Assessing the adequacy of Chinook stocks to meet the energetic needs of Southern resident killer whales in their summer range

Photo by Astrid van Ginneken, Center for Whale Research

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Evaluation requires 2 primary pieces of information

1) Number of salmon required by SRKW by species and stock to meet their energetic needs

2) Number of salmon available by species and stock

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SRKW summer range species/stock specific prey consumption model:

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Noren 2011

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SRKW min and max Daily Prey Energetic Requirement

	J Pod	J Pod	J Pod	K Pod	K Pod	K Pod	L Pod	L Pod	L Pod	Total	Total	Total
Age and Sex Class	# of whales	Min. DPER	Max. DPER	# of whales	Min. DPER	Max. DPER	# of whales	Min. DPER	Max. DPER	Whales	Min. DPER	Max. DPER
Adult male 31-50+	0	0	0	0	0	0	1	224,521	269,458	1	224,521	269,458
Adult male 21-30	0	0	0	1	224,521	269,458	3	673,563	808,374	4	898,084	1,077,831
Adolescent Male age 20	2	449,042	538,916	1	224,521	269,458	1	224,521	269,458	4	898,084	1,077,831
Adolescent Male age 19	0	0	0	0	0	0	1	215,189	258,259	1	215,189	258,259
Adolescent Male age 18	0	0	0	1	205,721	246,895	2	411,442	493,790	3	617,162	740,684
Adolescent Male age 17	0	0	0	0	0	0	0	0	0	0	0	0
Adolescent Male age 16	1	186,328	223,621	0	0	0	1	186,328	223,621	2	372,657	447,242
Adult female 40+	2	362,915	435,551	2	362,915	435,551	7	1,270,203	1,524,428	11	1,996,033	2,395,530
Adult female 15-40 nursing	4	1,088,745	1,306,653	1	272,186	326,663	4	1,088,745	1,306,653	9	2,449,677	2,939,968
Adult female 31-40 not nursing	2	362,915	435,551	2	362,915	435,551	4	725,830	871,102	8	1,451,660	1,742,203
Adult female 21-30 not nursing	1	181,458	217,775	3	544,373	653,326	2	362,915	435,551	6	1,088,745	1,306,653
	25	4,109,510	4,932,009	19	3,205,887	3,847,530	39	6,931,649	8,318,985	83		
				Total whales not including age zero nursing calves			83			83		
							Total JKL daily	14,247,046	17,098,524			

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SRKW min and max Daily Prey Energetic Requirement by area and month

JUNE	Avg % days resident in SJI	Avg % days resident in western JDFS	SJI	SJI	JDFS	JDFS
			Min DPER	Max DPER	Min DPER	Max DPER
J	76	24	3,123,227	3,748,326	986,282	1,183,682
K	36	64	1,154,119	1,385,110	2,051,767	2,462,418
L	50	50	3,465,824	4,159,492	3,465,824	4,159,492
JULY						
J	76	24	3,123,228	3,748,327	986,282	1,183,682
K	56	44	1,795,297	2,154,617	1,410,590	1,692,913
L	55	45	3,812,407	4,575,442	3,119,242	3,743,543
AUGUST						
J	53	47	2,178,040	2,613,965	1,931,470	2,318,044
K	47	53	1,506,767	1,808,339	1,699,120	2,039,190
L	53	47	3,673,774	4,409,062	3,257,875	3,909,923
SEPTEMBER						
J	56	44	2,301,326	2,761,925	1,808,184	2,170,083
K	48	52	1,538,826	1,846,814	1,667,061	2,000,715
L	57	43	3,951,040	4,741,822	2,980,609	3,577,163

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Table 5. Number of SRKW predation event scale samples for each summer month/GSI stock and DFO stock (NWFSC unpubl. data).

	DFO Fraser River Stock Id	Spring 4_2	Spring 5_2	Summer 4_1	Summer 5_2	Late-Fall Harrison	Other
	Gilbert Age	1.2	1.3	0.3	1.3	0.3	
	Fish Age (years)	4	5	4	5	4	
Month	Region of Origin*						
June	Upper Fraser	1	10				
	Mid-Fraser		2				
	Thompson		6				
	North Puget Sound						1

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Table 6. Mean weight (kg) of Chinook salmon by month for 8”mesh from Albion test fishery data (2002-2006).

