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Abundance and Run Timing of Dolly Varden in the Kanektok River, Togiak National Wildlife Refuge, 2008 - 2010

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Mark J. Lisac

Abstract

The anadromous Dolly Varden *Salvelinus malma* annual run in the Kanektok River has been estimated using a salmon escapement monitoring weir since 2002. The Dolly Varden run has averaged 11,519 fish during 2002 to 2007 with a high of 15,674. The 2008 run was only 71% (N = 8,140) of the long term average, but extreme high water delayed the weir installation by 22 days and high water allowed some fish to swim over the weir during much of the operational period in July. Although the project was slightly delayed in 2009 and 2010, the runs were back to back record returns at 26,066 and 43,292 fish, respectively. Run timing during 2009 and 2010 was the earliest on record with the mid point of the run occurring 15 and 6 days earlier than the historical average mid point of 25 July, respectively. We recommend continuing to monitor Dolly Varden returns at the Kanektok River weir from late June through mid August.

Introduction

Anadromous Dolly Varden *Salvelinus malma* are an important component of the subsistence harvest, the sport fishery, and the ecosystem in the Kanektok River drainage in southwestern Alaska. Although no specific harvest number is available for the Kanektok River Dolly Varden subsistence fishery, Dolly Varden accounted for 24% of the per capita weight of all subsistence harvested fish in Quinhagak in 1983 (Wolfe et al.1984). Between 2000 and 2009, the sport catch has averaged 22,168 char (Dolly Varden and Arctic char *Salvelinus alpinus* combined) in the entire Kanektok River and has ranged from 13,000 to over 36,000 fish per year (Chythlook 2009 and in prep.). This is the highest estimated Dolly Varden catch among all sport fisheries in the Kuskokwim region. Sport harvest for this same time period has averaged fewer than 400 fish.

Dolly Varden in Kanektok River seem to follow a similar anadromous life history pattern as other populations in southwestern Alaska (Lisac and Nelle 2000; Lisac 2004, 2007b, 2008b, 2009, 2010), South-central Alaska (Whalen 1993; Larson 1997), Northwest Alaska (DeCicco 1985) and in Southeast Alaska (Armstrong 1984). Juvenile Dolly Varden spend one to three years in freshwater before smolting and migrating to sea during the spring. They return to freshwater throughout the summer and fall after 30 to 110 days at sea. Immature and nonspawning fish do not necessarily return to their river system of origin, while spawners return to their home waters during the summer. After spawning in the fall they spend the winter in the main rivers and lakes mixed with immature and nonspawning mature fish from both local and non-local stocks. The annual return to freshwater generally begins with mature fish entering the

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rivers early in the run, and the immature and nonspawning fish arriving later. Timing of migration to the sea has generally corresponded with spring ice-out and high water, whereas the return to freshwater appears to be related to decreased water discharge (DeCicco 1985; Lisac and Nelle 2000).

The Dolly Varden annual run in the Kanektok River has been monitored through a cooperative project between the Alaska Department of Fish and Game, the Native Village of Kwinhagak, the Office of Subsistence Management, Coastal Villages Region Fund and Togiak National Wildlife Refuge since 2002. The Dolly Varden total run and annual run timing have been estimated using a resistance board (floating) weir designed for salmon escapement enumeration (Lisac 2006, 2007a, 2008a). The weir has a spacing of 4.3cm between pickets to accommodate the river discharge to primarily block salmon migration. Comparisons between weir live trap and seine caught Dolly Varden indicate that the weir is consistently successful at holding back fish approximately 420 mm and greater, although fish of all size ranges are counted through the weir (Lisac 2006). The weir provides a minimal count, but is a reasonable estimate of run strength as long as the weir is operated consistently between years. The weir operation is targeted to begin by 25 June. The weir was operated through September during all years prior to 2008. Late season high water had resulted in crew safety concerns and damage to the weir. Beginning in 2008, the cooperators agreed to terminate weir operation in August. For all years from 2002 to 2007, the run has averaged 11,519 fish and has ranged between 9,195 and 15,674 fish (Lisac 2006, 2007a, 2008a). For most years fish first reach the weir in early July with the majority of the run occurring between 16 July and 7 August. The mean midpoint of the run has occurred on 25 July.

The purpose of this report is to compile the annual Dolly Varden run data collected during the 2008, 2009 and 2010 seasons and present a comparison with runs monitored since 2002 (Estensen and Diesigner 2003, 2004; Linderman 2005; Jones and Linderman 2006; Lisac 2006, 2007a, 2008a; Pawluk and Jones 2007; Clark and Linderman 2009; Taylor and Clark 2010; Taylor and Elison 2010).

Study Area

The Kanektok River drainage lies along the northern boundary of the 4.7 million acre Togiak National Wildlife Refuge (Refuge) in southwest Alaska (Figure 1). The river originates in the Ahklun Mountains in the northeast corner of the Refuge and drains approximately 2,261 km^2. The Kanektok River flows from Kagati and Pegati lakes, elevation 320 m, and flows west for 146 km to the Bering Sea at Kuskokwim Bay. Numerous unnamed tributaries feed the lakes. Two named tributaries, Atmugiak and Akamunak creeks, feed Kagati Lake. The upper portion of the river is a single channel as it flows through mountain valleys. The river emerges from the mountains and flows across a broad alluvial plain composed primarily of gravel substrate where the river becomes braided with multiple side channels. The upper 116 km of the Kanektok River are within the Refuge Wilderness Area while the lower 30 km of river are bordered by Quinhagak Village corporation lands. The Village of Quinhagak is located near the mouth of the Kanektok River at Kuskokwim Bay.

The project weir is located approximately 70 river km upstream of Kuskokwim Bay. Four major tributaries flow from the south and join the Kanektok River upstream of the weir site and below Kagati Lake. They are (from lower to uppermost): Takshilik, Nukluk, Klak, and Kanuktik

creeks. Several smaller named tributaries flow from the north: Quickumguila, Olumagwilute, Sam, Nakailingak, Amakatatee and Paiyun creeks. Only Kanuktik and Klak creeks have headwater lakes of any significant size.

