CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE REPORT ON SACRAMENTO RIVER WINTER CHINOOK HISTORICAL AND CURRENT MANAGEMENT

After Sacramento River Winter Chinook (winter-run) were listed as "Endangered" under the ESA in 1989, fishery managers began utilizing fishery constraints to protect this stock, specifically on the sport fishery south of Point Arena (San Francisco and Monterey Bay south). Prior to 1992, the fishery was open from mid-February through mid-November with a 20" min size limit; however historical winter-run fin clips showed 28% of all winter-run recoveries occurred during the first two months of the season. Thus the opening date was delayed over time and now opens no earlier than the first Saturday in April. Additional protection was also provided by increasing the minimum size limit from 20 to 24 inches since it was known that winter-run were smaller in size than more abundant fall-run and late fall-run Chinook. Even though the tagging of winter-run began in 1978, coded-wire tag (CWT) releases were small in size and inconsistent from year to year and ocean recoveries were relatively rare (Table 1). As a result, the data were insufficient to determine the actual protection from size limit increases.

In the late 1990s, Livingston Stone Hatchery was built on the upper Sacramento River to supplement the natural production of winter-run from natural broodstock. Since 1998, the hatchery has produced approximately 100,000 to 250,000 winter-run each year. Almost all (≥95%) of these hatchery fish contain CWTs (Table 1) which now allows fishery managers to measure the direct impact of river and ocean sport and commercial fisheries harvest on this stock.

After winter-run populations began to increase in the early 2000s, the 2004 NOAA Fisheries Biological Opinion allowed the minimum size limit to decrease from 24 inches to 20 inches in the sport fisheries. Although increased minimum size limits had been used as a means of reducing winter-run mortality in sport and commercial fisheries, the magnitude of the mortality reduction associated with higher minimum size limits was difficult to estimate. NOAA Fisheries believed that a time series of winter-run CWT recoveries, which was not biased by annual changes in minimum size limit regulations, would be an important component in the future management of winter-run. Thus NOAA Fisheries recommended that the use of larger minimum size limits be phased out over the course of several seasons, if the spawning population continued to increase in size.

In 2010, NOAA Fisheries released a new Biological Opinion on winter-run that included the best available scientific information based on cohort reconstructions and estimates of ocean fishery impacts developed from CWT ocean recoveries of winter-run released from Livingston Stone Hatchery. NOAA fisheries determined that most winter-run impacts occurred on age-3 fish in sport and commercial fisheries south of Point Arena.

Of the 661 winter-run CWTs recovered in the California ocean fisheries (Table 1), most originated from Livingston Stone Hatchery and were recovered in fisheries during the 2000 through 2014 seasons. Of the 615 winter-run CWTs collected in California since 2000, almost 92% (n=563) were age-3 fish taken in the sport (Table 2) and commercial (Table 3) fisheries south of Point Arena; the remaining CWTs were either age-4 fish (n=39), age-2 fish (n=2) or taken from fisheries north of Point Arena (n=11). The two age-2 recoveries occurred in the sport fishery during the summer of 1999 in the San Francisco management area while "no minimum size limit" regulations were in effect. These fish were approximately 12 inches in length, far below current minimum size limit standards.

As part of the 2010 Biological Opinion, NMFS developed the winter-run Harvest Control Rule (HCR) to determine the total allowable impacts in ocean fisheries south of Point Arena. The three year geometric mean of total winter-run escapement to the upper Sacramento River is plotted against a sliding scale of impact rates that ranges from zero to twenty percent when the mean escapement is under 5,000 fish. There is no impact rate cap in effect when mean escapement exceeds 5,000. Each season, the winter-run impact rate cap is generated using the HCR, which largely determines the sport and commercial fishing opportunity south of Point Arena.

In 2012, NOAA Fisheries began utilizing the Winter-Run Harvest Model (WRHM) to determine winter-run impacts by month, management area, and fishery sector based on season structure and size limits in effect. The total CWT recoveries by time and area used to determine impact rates under the WRHM are shown in Tables 2 and 3. The majority of winter run recoveries occurred in the sport fishery (84%). In addition, most of these recoveries occurred prior to September each year with approximately 4% of the sport and 6% of the commercial CWTs taken in the fall fisheries (September-November).