	Stock				
Month	Spring 4-2	Spring 5-2	Summer 4-1	Summer5-2	Late-fall Harrison
June	5.8	8.4			
July	6.7		8.4	9.2	
August			8.1	9.3	
September					10.6

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Table 7. Caloric contents of salmon used in energetic requirements of killer whale model

Species	Location fish collected	Stock	River system	Prey sample #	Mean Weight (kg)	Mean caloric content (kcal fish-1)	Energy density kcal/kg	Kcal stock
Chinook	FRASER	SPRING 5-2 JUN	U,M,L - Fr; N,S-Thomp	19	8.4	17602		est. using CRSp
Chinook	FRASER	SPRING 4-2 JUN	L,N,S-Thomp	1	5.8	12019		est. using CRSp
Chinook	FRASER	SUMMER 5-2 JUL	M Fr, NT	6	9.2	17795		est. using Sum4-1
Chinook	FRASER	SUMMER 4-1 JUL	L Fr, S Thomp	4	8.4	16386	1942	Oneill at al 2006
Chinook	FRASER	SUMMER 5-2 AUG	M Fr, NT	1	9.3	18148		est. using Sum4-1
Chinook	FRASER	SUMMER 4-1 AUG	L Fr, S Thomp	10	8.1	15681		est. using Sum4-1
Chinook	FRASER	LATE FALL HARRISON		5	10.6	14451		est. using CRfall

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		J Pod			
		SJI			
	NMFS DATA	Chinook only			
	June	Normailzed % for	Min. DPER	Min. DPER	Min. DPER
Chinook	MEAN %	species/stock kcal		Fish/day	Fish/month
SPugetSound	**1.7**	1.20	28,372	3	95
NPugetSound	**1.0**	0.69	16,296	2	54
LowFraser	**0.1**	0.07	1,634	0	3
LowThompson	**5.0**	4.69	111,098	9	277
SThompson	**4.8**	4.50	106,457	6	181
NThompson	**0.1**	0.07	1,629	0	4
MidFraser	**6.1**	8.42	199,181	11	339
UpFraser	**77.3**	106.74	2,526,218	144	4305
CentValleyFall	**0.1**	0.07	1,697	0	3
CentBCCoast	**0.3**	0.32	7,598	1	15
WVancouverI	**0.1**	0.17	3,922	0	8
EVancouverI	**0.1**	0.13	3,137	0	6
	96.5				
Steelhead	**5.2**	1.81	42,808	10	288
Sockeye	**0.0**	0.00	0	0	0
Chum	**5.2**	1.57	37,230	10	288
Coho	**1.7**	0.51	11,983	3	81
Salmonid	**1.7**	0.51	11,983	3	81
Other	**1.7**	0.51	11,983	3	81
			3,123,228	**204**	**6,110**

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Table 9e. Estimated species and stock specific fish consumption by SRKW during June-September

GSI Stock	Min JKL	Max JKL	Total Min	Total Max	
SPugetSound	5,174	6,209			
NPugetSound	11,132	13,360	16,306	19,570	PS total
LowFraser	21,585	27,692			
LowThompson	2,654	2,761			
SThompson	24,549	29,462			
NThompson	7,895	8,217			
MidFraser	19,134	22,963			
UpFraser	19,993	23,995	95,810	115,090	FR Total
CentValleyFall	91	109			
CentBCCoast	125	150			
WVancouverI	1,981	2,378			
EVancouverI	559	670			
Total Chinook	-	-	114,872	137,967	
Total Steelhead	2,191	2,629			
Total Sockeye	2,060	2,473			
Total Chum	714	857			
Total Coho	1,853	2,437			
Total Salmonid	759	987	7,577	9,383	
Total Other	170	220			
Total Fish	123,400	148,596	123,400	148,596	Grand total

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Evaluation requires 2 primary pieces of information

1) Number of salmon required by SRKW by species and stock to meet their energetic needs

