Lake Chelan Kokanee Spawning Ground Surveys
2008
Final Report

Spawning kokanee (*Oncorhynchus nerka*) in Company Creek – Chelan County PUD, 2005. (Photo by Brad Buchsieb)

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January, 2009

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Introduction

Annual kokanee *(Oncorhynchus nerka)* and chinook *(Oncorhynchus tshawytscha)* salmon spawning ground surveys have been conducted within the Lake Chelan drainage by the Chelan County Public Utility District (District) since 1984. The District conducts these surveys as part of the Lake Chelan Fishery Plan (LCFP), which is included in Article 404 of the new Project License (FERC Project No. 637). The purpose of the District's spawning surveys within the basin is to document the annual trends of kokanee and chinook spawning populations and the effects of management actions within the Lake Chelan drainage.

Kokanee were stocked into Lake Chelan in 1917 and became the dominant sport fish in the lake until the mid 1970s. Kokanee populations declined after introductions of opossum shrimp *(Mysis relicta)* in 1967 (Brown 1984). Mysids were introduced to provide additional forage for kokanee; however, they appeared to be competitors with younger age classes of kokanee for the limited food sources in the lake. Mysids are generally not available to kokanee as forage, because they prefer to inhabit deeper water during daylight hours while kokanee feed near the surface (Peven 1989).

Chinook were originally introduced into Lake Chelan by the Washington Department of Fisheries (WDF) [1] in the mid 1970s and again in the 1990s to provide for a "trophy" fishery. The chinook grew well for the first few seasons, but their growth appeared to be tied to the abundance of kokanee (Brown 1984). The chinook have established an adfluvial population, with adult fish being observed on the spawning grounds and taken in the sport fishery.

Study Area and Methods

Most tributaries of Lake Chelan are generally steep and short (Figure 1). The Stehekin River is the principle tributary feeding the lake. The Stehekin is a relatively large glacial stream with the headwaters originating in the Cascade Mountains. The drainage covers an area of 321 square miles. The monthly mean flow for the Stehekin ranged between 500 and 3,725 cubic feet per second, based on data from water years 2003-2007(*Water Watch)* courtesy of the U.S. Geological Survey. Kokanee spawn in the Stehekin River and primarily in two tributaries of the Stehekin: Company and Blackberry Creeks (Figure 3). Except for the Stehekin River, kokanee do not travel far up the other Lake Chelan tributaries to spawn. The steep gradient of the streams usually confines kokanee spawning to the lower quarter mile. Kokanee run timing along Lake Chelan starts in the Stehekin Valley and progresses down lake throughout the spawning migration. The down lake streams included in the annual spawning ground surveys are Fish, Prince, Safety Harbor, Grade, Gold, and Mitchell creeks (all on the north shore) and 25-Mile and First creeks on the south shore.

[1] In 1994, Washington Department of Fisheries (WDF) and Washington Department of Wildlife (WDW) merged to form Washington Department of Fish and Wildlife (WDFW).

In 2008, district personnel conducted surveys between 4 September and 30 October every 7 to 14 days (Table 1). Surveys consist of walking in or along streams and counting all live kokanee and chinook. Large masses of kokanee congregating in pools are estimated. Data collected during these surveys are used to determine spawner days and escapement.

Spawner days are the total number of days spent in a stream by a population of fish in order for them to spawn. The estimated number of spawner days for each stream is determined by graphing the number of live fish counted over time and then by calculating the area of the resulting polygons (McNeil 1964; Neilson and Geen 1981; Shepherd et al. 1986).

Escapement is the number of adult fish returning to a stream that escape mortality from harvest and natural attrition, and comprise a spawning population (WDFW 2000). Kokanee escapement is calculated by dividing the estimated number of spawner days by the average time of spawner residence in the stream. The average spawner residence for kokanee is estimated to be 15 days (Brown 1984). The escapement for chinook spawners is estimated by using the same method used for kokanee (McNeil 1964; Neilson and Geen 1981; Shepherd et. al. 1986). The average spawner resident time for chinook is estimated to be 13 days. According to Neilson and Geen (1981), a spawner resident time of 13 days is considered to be high and as a result, the escapement estimates are conservative.

Results and Discussion

Kokanee Spawners

Escapement is considered to be a better indicator of run size than peak counts. Escapement indicates the total number of fish that spawn in a stream during the entire spawning season. Peak counts only indicate the maximum number of spawners observed in a stream at one time during the spawning season.

