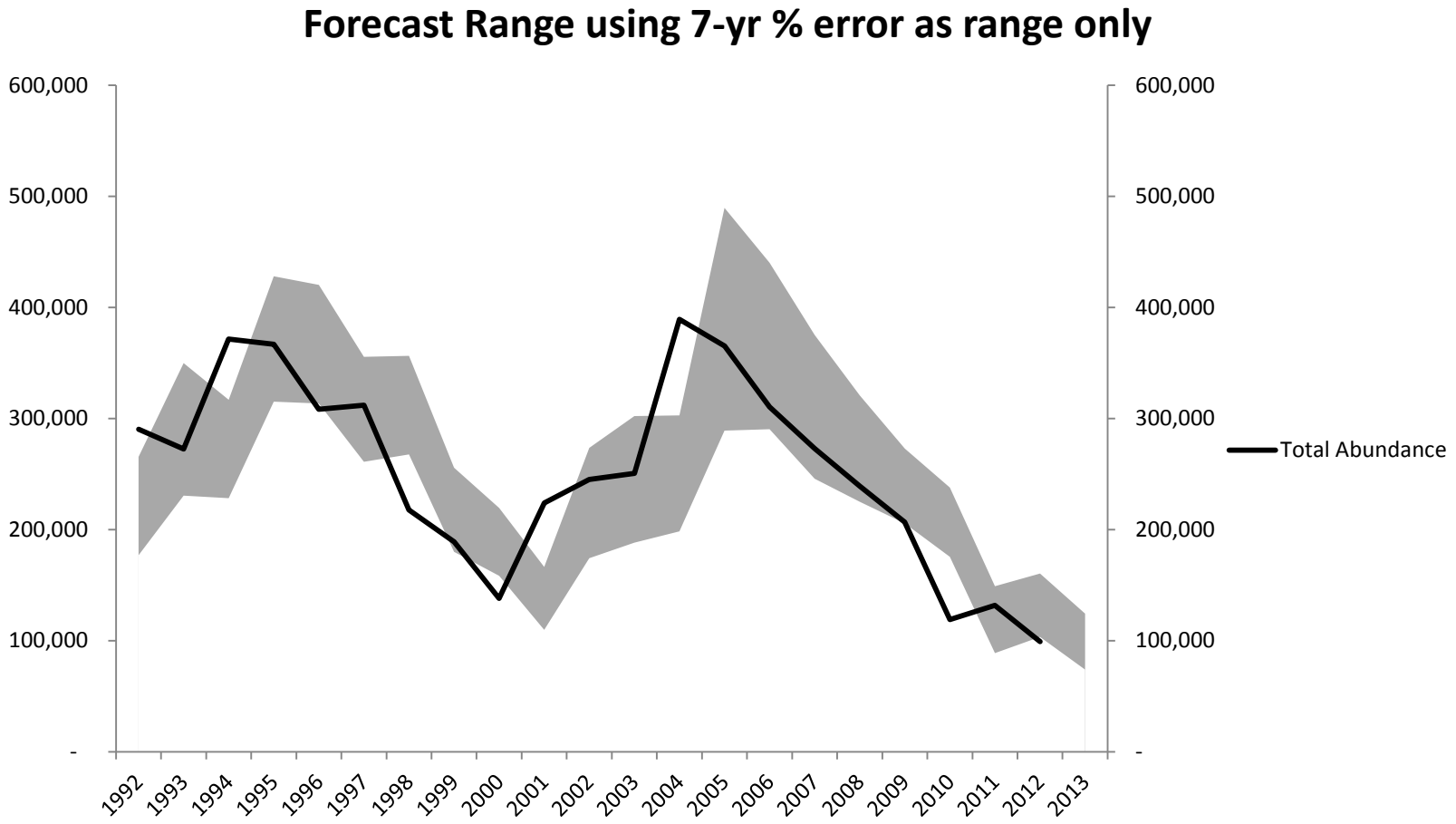
Forecast Adjustments

- Looking at the recent performance of a particular method identifies model error
- All models under and over forecast
  - Mostly in the same scenarios
    - i.e. Below avg. abundance = Over forecast
- Adjusting by recent error
- Incorporate recent error as range around forecast

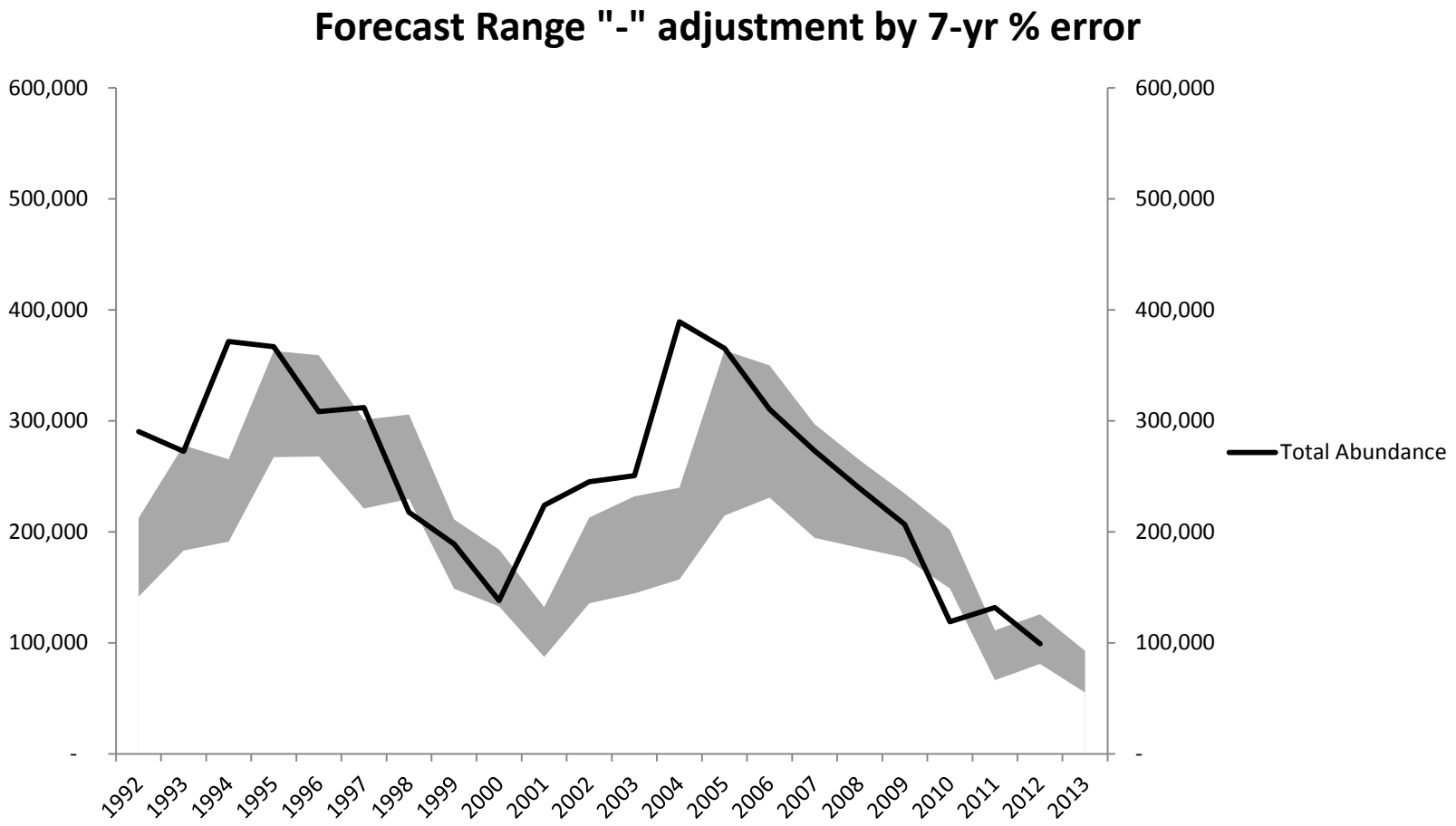
Requires we anticipate increases or decreases to abundance to add or subtract error. i.e. “Forecast” error direction to adjust forecast???????



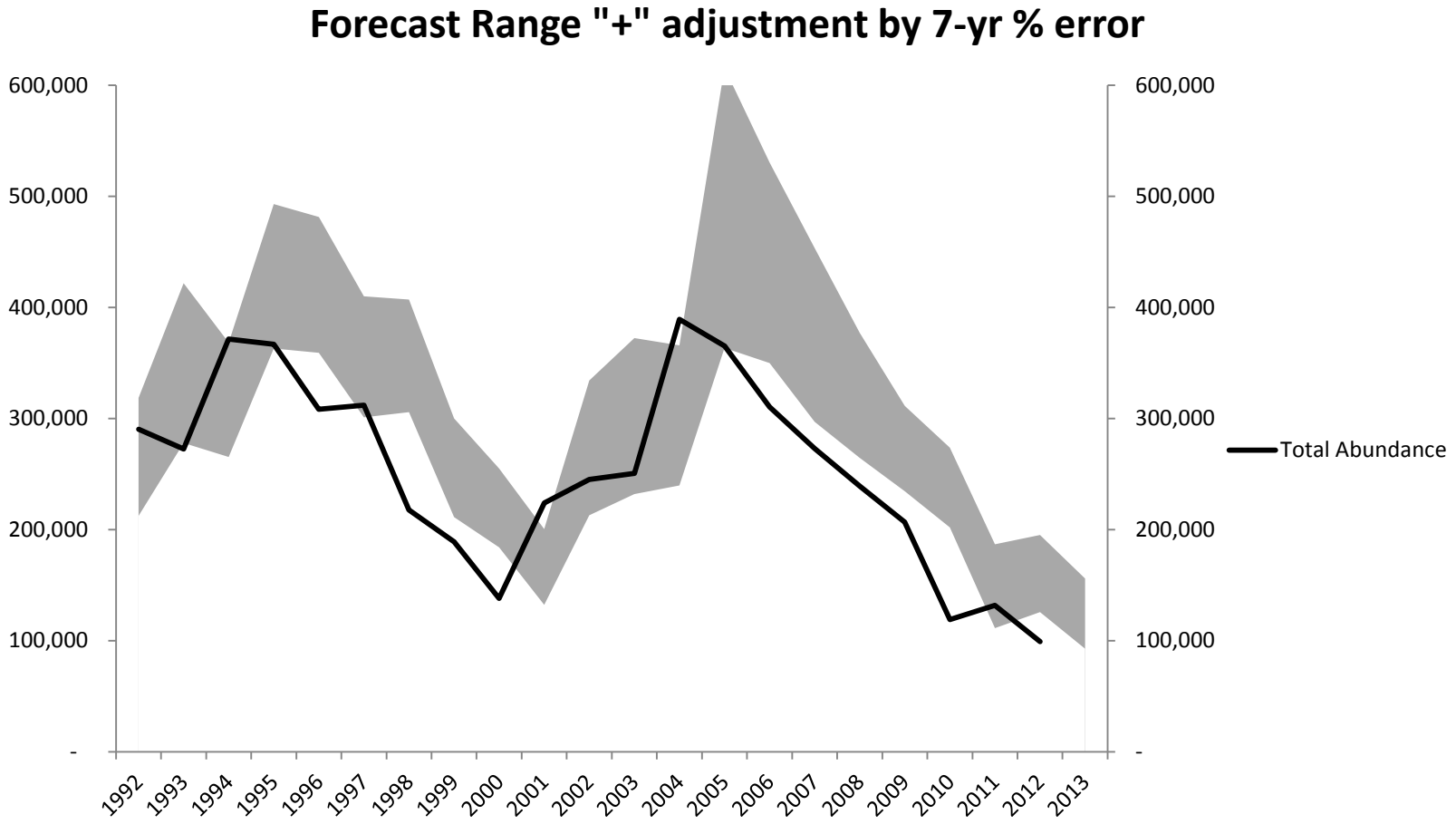
57% of Total Returns would have fallen within Forecast Range. 9 years not within range: 6 over, 3 under



43% of Total Returns would have fallen within Forecast Range. 12 years not within range: 2 over, 10 under



33% of Total Returns would have fallen within Forecast Range. 14 years not within range: 12 over, 2 under



2014 Forecast Methods

- Use Prior Year Total Return
  - Doesn't estimate towards average
  - All forecasts will be within actual observed return range
  - More conservative in low abundance years
  - Method self corrects quickly
    - One instance of consecutive forecasts being off
      - Conservative – Forecast was lower than return

Prior Year Return

- On average the total run increases/decreases by <25% annually
  - This is less than the error in most forecast models
- Similar to how historic “Outlooks” and were developed
  - “Similar” to last year
  - We now have a value, so it would be a forecast
- Management for upcoming year could be better informed based on the outcome from the prior year
  - Did we meet management goals (escapement)?
  - What could we have done better?
  - Earlier indication of management strategy
    - Last year is a good starting point

