2012 PUBLIC UTILITY DISTRICT NO. 1 OF DOUGLAS COUNTY NORTHERN PIKEMINNOW REMOVAL AND RESEARCH PROGRAM

WELLS HYDROELECTRIC PROJECT

FERC NO. 2149

January 2013

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ABSTRACT

Public Utility District No. 1 of Douglas County's (Douglas PUD) 2012 northern pikeminnow (*Ptychocheilus oregonensis*) removal efforts were conducted from April 12, 2012 to November 18, 2012. The designated capture area was from 1 mile below Wells Dam upstream to the boat-restricted zone (BRZ) of Chief Joseph Dam. A total of 12,596 pikeminnow were captured on setlines and 622 pikeminnow were captured on hook-and-line gear.

Fishing crews captured 13,218 northern pikeminnow; of those, 12,284 were equal to or greater than 229 mm in total length and 934 were less than 229 mm in total length. This cut-off length was established by BPA as the length at which pikeminnow become predatory on juvenile salmonids (Beaty 1991; Porter 2000) and has been used by Douglas PUD for over ten years of pikeminnow removal. These fish were captured during 5,547 hours of angling effort translating into an overall catch-per-unit-effort (CPUE) of 2.4 pikeminnow per hour. Within the lower Wells Reservoir from the Methow River confluence area to the forebay of Wells Dam, 6,185 fish were captured during 2,571 hours of effort translating into a CPUE of 2.4. Set-line efforts in the lower 1-mile section of the Methow River captured 322 fish during 130 hours of effort (CPUE = 2.5). Within Wells Reservoir from the mouth of the Methow River to Chief Joseph Dam, 1,115 pikeminnow were captured during 606 hours of effort, a CPUE of 1.8. The remaining fish were captured in the Wells Tailrace (5,596 pikeminnow) during 2,240 hours (CPUE =2.5). The 13,218 pikeminnow were captured over 9,160,000 hook hours, translating into an overall CPUE of 0.0014 fish per hook hour. From 1995 to present, pikeminnow removal programs sponsored by Douglas PUD have resulted in the capture of approximately 241,000 pikeminnow from the Wells Project.

A total of 5,426 non-target fish were captured and released representing 34.1% of the overall catch. Incidental encounters consisted of nine taxa: 3203 burbot (*Lota lota*), 724 peamouth (*Mylocheilus caurinus*), 603 sucker spp. (*Catostomus* spp.), 528 chiselmouth (*Acrocheilus alutaceus*), 161 sculpin spp. (*Cottus* spp.), 142 pikeminnow / chiselmouth hybrids, 72 white sturgeon (*Acipenser transmontanus*), 47 redside shiner (*Richardsonius balteatus*), and 18 brown bullhead catfish (*Ameiurus nebulosus*). All non-target fish were released alive. The presence of white sturgeon bycatch during the 2012 project is attributed to the release of juvenile sturgeon by Chelan PUD within Rocky Reach Reservoir as part of their White Sturgeon supplementation program. All incidentally captured white sturgeon were determined to be from this release by PIT tag and scute mark identification. No salmonids were encountered during the project. The setline removal system has consistently produced low levels of by catch, especially in regards to salmonids, over the previous 10 years. During the 2012 program a much lower number of pikeminnow were captured within Wells Reservoir than in previous years (11,291 fish captured in 2011 and 5,596 fish captured in 2012). The large number of burbot encountered and the documented predation of burbot on pikeminnow may have significantly reduced total pikeminnow catch within Wells reservoir in 2012.

Gonad analysis indicated that the peak spawning period for pikeminnow occurred during the period of July 27 to August 15th, during which time 51% of the sub-sampled pikeminnow were classified as ripe. During an average water year, pikeminnow spawn in late June or early July

(Jerald 2007, Jerald 2008) , therefore the 2012 data represents evidence of delayed egg maturation / spawning events during the current year.

Analysis of digestive tracts was performed on a 5.1% sample of the captured pikeminnow to assess their dietary preferences and predation rates on juvenile salmonids. Forty-three percent of the dissected pikeminnow digestive tracts were empty, 20% contained crayfish, 16% contained unidentified plant matter, 8% unidentified fish, 7% unidentified insect, 5% salmonids and 1% sculpin.