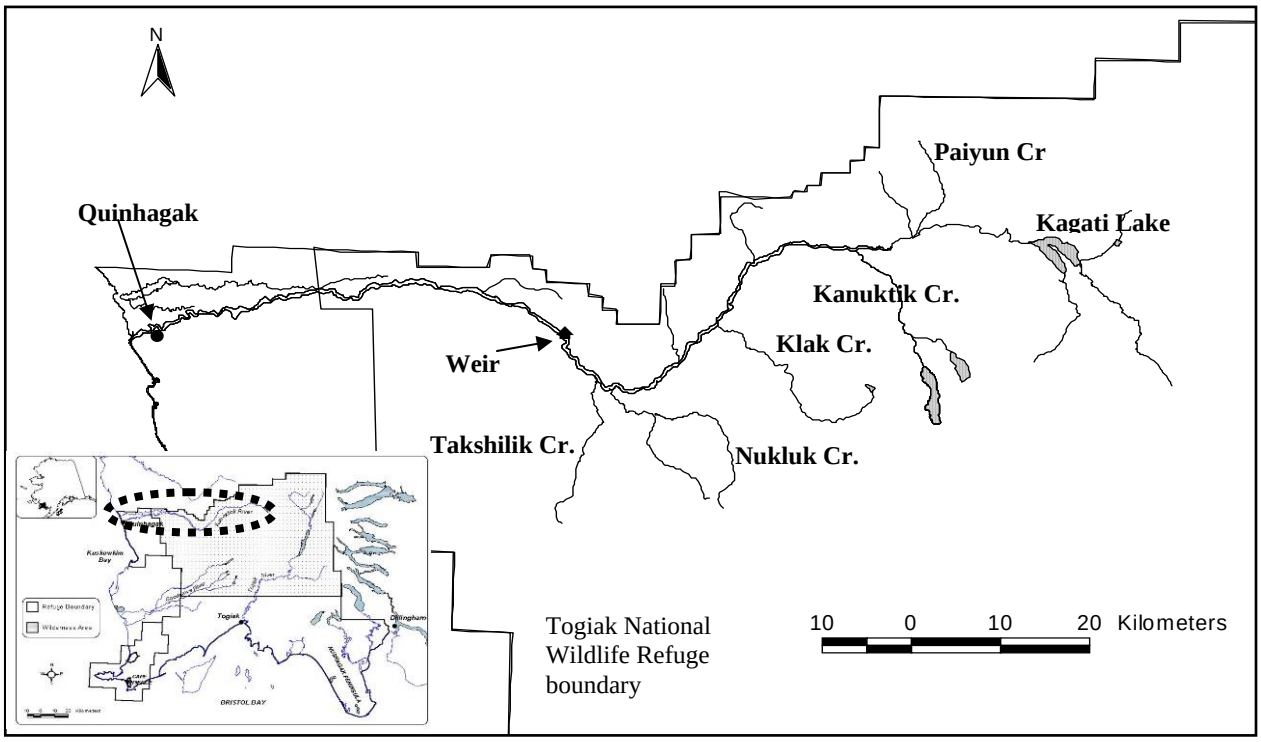

FIGURE 1. —Kanektok River drainage showing major tributary streams and the location of the weir.

Methods

Dolly Varden migrating upstream in the Kanektok River were counted at a weir located 70 river km upstream from Kuskokwim Bay. Detailed descriptions of how this weir is configured and has been operated are provided in annual reports by the Alaska Department of Fish and Game (Estensen and Diesigner 2003, 2004; Linderman 2005; Jones and Linderman 2006; Pawluk and Jones 2007; Clark and Linderman 2009; Taylor and Clark 2010; Taylor and Elison 2010, in prep.). A resistance board floating weir was used to span 76 m across the river. It had a 4.3 cm space between the weir pickets to accommodate the river discharge at high flows and to primarily block salmon migration. The weir was partially installed during the low water period in the spring, usually in April or May, with a target date of 25 June to be fully operational. Beginning in 2008, the weir operation ended by mid-August dependent on the observed sockeye salmon daily passage and water levels.

Dolly Varden total run abundance is the sum of number of Dolly Varden counted daily and estimated during the entire season of weir operation. The number of fish was estimated for those time periods when the weir was inoperable by using the average passage for the days or hours before and after the breach (Taylor and Elison 2010). Operation delays or failures were primarily due to high water events or a breach in the weir panel integrity.

Dolly Varden run timing is described by the date of first fish observed, the median passage date, and the time period when the middle 50% of the run (between the 25th and 75th percentiles) passed the weir. Annual cumulative abundance is plotted by date for each year.

When possible, Dolly Varden were captured in the weir live trap, measured for fork length, and classified by sex and maturity. Lisac (2006, 2007a) provides details of how the weir was used to capture Dolly Varden and how sex and maturity were determined. Length frequency distributions are presented in 10 mm increments. Cumulative length distributions are compared between years using a Kolmogorov-Smirnoff two-sample test, and differences were considered significant at an alpha level of 0.05. Tests were performed in NCSS (NCSS 2007).

Results

2008

High water during late June to mid July delayed weir installation in 2008 for 22 days after the 25 June targeted start date and was the latest start date of record for this project. The weir operated for a total of 36 days from 17 July to 21 August (Figures 2 and 3). The high water persisted throughout most of July allowing fish passage over the weir boat gate from 17 to 27 July. The total daily passage of Dolly Varden for these days were estimated by expanding three 20-minute counts of fish passing over the boat gate to account for the entire day, and adding that to the number of fish counted through the weir chute for that day. No attempt was made to estimate the daily passage for the 22 days prior to weir operation.