Kuskokwim River 2014 Preliminary Management Strategy

Travis Elison

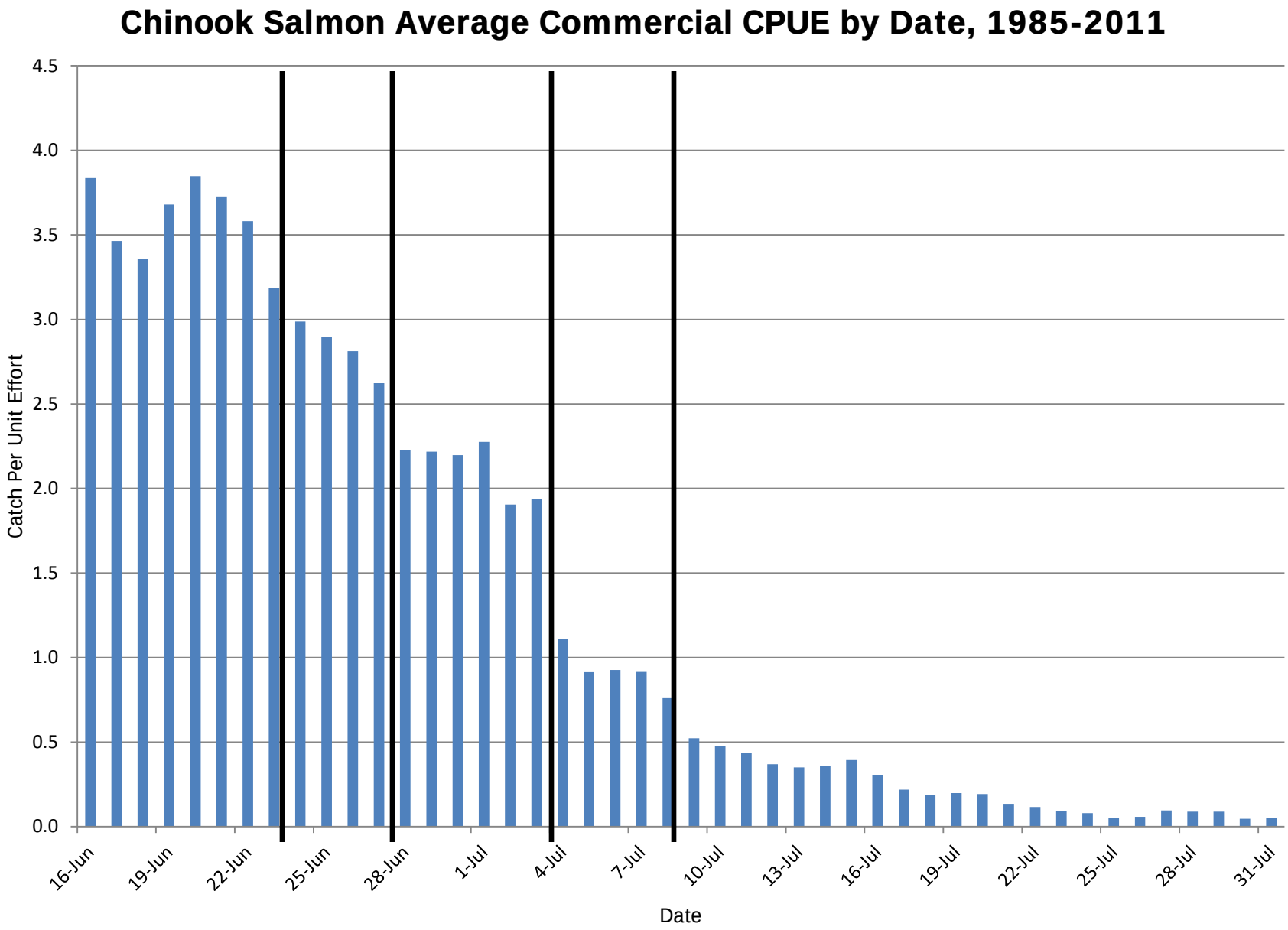
ADF&G/CF

Outline

- How many subsistence fishing households?
- Harvest power based on commercial data.
- Harvest timing based on subsistence calendars.
- Preliminary management strategy.

Table 30 - Estimated number of households that subsistence fished in communities surveyed, Kuskokwim Area, 2011. Page 1 of 2

	Unknown				oes Not Usually Harve				Light Harvesters				Medium Harvesters								Combined use groups			
Community	N	n	Mean	SE	N	n	Mean	SE	N	n	Mean	SE	N	n	Mean	SE	N	n	Mean	SE	Total N	total n	Est. Total	CI (95%)
Kongiganak	7	7	0	0	22	6	1	0	46	20	1	0	9	9	1	0	3	2	1	0	90	47	69	8
N. Kuskokwim Bay	7	7	0	0	22	6	.	.	46	20	1	0	9	9	1	0	3	2	1	0	90	47	69	8
Tuntutuliak	7	6	1	0	9	3	1	0	37	18	1	0	17	17	1	0	13	13	1	0	85	59	73	5
Eek	9	7	0	0	18	6	0	0	42	21	1	0	9	8	1	0	2	2	1	0	87	50	58	7
Kasigluk	23	20	1	0	23	6	1	0	33	17	1	0	12	12	1	0	5	5	1	0	108	71	86	6
Nunapitchuk	8	8	0	0	25	6	1	0	50	24	1	0	17	15	1	0	14	14	1	0	118	71	92	8
Atmautluak	4	2	0	0	15	5	0	0	24	13	1	0	12	12	1	0	2	2	1	0	60	36	36	4
Napakiak	5	5	0	0	28	9	1	0	42	21	1	0	13	13	1	0	5	5	1	0	93	53	74	9
Napaskiak	11	7	1	0	14	5	0	0	30	15	1	0	35	33	1	0	6	4	1	0	99	64	66	6
Oscarville	.	.	.	.	2	2	0	0	3	3	0	0	9	9	1	0	1	0	.	.	16	15	11	0
Bethel	.	.	.	.	.	.	.	.	2,087	881	1	0	.	.	.	.	.	.	.	.	2,087	881	1,175	52
Kwethluk	16	15	1	0	31	10	0	0	72	34	1	0	29	28	1	0	13	13	1	0	165	101	108	12
Akiachak	16	13	1	0	22	7	0	0	57	31	1	0	37	34	1	0	16	16	1	0	152	104	108	9
Akiak	4	3	1	0	10	3	0	0	35	14	1	0	15	14	1	0	13	4	1	0	80	39	58	9
Tuluksak	8	5	0	0	17	6	0	0	31	18	1	0	17	16	1	0	9	8	1	0	86	56	56	8
Lower Kuskokwim	111	91	1	0	214	68	0	0	2,543	1,110	1	0	222	211	1	0	99	86	1	0	3,236	1,600	2,000	58
Lower Kalskag	17	12	0	0	17	4	0	0	27	14	1	0	14	14	1	0	3	3	1	0	79	48	54	7
Upper Kalskag	8	7	0	0	13	3	0	0	34	19	1	0	5	5	1	0	5	5	1	0	67	41	51	6
Aniak	.	.	.	.	.	.	.	.	182	169	1	0	.	.	.	.	.	.	.	.	182	169	107	4
Chuathbaluk	2	2	1	0	8	8	0	0	14	13	1	0	5	5	1	0	2	2	1	0	31	30	16	1
Middle Kuskokwim	27	21	0	0	38	15	0	0	257	215	1	0	24	24	1	0	10	10	1	0	359	288	227	10
Crooked Creek	5	4	1	0	12	4	0	0	15	11	1	0	6	4	1	0	.	.	.	.	38	23	24	6
Red Devil	2	2	1	0	3	3	0	0	5	5	1	0	2	2	1	0	1	1	1	.	13	13	9	0
Sleetmute	4	3	0	0	11	10	0	0	17	13	1	0	3	2	1	0	2	1	1	.	37	29	22	3
Stony River	.	.	.	.	6	5	0	0	5	5	1	0	2	2	1	0	3	3	1	0	16	15	9	0
Lime Village	7	1	1	.	1	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15	2	.	.
McGrath	18	15	0	0	75	21	0	0	37	12	1	0	1	0	.	.	1	0	.	.	136	48	36	13
Takotna	11	6	1	0	9	8	0	0	.	.	.	.	.	.	.	.	.	.	.	.	23	17	8	4
Nikolai	2	2	1	0	9	9	0	0	21	20	1	0	.	.	.	.	1	1	1	.	33	32	18	1
Telida	.	.	.	.	2	0	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	0	.	.
Upper Kuskokwim	49	33	0	0	128	60	0	0	100	66	1	0	14	10	1	0	8	6	1	0	313	179	125	15
Kuskokwim River*	194	152	1	0	402	149	0	0	2,946	1,411	1	0	269	254	1	0	120	104	1	0	3,998	2,114	2,421	61


Chinook Salmon Average Commercial CPUE by Date, 1985-2011
Catch Per Unit Effort
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
16-Jun
19-Jun
22-Jun
25-Jun
28-Jun
1-Jul
4-Jul
7-Jul
10-Jul
13-Jul
16-Jul
19-Jul
22-Jul
25-Jul
28-Jul
31-Jul
Date

Kuskokwim River Commercial Catch Statistics 1985-2011, Restricted to 6-inch or Less Mesh Size

June 16 - 23 Historical Commercial Catches

				Chinook		Sockeye		Chum	
Date	Subdistrict	Permits	Hours	Catch	CPUE	Catch	CPUE	Catch	CPUE
6/16/1988	1-B	602	6	12,640	3.50	7,408	2.05	72,219	19.99
6/17/1996	1-B	245	2	2,045	4.17	1,850	3.78	11,560	23.59
6/18/1987	1-B	527	9	19,126	4.03	9,118	1.92	13,478	2.84
6/18/1992	1-B	567	8	9,756	2.15	8,508	1.88	32,695	7.21
6/19/1989	1-B	374	8	9,204	3.08	5,504	1.84	41,789	13.97
6/20/1985	W1 & W2	431	6	6,611	2.56	5,361	7.89	20,409	7.89
6/20/1988	1-B	612	6	11,708	3.19	14,502	3.95	113,628	30.94
6/20/1990	1-B	630	6	16,690	4.42	10,318	2.73	30,306	8.02
6/20/1991	1-B	601	6	13,813	3.83	19,732	5.47	13,266	3.68
6/20/1996	W1 & W2	283	2	2,046	3.61	6,423	11.35	27,442	48.48
6/20/2008	1-B	171	6	6,415	6.25	8,653	8.43	12,910	12.58
6/22/1992	W1	619	8	14,554	2.94	6,423	1.30	74,296	15.00
6/22/1995	1-B	569	4	6,895	3.03	4,420	1.94	49,157	21.60
6/23/1989	1-B	277	8	6,011	2.71	7,002	3.16	65,650	29.63
6/23/2009	1-B	167	4	3,003	4.50	8,112	12.14	9,149	13.70
Avg		445	6	9,368	3.6	8,222	4.7	39,197	17.3
Min		167	2	2,045	2.2	1,850	1.3	9,149	2.8
Max		630	9	19,126	6.3	19,732	12.1	113,628	48.5

Kuskokwim River Commercial Catch Statistics 1985-2011, Restricted to 6-inch or Less Mesh Size

June 24 - 27 Historical Commercial Catches

				Chinook		Sockeye		Chum	
Date	Subdistrict	Permits	Hours	Catch	CPUE	Catch	CPUE	Catch	CPUE
6/24/1985	W1 & W2	499	6	10,676	3.57	25,876	8.64	45,189	15.09
6/24/1987	W1	607	9	12,867	2.36	24,355	4.46	54,454	9.97
6/24/1988	W1 & W2	657	6	10,379	2.63	20,930	5.31	124,040	31.47
6/24/1991	W1	616	6	12,612	3.41	19,262	5.21	30,632	8.29
6/24/1994	1-B	576	8	14,221	3.09	38,958	8.45	87,214	18.93
6/24/1998	1-B	338	6	6,413	3.16	9,043	4.46	32,467	16.01
6/24/2005	1-B	188	4	2,276	3.03	7,938	10.56	13,553	18.02
6/24/2008	1-B	126	3	1,372	3.63	2,906	7.69	6,576	17.40
6/25/1990	W1	611	6	16,031	4.37	27,024	7.37	58,944	16.08
6/25/1992	W1 & W2	643	8	10,005	1.94	22,852	4.44	59,030	11.48
6/25/1993	1-B	622	8	8,184	1.64	26,363	5.30	34,123	6.86
6/25/2010	1-A	115	4	543	1.18	734	1.60	9,808	21.32
6/26/1986	W1 & W2	517	6	7,972	2.57	41,084	13.24	69,386	22.37
6/26/1989	W1	126	8	1,862	1.85	3,746	3.72	32,373	32.12
6/26/1995	W1 & W2	583	4	11,108	4.76	18,402	7.89	91,719	39.33
6/26/2006	1-A	74	6	1,647	3.71	5,218	11.75	19,694	44.36
6/26/2009	1-B	189	4	2,552	3.38	6,870	9.09	14,466	19.13
6/27/1985	W1 & W2	504	6	9,339	3.09	26,894	8.89	49,706	16.44
6/27/2008	1-B	135	3	990	2.44	3,842	9.49	7,867	19.42
Avg		407	6	7,424	2.9	17,489	7.2	44,276	20.2
Min		74	3	543	1.2	734	1.6	6,576	6.9
Max		657	9	16,031	4.8	41,084	13.2	124,040	44.4