To evaluate which areas and times have the highest relative impact rates, the WRHM was used to calculate impact rates with all months open (i.e., 30-31 days) and the minimum size limit in effect for sport (20 inches total length) and commercial (26 inches total length). Impacts in the sport fishery were more than twice that observed in the commercial fishery and Monterey impacts in both fisheries were nearly double those in San Francisco (Table 4). The highest impact rates are in Monterey sport during July, May and June, Monterey commercial in June, San Francisco sport in July, and San Francisco commercial during July. The highest fall fishery impacts occurred in San Francisco sport and commercial during October.

To further evaluate the times and areas where winter-run interactions and subsequent risk are the highest, age-3 recoveries were scaled identically to total recoveries per 10,000 fish landed (Tables 5 and 6). In this way times and areas where winter-run interactions are the most prevalent can be identified, without regard to differences in fishing opportunity. Sport and commercial fisheries in the Monterey management area in August and September were identified as having some of the highest rates of winter-run age-3 recoveries, along with the sport fishery in the San Francisco management area in November.

Available Genetic Stock Identification Data

In 2010, the California Genetic Stock Identification Collaboration (CA-GSI) included representatives from the commercial fishing industry, the California Salmon Council, the California Department of Fish and Wildlife (CDFW), and NOAA Fisheries. Due to significant ocean fishery constraints, the CA-GSI embarked on a coast-wide combined retention and non-retention sampling effort for genetic stock identification samples in all management areas during May through September 2010. Both tissues and scales were collected to allow for genetic stock identification and age assignment of fish sampled as the utility of GSI data as a management tool requires both stock identification and age in the ocean harvest. All samples were collected at sea by commercial fishers in both open and closed areas and/or times. However, since most of the California coast was closed to commercial salmon fishing, especially south of Point Arena, the primary mode of sampling was non-retention (62%) and included samples from sublegal salmon less than 26 inches total length. Geneticists at the NOAA Fisheries Southwest Fisheries Science Center analyzed the tissue samples while CDFW performed the scale analyses. A total of 4,495 samples comprised of 14 distinct stock assignments were aged from salmon collected between Crescent City and Santa Barbara. In August 2011, CDFW produced their age composition by stock report and delivered it to the CA-GSI (Supplemental CDFW Report 2).

During the 2010 study, there were 30 winter-run Chinook sampled, most of which were age-3 fish collected in the Morro Bay (n=16) and Santa Cruz (n=9) port areas during August and September (Figure 1a-c). There were also three age-2 fish, all collected in the latter half of September, with one each sampled in the Fort Bragg, San Francisco, and Santa Cruz port areas. The total lengths of these young fish were 17.6, 17.4 and 19.9 inches, respectively. One age-4 fish was also sampled in the Half Moon Bay port area during June. The relatively large distribution of winter-run observed south of Pigeon Point in 2010 is similar to the results of other GSI studies that were conducted by CDFW and NOAA Fisheries during the late 1990s and by the CA-GSI in subsequent years (2011-2014). More importantly, the high proportion (64%) of winter-run in the Morro Bay samples during August and September suggest above-average concentrations of winter-run south of Point Sur during late summer and early fall.

The available GSI information correlates well with what is known from CWT recovery data. The age-2 winter-run sampled in the CA-GSI 2010 study were all sublegal contacts that would have gone unidentified under normal harvest conditions in ocean fisheries.

Sub-Legal Chinook Release Information

Although the “number of salmon released” data is collected by Department field staff during dockside interviews with sport anglers and commercial trollers, it is not stock-specific and thus, cannot be used to estimate the effects of fall or other fisheries on sublegal winter-run at this time.

Table 1. Winter-run CWT releases and ocean recoveries, brood years 1978-2012.

Brood year	Total released	CWT tagged	Released w/CWTs	Ocean recoveries
1978	10,313	9,988	97%	6
1982	11,548	10,393	90%	0
1991	11,153	10,866	97%	3
1992	28,099	27,383	97%	17
1993	18,723	17,034	91%	5
1994	43,346	41,412	96%	11
1995	51,267	48,154	94%	4
1996	4,718	4,553	97%	0
1997	21,271	20,846	98%	0
1998*	153,912	147,007	96%	37
1999	30,841	30,367	98%	20
2000	166,207	162,198	98%	24
2001	252,278	242,383	96%	12
2002	232,723	221,334	95%	226
2003	218,617	216,676	99%	133
2004	168,261	143,280	85%	4
2005	173,344	163,935	95%	5
2006	196,288	181,681	93%	0
2007	71,883	69,066	96%	1
2008	146,211	133,587	91%	2
2009	198,582	183,644	92%	71
2010	123,859	113,905	92%	15
2011	194,264	185,313	95%	34
2012	181,857	169,967	93%	31
				661

* Livingston Stone Hatchery began production in 1998.

