

Abundance and Run Timing of Dolly Varden in the Middle Fork Goodnews River, 2008 and 2009

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Mark J. Lisac

Abstract

Dolly Varden annual run timing, run size, and spawner abundance have been estimated in the Middle Fork Goodnews River using a salmon escapement monitoring weir since 1996. This report summarizes the data collected during 2008 and 2009. The total annual counts were 1,421 and 1,608 Dolly Varden during 2008 and 2009, respectively. These are the two smallest run sizes recorded at the weir since 1996 which are below the average annual run of 2,695 fish. The number of mature prespawning Dolly Varden was estimated by apportioning the weir counts based on a sample of fish caught in the weir live trap. An estimated 1,207 and 870 mature Dolly Varden were present in 2008 and 2009, respectively. Run timing in 2008 was similar to observed historical averages for most years and bimodal in 2009 with 32% of the run passing the weir after 1 August. Run size estimates during all years are considered conservative because smaller sized Dolly Varden can escape through the weir pickets undetected.

Introduction

Dolly Varden are an important component of the subsistence harvest, sport fishery, and ecosystem in the Goodnews River drainage in southwest Alaska. Although no quantitative harvest estimates are available for the Goodnews River Dolly Varden subsistence fishery, Dolly Varden are likely harvested in quantities that match or exceed the harvest of salmon by weight (Wolfe et al.1984). Between 1995 and 2008, the sport catch has averaged 13,506 char (Dolly Varden and Arctic char) in the entire Goodnews River drainage (Chythlook 2009). This catch ranks second behind the Kanektok River ($N = 20,816$) among all estimated sport fisheries in the Kuskokwim region. The annual sport harvest of Dolly Varden from the Goodnews drainage has averaged 540 fish since 1995.

Togiak National Wildlife Refuge (Refuge) and the Alaska Department of Fish and Game (Department) have been documenting Dolly Varden passing the Middle Fork of the Goodnews River (MFGR) weir since 1996 (Lisac 2004, 2007a, 2008). For some years, the run has been bimodal, but for most years the majority of the run occurs between 10 and 25 July. The run has averaged 2,695 fish between 1996 and 2007 and has ranged between 1,761 and 6,616 fish (Lisac 2008). Monitoring the population health of Dolly Varden is difficult using annual returns because the run is comprised of fish from stocks of mixed origin and maturity (DeCicco 1985; Whalen 1992; Larson 1997; Lisac and Nelle 2000; Lisac 2004, 2006, 2007a, 2007b). Immature Dolly Varden may or may not return to their home water for summer feeding and overwintering, whereas mature Dolly Varden exhibit a strong fidelity to their natal streams for spawning. Therefore, estimating the annual number of Dolly Varden

returning to spawn in the drainage is a more useful measure of population trends. Beginning in 2001, the annual passage of mature prespawning Dolly Varden into the MFGR was estimated by apportioning the weir counts based on the maturity of fish sampled from the weir live trap (Lisac 2004, 2007a, 2008). Approximately 13% to 35% of the annual Dolly Varden run was captured at the weir during July to mid-August from 2001 to 2007. Sample sizes were adequate in four of those seven years to estimate the proportion of mature fish which accounted for between 40% and 68.5% of the sample. These estimates ranged from 703 to 2,292, and averaged approximately 1,260 prespawning Dolly Varden.

The purpose of this report is to provide a summary of the data collected during the 2008 and 2009 season. The objectives during 2008 and 2009 were to: 1) determine the annual run timing of Dolly Varden passing upstream of the MFGR weir; 2) estimate the number of prespawning Dolly Varden passing the MFGR weir between July and mid-August; and, 3) document length, sex and maturity of Dolly Varden immigrating past the MFGR weir.

Study Area

The majority of the Goodnews River drainage occurs within the 19,021 km² Togiak National Wildlife Refuge located in southwestern Alaska. The drainage consists of three river channels which drain approximately 2,600 km² in the Ahklun Mountains (U.S. Fish and Wildlife Service 1990; Figure 1). The MFGR is approximately 68 km long and parallels the mainstem Goodnews River, a 75 km branch to the north, before they join together approximately 6.5 km upstream of Goodnews Bay. Two branches flow from the Middle Fork Lakes for approximately 10 km before uniting to form the main MFGR. Kukaktlik River is the only named tributary to the MFGR and flows southwest from Kukaktlim Lake for approximately 33 km to join the MFGR approximately 55 km upstream of the confluence with the mainstem Goodnews River. The weir is located approximately 18 km upstream of Goodnews Bay on the MFGR.

Methods

Dolly Varden migrating upstream in the MFGR are counted at the weir and recorded as daily totals. Estensen (2001) provided a detailed description of how this weir is configured and operated, and Lisac (2008) provided details of how the weir was used to capture Dolly Varden. A second live trap was added to the weir in 2007 as part of an underwater video monitoring system. This new trap was designed to allow a smaller opening to exclude salmon and was large enough to reduce the chance of fish overcrowding so it could be fished effectively over night. Trap avoidance by Dolly Varden has been observed previously during daylight hours and when the trap is too crowded with salmon (Lisac 2004). The trap was inspected using snorkel gear each morning and any Dolly Varden seen were netted from the trap and sampled for size, sex and maturity. Dolly Varden were also captured intermittently throughout the day whenever they were encountered in the trap while salmon were being sampled.