As was observed during the 2011 project (Jerald 2012) significant environmental events hampered CPUE and total catch levels in 2012. River flows at Wells Dam from April to August 2012 ranged from 142% to 192% of average, with the highest monthly flows occurring in July (Douglas PUD 2013). This translated into difficult fishing conditions for the pikeminnow field crews. Given that Wells Dam is a run-of-the-river project with limited storage capacity, and that the turbine-discharge capacity was reduced due to maintenance and rehabilitation projects, high flows were sent through spill bays during the spring and summer freshet. The resultant turbulent conditions in the tailrace made it impossible for crews to capture pikeminnow within this normally productive area in May, June, and July.

The percentage of large (>350 mm) pikeminnow has declined from 23% in 2002, reaching a low of 14% in 2009. Thus, the pikeminnow removal program has reduced the average size of piscivorous pikeminnow >350 mm, or these large fish are no longer recruiting to the setline gear. We suspect the former is occurring. The size threshold of 350 mm was selected arbitrarily in an effort to monitor any change in annual pikeminnow length in the Wells Project.

1.0 INTRODUCTION

Throughout the Columbia River hydro system, numerous measures have been implemented to improve the survival of salmonids (*Oncorhynchus* spp.), which pass up to nine hydroelectric projects on their migrations to and from the ocean. As one of those measures, Public Utility District No. 1 of Douglas County (Douglas PUD) is required by the Federal Energy Regulatory Commission (FERC) via the Wells Hydroelectric Project Anadromous Fish Agreement and Habitat Conservation Plan (HCP, Section 4.3.3) to implement measures for the control of predacious northern pikeminnow (*Ptychocheilus oregonensis*) at the Wells Hydroelectric Project (Project). Thus, in an effort to understand and control predators of juvenile salmonids within the Project, Douglas PUD has funded research on, and removal of, northern pikeminnow since 1993.

Pikeminnow research and removal, initiated on the lower Columbia River during the summer of 1990, has been recognized as an important part of restoring salmonid stocks within the Columbia River system (Vigg et al. 1990; Matthews et al. 1991). Initial test fisheries utilizing hook and line removal methodology in the lower Columbia River captured 17,334 pikeminnow (Vigg et al. 1990). In 1991, 39,817 fish were removed from eight U.S. Army Corps of Engineers hydroelectric projects on the lower main stems of the Columbia and Snake Rivers (Beaty et al. 1991). Shortly thereafter, mid-Columbia Public Utility Districts (PUDs) began to investigate the possibilities of initiating similar pikeminnow research and removal activities.

In 1993, Douglas, Chelan, and Grant PUDs jointly funded a study of predation on juvenile salmonids in the mid-Columbia region (Burley and Poe 1994), to identify areas of northern pikeminnow abundance and areas of high predation on out-migrating juvenile salmonids. Density-index values of pikeminnow in the mid-Columbia reservoirs were as high as many reservoirs of the lower-Columbia. The immediate tailrace of Wells Dam and the outfall of Wells Hatchery were identified as sites where large concentrations of pikeminnow could be found relative to other locations within the Wells Project.

Douglas PUD initiated a northern pikeminnow test fishery in 1995, with the goals of assessing the effectiveness of several gear types for removing pikeminnow, estimating the population size of pikeminnow, and removing pikeminnow from the tailrace of Wells Dam (Bickford and Klinge 1996). During the summer of 1995, crews captured 1,198 pikeminnow, with the majority captured via conventional hook-and-line gear. A similar removal program in 1996 was intended to increase effort and remove as many pikeminnow as possible from the Wells tailrace (Bickford 1997). Unfortunately, removal efforts were hampered by difficult fishing conditions related to high river flows and velocity, and only 313 northern pikeminnow were captured, most on sport-fishing gear. Commercial setline gear was also utilized in 1996, and although the lines did not capture many pikeminnow, catch-per-unit-effort (CPUE) was high relative to other methods tested. Prompted by low catch rates in 1996, biologists at Douglas PUD initiated a behavioral study in 1997, radio-tagging northern pikeminnow throughout the Wells Reservoir and tailrace. Migration patterns, spawning locations, and preferred habitats of northern pikeminnow were identified throughout Wells Reservoir and from the Wells tailrace to eleven miles downstream at Chelan Falls (Bickford and Skillingstad 2000).