2) Number of salmon available by species and stock

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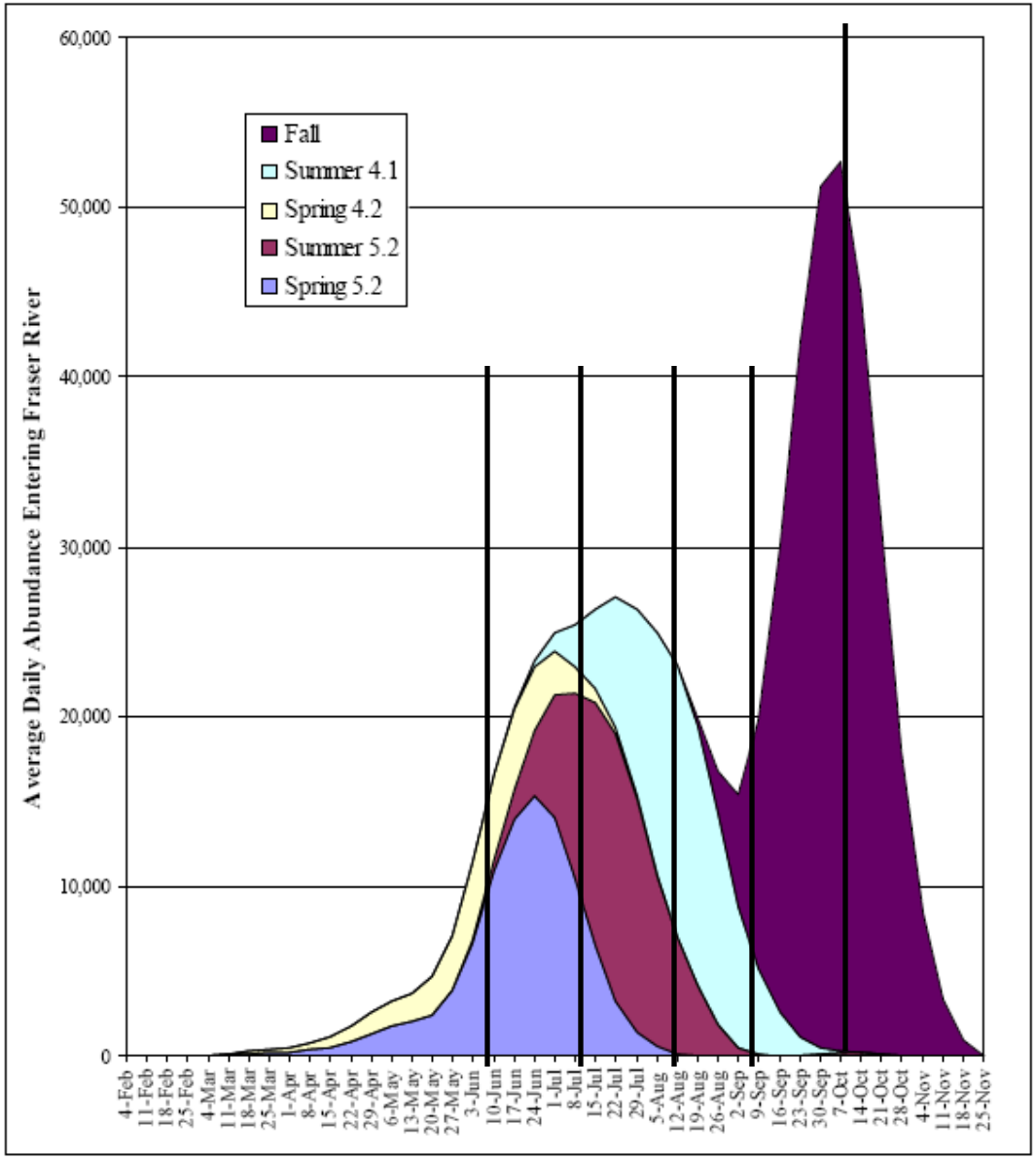
Run timing of major Fraser River Chinook Stocks – Fig. 5, English et al. 2007



Vertical lines define each summer month for which the proportional contribution of each stock was calculated

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Table 8. Estimated monthly availability of Fraser River salmon stocks based on mean of total return to Canada (Table 13) and apportioned by month based on run timing from Figure 5, English et al. (2007), moved back one week to account for approximate travel time of fish between the San Juan Islands and Albion.

	Stock						
Month	**Spring 4_2**	**Spring 5_2**	**Summer 4_1**	**Summer 5_2**	**Fall**		**Total fish available**
Mar	**600**	**316**					**917**
Apr	**3420**	**3930**					**7350**
May	**8899**	**14176**		**525**			**23600**
Jun	**9454**	**38534**	**1754**	**12759**			**62501**
Jul	**1379**	**11997**	**31708**	**43559**			**88643**
Aug		**206**	**30602**	**6690**	**16019**		**53715**
Sep			**4406**	**425**	**184630**		**189461**
Oct				**123**	**76749**		**76872**
Nov					**2353**		**2353**
	23752	**69160**	**68471**	**64080**	**279751**		**505214**