Dolly Varden were measured for fork length to the nearest 1.0 mm. Length frequency distributions in 10 mm increments were then calculated for all Dolly Varden from each annual sample. Dolly Varden greater than 250 mm were marked with an individually numbered T-bar anchor tag to help identify previously sampled fish. Sex, color code and maturity were recorded

for each fish. Fin clips were collected from all captured fish, stored in alcohol vials, segregated by sex and maturity, and archived for future genetic analysis.

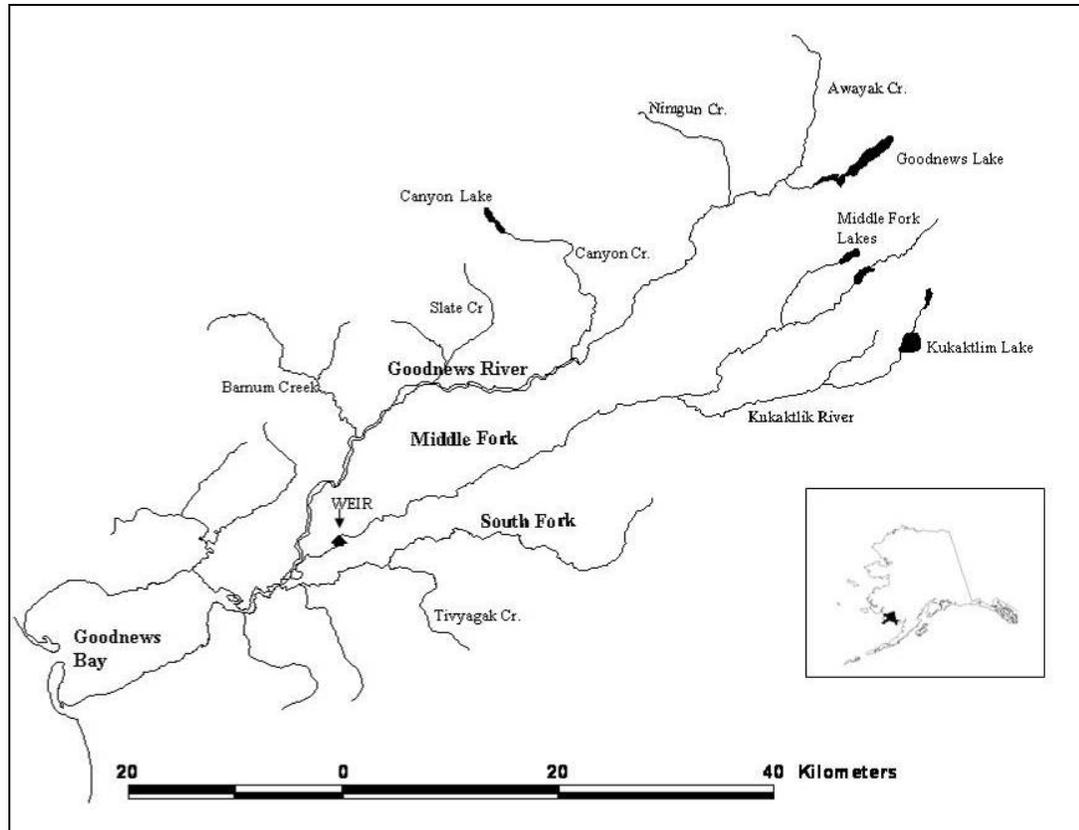


FIGURE 1. —Goodnews River drainage.

Maturity of fish was determined using external characteristics with periodic comparison to internal examination of gonad development by dissection as previously reported by Lisac (2006) and adapted from DeCicco (1985). Maturity classifications were: immature, nonspawner, prespawner, or unknown. Photographic keys were used to train field personnel to identify sex and maturity of fish based on external characteristics. The primary external characteristics used were the coloration of the body, head, jaw and fins. Three color codes were used to characterize each fish as being either 1) silver or showing no color; 2) showing signs of color change (darkening operculum, head and jaws, reddening of fins with white leading edge); or 3) full spawning colors. Head shape, kype formation, a swollen ovipositor or abdomen were used as sex determinant characteristics.

The sample period was divided into three temporal strata: prior to 21 July, 21 to 31 July, and after 31 July. The estimate of prespawners in each stratum was determined by multiplying the total Dolly Varden weir count during each stratum by the proportion of prespawners sampled from the same stratum (Cochran 1977; Larson 1997; Lisac 2006). The total number of Dolly Varden prespawners passing through the weir was determined by summing the estimate and variance for

each of the three strata. Since 2007 the number of prespawners was estimated for the entire time that the weir was in operation. Prior to 2007, the prespawner estimate was based on the number of fish that passed the weir only during the capture efforts. This is referred to as the “apportioned run” for the comparisons.

Results

2008

The weir was operated for a total of 76 d from 2 July to 15 September during 2008 (Figure 2; Appendix 1). A total of 1,421 Dolly Varden were counted through the weir. The first Dolly Varden was counted on 2 July and the median passage date occurred on 22 July. Approximately 61% of the run passed the weir during the 7-d period between 17 and 25 July.