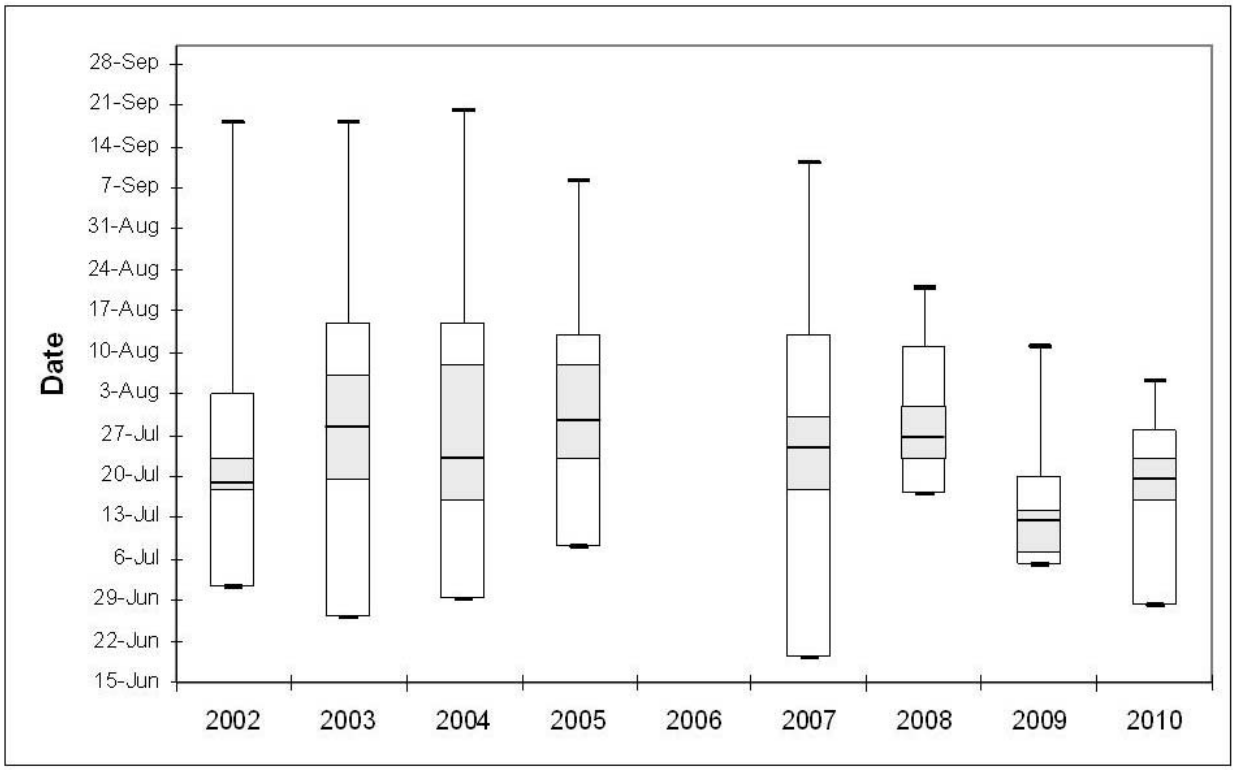

FIGURE 2. —Historic Dolly Varden run timing past the Kanektok River weir showing the first and last fish observed (vertical lines), the 90% observed abundance (box), the 50% peak abundance (shaded box), and the mid point (bold bar) of the run, 2002 to 2010.

A total of 8,140 Dolly Varden were estimated to have passed through the weir (Figure 4). This is approximately 71% of the average total count (N = 11,519) observed in prior years and only 52% of the previous historical high count (N = 15,674; 2002). The first Dolly Varden was counted on 17 July and the midpoint of the run occurred on 27 July, just two days after the historical midpoint of 25 July. Approximately 50% of the run arrived during the nine-day period between 24 July and 1 August, and the date of peak daily passage was 25 July (N = 870) (Appendix 1). Dolly Varden were still being counted through the weir until the last day of operation (N = 126). No fish were captured and sampled in 2008 due to the high water and limited crew on site.

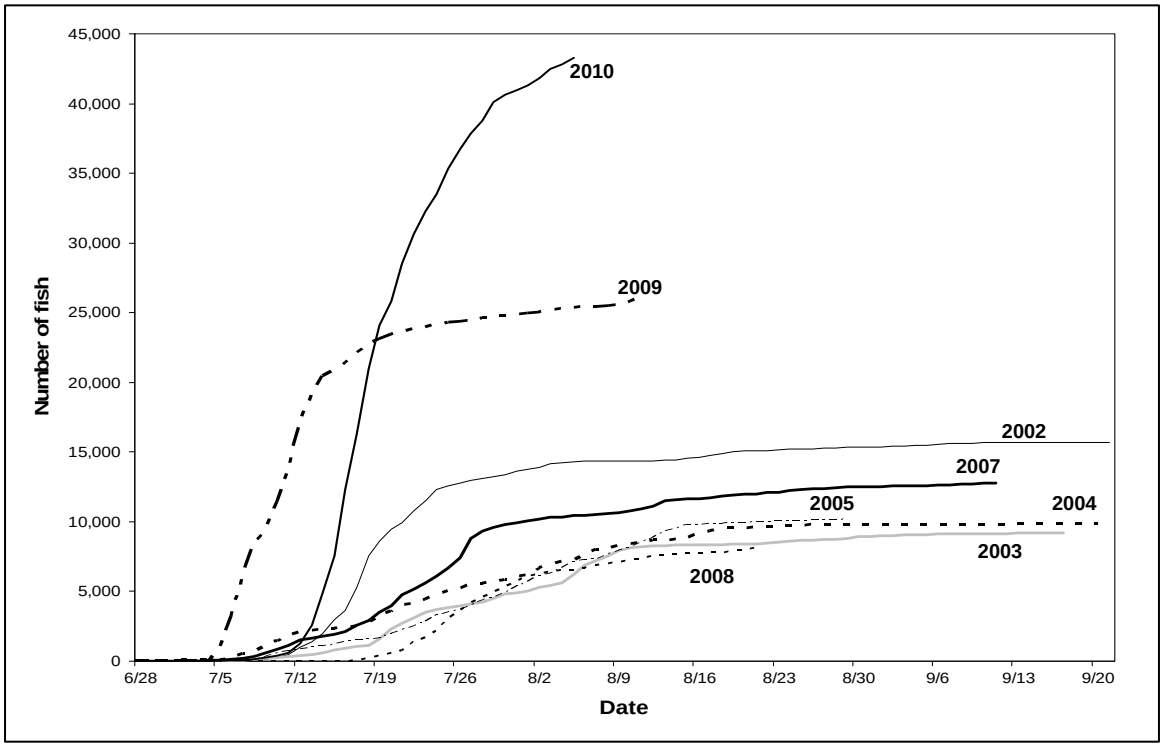

FIGURE 3. —Cumulative counts of Dolly Varden past the Kanektok River weir, 2002 to 2010.