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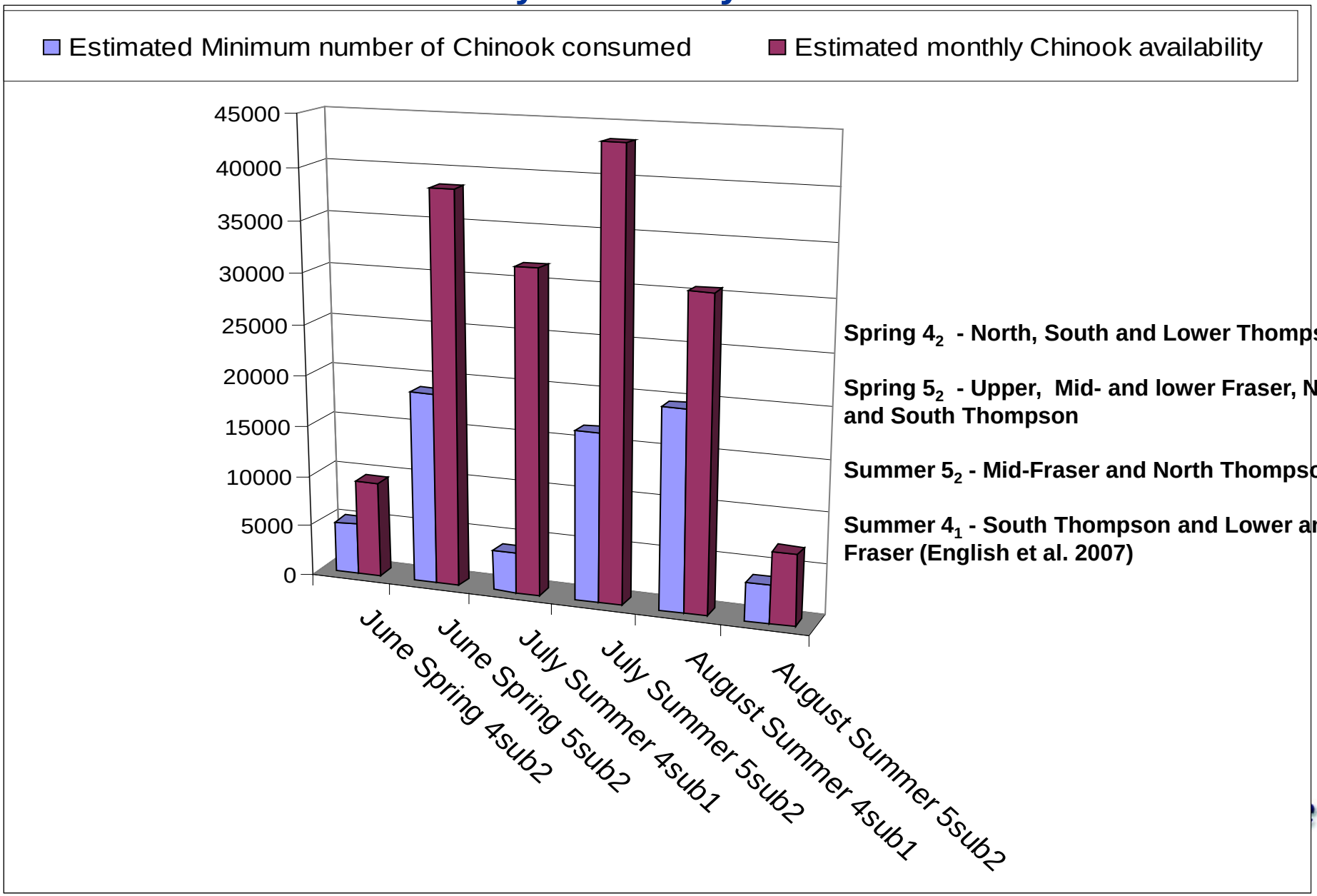
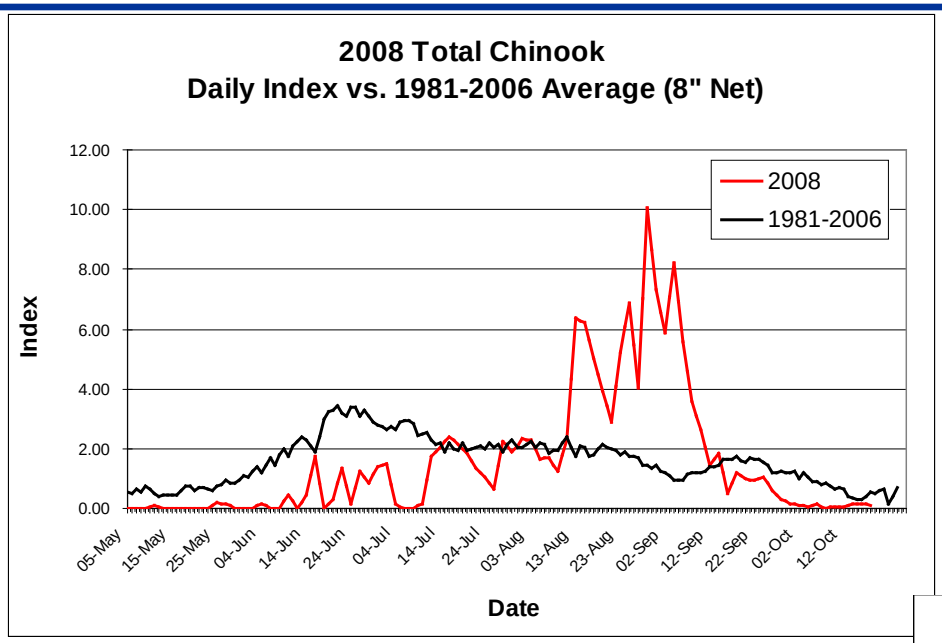
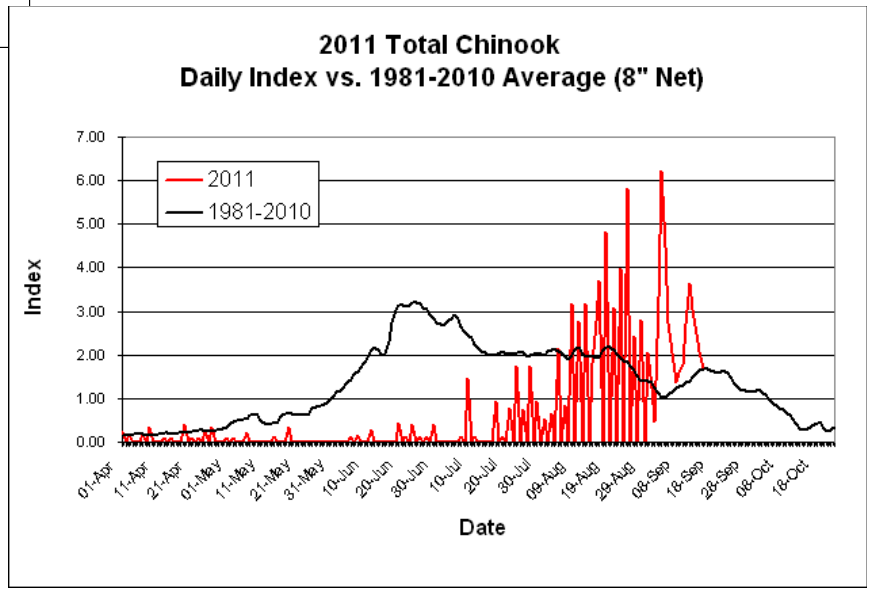
Estimated monthly SRKW Chinook stock specific consumption versus estimated monthly availability of Fraser River Chinook stocks