A total of 148 Dolly Varden were captured during 38 d of sampling between 2 July and 15 September (Figure 3) of which 147 were measured for fork length (Figure 4; Appendix 2). Fork length ranged from 131 mm to 620 mm and averaged 445 mm (SE = 6.4). Fork length recorded for prespawners ($N = 122$) ranged from 328 mm to 620 mm and averaged 464 mm (SE = 4.9). Average fork length for fish in the other maturity classes were 159 mm (SE = 11.8) for immature fish ($N = 4$), 379 mm (SE = 13.9) for unknowns ($N = 20$), and 543 mm for the one nonspawner fish.

An estimated 1,206 (SE = 36.0) prespawning Dolly Varden passed upstream of the weir between 2 July and 15 September. Estimates were calculated using the proportion of fish assigned as prespawners ($N = 122$; 82.4%) in the sample of 148 fish to the 1,421 Dolly Varden counted through the weir during the sample period (Table 1; Figure 5). The proportion of sampled prespawners declined from 90.2% in stratum 1 to 72.7% in stratum 3.

2009

The weir was operated for a total of 86 d from 28 June to 21 September 2009 (Figure 3; Appendix 1). A total of 1,608 Dolly Varden were counted through the weir during this period. The first Dolly Varden was observed on 29 June and the median passage occurred on 18 July. Run timing was more protracted and bimodal in 2009 with approximately 59% of the run arriving over a 48-d period between 9 July and 25 August, and 32% of the total run arriving after 1 August.

A total of 111 Dolly Varden were captured during 25 d of sampling between 1 July and 11 September (Figure 3). Fish measured for fork lengths ($N = 111$) ranged from 250 mm to 702 mm and averaged 390 mm (SE = 10.6) (Figure 4; Appendix 2). Fork length recorded for prespawners ($N = 42$) ranged from 359 mm to 702 mm and averaged 502 mm (SE = 11.5). Fork length for non-spawning fish ($N = 68$) ranged from 250 mm to 505 mm and averaged 322 mm (SE = 8.1). The only fish with unknown maturity had a measured fork length of 300 mm.

An estimated 870 (SE = 54.2) prespawning Dolly Varden passed upstream of the weir between 28 June and 21 September. Estimates were calculated using the proportion of fish assigned as prespawners ($N = 42$; 37.8%) in the sample of 111 fish to the 1,608 Dolly Varden counted through the weir (Table 1; Figure 5). The proportion of prespawners in the sample declined from 75.9% in stratum 1 to 13.8% in stratum 3.

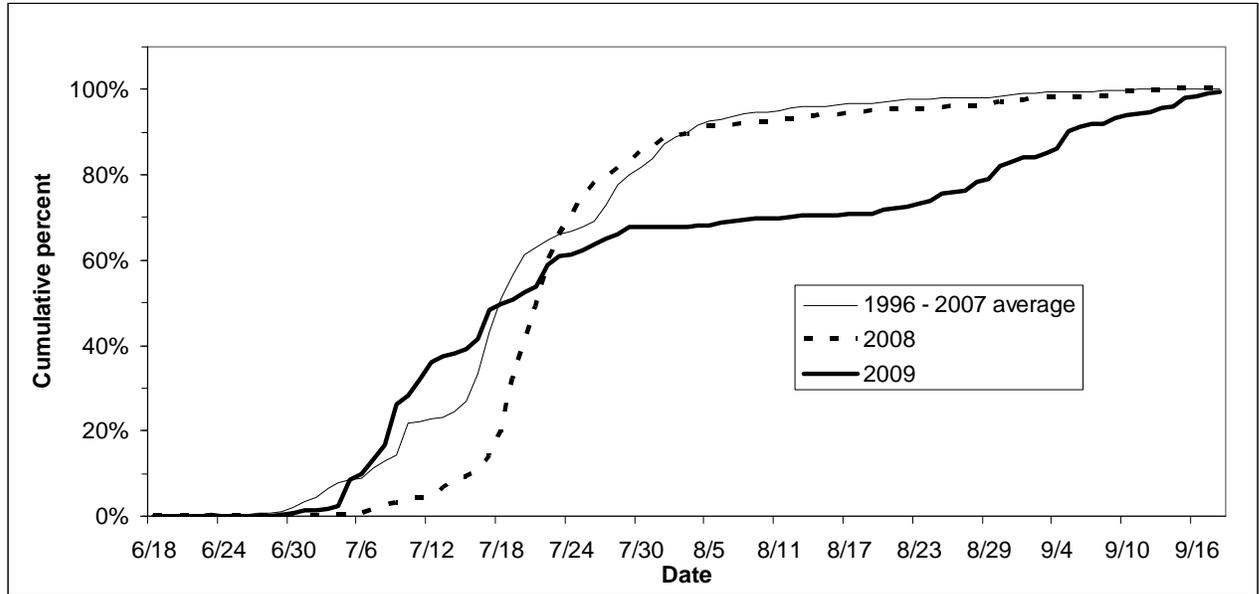


FIGURE 2. —Cumulative percent passage of Dolly Varden passing the MFGR weir. Passage from 1996 to 2007 is expressed as an average.

TABLE 1. —Estimated number of prespawning (PR) Dolly Varden from the MFGR by time strata during 2008 and 2009.