2009

A late ice break-up and high water delayed installation of the weir in 2009 for ten days from the 25 June targeted start date. The weir operated for a total of 38 days from 5 July to 11 August (Figures 2 and 3). A total of 26,066 Dolly Varden were counted through the weir (Figure 4). This is 2.4 times the average total count (N = 10,956) observed for all prior and 1.7 times the previous high count (N = 15,674; 2002). No attempt was made to estimate the daily passage for the days prior to weir being in operation. The first Dolly Varden was counted on 5 July and the midpoint of the run occurred on 11 July which is 15 days prior to the historical average midpoint of 25 July. Approximately 50% of the run arrived during the 8-day period between 7 and 14 July, and the date of peak passage was 12 July (N = 3,216) (Appendix 1). Dolly Varden were still being counted through the weir until the last day of operation (N = 275). No fish were captured and sampled in 2009 due to the high water and limited crew on site.

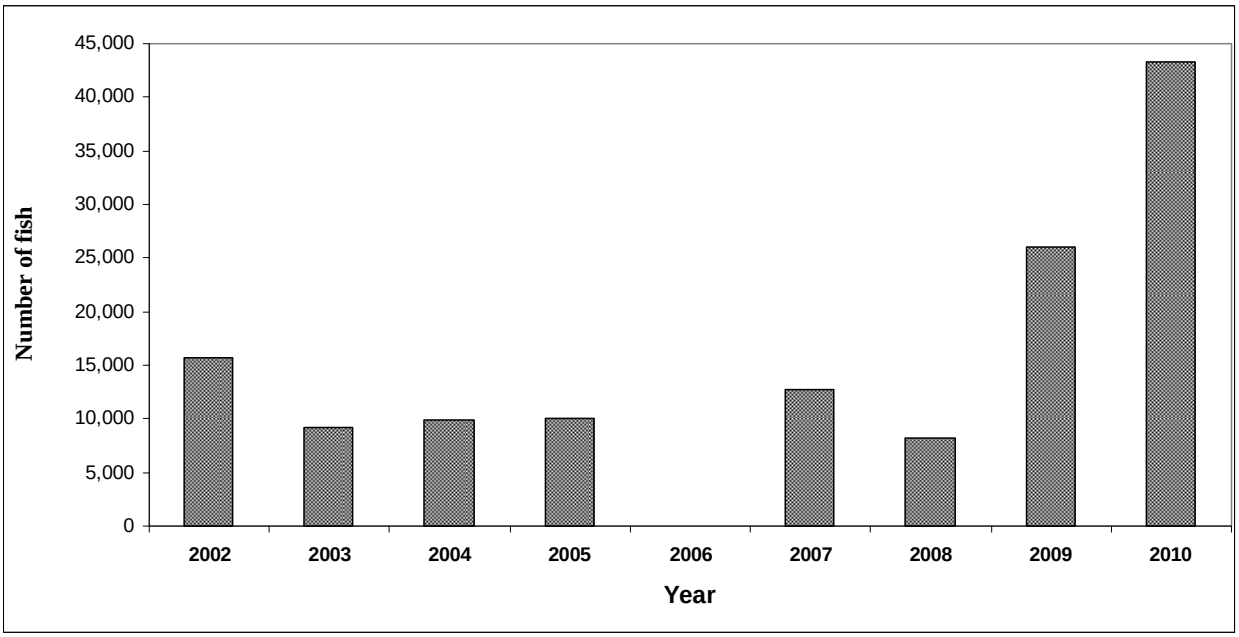

FIGURE 4. —Dolly Varden total run past the Kanektok River weir, 2002 to 2010.

2010

The installation of the weir was only delayed three days from the 25 June targeted start date. The weir operated for a total of 39 days from 28 June to 5 August (Figures 2 and 3). A total of 43,292 Dolly Varden were counted (Figure 4). This record run was 3.3 times the average total run (N = 13,115) observed for all previous years since 2002 and 1.7 times the historical high count (N = 26,066; 2009).

The first Dolly Varden was counted on 28 June and the midpoint of the run occurred on 19 July which is 6 days prior to the historical midpoint of 25 July. Approximately 50% of the run arrived during the 8-day period between 16 and 23 July, and the date of peak passage was 16 July (N = 4,739) which is the highest daily passage ever recorded (Appendix 1). Dolly Varden were still being counted through the weir until the last day of operation (N = 457).

A total of 222 Dolly Varden were captured during 15 days of sampling between 15 July and 1 August. The sample consisted of 120 females and 102 males, and all were classified as prespawners. All were measured for fork length (Figures 5 and 6), which ranged from 265 mm to 660 mm and averaged 511 mm (SE = 3.6). The cumulative length distribution for this sample is similar to those from fish sampled in 2002 ($D = 0.0611$; $p > 0.1$) and 2003 ($D = 0.1006$; $p > 0.8$), and significantly larger than fish sampled in 2004 ($D = 0.7119$; $p < .001$), 2005 ($D = 0.6488$; $p < .001$), and 2007($D = 0.2153$; $p < .001$) (Figure 6; Appendix 2).