Company Creek

In 2008, surveyors counted 1,285 kokanee in Company Creek during the first survey on 4 September, with a peak count of 6,619 kokanee occurring on 25 September (Tables 1 and 2). The estimated escapement for Company Creek is 16,246 kokanee (Table 3). In 2007 Company Creek had a peak count of 7,149 kokanee and an estimated escapement of 19,182 (Tables 2 and 3). The number of kokanee spawners in Company Creek has declined since 2006 (Table 3).

Blackberry Creek

In 2008, Surveyors counted 881 kokanee in Blackberry Creek during the first survey on 4 September, with a peak count of 1,605 kokanee occurring on 25 September (Tables 1 and 2). The estimated escapement for Blackberry Creek is 4,622 kokanee (Table 3) In 2007, Blackberry Creek had a peak count of 4,841 kokanee with an estimated escapement of 10,523 (Tables 2 and 3). The number of kokanee spawners in Blackberry Creek has declined since 2004 (Table 3).

Down Lake Tributaries

Kokanee were first observed in the down lake tributaries on 18 September. The spawning activity in these down lake tributaries is generally short in duration.

Fish Creek

In 2008, Fish Creek had a peak count of 10 kokanee which occurred on 18 September (Tables 1 and 2). The estimated escapement is 8 kokanee (Table 3). In 2007, the woody debris that had been blocking the mouth of Fish Creek in 2006 was no longer present and kokanee spawners were able to access the stream. In 2007, Fish creek had a peak count of 220 with an estimated escapement of 172. In 2006 due to the large amount of woody debris that collected at the mouth of Fish Creek during the 2006 spring runoff, returning kokanee spawners could not access the stream. Surveyors did observe kokanee congregating at the mouth but no kokanee were observed within the stream. In 2005, Fish Creek had a peak count of 351 kokanee with an estimated escapement of 482 fish (Tables 2 and 3).

Prince Creek

In 2008, Prince Creek had a peak count of 2 kokanee which occurred on 25 September (Tables 1 and 2). The estimated escapement is 2 kokanee (Table 3). In 2007, Prince Creek had a peak count of 57 kokanee with an estimated escapement of 45 kokanee (Tables 2 and 3). In 2006, Prince Creek had a peak count of 72 kokanee with an estimated escapement of 93 kokanee (Tables 2 and 3).

Habitat improvement structures placed in the stream by WDFW and the United States Forest Service (USFS) make it difficult for spawning kokanee to ascend upstream. The access to kokanee spawners in 2008 was blocked a short distance from the mouth due to a log structure (Appendix B). No spawners were observed above this structure. For more information about the habitat improvement structures please refer to Stone and Fielder (2004).

Safety Harbor Creek

In 2008, Safety Harbor Creek had a peak count of 21 kokanee on 2 October (Tables 1 and 2). The estimated escapement was 20 kokanee (Table 3). In 2007, Safety Harbor Creek had a peak count of 5 kokanee with an estimated escapement of 4 kokanee (Tables 2 and 3). Low flow and debris made it difficult for spawners to ascend very far upstream (Appendix C.). In 2006, Safety Harbor Creek had a peak count of 119 kokanee with an estimated escapement of 149 kokanee (Tables 2 and 3). A log jam was dislodged during the 2006 spring runoff making it easier for kokanee to ascend further up the stream.

Grade Creek

No kokanee were observed in Grade Creek during the 2008 kokanee spawning surveys. In 2007 and 2006 no kokanee were observed in Grade Creek during the kokanee spawning surveys; however, in 2006 surveyors did observe kokanee congregating at the mouth. In 2005, the peak count for Grade Creek was 13 kokanee with an estimated escapement of 7 fish (Tables 2 and 3).

Gold Creek

No kokanee have been observed in Gold Creek from 2006 through 2008 spawning surveys (Table 2). In 2005, the peak count for Gold Creek was 14 kokanee with an estimated escapement of 7 kokanee (Tables 2 and 3).

Mitchell Creek

No kokanee were observed in Mitchell Creek during the 2007 and 2008 spawning surveys. In 2006 Mitchell Creek had a peak count of 10, with an estimated escapement of 7 (Tables 2 and 3). No kokanee were observed spawning in Mitchell Creek from 2003-2005.