Year	Strata	Weir count	Number sampled	Percent sampled	Number PR	Percent PR in sample	Estimated PR	SE
2008	1	462	51	11.0%	46	90.2%	417	16.6
	2	756	53	7.0%	45	84.9%	642	30.7
	3	203	44	21.7%	32	72.7%	148	8.9
	Total	1,421	148	10.4%	123	83.1%	1,206	36.0
2009	1	846	29	3.4%	22	75.9%	642	51.0
	2	242	17	7.0%	11	64.7%	157	18.0
	3	520	65	12.5%	9	13.8%	72	2.9
	Total	1,608	111	6.9%	42	37.8%	870	54.2

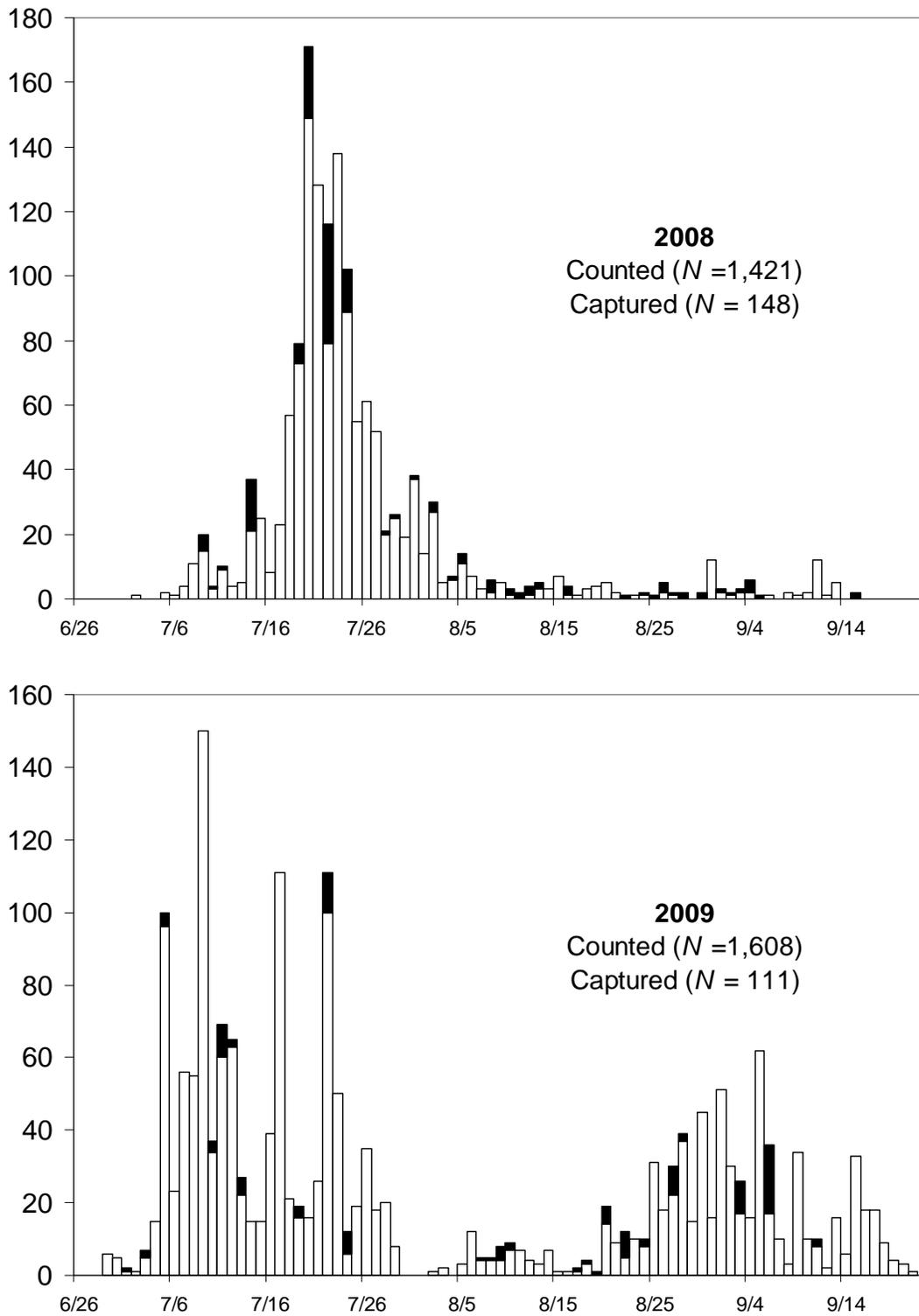


FIGURE 3.—Number of Dolly Varden counted (clear bar) and captured (black bar) at the Middle Fork Goodnews River weir during, 2008 and 2009.