Table 2. Winter-run CWT Age-3 Recoveries in California Sport Fishery, 2000-2014.

San Francisco Management Area Sport CWT Recoveries

Broodyr	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total	Tagged	% Recovered
1998	2000	1	0	2	1	1	0	2	0	7	147,007	0.0048%
1999	2001	0	0	1	3	2	0	0	0	6	30,367	0.0198%
2000	2002	0	2	1	3	1	0	0	0	7	162,198	0.0043%
2001	2003	0	4	4	1	0	0	0	0	9	242,383	0.0037%
2002	2004	1	34	28	31	9	0	1	4	108	221,334	0.0488%
2003	2005	12	10	15	11	4	1	0	1	54	216,676	0.0249%
2004	2006	0	0	1	2	0	0	0	0	3	143,280	0.0021%
2005	2007	0	1	0	0	0	0	0	0	1	163,935	0.0006%
2008	2010	0	0	0	1	0	0			1	133,587	0.0007%
2009	2011	0	0	1	3	7	2	1		14	183,644	0.0076%
2010	2012	0	0	1	2	0	0	0	0	3	113,905	0.0026%
2011	2013	0	2	0	2	0	0	2	0	6	185,313	0.0032%
2012	2014	0	0	1	3	7	2	1	0	14	169,967	0.0082%
	SF sport	14	53	55	63	31	5	7	5	233	49%	

Monterey Bay Port Sport CWT Recoveries

Broodyr	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total	Tagged	% Recovered
1998	2000	0	0	8	12	1	1	0		22	147,007	0.0150%
1999	2001	1	1	0	3	0	0			5	30,367	0.0165%
2000	2002	0	3	1	2	1	0			7	162,198	0.0043%
2001	2003	0	0	0	2	0	0			2	242,383	0.0008%
2002	2004	2	4	8	30	4	1	0		49	221,334	0.0221%
2003	2005	7	12	9	5	0	0			33	216,676	0.0152%
2004	2006	1	0	0	0	0	0			1	143,280	0.0007%
2005	2007	0	0	1	1	0	0	0		2	163,935	0.0012%
2008	2010									0	133,587	0.0000%
2009	2011	1	0	1	15	15	0			32	183,644	0.0174%
2010	2012	0	0	0	2	0	0	0		2	113,905	0.0018%
2011	2013	0	0	0	11	7	0	0		18	185,313	0.0097%
2012	2014	2	0	0	2	1	0	0		5	169,967	0.0029%
	MO sport	14	20	28	85	29	2	0		178	38%	

Morro Bay-Santa Barbara Port Area Sport CWT Recoveries

Broodyr	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total	Tagged	% Recovered
1998	2000	0	0	0	0	0	0	0		0	147,007	0.0000%
1999	2001	2	0	0	0	0	0			2	30,367	0.0066%
2000	2002	0	0	2	0	0	0			2	162,198	0.0012%
2001	2003	0	0	0	0	0	0			0	242,383	0.0000%
2002	2004	2	6	0	2	0	0	0		10	221,334	0.0045%
2003	2005	5	2	18	3	0	0			28	216,676	0.0129%
2004	2006	0	0	0	0	0	0			0	143,280	0.0000%
2005	2007	0	1	0	1	0	0	0		2	163,935	0.0012%
2008	2010	0	0	0	0	0	0			0	133,587	0.0000%
2009	2011	1	0	8	0	4	0			13	183,644	0.0071%
2010	2012	0	0	0	0	1	0	0		1	113,905	0.0009%
2011	2013	0	0	1	0	0	0	0		1	185,313	0.0005%
2012	2014	0	3	0	0	0	0	0		3	169,967	0.0018%
	MO sport	10	12	29	6	5	0	0		62	13%	

Sport total	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total	prop fall
	38	85	112	154	65	7	7	5	473	4.02%

= 20" TL size limit

= 24" TL size limit

Table 3. Winter-Run CWT Age-3 Recoveries in California Commercial Fishery, 2000-2014.