In an effort to increase catch levels and conduct studies on northern pikeminnow, Columbia Research was hired by Douglas PUD in 1998. Columbia Research's removal strategy focused on an incentive-based fishery with a crew of experienced anglers paid on a per-fish basis (anglers hired directly by Douglas PUD in 1995 and 1996 were paid by the hour). Anglers in 1998 captured 7,347 pikeminnow, a significant increase over the numbers of fish captured during previous years. Catch numbers increased during each subsequent year, with 10,382 pikeminnow captured in 1999 and 12,338 in 2000. Catch numbers totaled 14,935, 20,201, and 20,065[1] pikeminnow, in 2002, 2003, and 2004, respectively. From 2005 to 2011 catch per year has ranged from approximately 16,000 to 20,000 fish annually. The success of these annual efforts demonstrates the efficacy of the setline capture technique as implemented by Columbia Research, and the capacity of the program to annually harvest significant numbers of northern pikeminnow from the Project.

To date, pikeminnow removal programs sponsored by Douglas PUD have resulted in the capture and removal of approximately 241,000 pikeminnow. It is believed that these programs have significantly decreased predation on outbound juvenile salmonids within Wells Reservoir and in the immediate Wells tailrace. This report outlines the results of Douglas PUD's 2012 pikeminnow removal project implemented by Columbia Research, and compares the current data with those collected during previous removal efforts from 2002 to 2011.

2.0 MATERIALS AND METHODS

One vessel rotated three to five crewmembers during the project. Setline efforts were initiated on April 12, 2012 and were completed on November 18, 2012. In 2012 crews were not able to set gear due to dangerously turbulent water conditions below Wells Dam. Due to these factors, no fishing took place from July 1 to July 26. Semi-monthly summaries were provided to Douglas PUD during the project, which updated Douglas PUD biologists with project status and progress rates. Setline crews filled out daily data sheets specifying locations fished, number of fish caught per location, setline set times, and incidental catch.

Additionally, in 2012 anglers initiated hook-and-line efforts within the immediate Wells tailrace. Hook-and-line anglers focused on the rip-rap sections below the entrances of the east and west Wells fish ladders. It was not feasible to utilize set lines in these areas due to the large rocks that entangled setline gear as well as the turbulent flows experienced in these areas in 2012. It was observed in these areas that larger pikeminnow were actively feeding. In an attempt to target these pikeminnow, anglers utilized hook-and-line gear to focus on the narrow rocky channel areas. A variety of baits were fished on the bottom including worms, maggots, shrimp and crickets.

The 2012 pikeminnow removal efforts were conducted throughout the Project from the tailrace area of Wells Dam upstream to the boat restricted zone (BRZ) in the tailrace of Chief Joseph Dam. A scientific collection permit was obtained from the Washington Department of Fish and Wildlife allowing crews to place setlines throughout the study area including the lower 1-mile section of the Methow River, the mouth of the Wells Hatchery outlet channel and the BRZ of

[1] Includes 503 fish captured in 2004 that were not enumerated until 2005, and were not included in the totals reported in the 2004 report.

Wells Dam. Captured northern pikeminnow were categorized by one of four primary catch locations: Pikeminnow captured downstream from Wells Dam were designated "Wells Tailrace." Fish captured in the reservoir between Wells Dam and the Methow River confluence were designated "Lower Wells Reservoir." Fish captured from the Methow River confluence to the tailrace of Chief Joseph Dam were designated "Upper Wells Reservoir." Fish captured within the Methow River were designated "Methow River." CPUE rates were calculated for each location.

From 12 to 18 setlines were retrieved, baited and set each day by a crew of three individuals. Each line contained approximately 150 hooks. Setline gear was fished on the bottom. Each setline consisted of a main line with a buoy and a weight attached to each end. Hooks were spaced evenly along the main line between the end weights. The hooks were then attached via leaders of 6-pound-test monofilament approximately 0.6 meters in length. Setline gear was checked once daily, allowing crews to release all non-target fish back into the river unharmed. CPUE was calculated by summing hours spent to retrieve, check, and reset lines as well as travel and preparation time (tying hooks, assembling lines, etc.). Hook-time fished was calculated as the number of hooks fished each day multiplied by total days fished multiplied by 24 hours. Effort calculations methods are consistent from 2002 to 2011 of the pikeminnow program, allowing for easy comparison within and between years.

Biological data were collected randomly from 5.1% of the weekly catch. Biological data consisted of fork length, weight, sex, digestive-tract contents, and gonad maturity. Fork lengths were measured to the nearest millimeter. An Ohaus 5000 electronic scale was used to weigh fish to the nearest 2 grams. Pikeminnow were categorized as male, female, or unidentified, and gonad maturity was identified on a scale of 0 to 4, corresponding to the criteria listed in Table 1. Digestive-tract contents were visually identified. These methods are consistent with previous years of biological data analysis (Jerald 2010, Jerald 2011).

Table 1. Gonad maturity codes.