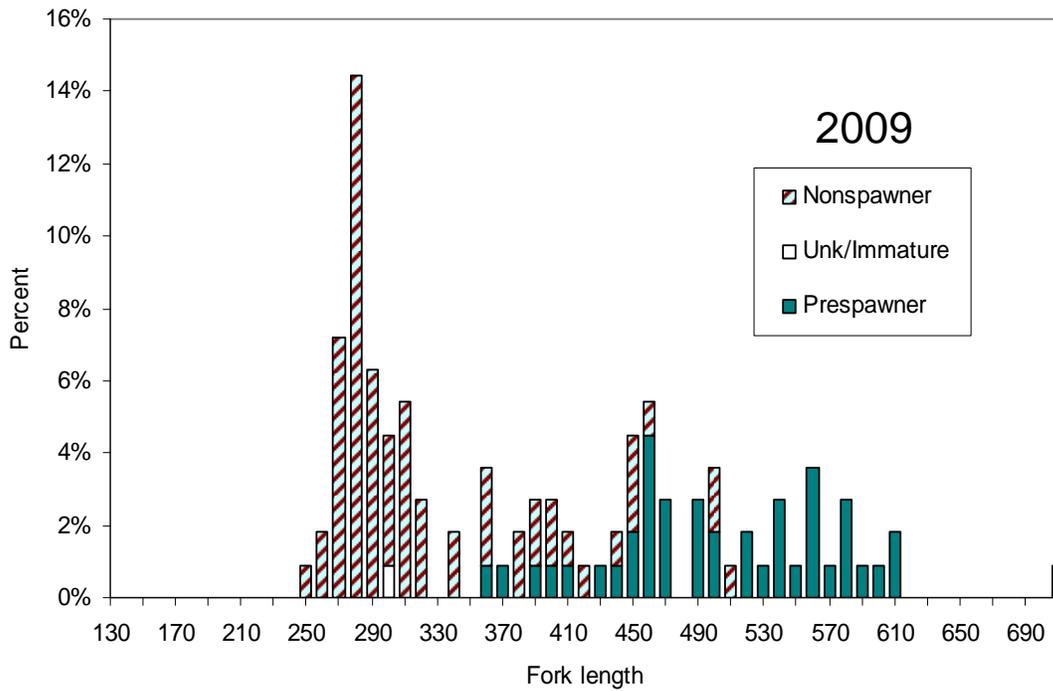
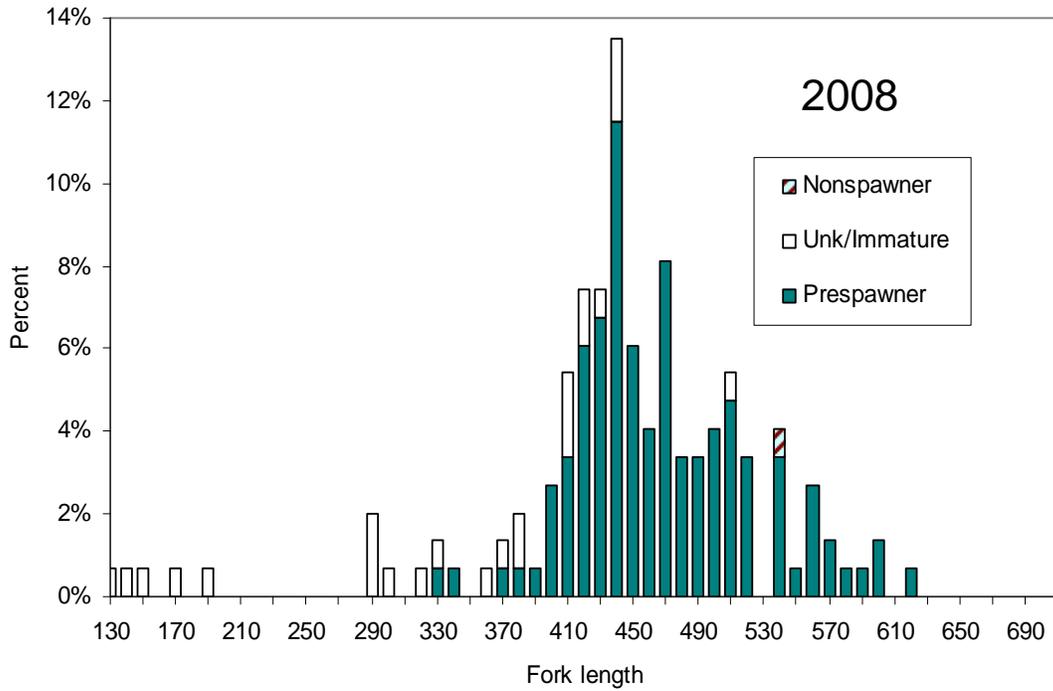


FIGURE 4. —Fork length frequency distribution for Dolly Varden by maturity that were captured at the Middle Fork Goodnews River weir during 2008 and 2009.