25-Mile Creek

In 2008, 25-Mile Creek had a peak count of 320 kokanee which occurred on 2 October (Tables 1 and 2). The estimated escapement is 519 kokanee (Table 3). In 2008, kokanee spawners were observed a short distance above the culvert that passes under the South Lake Shore Road. In 2007, 25-Mile Creek had a peak count of 12 kokanee (Tables 1 and 2) with an estimated escapement of 22 kokanee (Table 3). No kokanee spawners were observed in 2007 above the culvert that passes under the South Lake Shore Road due to low water flow and blockage (Appendix A). In 2006 25-Mile Creek had a peak count of 284 kokanee, with an estimated escapement of 319 kokanee (Tables 2 and 3).
The man-made spawning channel was rendered unusable since the fall of 2004 by a flood occurring in the 25-Mile Creek drainage causing the spawning channel to fill completely with silt and stopping water flow through the channel (Appendix A). For more information about the construction and maintenance of the spawning channel, please refer to Stone and Fielder (2004).

First Creek

In 2008, First Creek had a peak count of 144 kokanee which occurred on 2 October (Tables 1 and 2). The estimated escapement is 200 kokanee (Table 3). No kokanee were observed in First Creek during the 2007 kokanee spawning surveys. In 2006 First Creek had a peak count of 44 kokanee with an estimated escapement of 30 fish (Tables 2 and 3). During 2006 the upstream passage of kokanee was blocked by spring runoff debris. This blockage occurred downstream of the South Lake Shore Road bridge, within the Chelan State Park boundary.

Chinook Spawners

Company Creek

In 2008, Company Creek had a peak count of 7 chinook with an estimated escapement of 9 (Tables 4 and 5). In 2007, Company Creek had a peak count of 2 chinook with an estimated escapement of 3 (Tables 4 and 5). No chinook spawners were observed in Company Creek in 2006. In 2005, Company Creek had a peak count of 18 chinook with an estimated escapement of 19 which was the highest escapement since 1995 (Tables 4 and 5).

Blackberry Creek

In 2008, Blackberry Creek had a peak count of 5 chinook with an estimated escapement of 8 (Table 4). In 2007, Blackberry Creek had a peak count of 3 chinook with an estimated escapement of 5 (Table 4). In 2006, Blackberry Creek had a peak count of 3 chinook with an estimated escapement of 5 fish (Table 4). In 2005, Blackberry Creek had a peak count of 17 chinook with an estimated escapement of 14 fish (Table 4).

Summary and Conclusions

Company, Blackberry, Safety Harbor, 25-Mile, and First creeks have been surveyed consistently since 1981. Between 1984 and 1989, these creeks comprised approximately 97.1% to 99.6% of the kokanee escapement when all streams with spawning habitat were surveyed (Peven 1990). From 1981 to 2005, there has been an overall steady increase in the estimated kokanee escapement for Company, Blackberry, Safety Harbor, 25-Mile, and First creeks. However, the estimated kokanee escapement for 2006 decreased greatly due to a flood event that occurred in the fall of 2003 in the Stehekin valley (Figure 2) which likely scoured many of the kokanee redds. In 2007 kokanee escapement decreased from 2006 perhaps due to the effects of the 2003 flood event. In 2007, there were a much lower number of kokanee spawners in Safety Harbor and 25-Mile creeks and no spawners were observed in First Creek. The estimated escapement for these aforementioned streams in 2008 is 21,607 kokanee. In addition, Fish Creek and Prince Creek have also been used by a small number of kokanee spawners.

The majority of kokanee spawners are either 3 or 4 year old fish (2+ and 3+ fish) (Peven 1990). The number of fish observed on the spawning grounds in 2008 reflects the number of spawners in 2004 and 2005 and the survival rate of progeny from those two years.

Mysids are present in Lake Chelan. Mysids may compete with younger age classes of kokanee for food and can have a substantial impact on the kokanee population in the lake. Large predatory fish such as chinook and lake trout can also adversely affect a kokanee population. Based on kokanee spawning surveys, the kokanee population in the Lake Chelan drainage has declined since 2003.

Hatchery Enhancement Efforts

Article 6(d) and Section 4.6.3 of Chapter 6 of the Comprehensive Plan require Chelan PUD to make available to the WDFW sufficient funding to rear annually the following resident fish at the Chelan Hatchery for stocking in Lake Chelan:

1. Approximately 5,000 pounds of salmonid fingerlings (for example: 500,000 fish at 100 fish/lb., presently kokanee).

2. Approximately 33,000 pounds of catchable-sized salmonids (for example: approximately 100,000 fish at 3 fish/lb., presently Westslope cutthroat trout and triploid rainbow trout).