0	Unidentified	Gonads could not be distinguished between male and female.
1	Immature	Gonads thin and streamlined, sex may be difficult to determine.
2	Developing	Eggs and milt do not flow easily with pressure, but sex is easily determined. Eggs are small and gray in color.
3	Ripe	Females contain orange-colored eggs. Eggs or milt flow freely with gentle pressure.
4	Spent	Gonad size reduced. Some eggs or sperm may still be present.

3.0 RESULTS

A total of 13,218 northern pikeminnow were captured over 5,547 hours of setline effort, equating to an overall CPUE of 2.4 fish per angling hour. Over the fishing season, setline efforts translated into 9,160,000 hook hours for an overall CPUE of 0.0014 fish per hook hour. Greater than 92% of the captured fish (12,284) were equal to or greater than 229 mm in total length, The balance, 934 (~8%), of captured pikeminnow were less than 229 mm.

Within the lower Wells Reservoir from the Methow River confluence area to the forebay of Wells Dam, 6,185 fish were captured during 2,571 hours of effort translating into a CPUE of 2.4. Setline efforts in the Methow River captured 322 fish during 130 hours of effort (CPUE = 2.5). Within Wells Reservoir from the mouth of the Methow River to Chief Joseph Dam, 1,115 pikeminnow were captured during 606 hours of effort, a CPUE of 1.8. The remaining fish were captured in the Wells Tailrace (5,596 pikeminnow) during 2,240 hours (CPUE =2.5) (Figure 1). Of these 5,596 pikeminnow captured in the Wells Tailrace, 4,974 fish were captured on setlines and 622 fish were captured on hook-and–line gear.

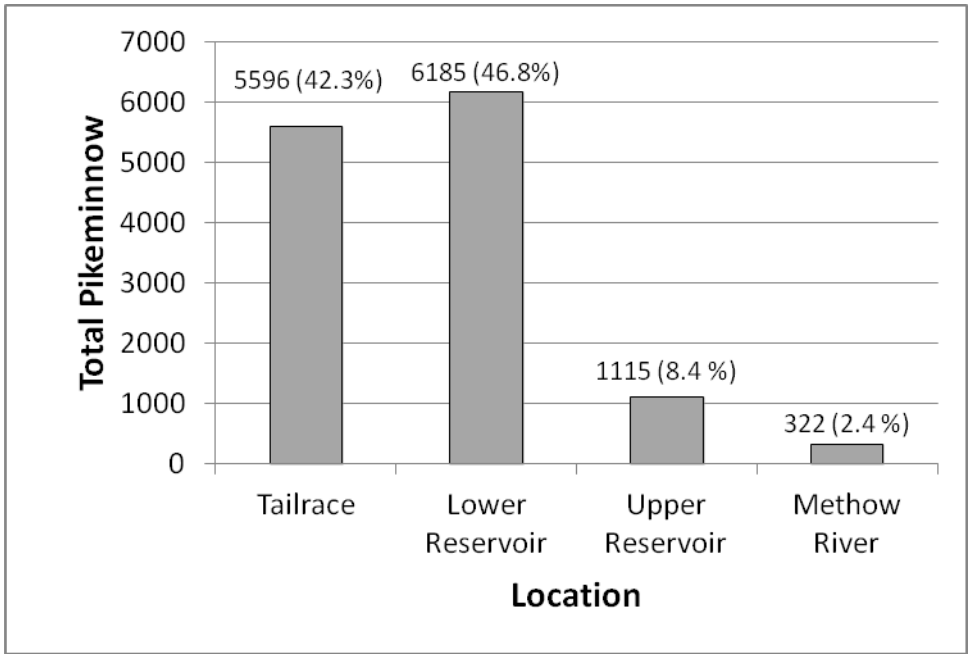

Figure 1. Catch (percentage of total catch) of northern pikeminnow by location.

Effort in the beginning of the 2012 removal program was focused in Wells Reservoir. Initial efforts in April and May were focused within the lower reservoir area from the mouth of the Methow River to Wells forebay. Catch levels during this spring period ranged from 1.8 to 2.7 (Table 2). Project CPUE rates dropped during the second half of June as a result of two factors. First, CPUE dropped significantly within Wells Reservoir which is a phenomenon documented annually during the first week of June (Jerald 2009, Jerald 2010). Second, as crews transferred fishing effort from the reservoir to the normally productive Wells Tailrace, they encountered high spill conditions which made it impossible to work the setline gear. At that point, crews discontinued effort in July due to dangerous water conditions and very low CPUE rates. Average monthly river flow volume (kcfs) was 192% of average river flow in July of 2012 (Douglas PUD 2013). Spill eventually decreased towards the end of July allowing crews to re-initiate fishing effort on July 27th. CPUE levels remained consistently low from August to October in the Wells tailrace. In October crews returned to Wells Reservoir resulting in a slight spike in CPUE during the second half of October.