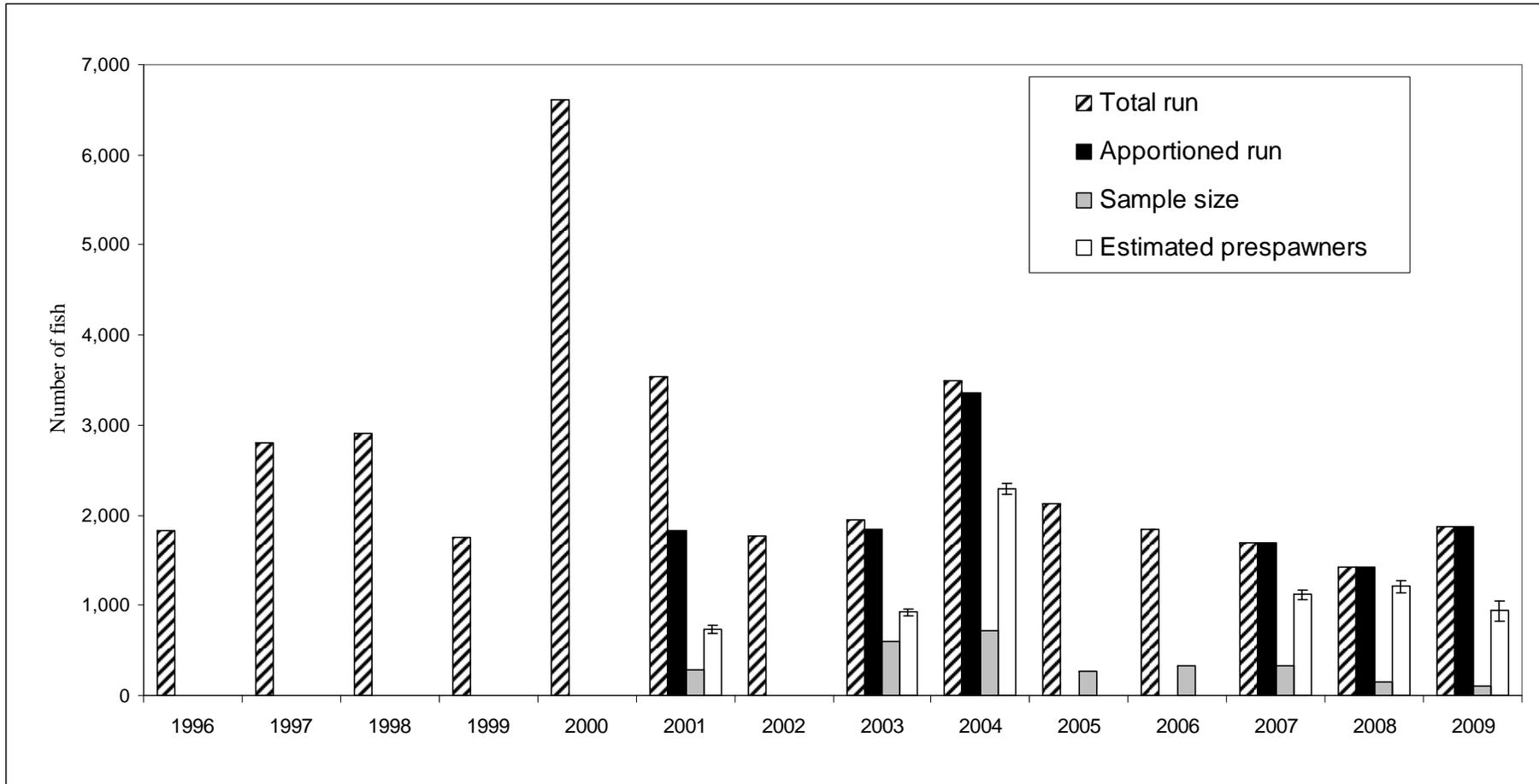


FIGURE 5. —Historical number of Dolly Varden counted for the season (total run), counted during study period (apportioned run), the number sampled, and estimated prespawner abundance for years when available, MFGR weir, 1996 - 2009.

* The apportioned run is different than the total run for years when the sampling effort ended earlier than the weir operation.

Discussion

The objectives to document run timing, total abundance and spawner abundance of Dolly Varden in the Middle Fork Goodnews River were successfully achieved in 2008 and 2009. When compared to the average run timing observed over the last twelve years (1996 to 2007) the midpoint of the 2008 and 2009 runs occurred within the historical range and within six days of each other. However, the 2008 run began late, but was compressed into a short timeframe with 50% of the run occurring in a 7-d period and 90% in a 19-d period (Figure 2 and Appendix 1). In contrast, the 2009 run was protracted over a total of 81 d, with 50% and 90% of the run occurring over a 48-d and 62-d periods, respectively. The 2009 run was similar to other years (2000, 2001, 2003, 2004 and 2007) that had a bimodal run. This was caused by a significant component (32%) of the run arriving after 31 July 2009. The fish that arrived during the last stratum had the smallest overall fork length (330 mm; SE = 10.8) compared to the early strata and were primarily (86%) nonspawners and immature fish. Seasonal variations in Dolly Varden run timing, maturity and fish size have been well documented in southwestern Alaska (Lisac & Nelle 2000; Lisac 2004, 2006, 2007a) and other areas within Alaska (Whalen 1993; Larson 1994, 1997). Mature larger fish generally enter the rivers earlier followed by smaller nonspawners. These nonspawners can be a substantial component of the run during some years and not in others. These fish could be an indication of future recruitment to the spawning population or of mixed stocks from other river populations utilizing the MFR to feed and overwinter.

The total run and estimated number of spawners for both years were the lowest on record (Appendices 1 and 3). The total runs for the last five years have all been below the 12-year average of 2,695 fish. Although run size estimates during all years are considered conservative because smaller sized Dolly Varden can escape through the weir pickets undetected, this observed decline is not attributed to the weir design and operation, but is more likely due to natural fluctuations or other influences. Other than the addition of a larger live trap and an underwater video recorder, the configuration and operation of the weir has remained consistent since 1996 when it was converted to a floating resistance board weir. During most years there were days when the weir was not functioning due to damage or high water, or partial daily counts were recorded. Over the last five years this has ranged from 4 to 13 d annually. Most of these days occurred during times when Dolly Varden passage is traditionally low (August and September). Cyclic trends in Dolly Varden populations have been documented in other river systems throughout Alaska (Armstrong 1984; Whalen 1993; Larson 1994). Dolly Varden observed at the Middle Fork Goodnews River weir will require continued monitoring to understand the full range of variation in run sizes.