San Francisco Management Area Commercial CWT Recoveries

Broodyr	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total	Tagged	% Recovered
1998	2000		0	0	0	0	0			0	147,007	0.0000%
1999	2001		0	0	2	0	0	0		2	30,367	0.0066%
2000	2002		0	2	1	1	0	0		4	162,198	0.0025%
2001	2003		0	0	0	0	0	0		0	242,383	0.0000%
2002	2004		3	14	2	0	0	0		19	221,334	0.0086%
2003	2005				4	1	1	0		6	216,676	0.0028%
2004	2006				0	0	0	0		0	143,280	0.0000%
2005	2007		0		0	0	0	0		0	163,935	0.0000%
2009	2011		0	0	0	1	0	0		1	183,644	0.0005%
2010	2012		0	0	1	0	0	0		1	113,905	0.0009%
2011	2013		0	0	0	1	0	2		3	185,313	0.0016%
2012	2014		0	0	0	1	1	0		2	169,967	0.0012%
	SF comm		3	16	10	5	2	2		38	42%	

Monterey Bay Port Area Commercial CWT Recoveries

Broodyr	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total	Tagged	% Recovered
1998	2000		0	1	0	0	0			1	147,007	0.0007%
1999	2001		0	0	0	0	0			0	30,367	0.0000%
2000	2002		0	0	2	0	0			2	162,198	0.0012%
2001	2003		0	0	0	0	0			0	242,383	0.0000%
2002	2004		1	3	9	1	0			14	221,334	0.0063%
2003	2005		0		0	1	0			1	216,676	0.0005%
2004	2006		0		0	0	0			0	143,280	0.0000%
2005	2007		0		0	0	0			0	163,935	0.0000%
2009	2011		2	2	0	2				6	183,644	0.0033%
2010	2012		0	0	0	0	0			0	113,905	0.0000%
2011	2013		0	1	3	2	0			6	185,313	0.0032%
2012	2014		0	0	4	1				5	169,967	0.0029%
	MO comm		3	7	18	7	0			35	39%	0.0016%

Morro Bay-Santa Barbara Port Area Commercial CWT Recoveries

Broodyr	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total	Tagged	% Recovered
1998	2000		0	3	0	0	0			3	147,007	0.0020%
1999	2001		0	0	0	0	0			0	30,367	0.0000%
2000	2002		0	0	0	0	0			0	162,198	0.0000%
2001	2003		0	0	0	0	0			0	242,383	0.0000%
2002	2004		0	0	1	0	0			1	221,334	0.0005%
2003	2005		0	2	1	2	0			5	216,676	0.0023%
2004	2006		0	0	0	0	0			0	143,280	0.0000%
2005	2007		0	0	0	0	0			0	163,935	0.0000%
2009	2011		0	2	0	0				2	183,644	0.0011%
2010	2012		0	0	0	5	1			6	113,905	0.0053%
2011	2013		0	0	0	0	0			0	185,313	0.0000%
2012	2014		0	0	0	0				0	169,967	0.0000%
	MO comm		0	7	2	7	1			17	19%	0.0008%

Comm total	apr	may	jun	jul	aug	sep	oct	nov	total	prop fall
		6	30	30	19	3	2		90	5.56%

= 26" TL size limit
= 27" TL size limit
= 28" TL size limit

Table 4. Winter-Run Harvest Model Age-3 Impacts Based on Full Month Open in All Cells.

Winter-run Age-3 Impact Rate: **Ocean Sport 20"** size limit

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
SF	0.536	0.949	1.300	**1.833**	0.537	0.050	**0.226**	0.090	5.521
MO	**2.875**	1.057	**2.158**	**3.472**	1.124	0.079			10.765
Total	3.411	2.005	3.458	5.305	1.661	0.129	0.226	0.090	16.286

Winter-run Age-3 Impact Rate: **Ocean Commercial 26"** size limit

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
SF		0.184	0.915	**1.211**	0.400	0.010	**0.198**		2.918
MO		0.398	**1.858**	0.951	0.969	0.100			4.278
Total		0.582	2.774	2.163	1.369	0.110	0.198		7.196

= Fall fisheries

Table 5. Winter-run CWT Age-3 Recoveries per 10,000 salmon landed in California Sport Fishery, 2000-2014.