Kuskokwim River Commercial Catch Statistics 1985-2011, Restricted to 6-inch or Less Mesh Size

June 28 - July 4 Historical Commercial Catches

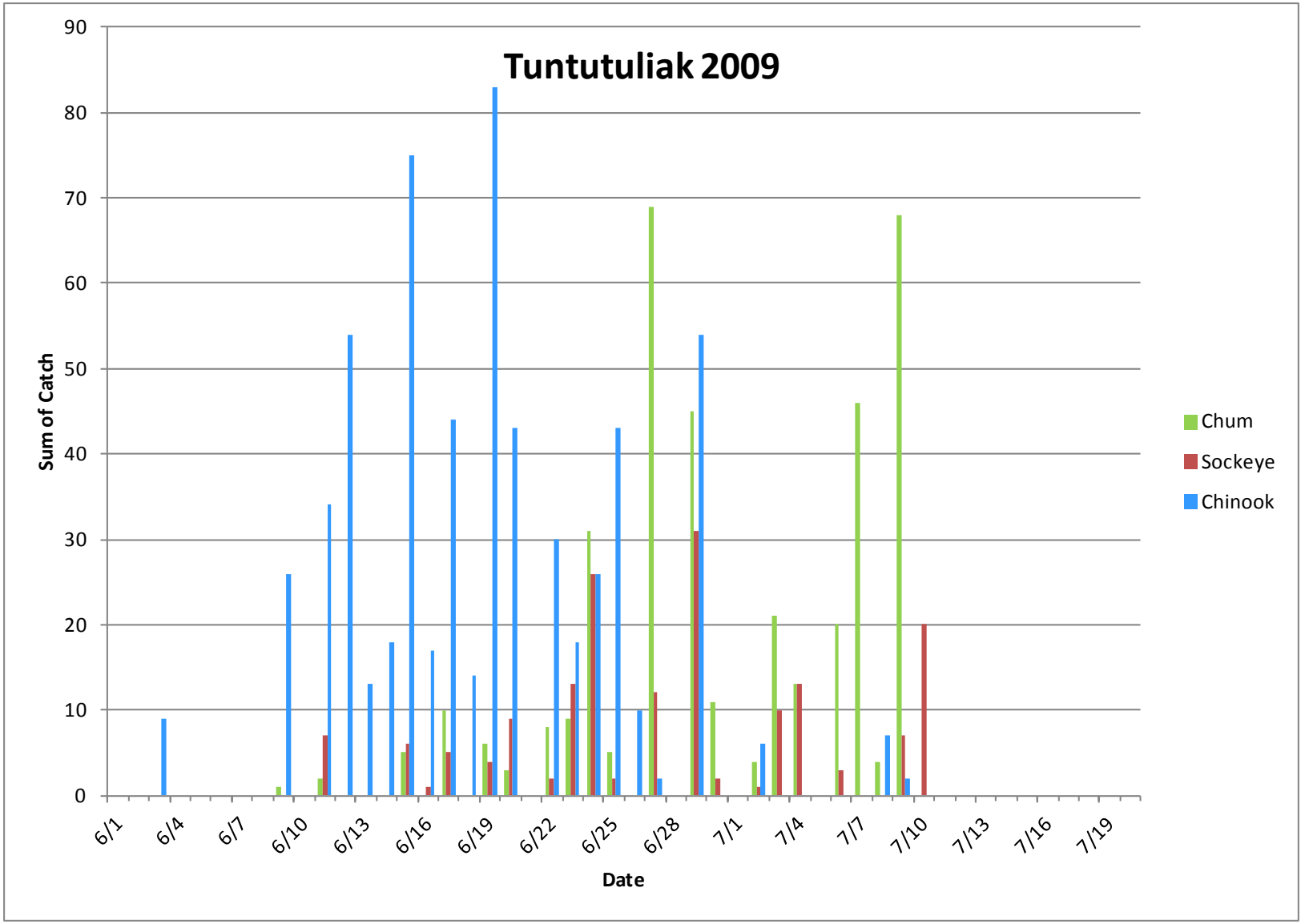
				Chinook		Sockeye		Chum	
Date	Subdistrict	Permits	Hours	Catch	CPUE	Catch	CPUE	Catch	CPUE
6/28/1998	W1 & W2	626	6	6,096	1.62	18,267	4.86	160,114	42.63
6/28/2005	1-A	51	3	405	2.65	2,879	18.82	3,178	20.77
6/28/2006	1-B	99	6	846	1.42	6,456	10.87	16,312	27.46
6/28/2010	1-B	216	4	1,181	1.37	3,536	4.09	22,038	25.51
6/29/1990	W1 & W2	659	6	10,069	2.55	19,509	4.93	78,749	19.92
6/29/1992	W1 & W2	617	6	8,138	2.20	26,607	7.19	82,652	22.33
6/29/1995	W1 & W2	579	4	5,679	2.45	20,390	8.80	92,218	39.82
6/29/1998	W1	426	6	6,358	2.49	22,506	8.81	66,789	26.13
6/30/1986	W1 & W2	589	6	4,586	1.30	23,804	6.74	62,399	17.66
6/30/1987	W1	564	9	6,193	1.22	39,112	7.71	112,963	22.25
6/30/1989	W1 & W2	657	8	9,842	1.87	10,801	2.05	138,982	26.44
6/30/1999	1-B	409	6	4,668	1.90	16,772	6.83	22,700	9.25
6/30/2004	1-A	52	2	522	5.02	1,781	17.13	2,798	26.90
6/30/2005	1-A	71	4	850	2.99	6,290	22.15	7,317	25.76
7/1/1985	W1 & W2	528	6	6,947	2.19	32,182	10.16	50,325	15.89
7/1/1991	W1 & W2	646	6	6,449	1.66	25,628	6.61	53,164	13.72
7/1/2005	1-B	151	4	874	1.45	6,962	11.53	27,901	46.19
7/1/2009	1-B	173	3	762	1.47	7,798	15.03	18,833	36.29
7/2/1988	W1 & W2	599	6	3,999	1.11	15,681	4.36	196,071	54.56
7/2/1996	W1	224	2	545	1.22	3,962	8.84	20,915	46.69
7/2/2004	1-A	44	3	488	3.70	1,900	14.39	2,426	18.38
7/3/1986	W1 & W2	564	6	3,392	1.00	16,031	4.74	67,088	19.83
7/3/1987	W1 & W2	595	6	7,295	2.04	44,541	12.48	69,983	19.60
7/3/1989	W1 & W2	647	6	4,971	1.28	6,046	1.56	96,446	24.84
7/3/1995	W1 & W2	484	4	3,131	1.62	17,535	9.06	91,627	47.33
7/3/1998	W1	445	4	2,277	1.28	15,985	8.98	51,471	28.92
7/4/1985	W1	461	6	3,777	1.37	16,126	5.83	28,630	10.35
Avg		414	5	4,087	1.9	15,892	9.1	60,892	27.2
Min		44	2	405	1.0	1,781	1.6	2,426	9.3
Max		659	9	10,069	5.0	44,541	22.1	196,071	54.6

Kuskokwim River Commercial Catch Statistics 1985-2011, Restricted to 6-inch or Less Mesh Size

July 2 - 8 Historical Commercial Catches

				Chinook		Sockeye		Chum	
Date	Subdistrict	Permits	Hours	Catch	CPUE	Catch	CPUE	Catch	CPUE
7/5/1988	W1	579	6	2,340	0.67	7,284	2.10	163,971	47.20
7/5/1989	W1 & W2	567	6	3,575	1.05	3,093	0.91	89,269	26.24
7/5/1990	W1 & W2	606	6	4,538	1.25	11,320	3.11	91,232	25.09
7/5/1996	W1 & W2	194	2	316	0.81	3,481	8.97	16,853	43.44
7/5/2000	1-B	224	4	357	0.40	3,658	4.08	11,026	12.31
7/5/2011	1-B	112	4	237	0.53	2,520	5.63	13,884	30.99
7/6/1991	W1 & W2	605	6	2,443	0.67	24,832	6.84	42,441	11.69
7/6/1992	W1 & W2	596	8	3,560	0.75	8,448	1.77	87,036	18.25
7/6/1995	W1 & W2	489	4	1,595	0.82	15,096	7.72	83,618	42.75
7/6/2004	1-A	38	3	238	2.09	1,853	16.25	1,946	17.07
7/6/2010	1-A	87	6	290	0.56	3,554	6.81	17,467	33.46
7/7/1986	W1 & W2	588	6	1,922	0.54	8,373	2.37	56,370	15.98
7/7/1987	W1 & W2	599	6	4,571	1.27	10,655	2.96	107,211	29.83
7/7/2004	1-B	50	4	384	1.92	1,780	8.90	5,086	25.43
7/7/2011	1-A	62	3	106	0.57	2,348	12.62	8,132	43.72
7/8/1988	W1	605	6	1,895	0.52	3,628	1.00	138,858	38.25
7/8/1989	W1	621	6	3,136	0.84	3,177	0.85	119,066	31.96
7/8/1996	W1 & W2	211	2	178	0.42	6,795	16.10	18,801	44.55
Avg		380	5	1,760	0.9	6,772	6.1	59,570	29.9
Min		38	2	106	0.4	1,780	0.9	1,946	11.7
Max		621	8	4,571	2.1	24,832	16.3	163,971	47.2

Subsistence Calendars



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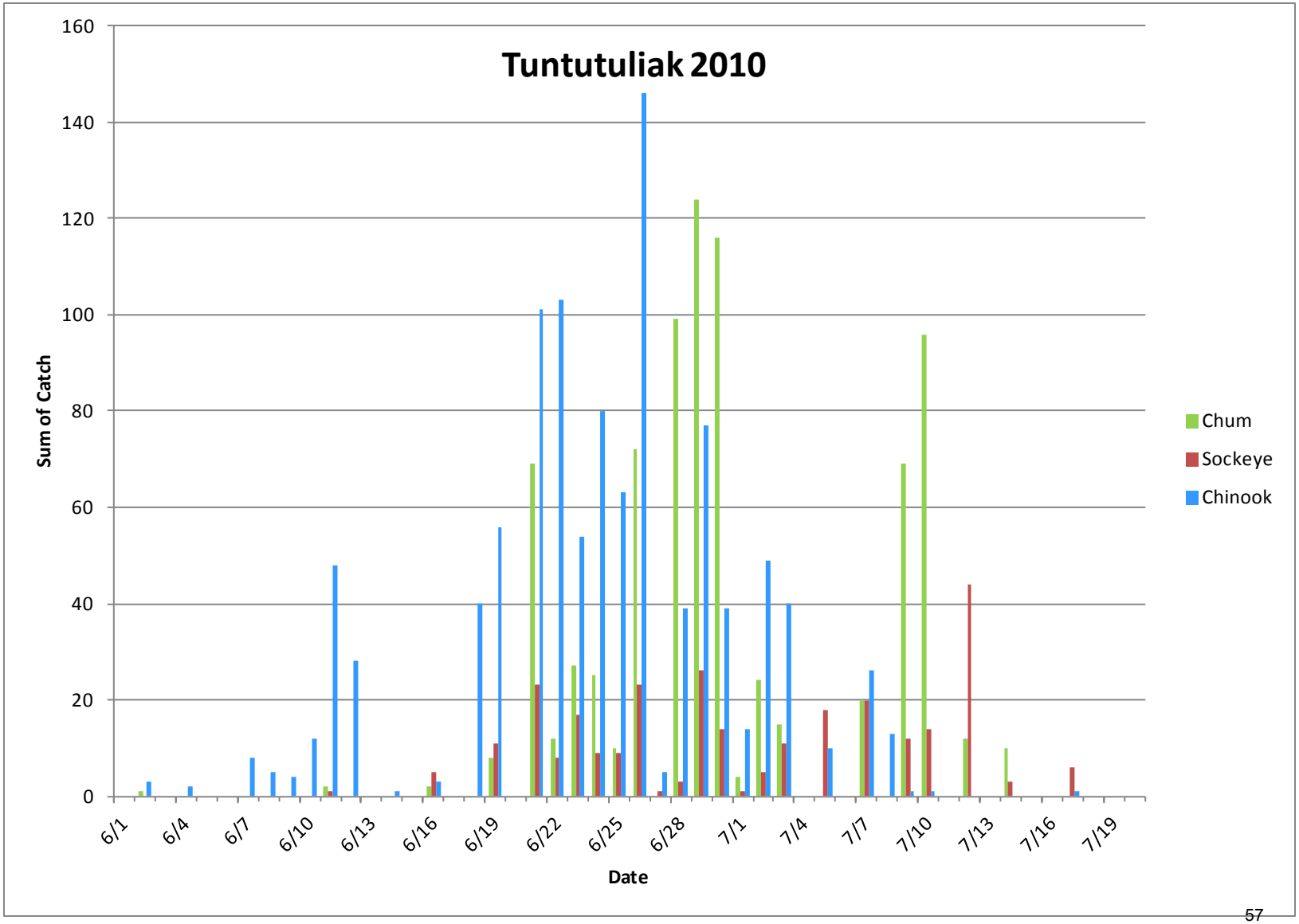