As provided in Article 6(d) (1), the estimated cost to Chelan PUD of these activities is $30,000 per year (in 2003 dollars).

Article 6(d) (2) and Section 4.6.3 of Chapter 6 of the Comprehensive Plan provide that:

> (2) If WDFW, after coordination with the National Park Service, United States Department of Agriculture Forest Service, and United States Fish and Wildlife Service, and after consultation with the Lake Chelan Fishery Forum, decides, at any time during the term of the New License or any subsequent annual licenses, to reduce or eliminate fish stocking into Lake Chelan, the resulting savings shall be available to WDFW for other Lake Chelan fish management activities. Funds to be made available from reductions in fish production shall be determined as equivalent to the proportion of fish production poundage reduced. The funds saved shall be calculated as follows: take the number of pounds of fish production reduced, divide by the 38,000 pounds of fish initially to be produced, and multiply by the $30,000 (as adjusted under section 19 of the Agreement up to the year of the decision to reduce production). For example, if 5,000 pounds of kokanee production was eliminated, $3,950 would be available for other fish management activities (5,000/38,000 x $30,000 escalated = $3,950 escalated).

Acknowledgements

Several District employees assisted with spawning surveys this fall. Todd West assisted with manpower and administrative support. Bob Nielsen coordinated transportation arrangements for the field work in the Stehekin Valley. Fish and Wildlife personnel assisting with surveys included: Barry Keesee, Steve Hemstrom, Joe Miller, and Lance Keller.