San Francisco Management Area Sport CWT Recoveries

Broodyr	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Avg	Exp CWTs*	Total catch
1998	2000	5	0	4	4	4	0	14	0	4	25.22	64,653
1999	2001	0	0	25	10	12	0	0	0	6	23.46	39,856
2000	2002	0	6	2	4	3	0	0	0	3	27.80	87,008
2001	2003	0	13	13	2	0	0	0		6	33.20	56,616
2002	2004	5	66	42	26	13	0	9	380	30	393.66	130,220
2003	2005	37	24	29	16	19	3	0	54	20	142.11	72,824
2004	2006	0	0	2	4	0	0	0	0	2	12.72	54,926
2005	2007	0	8	0	0	0	0	0	0	2	3.54	16,796
2008	2010	0	0	0	25	0	0			7	4.37	6,116
2009	2011	0	0	74	19	22	8	18		16	31.96	19,734
2010	2012	0	0	3	4	0	0	0	0	2	8.47	46,189
2011	2013	0	7	0	4	0	0	50	0	4	22.66	61,291
2012	2014	0	0	46	18	18	10	9	0	14	44.78	32,359
SF sport avg		4	10	18	10	7	2	8	43	9		

Monterey Management Area Sport CWT Recoveries

Broodyr	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Avg	Exp CWTs*	Total catch
1998	2000	0	0	26	44	10	27			11	89.75	81,782
1999	2001	7	16	0	85	0	0			16	32.42	20,039
2000	2002	0	23	33	17	69	0			8	36.75	47,703
2001	2003	0	0	0	34	0				8	10.65	13,126
2002	2004	8	124	220	131	155	666			69	307.50	44,845
2003	2005	73	291	76	59	0	0			86	264.92	30,706
2004	2006	10	0	0	0		0			7	7.30	10,970
2005	2007	0	81	34	202	0	0			43	26.78	6,261
2008	2010	0	0	0	0	0				0		6,295
2009	2011	25	0	384	113	335	0			142	180.27	12,703
2010	2012	0	0	0	13	100	0	0		4	12.98	30,364
2011	2013	0	0	43	191	569	0			68	72.78	10,634
2012	2014	8	167	0	162	265	0	0		30	42.02	14,020
MO sport avg		10	54	63	81	125	63	0		38		

Sport avg	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Avg
	7	32	41	46	66	32	4	43	23

* - Winter-run CWTs expanded for hatchery production and sampling rate

= 20" TL size limit

= 24" TL size limit

Table 6. Winter-run CWT Age-3 Recoveries per 10,000 salmon landed in California Commercial Fishery, 2000-2014.

San Francisco Management Area Commercial CWT Recoveries

Broodyr	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Avg	Exp CWTs*	Total catch
1998	2000		0	0	0	0	0			0		250,368
1999	2001		0	0	1	0	0	0		0.4	5.71	136,630
2000	2002		0	1	0	5	0	0		1	15.48	242,872
2001	2003		0	0	0	0	0	0		0		202,876
2002	2004		2	4	1	0	0	0		3	78.60	298,229
2003	2005				1	1	1	0		1	17.50	170,531
2004	2006				0	0	0	0		0		47,689
2005	2007		0		0	0	0	0		0		75,254
2009	2011		0	0	0	21	0	0		1	2.92	21,912
2010	2012		0	0	1	0	0	0		0.2	2.94	119,100
2011	2013		0	0	0	4	0	59		1	8.57	143,654
2012	2014		0	0	0	2	3	0		1	6.14	81,506
SF comm avg			0	1	0	3	0	5		1		

Monterey Management Area Commercial CWT Recoveries

Broodyr	Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Avg	Exp CWTs*	Total catch
1998	2000		0	2	0	0				1	10.72	197,184
1999	2001		0	0	0	0	0			0		35,940
2000	2002		0	0	3	0	0			1	6.97	69,980
2001	2003		0	0	0	0	0			0		36,099
2002	2004		2	5	32	54	0			11	68.60	64,707
2003	2005		0	12	1	21	0			2	21.82	117,408
2004	2006		0	0	0	0	0			0		11,204
2005	2007		0	0	0	0	0			0		14,009
2009	2011		14	60	0	224	0			33	21.31	6,414
2010	2012		0	0	0	112	232			5	24.06	52,972
2011	2013		0	2	26	147	0			6	17.23	27,637
2012	2014		0	0	63	75				20	15.28	7,566
MO comm avg			1	7	10	53	23			7		