Albion test fishery data





Reduced availability of Spring Chinook due to:

1) Recent lower returns

2) Shift towards later return timing

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Changes in Run Timing
Methods overview

- Fit finite mixture models (2 or 3 mixtures) to daily counts from Fraser / Columbia

- Have there been patterns in run timing since 1980s?
- Trends in variance since 1980s?
- Timing of peak run times?

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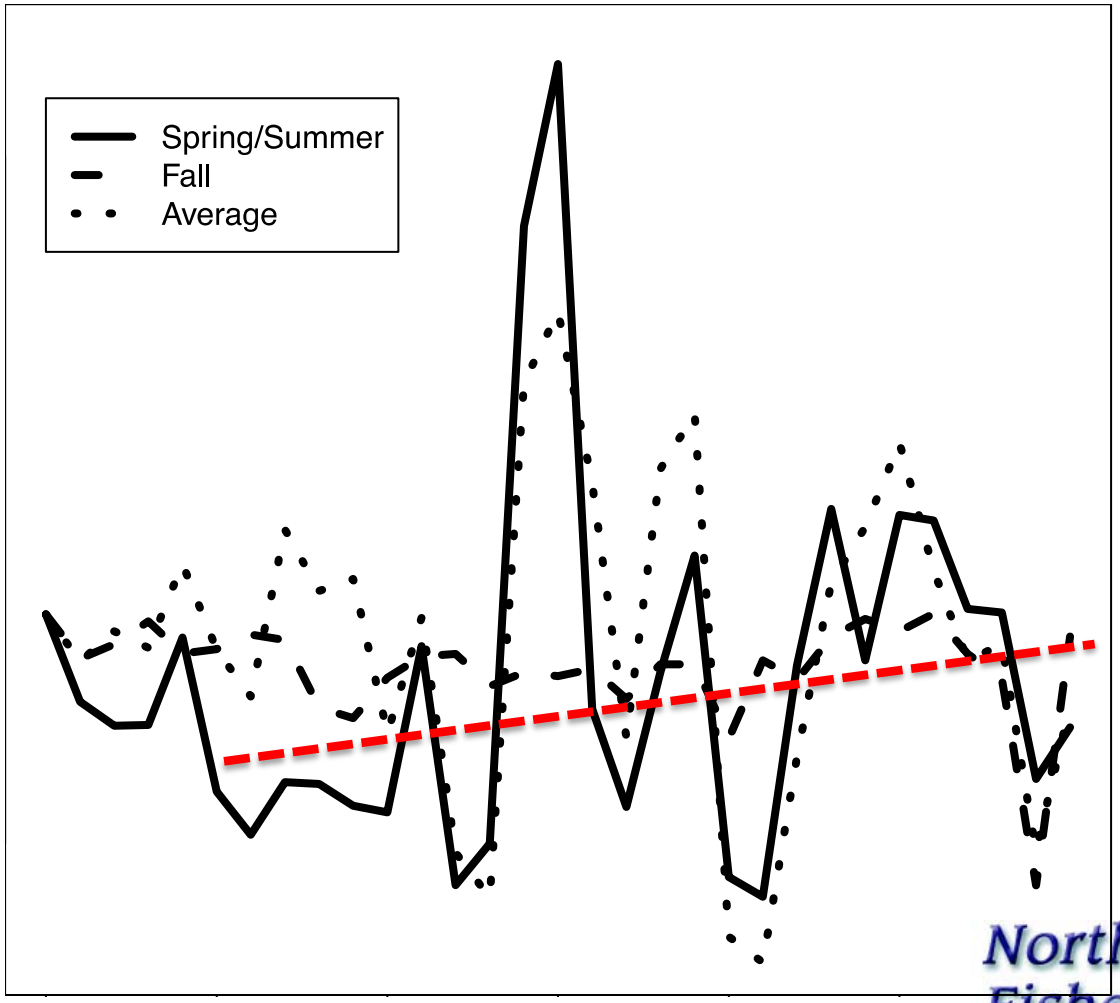
Columbia Chinook (no strong trend)