In most years since 2002, the Wells Tailrace catch has equaled or outpaced the catch in the Wells Reservoir; however, in 2011and 2012 (high water years) the tailrace catch was lower than Wells

Reservoir. For example, the average of catches for the years 2002-2010 is 8,626 in the Wells Reservoir and 11,311 in the Wells Tailrace. In 2011 the catches for these locations were 11,291 and 5,011, respectively. In 2012 catches for these locations were 7,622 and 5,596 respectively. In addition, catch per unit effort in the Wells Tailrace declined dramatically in 2011 and 2012 compared to the average from 2004 to 2010. The average of CPUEs in the tailrace from 2004-2010 is 5.17; in both 2011 and 2012 CPUE was 2.5.

Table 2. Semi-monthly numbers of pikeminnow caught and CPUE during the 2012 removal program.

Semi-month	Pikeminnow over 229 mm	Pikeminnow under 229 mm	Total Pikeminnow	Effort (Hrs)	Total CPUE
4/12 – 4/30	1579	51	1630	602	2.7
5/1 – 5/15	1070	106	1176	446	2.6
5/16 – 5/31	718	63	781	424	1.8
6/1 – 6/20	1124	97	1221	502	2.4
6/21 – 6/30	228	11	239	156	1.5
7/1 – 7/15	No Fishing				
7/15 – 7/26	No Fishing				
7/27 – 8/15	1061	32	1093	422	2.6
8/16 – 8/28	803	56	859	385	2.2
8/29 – 9/15	1696	57	1753	594	3.0
9/16 – 9/30	1279	25	1304	584	2.2
10/1 –10/15	1041	123	1164	562	2.0
10/16-10/31	1107	265	1372	548	2.5
11/1-11/18	578	48	626	322	1.9
Total	**12284**	**934**	**13218**	**5547**	**2.4**

CPUE for setline gear placed within the lower 1-mile stretch of the Methow River was similar to the CPUE rates recorded in the productive Wells Reservoir locations. We surmise that the Methow confluence area provides increased predator opportunity as prey (juvenile salmonids and lamprey) must travel through this narrow corridor during the annual outmigration.

A total of 675 digestive tracts were sampled. This random sample was collected throughout the entire 2012 effort and on all size classes (pikeminnow over and under 229 mm). Of the 675 pikeminnow digestive tracts sampled, 43% were empty, 20% contained crayfish, 16% contained unidentified plant matter, 8% unidentified fish, 7% unidentified insect, 5% salmonids, and 1% sculpin (Figure 2; Table 3). "Unidentified fish" may include salmonids that were unrecognizable in their digested state, and/or would require laboratory techniques to provide a positive identification. Table 3 provides sampling observations of bi-weekly dietary behavior, and also the items consumed as a percentage of the digestive tracts with contents. The presence of salmonids in sampled digestive tracts was recorded from the onset of fishing efforts in April through the end of September. Gonad analysis indicated that the 2012 peak spawn period for northern pikeminnow occurred from July 27 to August 15th, at which time 51% of the sub-sampled fish were classified as ripe.