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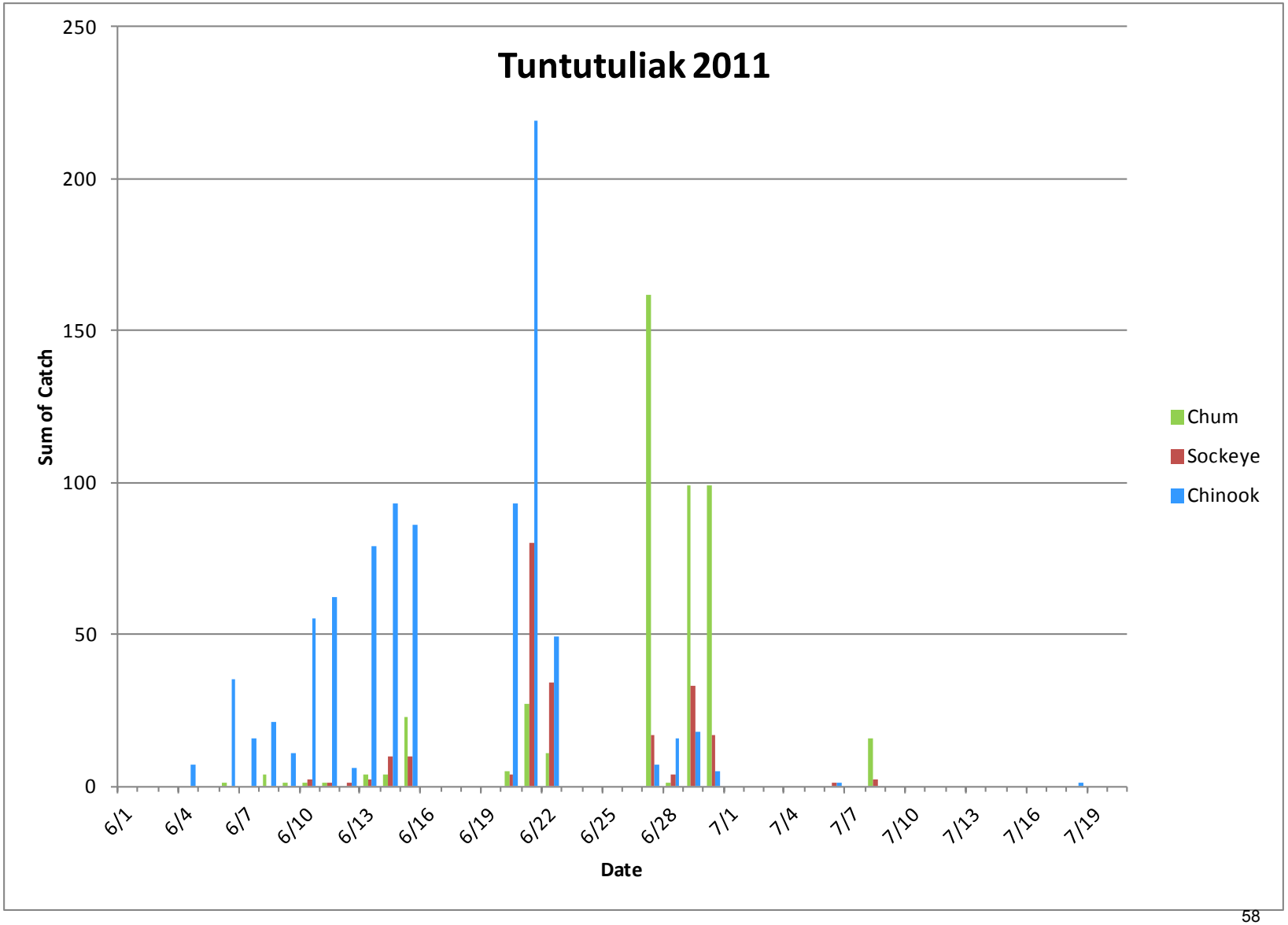

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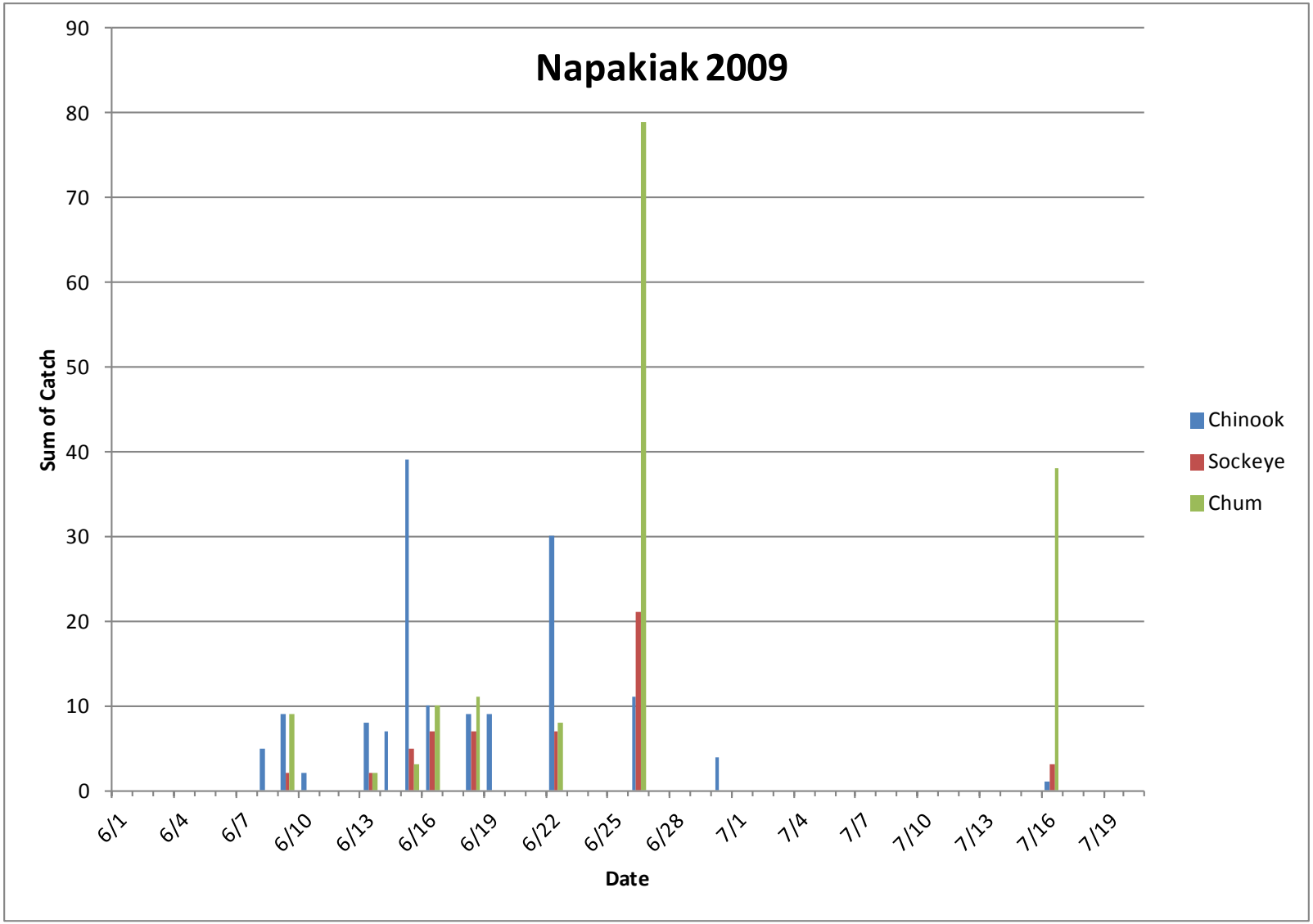

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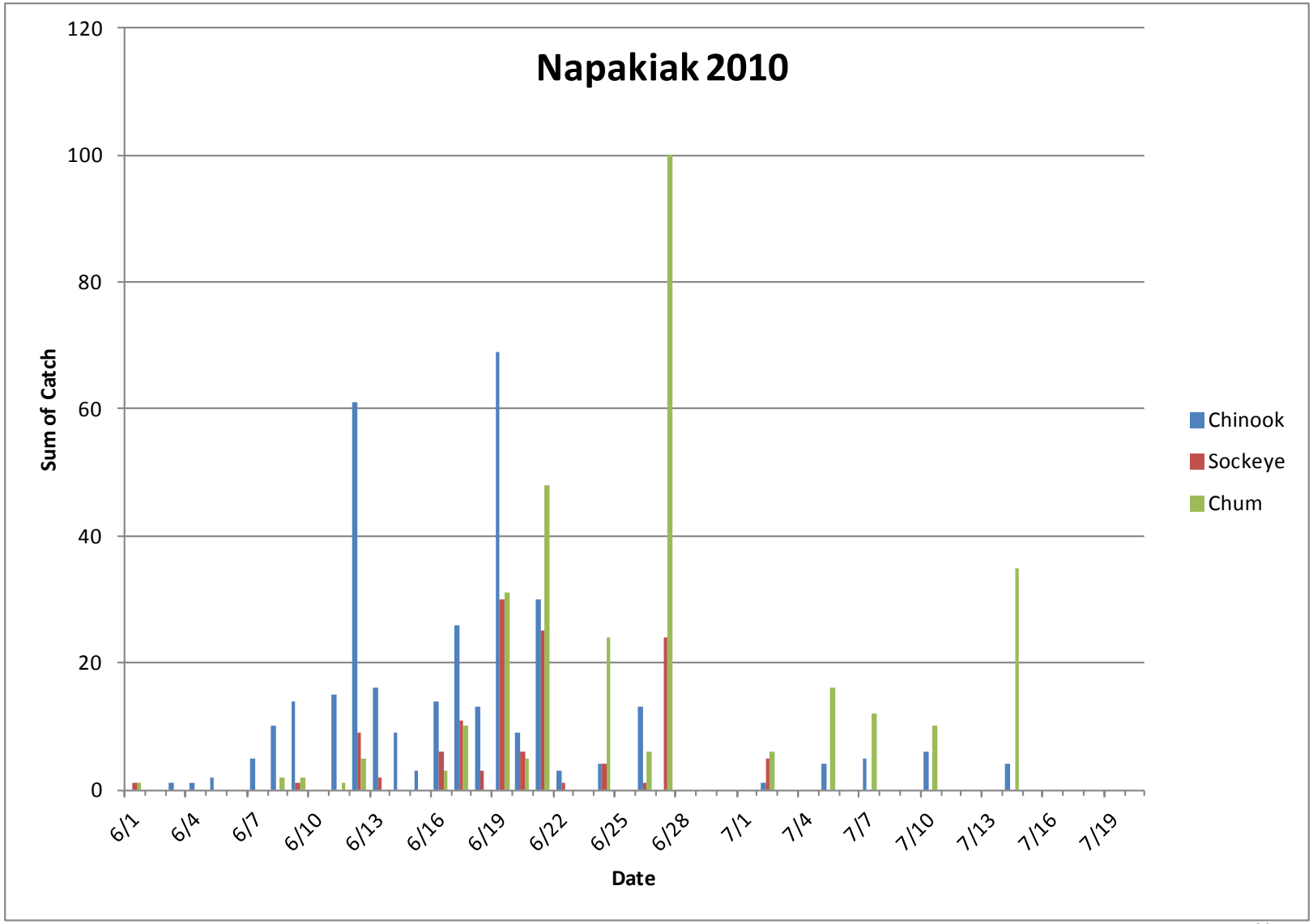