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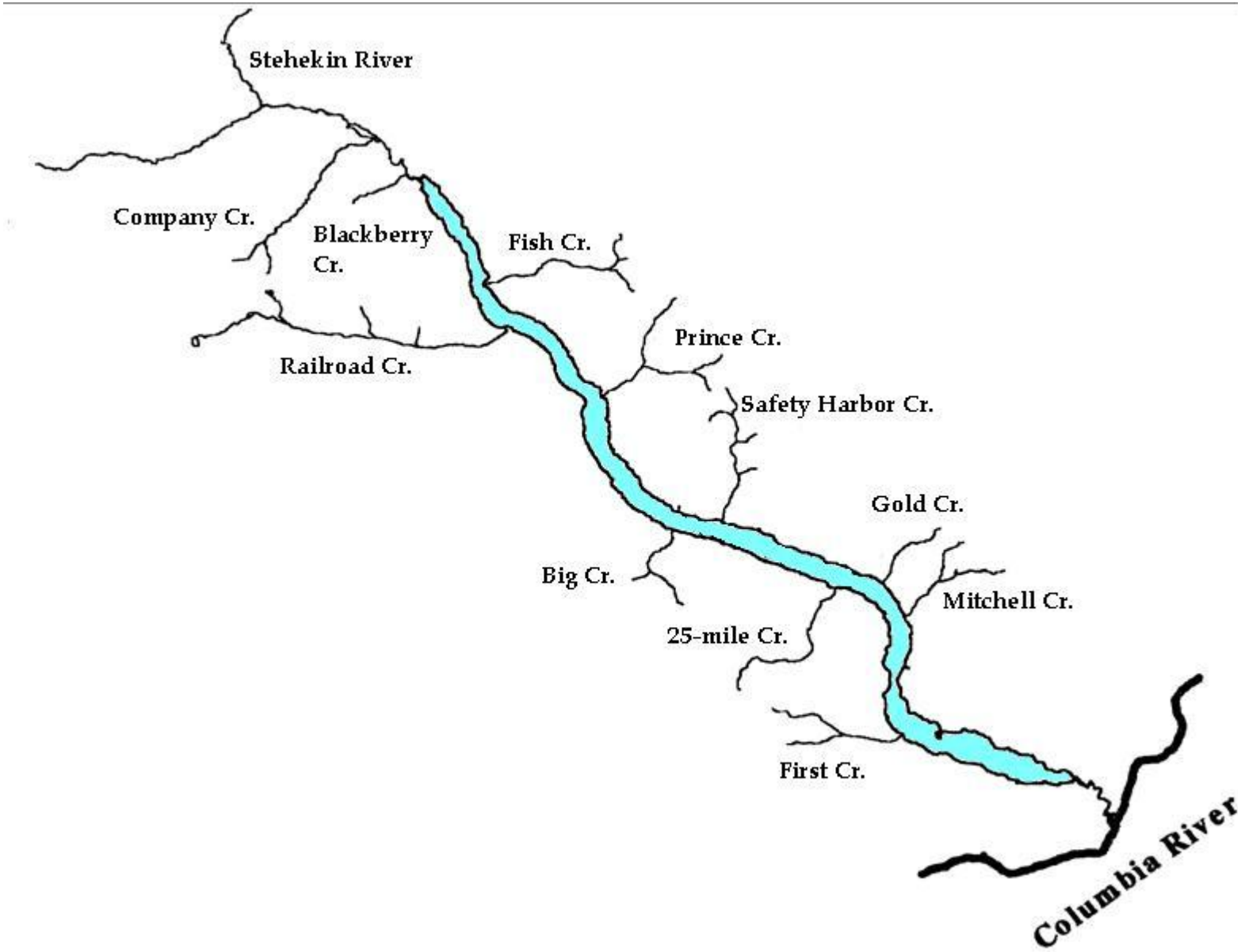
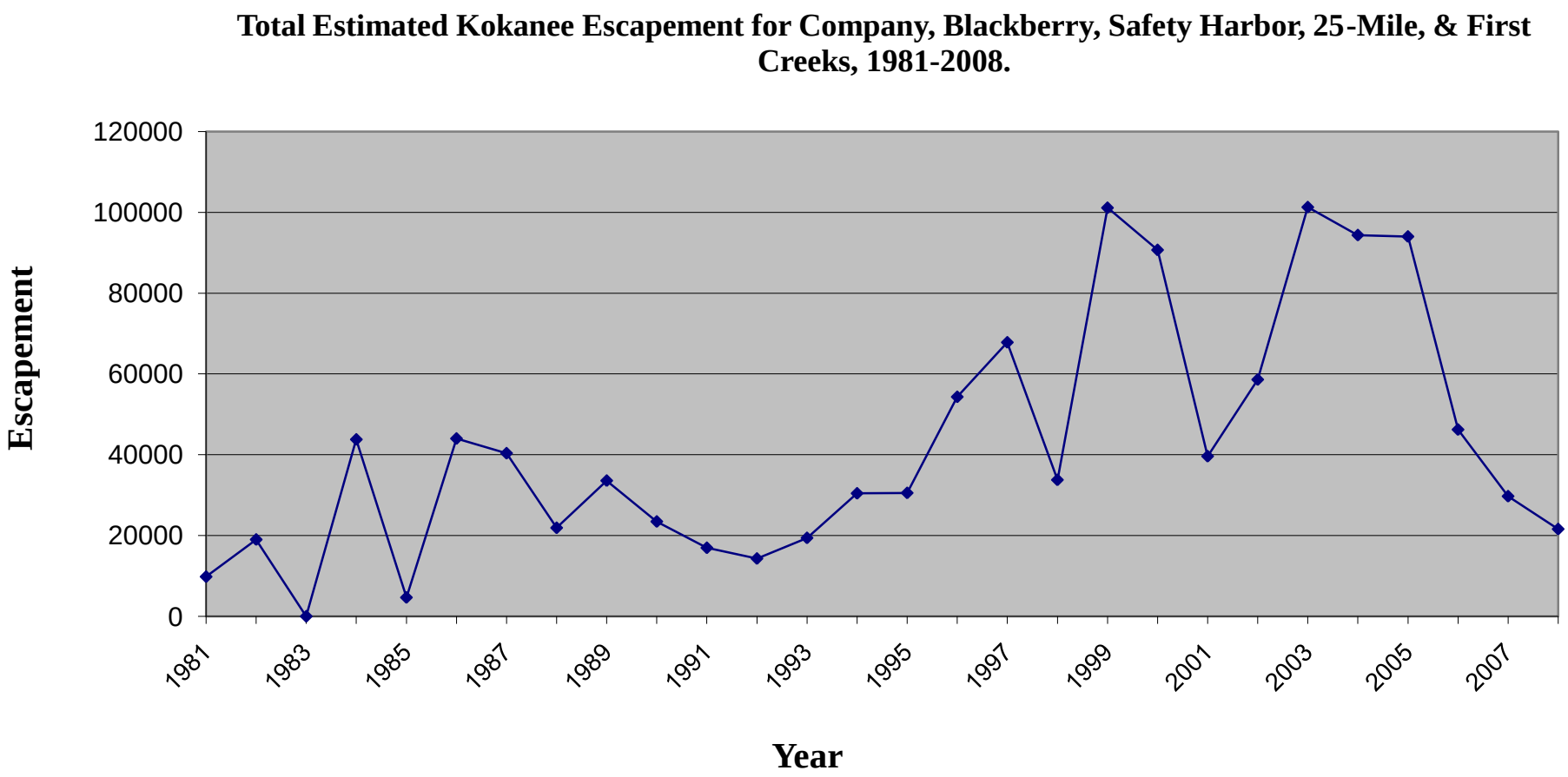


Figure 1. Lake Chelan Drainage With Associated Kokanee Spawning Streams.