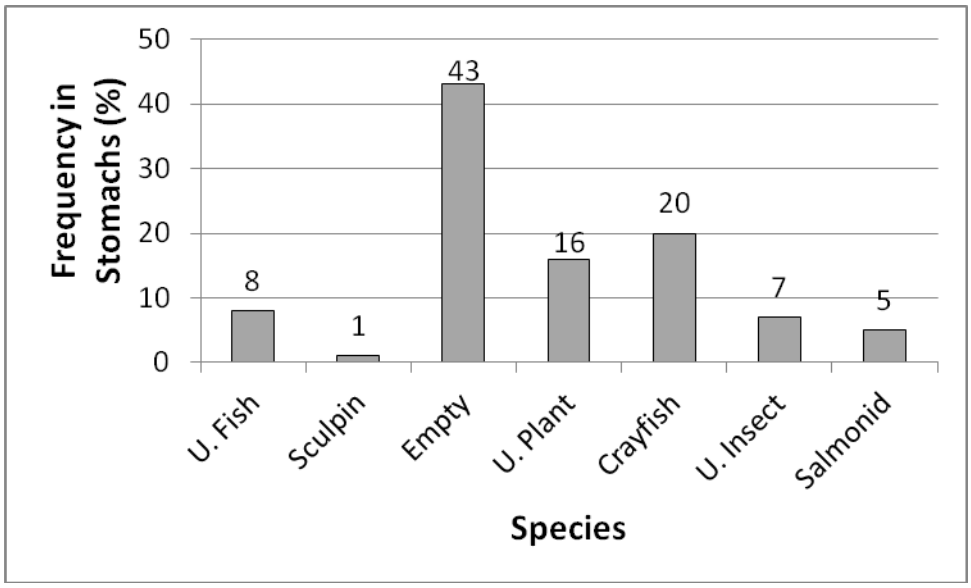

Figure 2. **2012 digestive-tract contents, as determined from analysis of 675 pikeminnow digestive tracts. The abbreviation "U." indicates "unidentified" items within the respective categories. In the case of "U. Fish," this category encompasses all fish other than lampreys, sculpin, or salmonids; "U. Plant" comprises all plant matter and "U. Insect" all arthropods other than crayfish.**

Table 3. **Results of analysis of digestive-tract contents for 2012 by week and number of digestive tracts sampled (*N*). Content categories are listed as the number of digestive tracts sampled that week containing that item. Values in parentheses in the "total" row are the percentages of the number of digestive tracts with contents that were sampled that week. "U." = Unidentified.**

				Content Category (breakdown of "Content Present" only)					
Bi-Week	***N***	**Empty**	**Content Present**	**Salmonid**	**U. Plant**	**U. Fish**	**Crayfish**	**Sculpin**	**U. Insect**
4/12 – 4/30	80	58	22	2	4	6	10	0	0
5/1 – 5/15	60	26	34	5	5	7	15	0	2
5/16 – 5/31	40	12	28	6	6	5	8	0	3
6/1 – 6/20	60	16	44	5	7	8	18	0	6
6/21 – 6/30	15	7	8	1	3	1	2	0	1
7/1 – 7/15		No	Fishing						
7/15 – 7/26		No	Fishing						
7/27 – 8/15	55	23	32	3	9	4	10	2	4
8/16 – 8/28	45	14	31	4	8	4	9	1	5
8/29 – 9/15	85	37	48	7	14	6	12	3	6
9/16 – 9/30	70	28	42	2	15	3	15	2	5
10/1 –10/15	60	17	43	0	14	4	16	1	8
10/16-10/31	70	26	44	0	18	3	17	0	6
11/1-11/18	35	22	13	0	4	0	6	0	3
Total	675	409 (46)	476 (54)	35	107	51	138	9	49

A total of 5,426 non-target fish were captured and released representing 34.1% of the overall catch. Incidental encounters consisted of nine taxa: 3203 burbot (*Lota lota*), 724 peamouth (*Mylocheilus caurinus*), 603 sucker spp. (*Catostomus* spp.), 528 chiselmouth (*Acrocheilus alutaceus*), 161 sculpin spp. (*Cottus* spp.), 142 pikeminnow / chiselmouth hybrids, 72 white sturgeon (*Acipenser transmontanus*), 47 redside shiner (*Richardsonius balteatus*), and 18 brown bullhead catfish (*Ameiurus nebulosus*) (Figure 3). All non-target fish were released alive. No salmonids were captured during the project.

In regards to incidental encounters using hook-and-line angling techniques in the immediate Wells Tailrace, the following incidental species were encountered (these fish are reflected in the totals outlined above). Peamouth (*Mylocheilus caurinus*), 122 fish, burbot (*Lota lota*), 78 fish, sucker spp. (*Catostomus* spp.), 45 fish, pikeminnow / chiselmouth hybrids, 18 fish.