Comm avg	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Avg
		1	4	5	28	12	5		4

* - Winter-run CWTs expanded for hatchery production and sampling rate

= 26" TL size limit
= 27" TL size limit
= 28" TL size limit

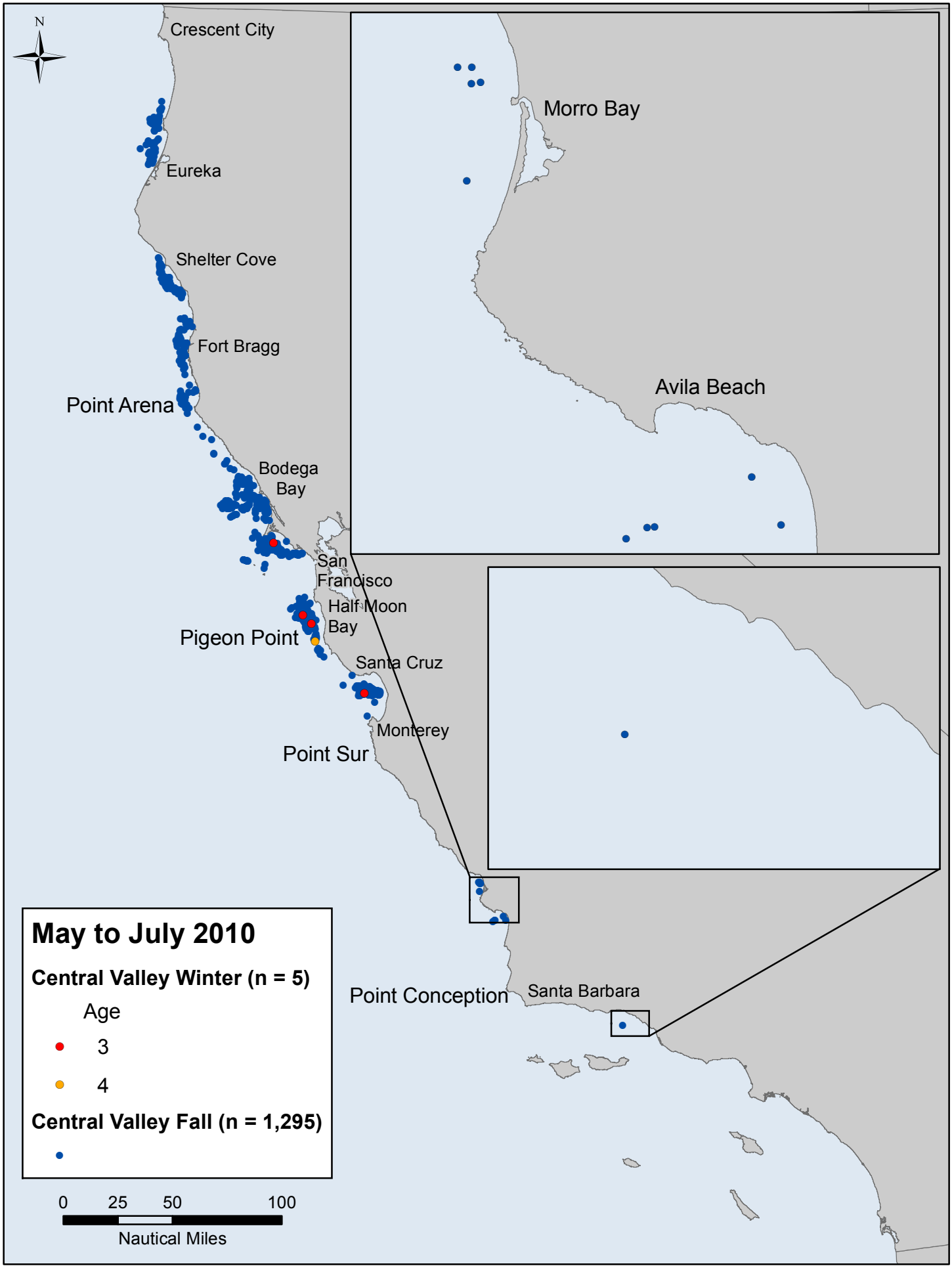

Figure 1a. Map of Central Valley winter-run (by age) and fall-run Chinook identified from tissue and scales samples collected during May through July 2010 in CA-GSI collaborative study.