Note: No surveys were conducted in 1983.

Figure 2. Total Estimated Kokanee Escapement for Company, Blackberry, Safety Harbor, 25-Mile, and First Creeks, 1981-2008.

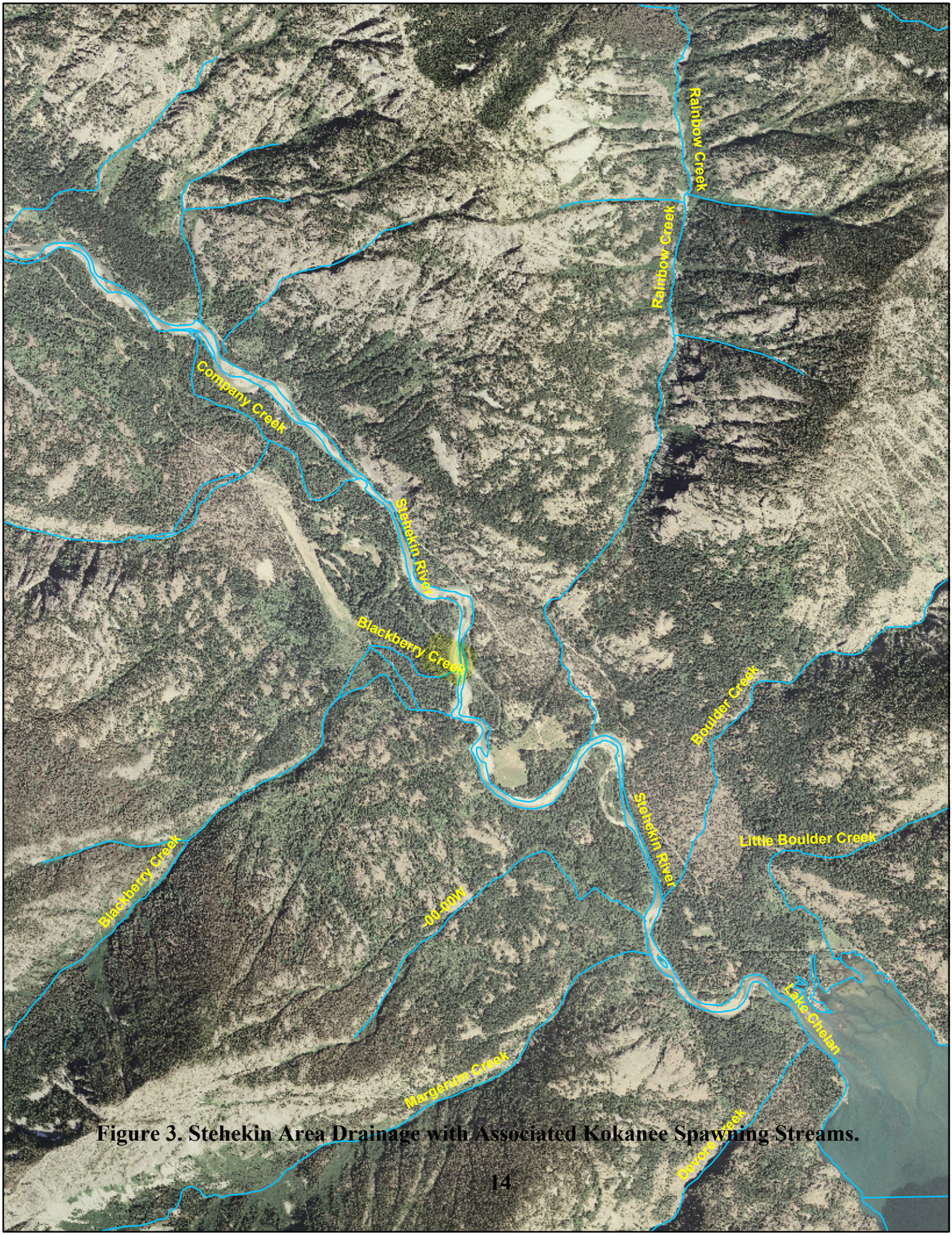


Figure 3. Stehekin Area Drainage with Associated Kokanee Spawning Streams.