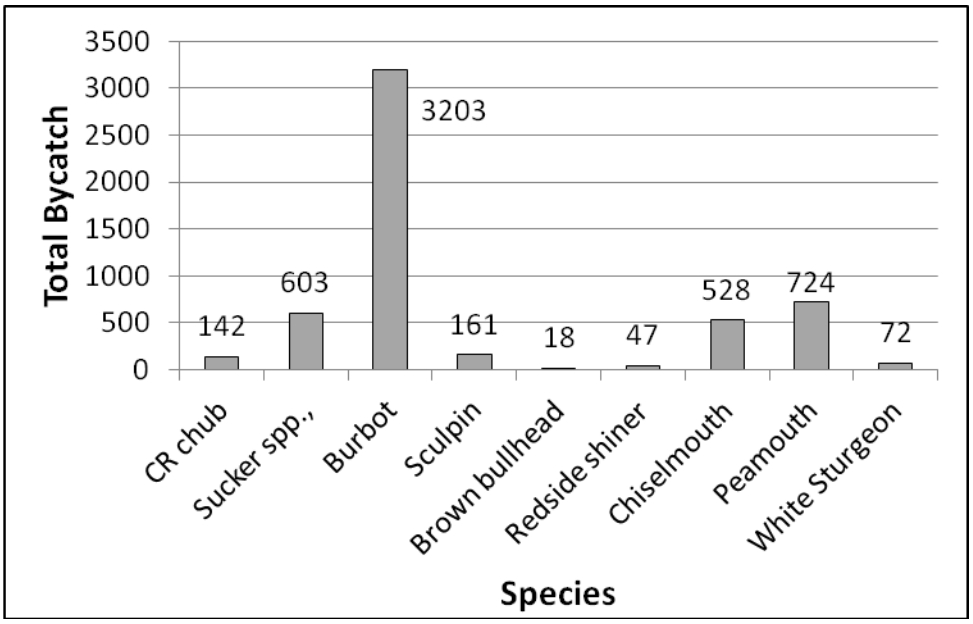

Figure 3. Numbers of non-target (incidental) fish by taxa captured in 2012.

During 2012 a high incidence of burbot were recorded in Wells Reservoir (Table 4). An increasing trend in burbot encounters has been documented over the last 3 years. Total burbot catch in 2010 was 146 fish, 579 fish in 2011, and 3203 fish in 2012. Previous to 2012, much of the burbot catch was restricted to the deep China Ditch section of the reservoir below the Methow River confluence. In 2012 burbot were encountered in large numbers throughout the reservoir area.

Table 4. Numbers of non-target (incidental) fish captured per bi-weekly period in the 2012 fishery.

Semi-month	Sucker Sp.	Burbot	Sculpin	Peamouth	Bull-head	Redside Shiner	White Sturgeon	Chisel-mouth	Hybrid
4/12 – 4/30	43	522	0	154	0	4	0	85	12
5/1 – 5/15	52	423	8	102	2	6	0	89	22
5/16 – 5/31	45	349	16	84	3	8	0	68	17
6/1 – 6/20	64	604	21	102	7	9	0	77	20
6/21 – 6/30	43	40	14	11	0	0	0	3	4
7/1 – 7/15	No	Fishing							
7/15 – 7/26	No	Fishing							
7/27 – 8/15	58	18	21	32	0	2	12	8	7
8/16 – 8/28	50	17	18	28	0	0	18	8	6
8/29 – 9/15	64	28	19	42	0	4	23	16	8
9/16 – 9/30	58	10	11	22	0	2	11	11	7
10/1 –10/15	52	252	14	48	2	3	8	36	16
10/16-10/31	46	638	13	96	3	6	0	88	14
11/1-11/18	28	302	6	3	1	3	0	39	9
Total	603	3203	161	724	18	47	72	528	142

4.0 DISCUSSION

A relatively low number of pikeminnow were captured in 2011 and 2012 when compared to pikeminnow captured from 2003 to 2010 (Figure 4). Significant environmental events hampered CPUE and total catch levels during the 2011 and 2012 projects. 2011 and 2012 were two of the highest flow years on record within the Columbia River (Douglas PUD 2013). This translated into difficult fishing conditions for the pikeminnow field crews. As a result of dramatic drafting at Grand Coulee and Chief Joseph Dam, large quantities of water were spilled at Wells Dam during months in which fishing has historically been productive in the tailrace (May, June, and July). Typically during the annual fishery, approximately 11,000 pikeminnow are captured from the productive Wells Tailrace location. In 2011, only 5,011 pikeminnow were caught at that location and in 2012 only 5,596 pikeminnow were captured in the Well Tailrace (Figure 1).