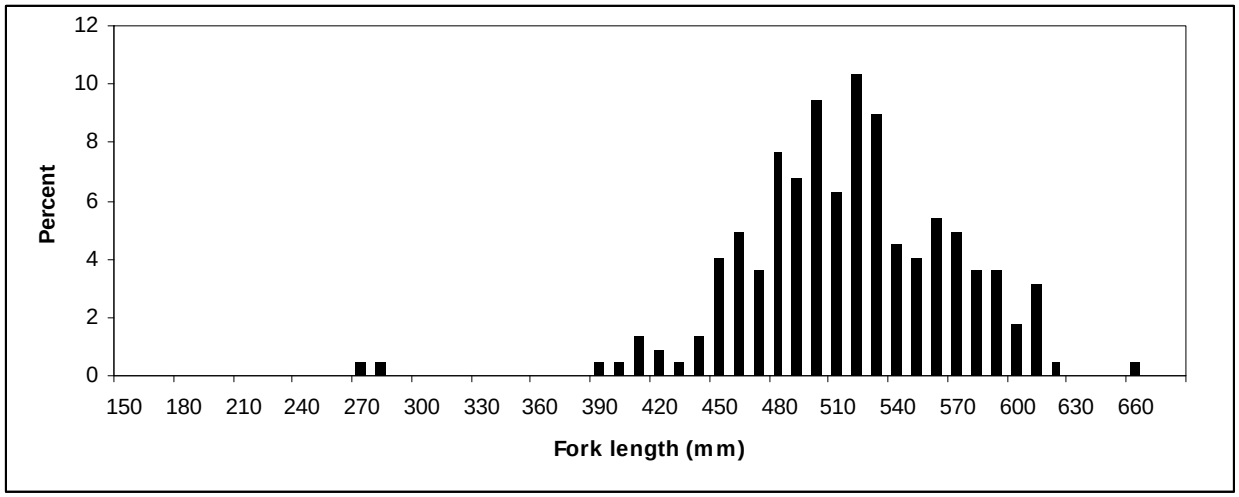

FIGURE 5. —Length frequency distribution expressed as percent of sample for Dolly Varden caught at the Kanektok River weir, 2010.

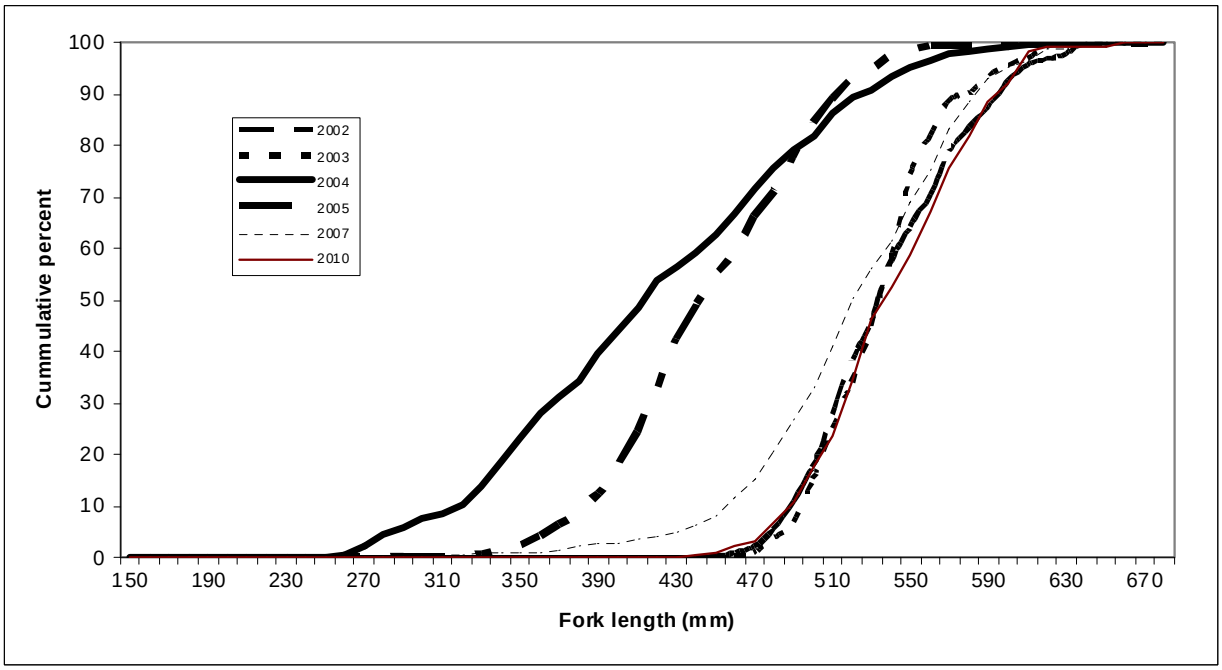

FIGURE 6. —Cumulative length frequency distribution of Dolly Varden sampled at the Kanektok River weir between 2002 and 2010.

Discussion

Documenting the abundance and run timing of anadromous Dolly Varden in the Kanektok River has been successful, but not without its challenges. Delays in weir operation due to high water and suspending operation during August for the last 3 years has resulted in incomplete counts of the run. This is especially true when high water in 2008 delayed weir operation by 22 days and the run was the lowest ever reported. In other years (2002 to 2007), a mean passage of

approximately 21% had arrived at the weir by 17 July. Assuming that the actual run timing was similar to previous years with a cumulative passage ranging from 11% to 34% by 17 July, the total Dolly Varden abundance in the Kanektok River would be estimated as 9,146 to 10,304 Dolly Varden. However, the Dolly Varden cumulative run timing and abundance observed in 2008 at the weir on the Middle Fork (MF) Goodnews River to the south exhibited a similar pattern (Lisac 2010; Appendix 3). That run also had later run timing and was the lowest recorded abundance since that project began monitoring Dolly Varden in 1996. For the time period of 2002 to 2007, the mean cumulative passage of Dolly Varden at the MFGRW was approximately 34% on 17 July. In 2008 the cumulative passage was 11%, indicating a very late run by comparison.

The delays in run monitoring in 2009 and 2010 due to high water were not as severe as 2008, but likely affected run timing and abundance estimates. However, the number of fish missed in the early run was likely not significant and was overwhelmed by the record returns of Dolly Varden in those years. In 2009, there were 1,050 Dolly Varden counted on the first day of operation (5 July). This is the highest passage ever recorded for this date, and in fact is double the cumulative escapements observed by this date for all other years combined (N = 469). The count on 5 July 2009 accounted for 4% of the total run as compared to 0.6% (range 0.3 to 1.0%) for the median cumulative escapement during all other years on that date. It is likely that the run timing in 2009 was earlier and actual abundance was higher.