Table 1. Kokanee Spawners Observed in Lake Chelan Tributaries, 2008.

	Survey Dates												
Tributaries	**4-Sep**	**11-Sep**	**18-Sep**	**19-Sep**	**25-Sep**	**26-Sep**	**2-Oct**	**9-Oct**	**10-Oct**	**16-Oct**	**23-Oct**	**24-Oct**	**30-Oct**
Company Creek	1,285	3,987	6,442		6,619			5,060			1,956		
Blackberry Creek	881	925	1,321		1,605			1,483			893		
Fish Creek			10		6			0					
Prince Creek			2		2		1	0					
Safety Harbor			0		5		21	16					
Grade Creek							0						
Gold Creek							0						
Mitchell Creek							0						
25-Mile Creek				124		245	320		226	161		76	24
First Creek				16		120	144		101	50		1	0

Table 2. Peak Kokanee Spawner Counts in the Lake Chelan Drainage, 1981-2008.

Spawning Area	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Company Creek	1,473	6,052		12,753	1,547	14,527	11,668	8,684	8,292	8,306	8,123	5,673	7,682	14,799
Blackberry Creek				3,639	233	1,844	875	645	1,544	842	588	742	823	1,614
Safety Harbor	1,020	1,820		1,180	131	2,174	969	424	1,652	490	68	105	533	90
25-Mile Creek	1,808	2,492		1,801	228	1,147	1,168	487	2,983	859	83	94	201	52
First Creek	611	479		703	72	1,593	1,495	294	778	348	51	88	150	34
Mitchell Creek	99	138		342		289	298	186	198					
Gold Creek	2	4		285		42	77	24	56					
Grade Creek	42	39		210		63	138	54	73					
Prince Creek	53	50		208		16	26	18	63					
Fish Creek	75	140		165	8	265	350	142	194					
Stehekin River (lower 6.5 miles)						12502	2188	1639						
Total of Company, Blackberry, Safety-Harbor, 25-Mile, and First Creek	4,912	10,843	0	20,076	2,211	21,285	16,175	10,534	15,249	10,845	8,913	6,702	9,389	16,589

Spawning Area	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Company Creek	12,832	22,232	20,895	11,444	22,667	19,841	10,058	16,388	26,320	35,445	26,951	14,649	7,149	6,619
Blackberry Creek	1,948	3,002	9,756	3,225	13,521	18,214	6,966	13,046	20,596	17,100	13,158	6,437	4,841	1,605
Safety Harbor	357	970	87	688	1,008	258		101		2	20	119	5	21
25-Mile Creek	123	262	62	236	1,159	46	122	465	112	17	727	284	12	320
First Creek	115	127	3	32	835	6	84	375	0	34	462	44	0	144
Mitchell Creek				26	267	0		12	0	0	0	10	0	0
Gold Creek				104	70	0		1	0	0	14	0	0	0
Grade Creek				140	118	0		65	0	0	13	0	0	0
Prince Creek				312	229	4		269	73	184	246	72	57	2
Fish Creek				746	373	16		359	49	261	351	0	220	10
Stehekin River (lower 6.5 miles)				8,621	12,090		7,032	5,148						
Total of Company, Blackberry, Safety-Harbor, 25-Mile, and First Creek	15,375	26,593	30,803	15,625	39,190	38,365	17,230	30,375	47,028	52,598	41,318	21,533	12,007	8,709

Table 3. Estimated Kokanee Escapement in the Lake Chelan Drainage, 1981-2008.

Spawning Area	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Company Creek	5,010	13,162		27,324	3,496	31,723	31,981	18,375	20,137	19,057	15,387	12,317	15,919	26,654
Blackberry Creek				10,128	553	4,089	2,079	1,723	3,511	1,690	1,289	1,702	1,900	3,599
Safety Harbor	2,384	2,880		1,891	164	3,894	1,996	671	3,132	845	85	86	993	86
25-Mile Creek	1,808	2,492		3,466	380	2,202	2,079	873	5,645	1,338	136	143	422	54
First Creek	611	479		990	75	2,112	2,246	269	1,170	540	68	57	179	54
Mitchell Creek	116	109		348		243	300	152						
Gold Creek	1	29		267	0	47	60	21						
Grade Creek	21	37		184		100	177	63						
Prince Creek	103	37		230		21	24	15						
Fish Creek	137	173		153	10	397	581	189						
Total of Company, Blackberry, Safety-Harbor, 25-Mile and First	**9,813**	**19,013**	**0**	**43,799**	**4,668**	**44,020**	**40,381**	**21,911**	**33,595**	**23,470**	**16,965**	**14,305**	**19,413**	**30,447**