Using external physical characteristics to determine maturity and estimate the number of spawners in annual Dolly Varden run at the Middle Fork Goodnews River has limitations. This is primarily due to the close proximity of the weir to the bay and hence, the fish having little time in freshwater when they are returning from the ocean (Lisac 2008). Actually measuring gonad development would be more accurate (Whalen 1993; Larson 1994), but would require destructive sampling. This is not practical or desirable on this small population. A separate project is currently developing a Dolly Varden genetic stock identification baseline for western Alaska. Tissue samples have been collected from spawning adults and juveniles in 40 tributaries in southwest Alaska. Other collections have occurred in western Alaska north to the Beaufort

Sea. This baseline will have future applications for mixed stock analysis of samples collected at this weir. Identifying the proportion of fish belonging to this drainage will allow managers to better monitor the health of the MFGR Dolly Varden population, and provide a better estimate of spawner abundance which will help determine the recruitment potential for the population.

Acknowledgements

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APPENDIX 1. —Daily Dolly Varden passage at Middle Fork Goodnews River weir showing the midpoint (box), and peak 50% of the run (shaded area), 1996 - 2009. (page 1 of 2)

Date	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
6/18								0						
6/19								0						
6/20								2						
6/21								2	1					
6/22								1	9					
6/23	0	0						4	11					
6/24	5	4						4	7					
6/25	1	0					4	1	14			1		
6/26	10	0				0	0	0	9	4		1		
6/27		2				0	1	4	14	13	1	0		
6/28		16				0	2	1	14	15	1	0		0
6/29		2				0	1	1	32	3	8	10		6
6/30		9				0	1	2	19	39	39	1		5
7/01	65	30				5	2	0	14	6	67	11		10
7/02	40	120			3	0	7	1	25	78	70	9	1	1
7/03	51	118			0	3	7	4	10	64	21	24	0	4
7/04	63	117	1	2	6	3	7	3	44	20	32	48	0	15
7/05	84	110	3	3	6	0	0	4	56	21	22	25	2	96
7/06	108	217	7	1	7	11	8	19	23	57	11	52	1	23
7/07	88	172	7	0	3	4	25	8	13	34	38	85	4	56
7/08	39	189	13	0	27	8	26	13	74	105	45	78	11	55
7/09	83	207	42	1	36	0	63	20	68	60	10	38	20	150
7/10	193	332	45	2	59	3	100	3	33	48	32	20	4	34
7/11	28	230	37	5	34	6	239	29	54	30	8	71	10	60
7/12	65	104	97	6	35	18	112	20	42	201	5	27	4	63
7/13		71	113	7	44	26	278	29	51	192	9	44	5	22
7/14		138	167	12	16	29	261	51	52	195	9	62	37	15
7/15		74	148	22	98	15	74	33	13	174	17	48	25	15
7/16		103	105	60	47	60	125	49	20	58	17	78	8	39
7/17		43	192	25	49	53	132	55	43	16	42	52	23	111
7/18		101	283	33	47	50	102	83	56	47	64	54	57	21
7/19		78	231	20	143	117	24	134	130	64	58	97	79	16
7/20	17	64	170	60	145	30	25	121	307	21	81	48	171	29
7/21	87	16	300	48	72	46	22	95	283	19	55	73	128	18
7/22	73	26	204	90	75	60	28	54	274	28	16	38	116	83
7/23	60	15	172	138	22	47	12	51	150	38	46	39	138	33
7/24	160	11	89	267	53	82	8	98	76	47	32	21	102	6
7/25	163	9	126	92	25	124	3	109	101	42	22	14	55	16
7/26	72	6	29	50	10	120	4	80	128	9	52	16	61	24
7/27	75	4	25	108	5	194	0	68	69	5	111	22	52	18
7/28	60		8	108	22	181	2	45	47	14	242	59	21	20
7/29			4	168	11	93	5	68	47	57	150	13	26	24
7/30			23	31	12	54	1	62	34	37	45	19	19	0
7/31		2	29	122	7	86	9	71	73	53	29	13	38	0
8/01		7	17	43	6	112	0	114	45	31	43	28	14	1
8/02		5	23	104	1	42	5	57	53	28	63	21	30	1
8/03		1	21	54	0	12	9	36	24	13	27	25	5	2
8/04		1	11		0	55	2	46	12	20	9	9	7	1
8/05		2	12		0	38	2	31	8	5	18	11	14	3
8/06		8	11		0	37	0	21	15	4	13	8	7	12
8/07		2	7		0	25	0	7	6	9	26	9	3	4