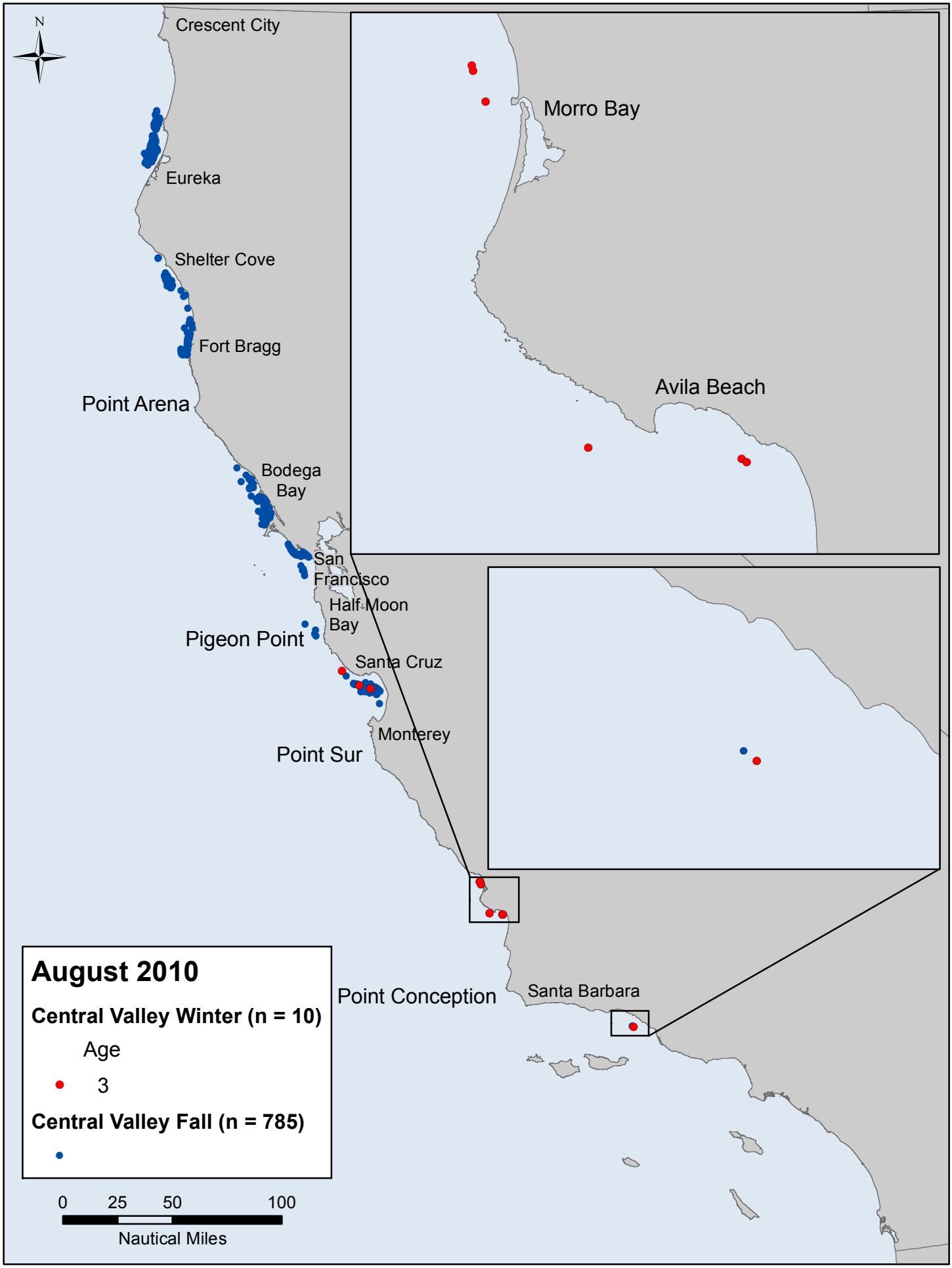

Figure 1b. Map of Central Valley winter-run (by age) and fall-run Chinook identified from tissue and scales samples collected during August 2010 in CA-GSI collaborative study.