For these later three years the weir operation was suspended earlier in August than any of the previous years. During previous years the weir was operated into September and the Dolly Varden run appeared to have tailed off by mid-August. Even though the 2009 and 2010 run timing was early by comparison to other years, there were still 275 and 457 fish counted on the last day of operation, respectively. These daily counts were approximately 1% of the total run. The early end to the weir operation likely resulted in missing some late run fish, but it does not appear to have significantly affected the total run estimate for these two years.

Variability in anadromous Dolly Varden run abundance, timing (Figure 3), and fish size (Figure 6; Appendix 2) has been documented throughout Alaska (Armstrong 1984; Whalen 1993; Larson 1997). Most variability has been attributed to ocean or freshwater survival affecting recruitment, other unidentified environmental conditions, or naturally random migration of immature and nonspawning fish to other streams for overwintering. Larson (1997) monitored the Dolly Varden run into the Anchor River on the Kenai Peninsula from 1987 to 1995 and documented runs ranging from 8,262 to 17, 259. Whalen (1993) counted emigrating Dolly Varden at the outlet of Buskin Lake on Kodiak Island and documented abundance ranging from 21,797 to 91,107 during 1985 to 1992. Both documented inter- and intra-annual variations in fish size distribution as well.

Although observed Dolly Varden run timing did vary slightly at the Kanektok River weir between years, it does follow the general pattern of beginning in early July, peaking between mid- to late-July, and 90% of the run arriving by mid-August (Lisac 2006, 2007a, 2008a). This is similar to the Dolly Varden run timing observed at the Middle Fork Goodnews River to the south (Lisac 2004, 2007b, 2008b, 2009, 2010). For most years (excluding 2009) the cumulative run curves are similar between the two studies although the run at the MF Goodnews River weir usually occurs a few days earlier (Appendix 3). This is not surprising and is likely due to the locations of these two projects in relation to Kuskokwim Bay. The MF Goodnews River weir is located approximately 12 river km upstream from Kuskokwim Bay compared to 70 river km

upstream for the Kanektok weir. This greater distance would likely require more travel time for fish.

It is unknown what factors affect Dolly Varden run timing. Others (Armstrong 1984; DeCicco 1985; Whalen 1993; Larson 1997; Lisac and Nelle 2000) have suggested that stream discharge, water temperature, ocean feeding conditions, time at sea, or salmon abundance may play a role in prompting fish to enter freshwater. Dolly Varden runs at the Kanektok River weir primarily occur during July, at which time water levels generally recede (Appendix 4).

It is recommended to continue to monitor the Dolly Varden run at the Kanektok River weir. Annual monitoring can reveal trends and periodicity in Dolly Varden total abundance. To ensure that these counts are representative of Dolly Varden abundance, the weir should be operated for a consistent time period each year. Monitoring should occur from late June until mid-August to capture the majority of the annual run.

Acknowledgements

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APPENDIX 1. —Historical Dolly Varden daily count and total run with the midpoint (box), and peak (50%) of the run (shaded area), Kanektok River 2002 - 2010. No counts were made in 2006.