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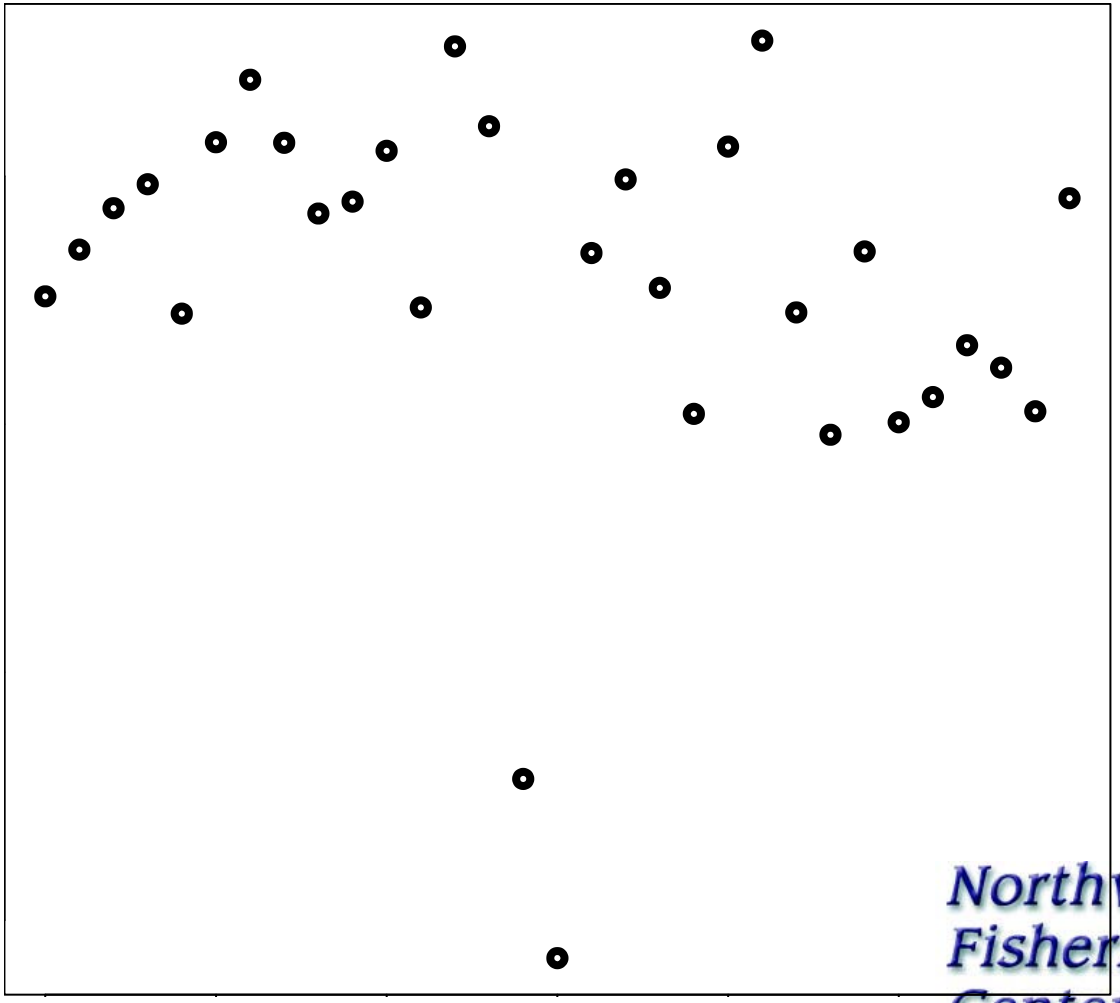
Difference in Columbia peak times