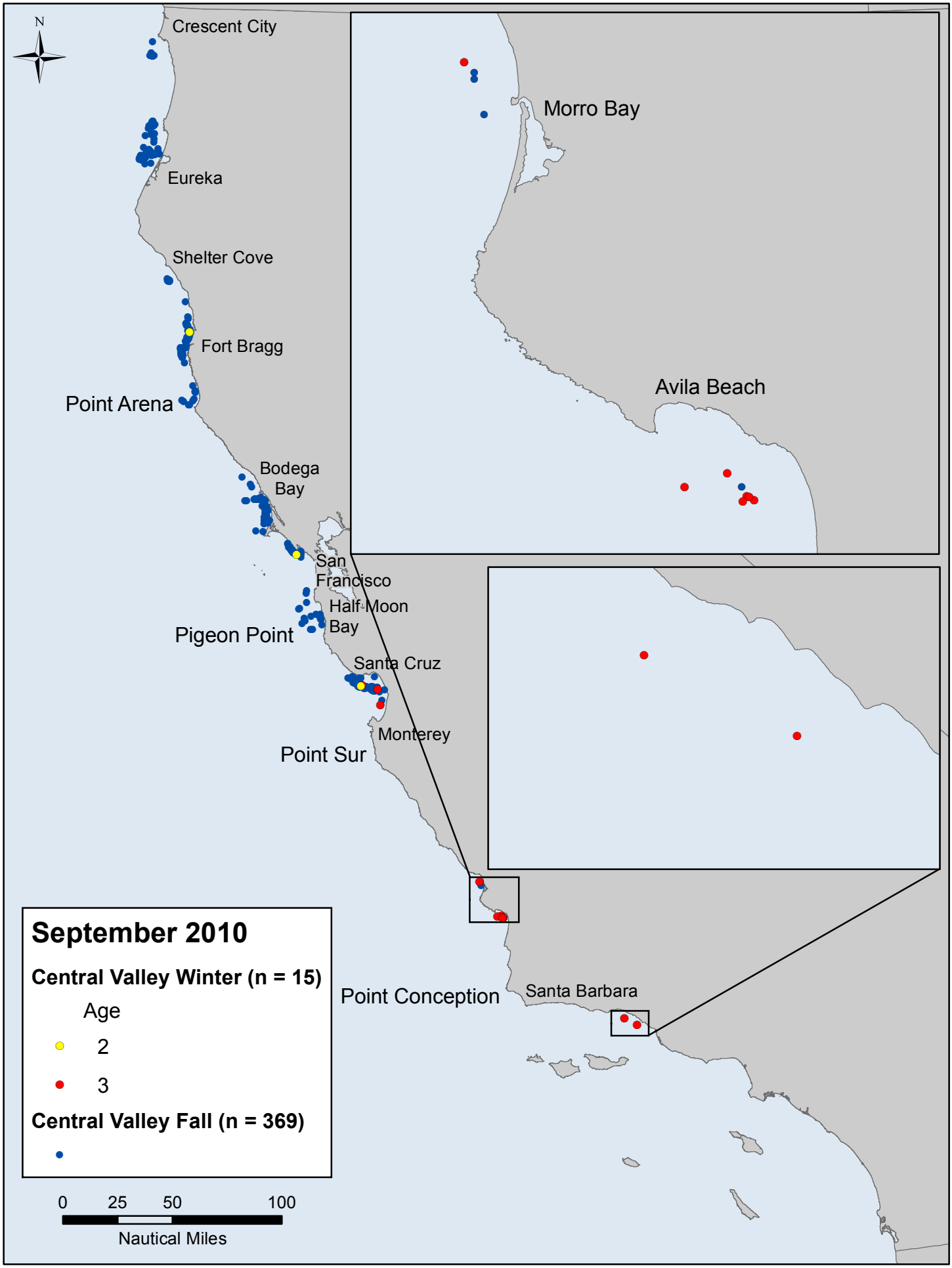

Figure 1c. Map of Central Valley winter-run (by age) and fall-run Chinook identified from tissue and scales samples collected during September 2010 in CA-GSI collaborative study.