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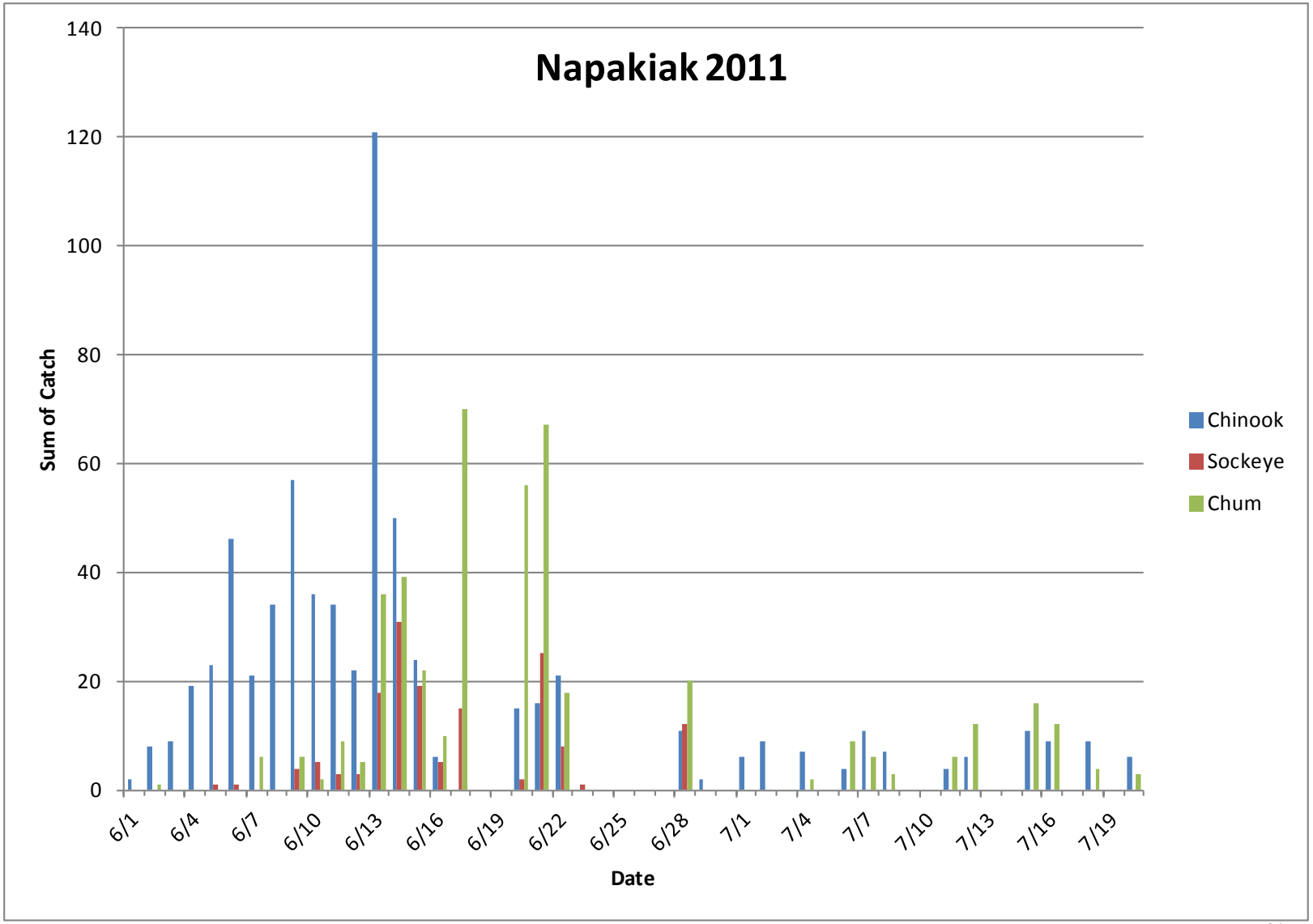

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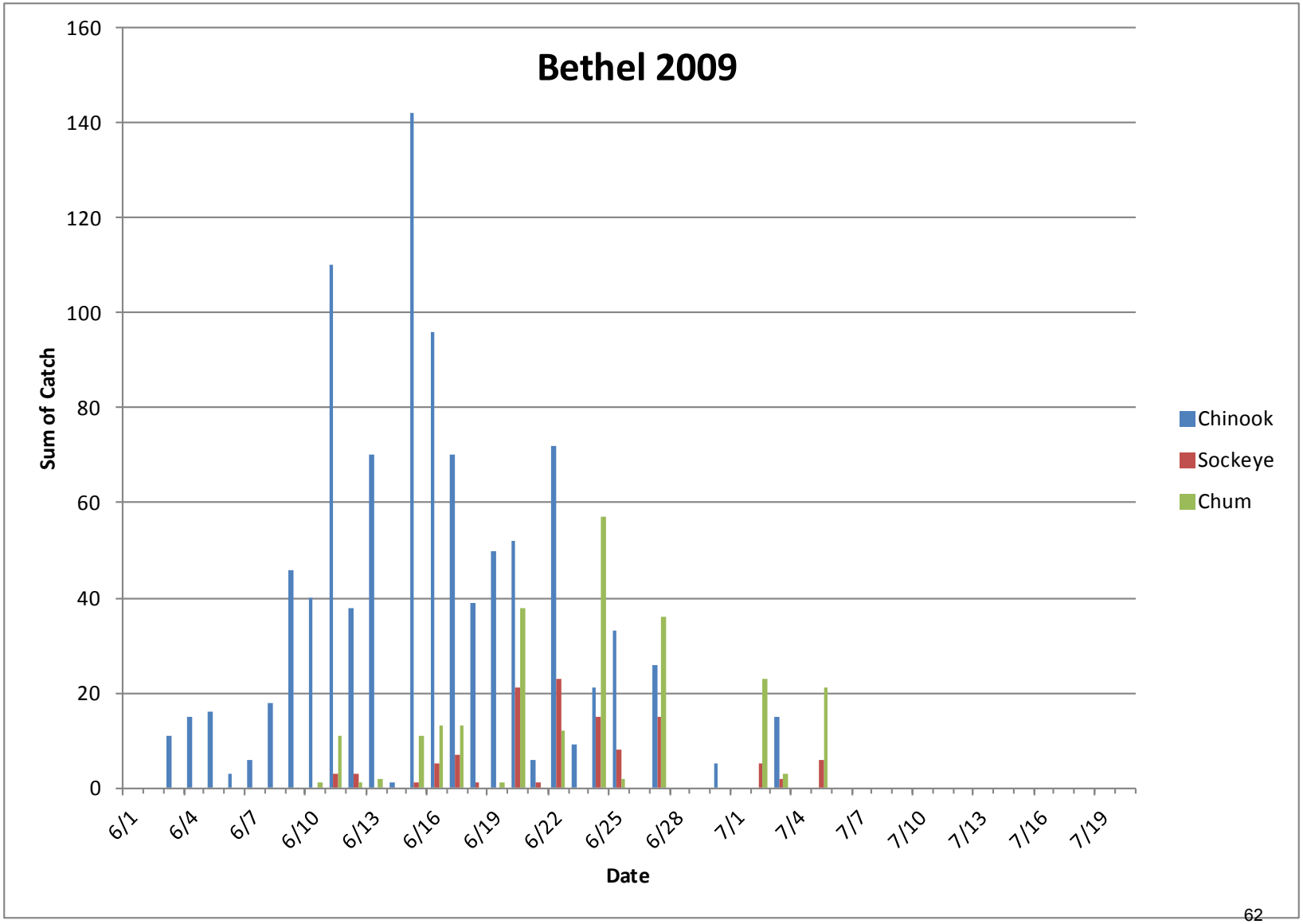

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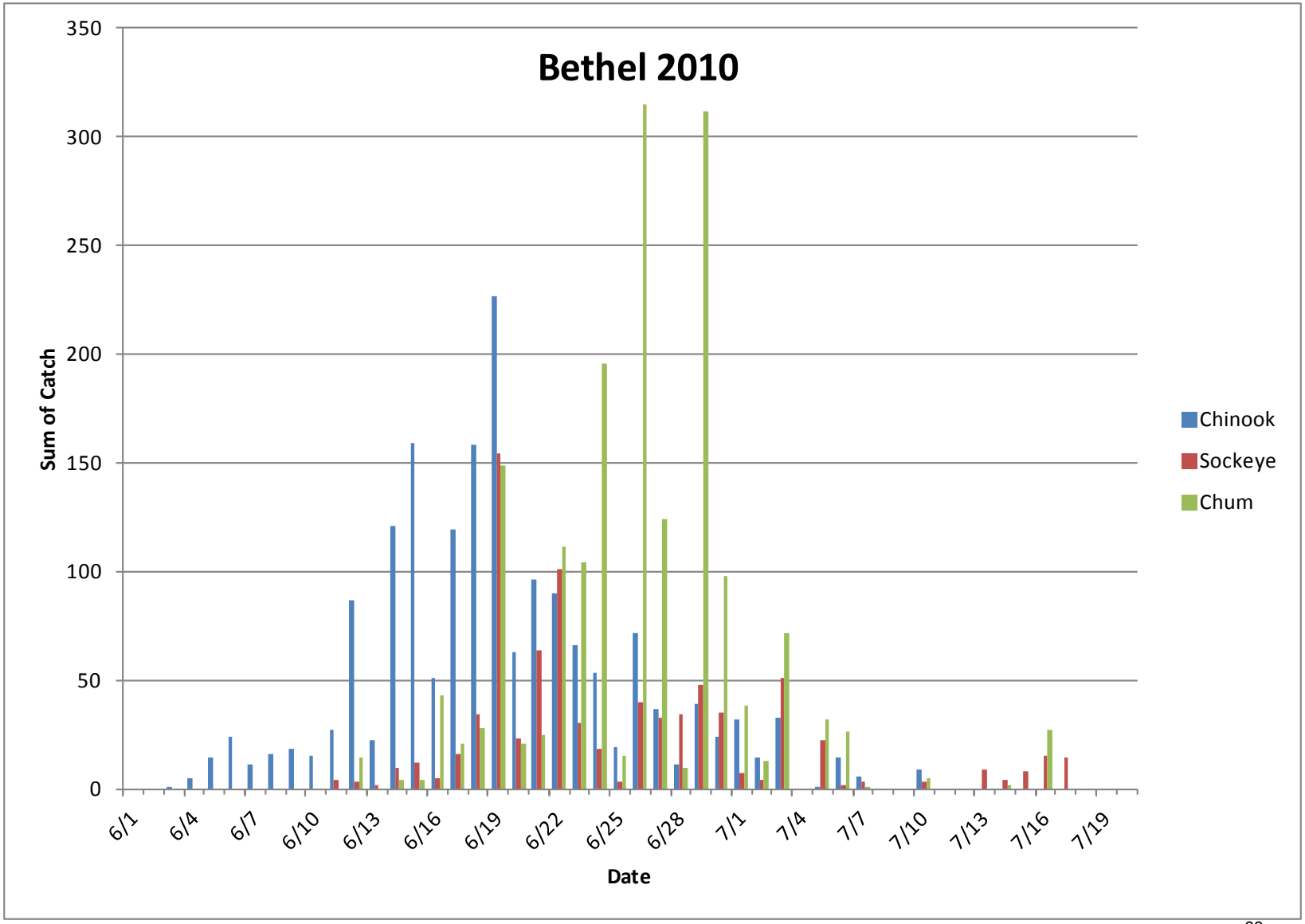

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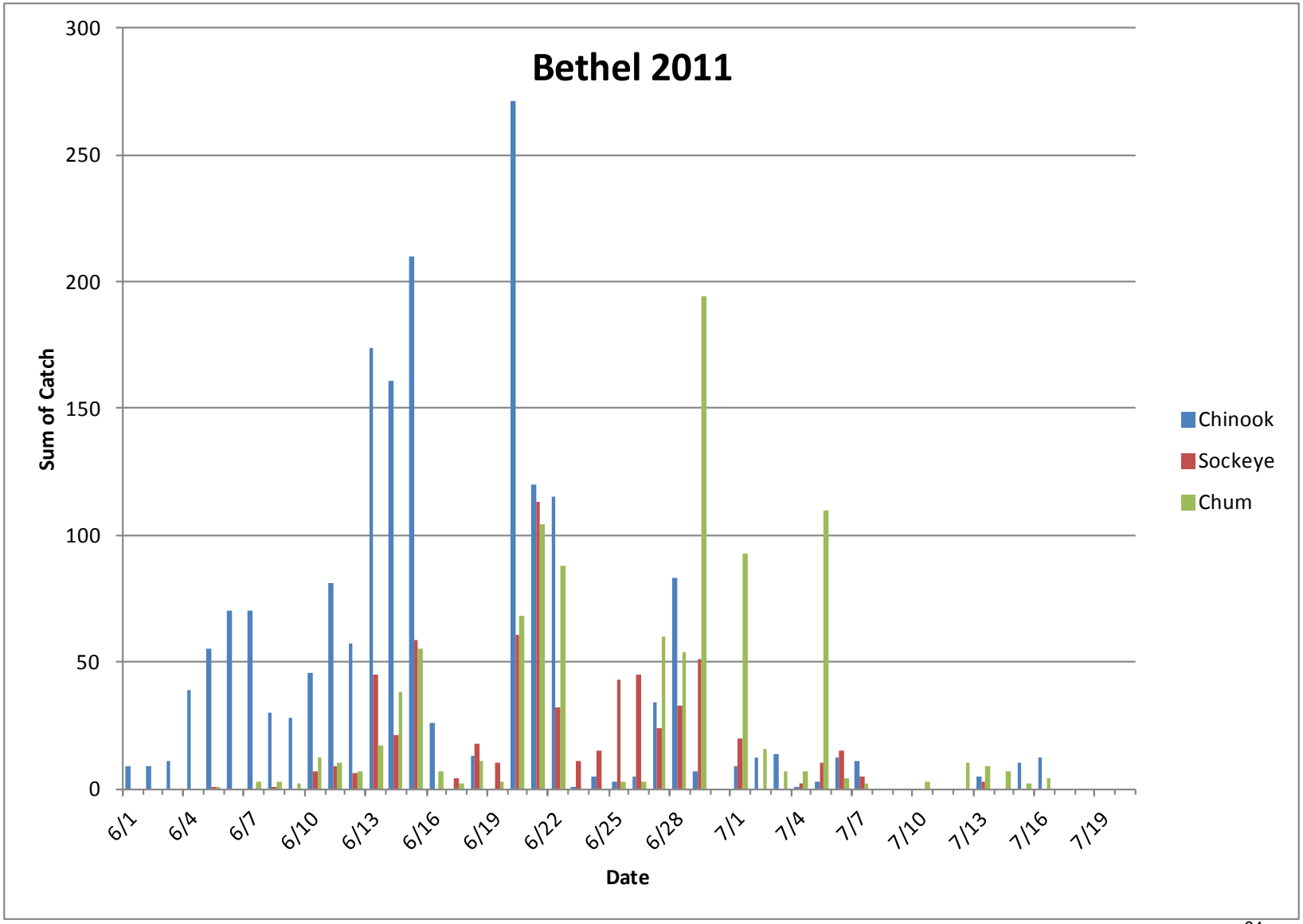