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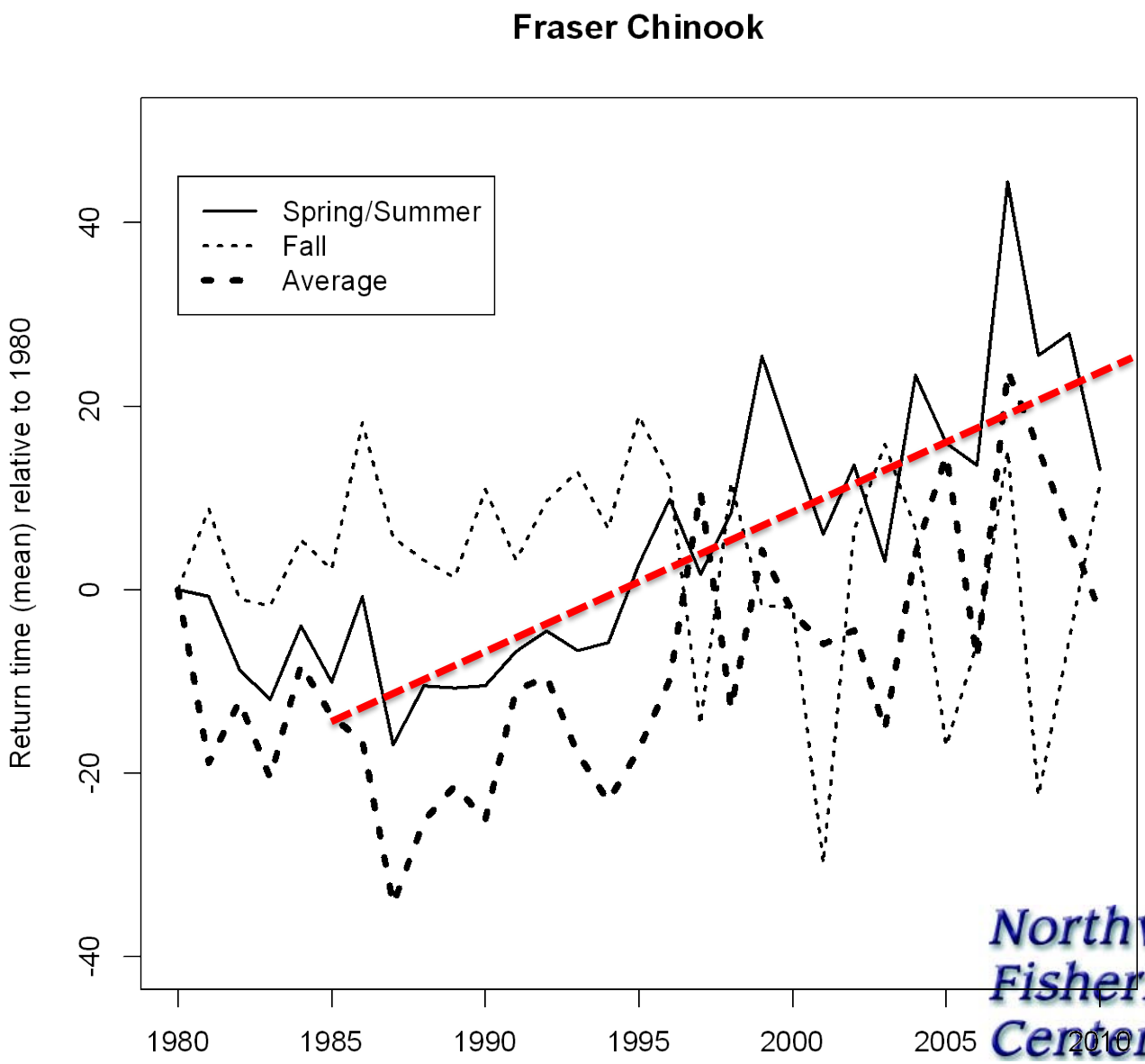
Fraser Chinook arriving > 1 month later



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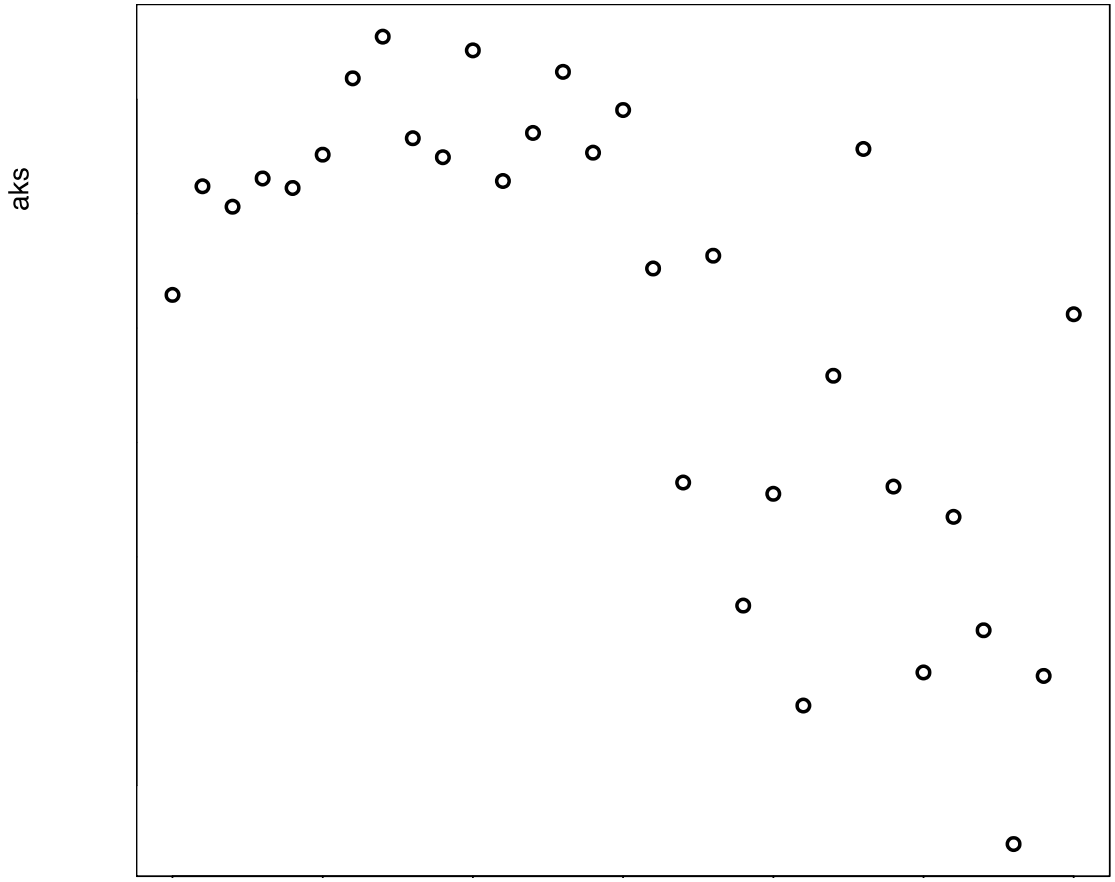
Difference in Fraser peak times