Spawning Area	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Company Creek	25,194	44,206	44,991	23,342	59,298	41,814	23,255	33,349	54,376	58,231	63,256	32,927	19,182	16,246
Blackberry Creek	4,339	7,708	22,642	9,035	36,817	48,410	16,138	23,962	46,797	36,125	29,177	12,815	10,523	4,622
Safety Harbor	643	1,610	105	1,008	1,544	437		101		1	18	149	4	20
25-Mile Creek	240	592	93	357	2,273	46	162	654	136	15	1,022	319	22	519
First Creek	135	224	2	44	1,215	6	80	557	0	20	566	30	0	200
Mitchell Creek				26	267	0		14	0	0	0	7	0	0
Gold Creek				104	79	0		1	0	0	7	0	0	0
Grade Creek				140	167	0		73	0	0	7	0	0	0
Prince Creek				401	382	4		269	73	235	245	93	45	2
Fish Creek				1,278	465	21		361	49	390	482	0	172	8
Total of Company, Blackberry, Safety-Harbor, 25-Mile and First	**30,551**	**54,340**	**67,833**	**33,786**	**101,147**	**90,713**	**39,635**	**58,623**	**101,309**	**94,392**	**94,039**	**46,240**	**29,732**	**21,607**

Table 4. Peak Chinook Spawner Counts in Company Creek and Blackberry Creek, 1993-2008.

Spawning Area	1993	1994	1995	1996	1997	1998	1999	2000
Company Creek	6	6	13	2	9	2	12	6
Blackberry Creek	1	1	0	0	5	1	1	4

Spawning Area	2001	2002	2003	2004	2005	2006	2007	2008
Company Creek	6	1	2	1	18	0	2	7
Blackberry Creek	4	3	14	18	17	3	3	5

Table 5. Estimated Chinook Escapement in Company Creek, 1984-2008

Year	Chinook
1984	153
1985	160
1986	23
1987	66
1988	57
1989	106
1990	81
1991	24
1992	31
1993	12
1994	7
1995	25
1996	5
1997	14
1998	3
1999	18
2000	15
2001	11
2002	5
2003	3
2004	3
2005	19
2006	0
2007	3
2008	9

Table 6. Numbers of Kokanee Salmon Stocked into Lake Chelan From 1994 to 2008.

Year	Number	Date released	Release location	Stock used
1994	756,315	April, May	25-Mile Ck	LW, OR
1995	452,400	May	25-Mile Ck	LW
1996	71,060	April	25-Mile Ck	LW
1997	505,659	May	25-Mile Ck	LW
1998	933,021	April, May	Lake & 25-Mile Ck	LW
1999	329,322	April	Lake	LW
2000	478,266	April	Lake	LW
2001	286,831	April	Lake	LW
2002	467,291	May 6, 21, 24	Lake	LW
2003	499,953	May 9, 17, 22	Lake	LW
2004	515,838	May, June	Lake	LW
2005	478,956	May 10, 17, June 13	Lakeside & Mill Bay	LW
2006	0	NA	NA	NA
2007	91,643	May	Lake	LC, LW
2008	224,000	May	Yacht Club	LC
Total	**6,090,555**			

Key for fish stock:

SH = Safety Harbor (Lake Chelan)
FIRST = First Creek (Lake Chelan)
25-M = Twentyfive Mile Creek (Lake Chelan)
ID = Idaho (unspecified)
OR = Oregon (unspecified)
LP = Lake Paulina (Oregon)
WF = Wizard Falls (Oregon)
YAK = Yakima (Washington)
LW = Lake Watcom (Washington)
LC = Lake Chelan (Washington)

Appendix A: 25 Mile Creek and Spawning Channel

Appendix A. 25-Mile Creek Spawning Channel, (Photos taken in 2007).

Appendix B: Prince Creek Blockage

Appendix B. Prince Creek Blockage, (Photos taken in 2007).

Appendix C: Safety Harbor Debris

Appendix C. Safety Harbor Creek Debris and Blockage.
(Photos taken in 2007).