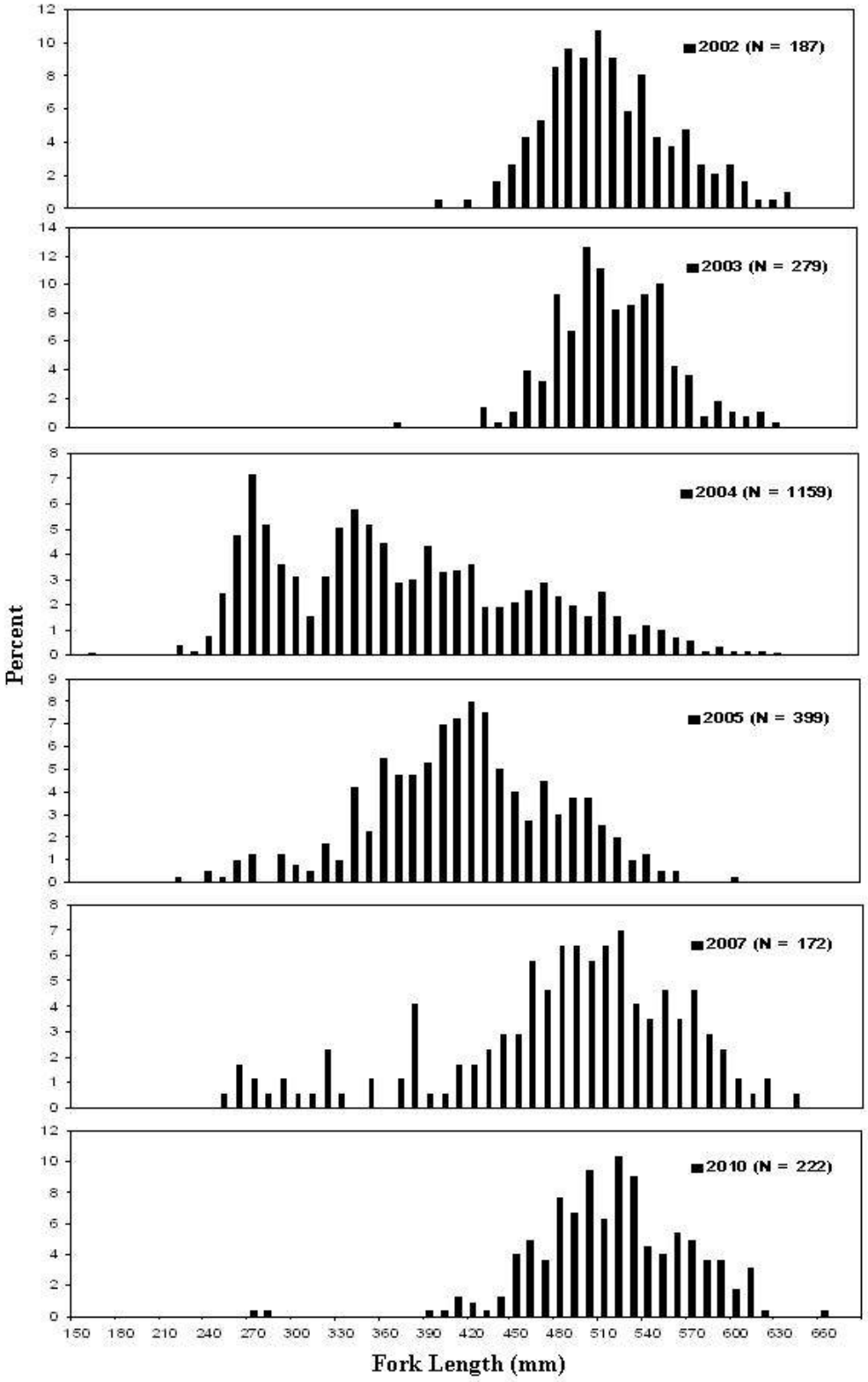
Date	2002	2003	2004	2005	2006	2007	2008	2009	2010
6/18					NA				
6/19						1			
6/20						1			
6/21						0			
6/22						0			
6/23						0			
6/24		0				3			
6/25		0				0			
6/26		1				1			
6/27		1				0			
6/28		5				1			4
6/29		0	2			0			5
6/30		1	12			2			2
7/01	7	1	20			4			9
7/02	18	9	8			10			1
7/03	6	2	15			7			4
7/04	5	17	17			12			6
7/05	12	23	25			34		1,050	16
7/06	10	18	81			44		2,116	9
7/07	6	7	325			59		2,975	22
7/08	21	44	248	65[b]		143		2,242	54[a]
7/09	53	72	337	267		266		1,098	125
7/10	128	72	375	292		257		1,990	146
7/11	177	49	374	137		277		2,216	203
7/12	543	48	237	126		395		3,435	644
7/13	418	87	86	93		179		1,995	1,325
7/14	551	145	74	100		94		1,336	2,323
7/15	993	186	101[b]	91		132		487	2,668
7/16	700	157	109	201		176		525	4,739
7/17	1,623	81	94	158		460	95[a]	718	4,066
7/18	2,245	116	243	88		363	158[a]	577	4,598
7/19	1,071	479	480[b]	7		615	177[a]	353	3,091
7/20	893	673	341	329		475	182[a]	296	1,741
7/21	431	414	342	322		771	160[a]	226	2,728
7/22	848	400	235	266		385	643[a]	157	2,096
7/23	771	409	254	295		461	305[a]	179	1,686
7/24	770	170	261	450		473	442[a]	188	1,189
7/25	271	148	314	239		566	870[a]	114	1,839
7/26	178	167	237	194		774	598	95	1,374[a]
7/27	253	88	237	242		1,343	546	83	1,130
7/28	128	121	104	402		557	366	135	951[a]
7/29	94	295	132	187		282	395	103	1,309[a]
7/30	175	304	125	322		186	428	70	542
7/31	242	108	173	477		141	392	100	328[a]
8/01	154	136	228	330		133	313	114	302
8/02	90	210	431	386		146	242	65	556
8/03	263	164	303	189		84	122	155	624[a]
8/04	109	170	153	410		43	86	75	380
8/05	48	601	141	394		78	28	61	457
8/06	24	706	320	236		41	167	58	
8/07	10	305	390	75		66	143	49	

APPENDIX 1. —Historical Dolly Varden daily count and total run with the midpoint (box), and peak (50%) of the run (shaded area) highlighted, Kanektok River 2002 - 2010. No counts were made in 2006. (Continued)

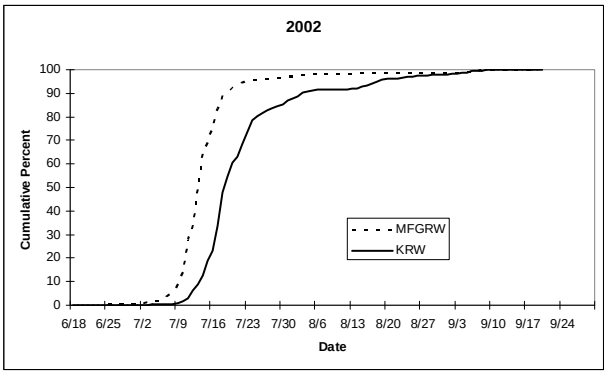
Date	2002	2003	2004	2005	2006	2007	2008	2009	2010
8/08	15	367	58	275	NA	46	182	70	
8/09	7	361	200	213		81	92	66	
8/10	1	209	148	251		149	130	219	
8/11	5	37	155	336		136	159	275	
8/12	12	80	98	319		202	122		
8/13	26	30	47	457		354	94		
8/14	46	21	39	191		103	52		
8/15	76	2	169	279		41	33		
8/16	91	13	242	36		36	23		
8/17	138	23	195	23		46	36		
8/18	157	18	139	16 [b]		92	49		
8/19	107	18	36	80 [b]		84	70		
8/20	46	18	48	4 [b]		47	114		
8/21	24	30	51	34 [b]		34 [b]	126		
8/22	8	59	8	4 [b]		117 [b]			
8/23	62	52	23	42 [b]		35			
8/24	32	57	36	20 [b]		89			
8/25	32	51	63	37		87			
8/26	23	38	24	32 [b]		32			
8/27	51	19	3	9 [b]		49			
8/28	6	20	3	13		59			
8/29	25	58	0	32		42			
8/30	2	122	2	[b]		7			
8/31	15	48	2	[b]		19			
9/01	18	20	4	[b]		22			
9/02	27	10	2	[b]		16			
9/03	5	50	1	[b]		14			
9/04	88	35	0	0		7			
9/05	13	15	4	9		29			
9/06	86	11	2	2		26			
9/07	28	8	3	8		13			
9/08	12	15	9	1 [b]		32			
9/09	27	5	8			54			
9/10	7	14	7			35			
9/11	2	6	7			8			
9/12	3	11	2						
9/13	3	10	6						
9/14	0	8	5						
9/15	4	4	1						
9/16	3	3	5						
9/17	1	9	3						
9/18	1		4						
9/19	0		3						
9/20	0		12						
9/21									
Total	15,674	9,195	9,861	10,093		12,784	8,140	26,066	43,292