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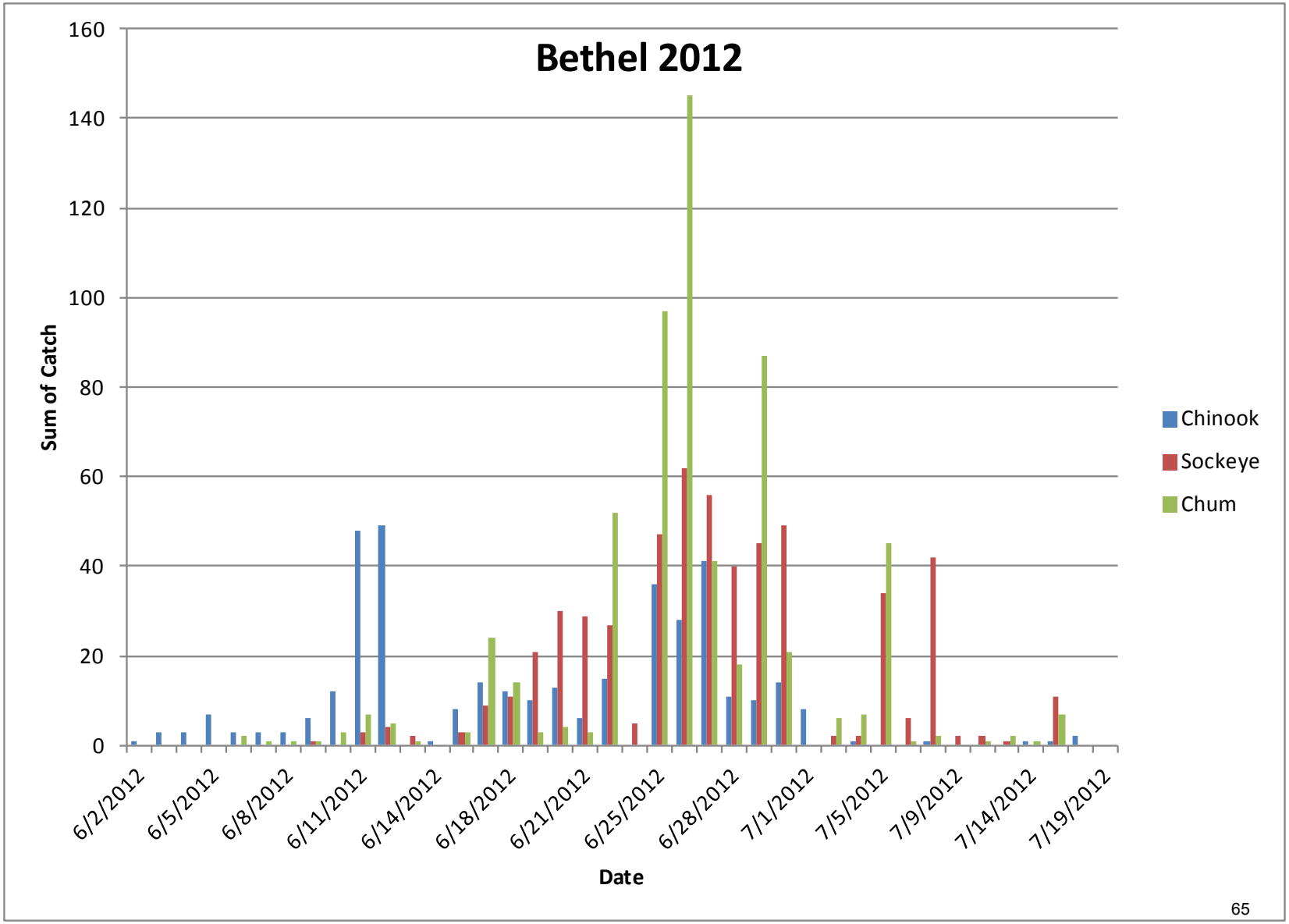

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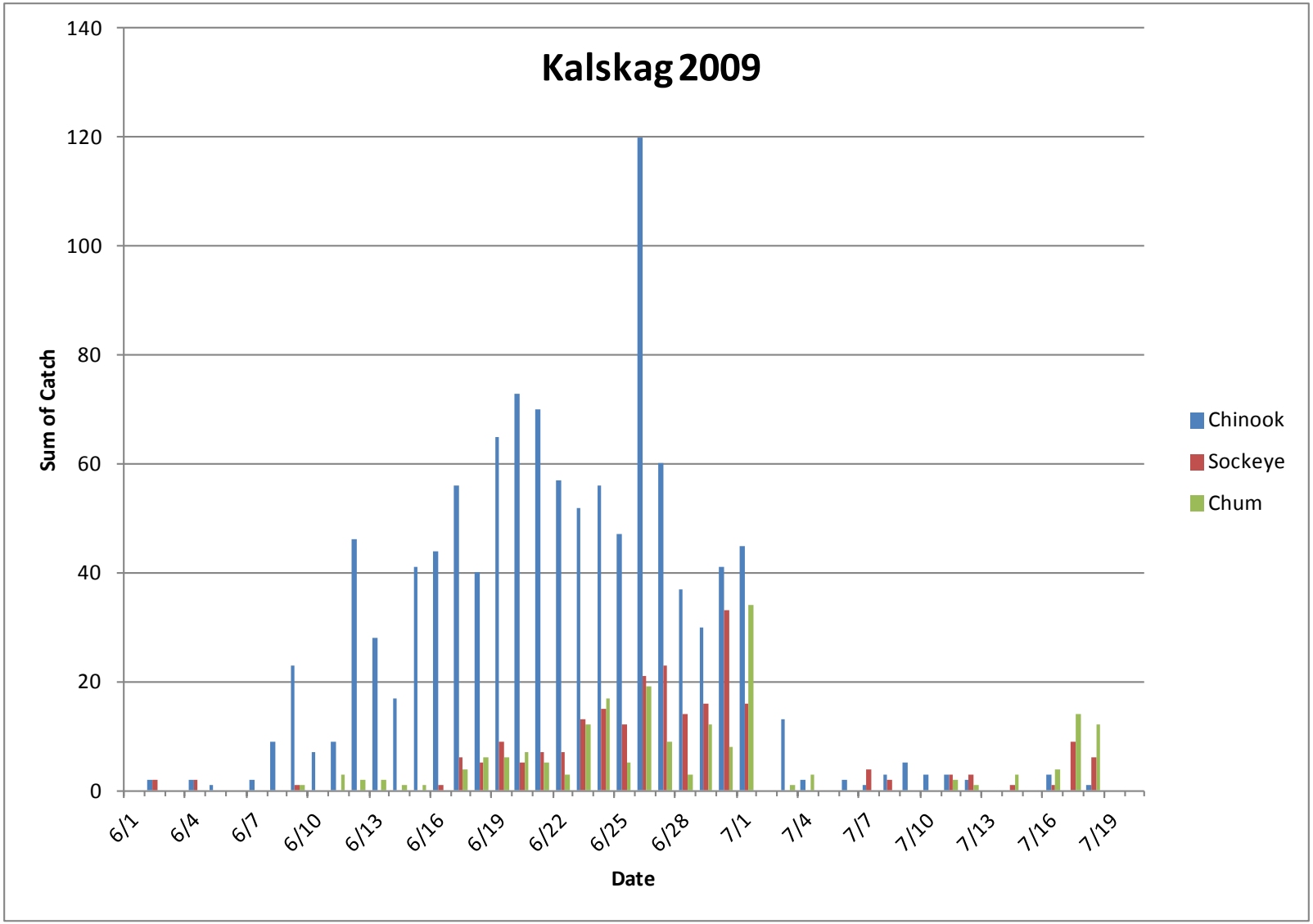

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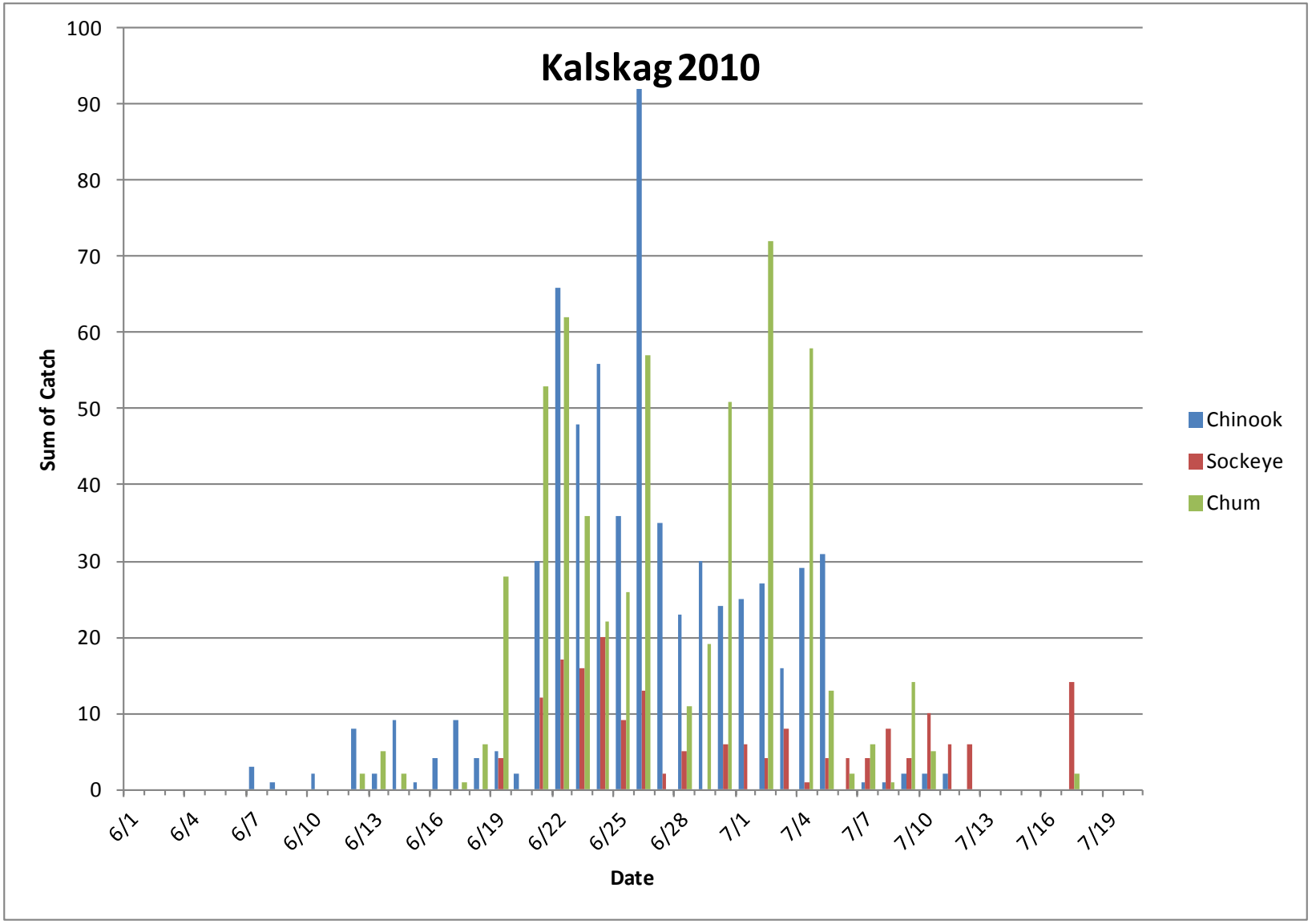