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- Run timing:
  - Fraser Spring Chinook arriving later
  - No apparent trend for Columbia Chinook

- Difference between fall and spring peak times:
  - Decline in both Fraser / Columbia

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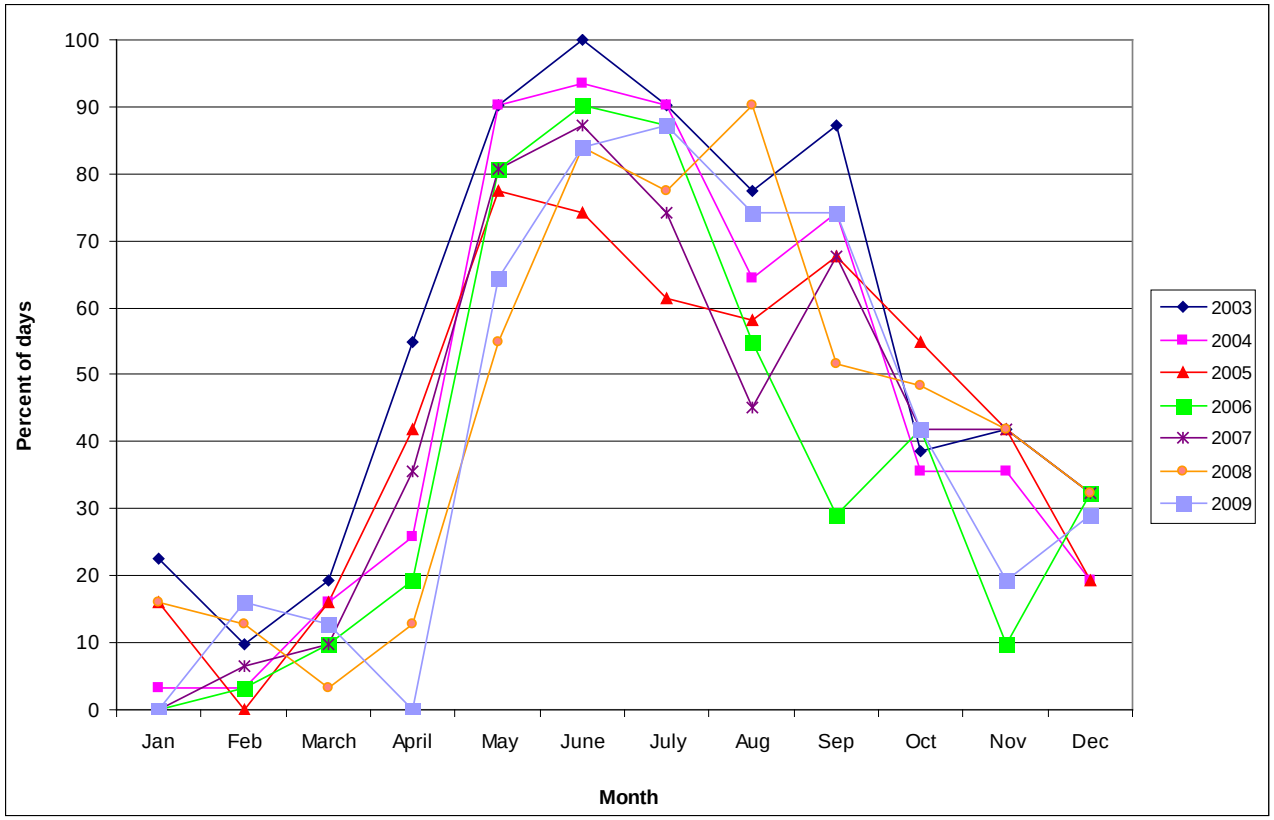
Recent SRKW residency patterns

Percentage of days any Southern resident killer whale pods were present in fours areas of inland waters showing interannual variability



Data from 2003-2009

Note that 2008 and 2009 showed low occurrence in April-June
This pattern has continued in 2010 and 2011 – also have observed more pod fractionation

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Questions?

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