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Date	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
8/08	3	0	3		0	1	0	11	4	13	5	8	6	4
8/09	0	0	9		0	19	2	15	0	12	6	11	5	4
8/10	4	0	16		3	10	1	2	5	2	3	15	3	2
8/11	15		18		2	8	0	5	1	6	13	11	2	2
8/12	10		3		1	6	1	0	0	3	15	11	4	4
8/13	18	16	1		3	7	0	2	10	3	15	9	5	3
8/14	7	4	2	0	3	5	1	3	5	1	5	6	3	3
8/15	6	1	1	5	3	16	1	3	12	1	0	9	7	1
8/16	8	8	12	2	7	13	0	4	14	1	0	15	4	1
8/17	11	3	5	4	13	6	0	19	63	3	5	7	1	1
8/18	11	0	4	11	10	3	3	7	49	1	0	16	3	3
8/19	12	1	1	6	35	12	0	0	37	3	0	12	4	0
8/20	8	1		4	38	12	0	3	65	0	3	12	5	14
8/21	14	0	8	4	36	1	0	2	337	3	0	15	2	9
8/22	9	0	3	6	13	1	0	21	15	0	2	12	1	5
8/23	3	0	3	5	28	1	1	1	12	1	0	10	1	10
8/24		6	8	4	36	0	0	2	21	3	1	15	2	10
8/25	0	9	1	1	48	13	1	4	7	2	5	17	1	29
8/26	2	1	4		188	17	1	2	16	3	2	6	5	3
8/27	0	10	6		452	7	0	1	1	2	4	5	2	9
8/28	0	5	3		225	9	0	7	12	0	6	2	2	31
8/29		1	3		378	20	0	1	5	3	4	7	0	13
8/30		4	7		154	41	0	1	3	1	4	1	2	45
8/31		1	4		219	60	0	3	4	7	6	1	12	16
9/01	0	1			751	107	0	1	2	7	7	4	3	16
9/02		1			676	62	1	1	0	2	10	6	2	4
9/03		7			385	99	0	2	1	6	7	7	3	17
9/04		0			89	142	1	0	1	3	2	6	6	16
9/05		3			198	180	1	2	1	7	2	2	1	62
9/06		1			66	142	5	1	2	4	3	1	1	17
9/07		2			13	71	3	2	5	1	1	0	0	10
9/08					414	32	6	0	4	0		2	2	3
9/09					404	122	0	0	10	0		5	1	22
9/10					184	21	1	7	7	0		4	2	10
9/11					57	81	0	0	6	0			12	8
9/12					64	69	2	0	5	0			1	2
9/13					24	47	0	0	0				5	16
9/14					7	1	0	0	4				0	6
9/15					47	36	0	0	1				2	33
9/16					62	32	0	0	4					4
9/17					57	33	0	0	7					11
9/18					3	2	0	0	6					9
9/19					31	4			9					4
9/20					34	5			16					3
9/21					13	6								1
9/22					16	36								
9/23						0								
9/24						3								
9/25						16								
9/26						4								
9/27						10								
9/28						3								
9/29						30								
9/30						2								
Total	1,829	2,808	2,915	1,761	6,616	3,535	1,770	1,949	3,492	2,128	1,842	1,692	1,422	1,608

APPENDIX 2. —Mean fork length and size range for Dolly Varden caught at the Middle Fork Goodnews River weir, 2001 – 2007¹, 2008 and 2009.

	2001	2003	2004	2005	2006	2007	2008	2009
<u>Total</u>								
Mean FL	477.0	436.0	409.4	456.5	464.7	450.1	444.8	389.9
SE	3.3	2.7	2.5	2.7	2.2	4.1	6.4	10.6
Minimum	308	268	159	255	310	239	131	250
Maximum	619	660	643	625	625	656	620	702
N	278	644	803	271	330	318	147	111
<u>Prespawners</u>								
Mean FL	523.0	455.7	441.8	484.6	492.5	483.5	464.2	502.3
SE	3.9	4.1	2.1	10.2	8.6	4.3	4.9	11.5
Minimum	431	271	324	418	419	339	328	359
Maximum	619	641	643	607	565	656	620	702
N	112	294	489	18	22	208	122	42

¹Lisac 2008

APPENDIX 3. —Estimated prespawning (PR) Dolly Varden at the MFGR weir by time strata, 2001 to 2007¹.

Year ²	Time strata	Weir count	Number sampled	Percent sampled	Number PR	Percent PR in sample	Estimated PR	SE
2001	1	441	58	13.2%	17	29.3%	129	7.3
	2	1,087	182	16.7%	74	40.7%	442	14.7
	3	296	38	12.8%	21	55.3%	164	12.5
	Total	1,824	278	15.2%	112	40.3%	735	20.6
2003	1	701	106	15.1%	48	45.3%	317	14.2
	2	801	283	35.3%	173	61.1%	490	11.4
	3	340	205	60.3%	72	35.1%	119	2.5
	Total	1,842	594	32.2%	293	49.3%	927	18.4
2004	1	1,258	144	11.4%	135	93.8%	1,179	22.5
	2	1,282	485	37.8%	328	67.6%	867	14.5
	3	813	86	10.6%	26	30.2%	246	11.6
	Total	3,353	715	21.3%	489	68.4%	2,292	29.2
2007	1	984	146	14.8%	116	79.5%	782	24.2
	2	327	146	44.6%	82	56.2%	184	5.6
	3	381	32	8.4%	13	40.6%	155	13.1
	Total	1,692	324	20.4%	211	65.1%	1,120	28.1

¹Lisac 2008

²No estimate available due to insufficient sample size in 2002, 2005 and 2006.