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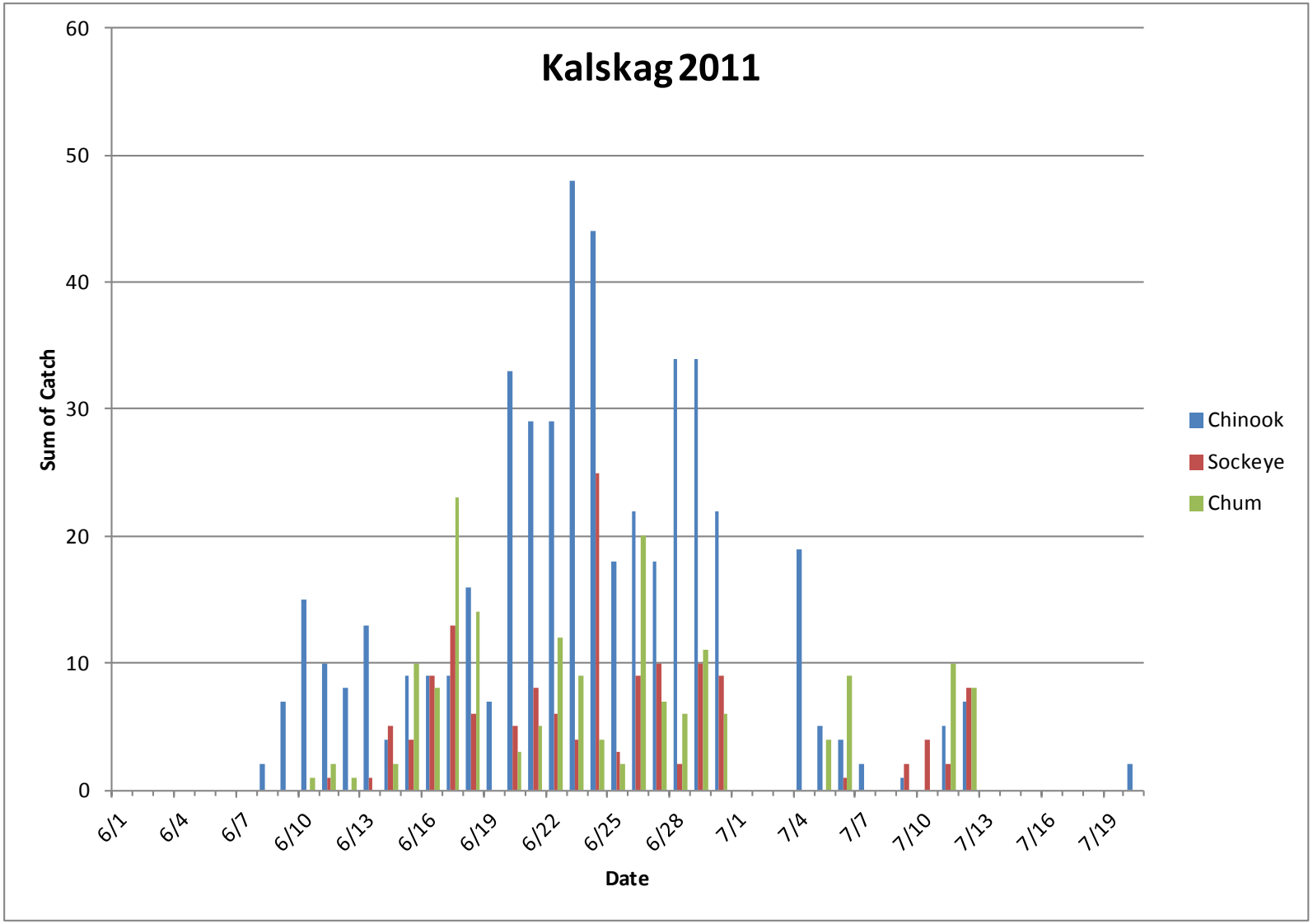

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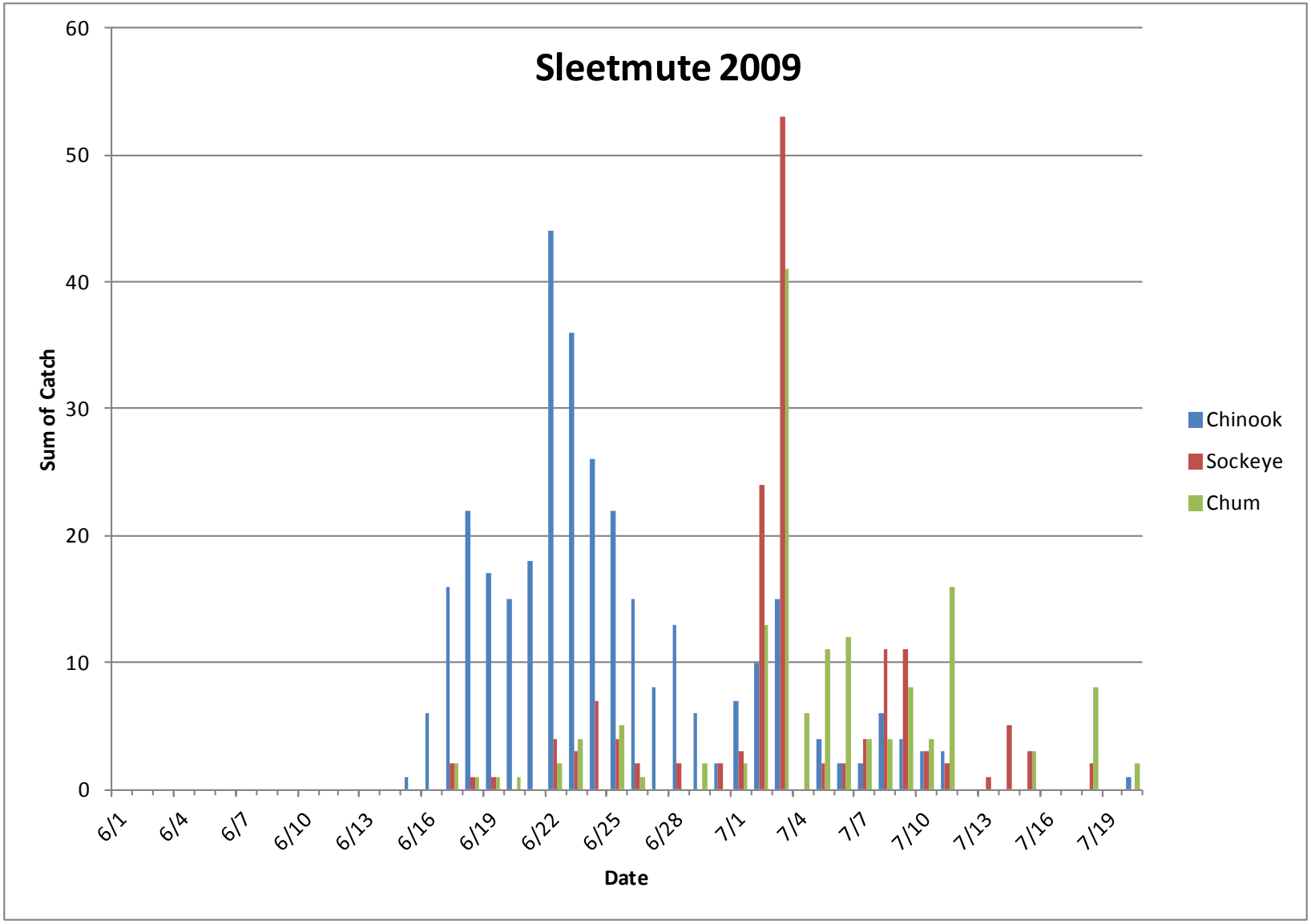

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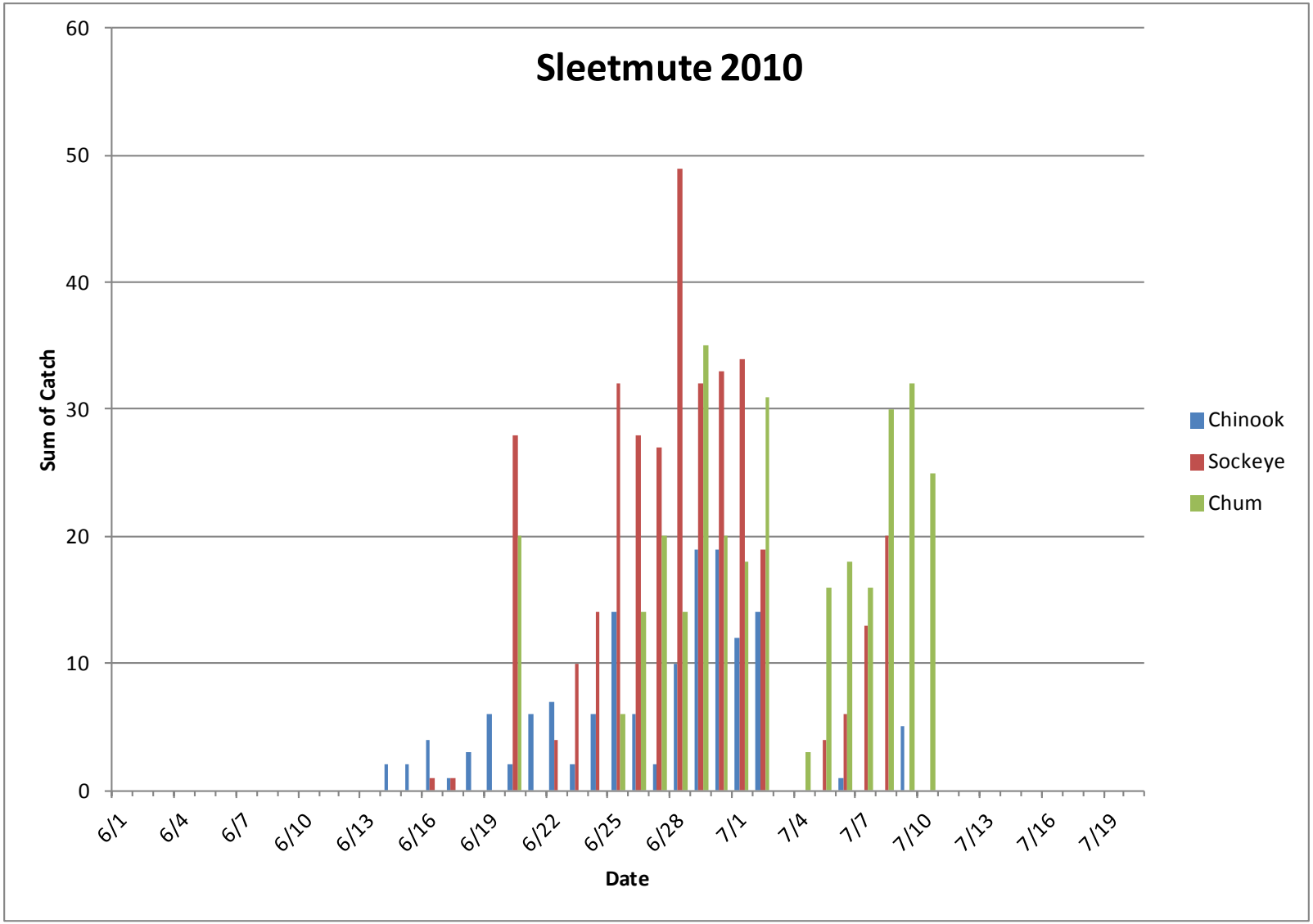

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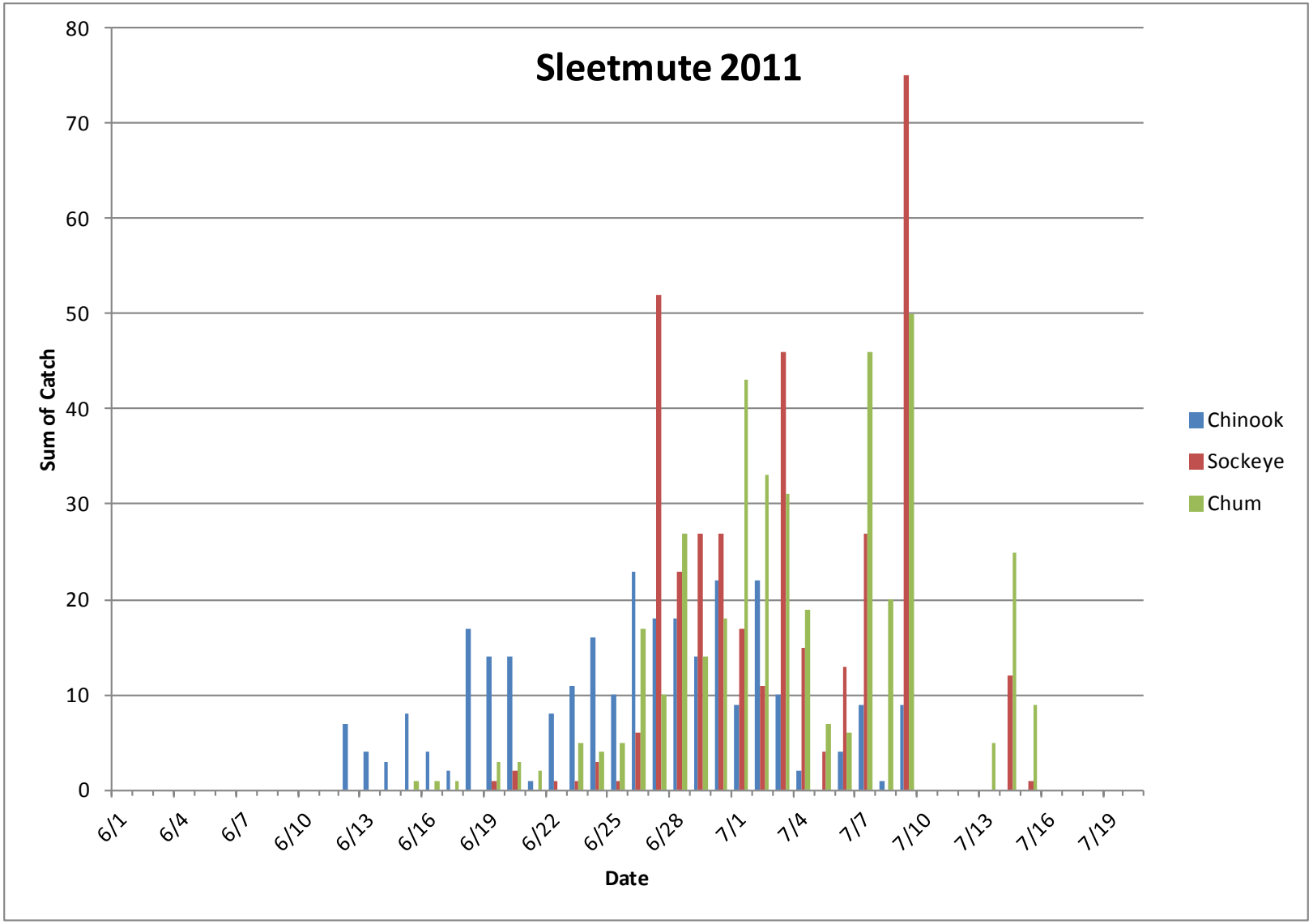