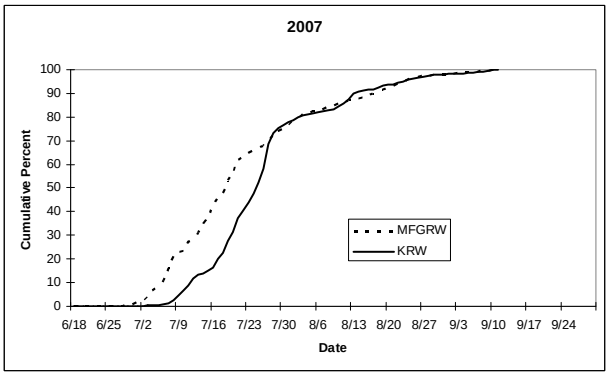
[a] Daily passage estimated due to weir not being operational or experiencing a partial breach.
[b] Partial day or no count made and passage was not estimated.

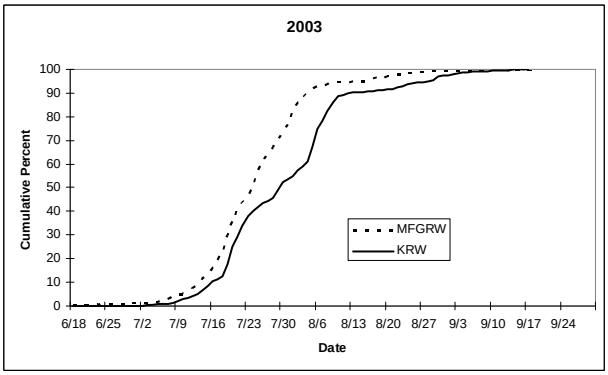
APPENDIX 2. —Length frequency distribution expressed as percent of sample and the number of Dolly Varden sampled per year at the Kanektok River weir, 2002 to 2010.

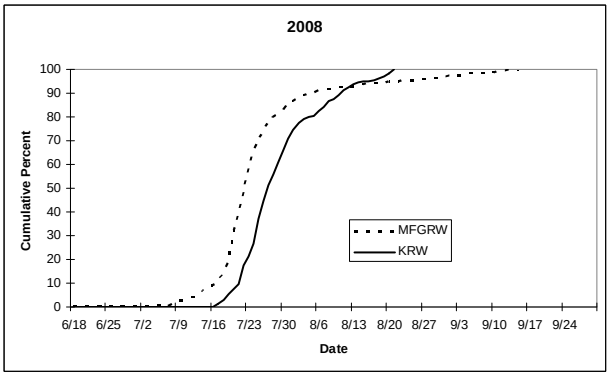


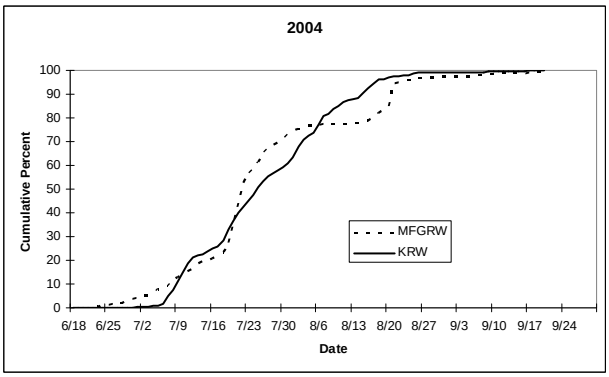
APPENDIX 3. —Dolly Varden cumulative total run at the Kanektok River weir and Middle Fork Goodnews River weir, 2002 - 2010.

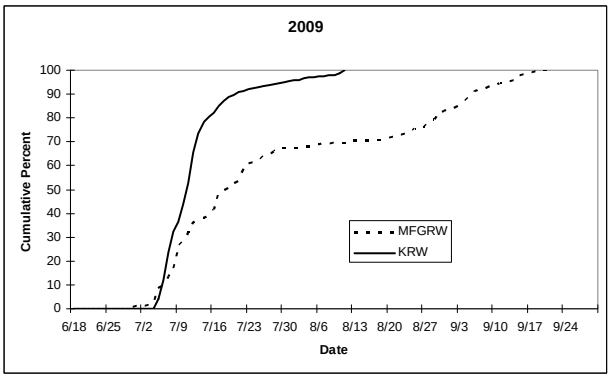


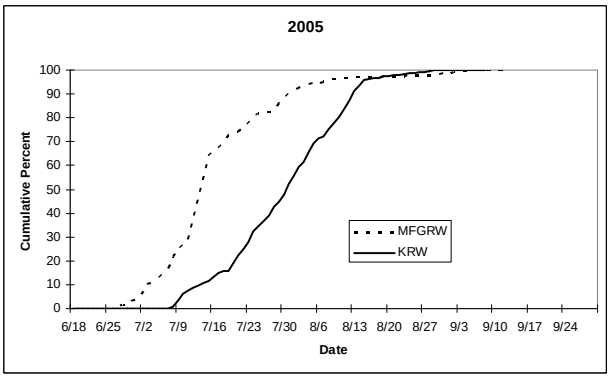


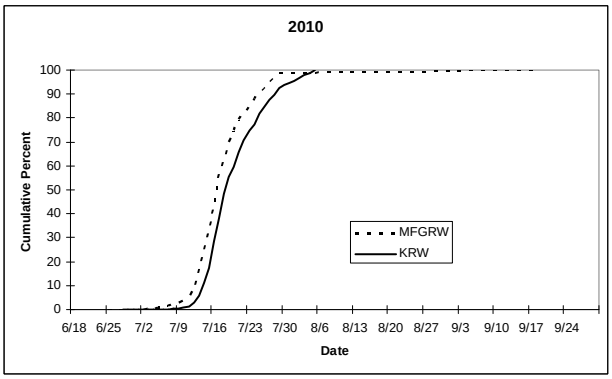












APPENDIX 4. —Daily Dolly Varden count (solid line) and recorded water levels (dashed line) at the Kanektok River weir, 2003 - 2010.