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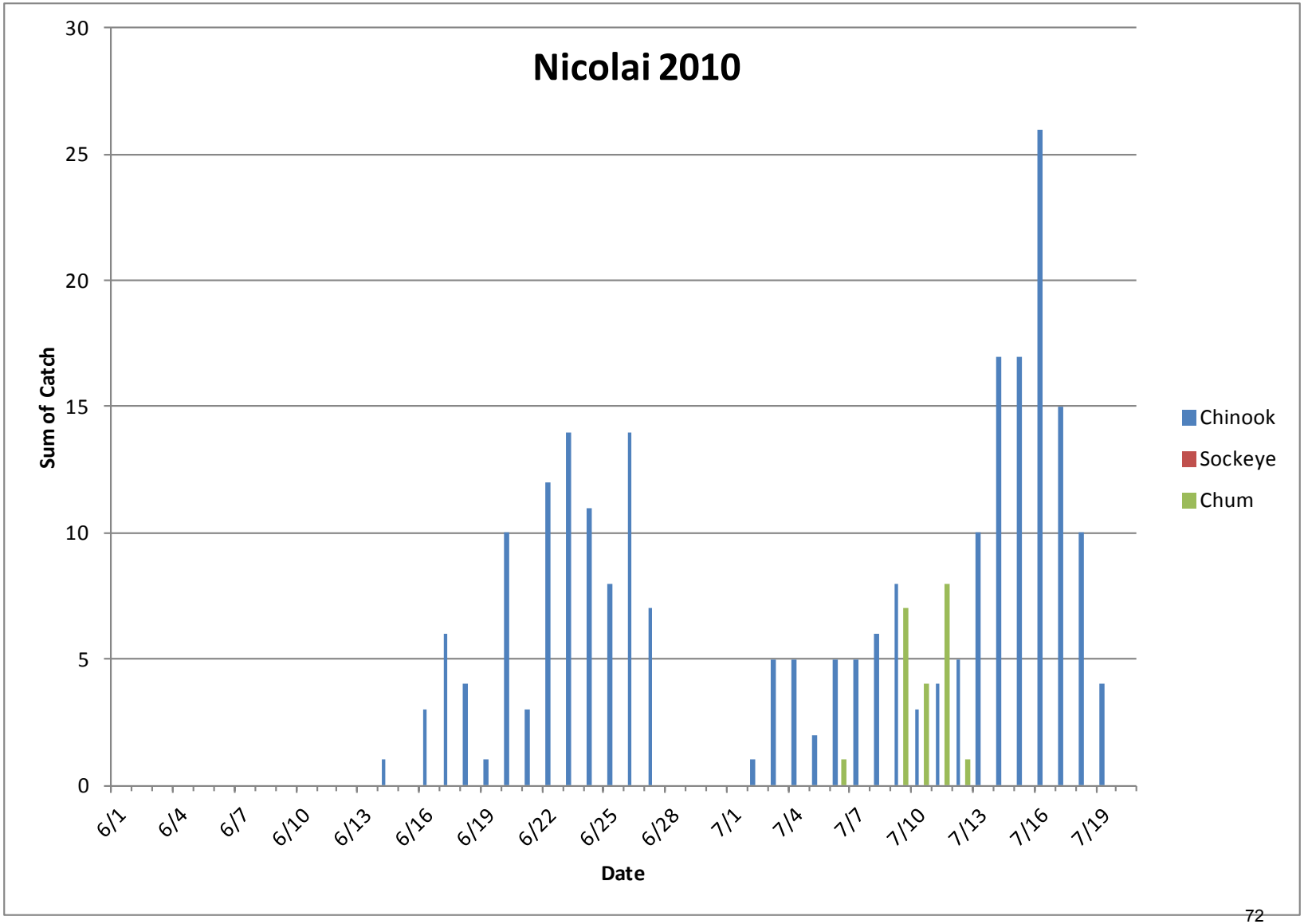

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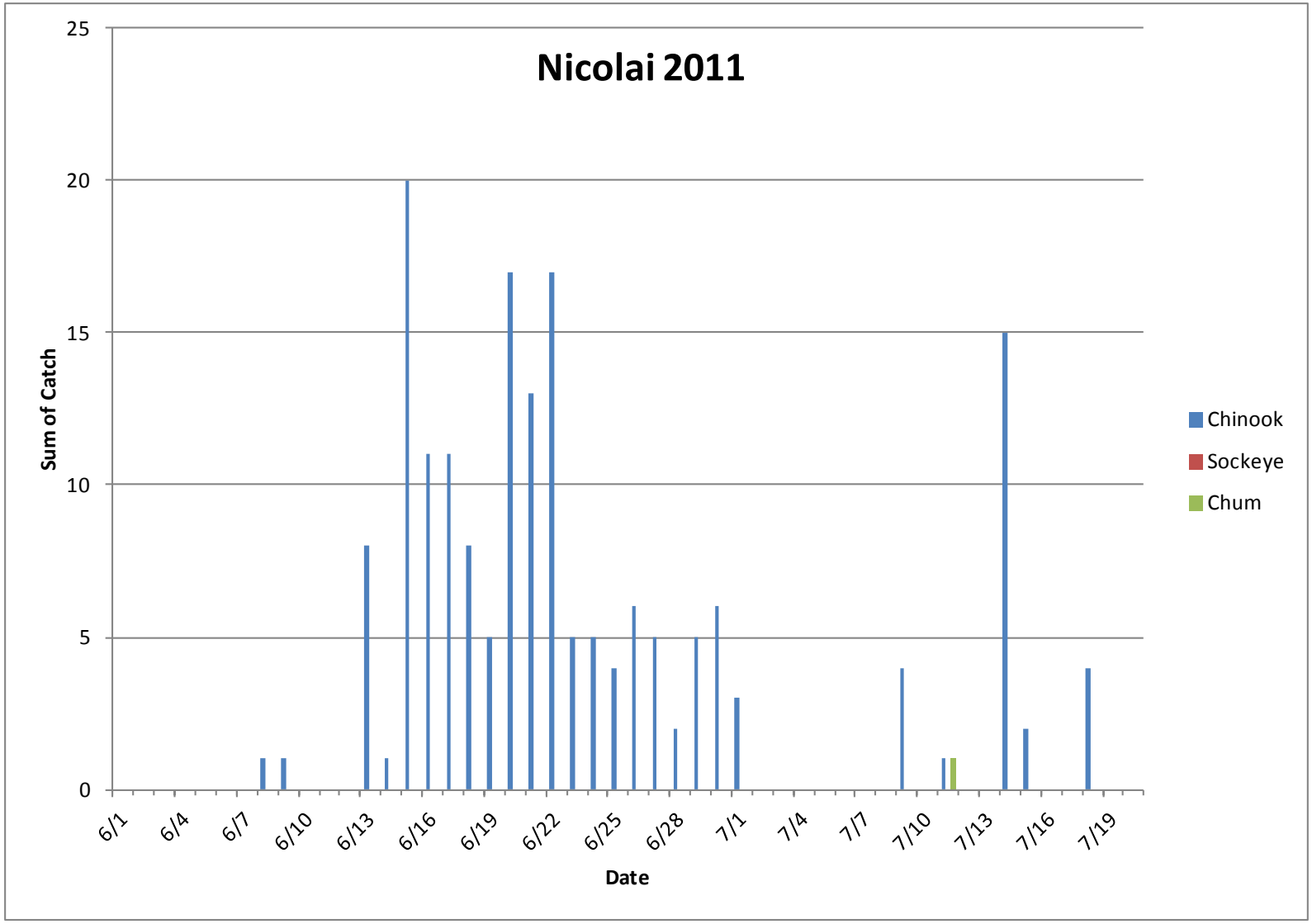
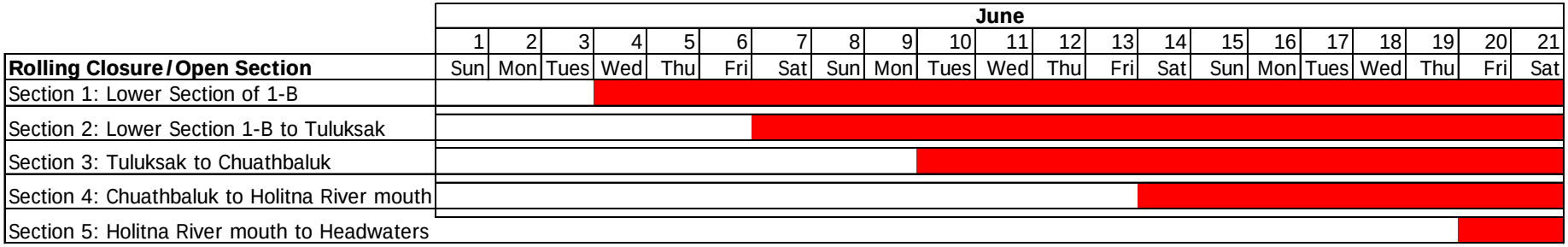
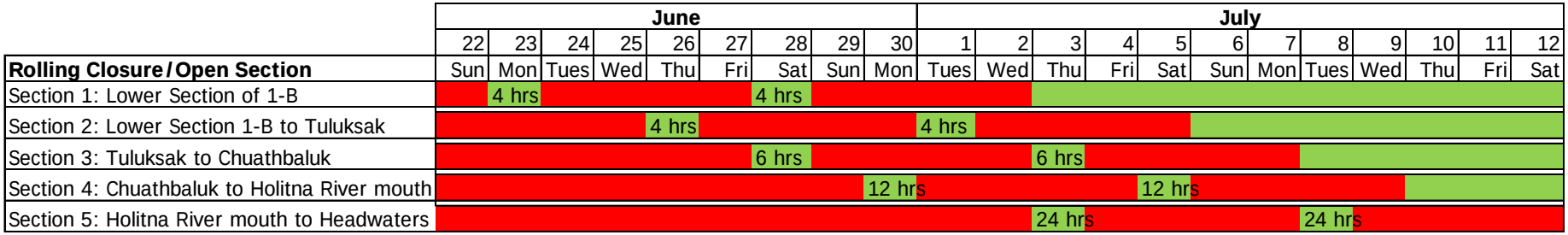


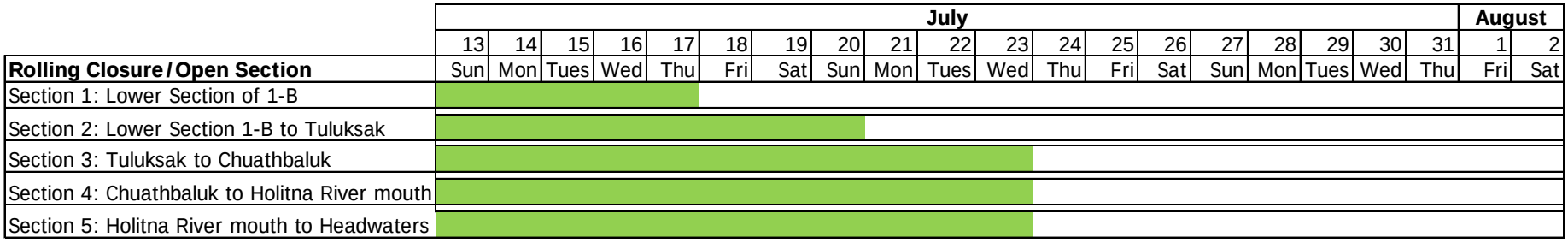
Kuskokwim River 2014 Preliminary Management Strategy

- Close king salmon sport fishing.
- Tributary subsistence closures June 1 – July 25.
- Start the season on a subsistence fishing schedule.
  - Close salmon fishing early in the season.
  - Apply closures/fishing periods based on run timing and travel speed.
  - Fishing periods restricted to 6-inch or less mesh size once chum and sockeye are abundant.
  - Provide more opportunity (fishing time) in upper river sections.
  - Cancel scheduled fishing periods if run assessment indicates abundance is not adequate to achieve escapement goals.
  - Reduce closures if run assessment indicates adequate abundance to achieve escapement goals.

Preliminary 2014 Subsistence Fishing Schedule







Key

	No restrictions
	Closed to salmon fishing
	Gillnets restricted 6-inch or less mesh size and livebox is required on fishwheels