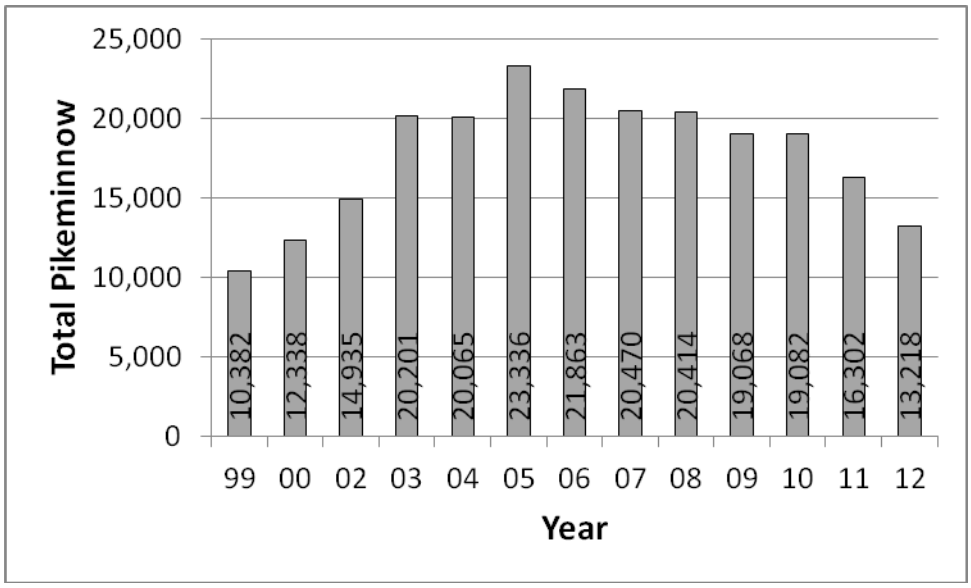

Figure 4. Douglas County PUD total northern pikeminnow catch by year.

4.1 Pikeminnow Diet

The timing of the peak migration of salmonid smolts from the Methow and Okanogan rivers corresponds with an increase in smolts in pikeminnow diets as identified during stomach analysis (data on the timing of smolt migration from Columbia River DART http://www.cbr.washington.edu/). In 2012 a high incidence of salmonids were also identified in pikeminnow gut analysis during August and September. This occurrence of salmonids in gut analysis has not been documented within previous year's data (Jerald 2011, Jerald 2012).

4.2 Incidental Catch

During the development stage of the setline removal approach, concerns were raised regarding high incidental catch and mortality. In contrast to those concerns, setline methods have proven to be highly selective for northern pikeminnow, with extremely low rates of encounter with non-target sensitive and game species, including no encounters with salmonids (Jerald 1998; Jerald 1999; Jerald 2000; Magnotti and Jerald 2001; Jerald 2005). Setlines have allowed for the selective harvesting of northern pikeminnow from all depths and substrates, in most currents, and in all seasons, with minimal by catch of non-target species, and to date, no bycatch of salmonids other than whitefish. Previous annual reports (Jerald 2005, Jerald 2006) discuss possible explanations for the selectivity of the setline techniques.

In 2012, an atypically high number of burbot were encountered within Wells Reservoir. An increasing trend in burbot encounters has been documented over the last 3 years. Total burbot catch in 2010 was 146 fish, 579 fish in 2011, and 3,203 fish in 2012. Previous to 2012, much of the burbot catch was restricted to the deep China Ditch section of the reservoir below the Methow River confluence. In 2012 burbot were encountered in large numbers throughout the reservoir area. In 2012 crews ran from 14 to 16 set lines per day and recorded an estimated

average of 2 burbot per set line (for example, in April, 258 setlines were deployed and 522 incidental burbot were recorded). A majority of these burbot had been hooked while feeding on pikeminnow that were captured on the setline gear as evidenced by pikeminnow inside the burbot mouths when pulled into the boat. It was clear that burbot were keying in on the setline gear to feed on the previously hooked pikeminnow. This could account for a significant reduction in pikeminnow catch on the setline gear (e.g. if an average of 1 pikeminnow was lost to burbot predation on each line, a total of 522 pikeminnow would have been lost during the April fishing session). As an additional observation, a number of burbot regurgitated salmonid smolts when captured in the Methow / China Ditch area during the peak smolt outmigration in May and June.

Incidental encounters with burbot on the setline gear in 2012 (3,203) were over five times higher than in 2011 (579). During the 2012 program a much lower number of pikeminnow were captured (5,596 fish) within Wells Reservoir than in 2011 (11,291 fish). The documented predation of burbot captured on pikeminnow gear may have significantly reduced total pikeminnow catch within Wells reservoir in 2012.

Hook-and-line angling resulted in no encounters with endangered or sensitive species. Hook-and-line anglers focused on using dead baits placed on the bottom of the water columns, similar to baits placed on the setline gear. The result was incidental encounters similar to that observed on the setline gear.

4.3 Yearly Comparisons

Catch information has been compiled from the annual Douglas PUD removal programs to provide comparative analysis of the yearly data from multiple years of intensive setline efforts. From 2002 until present, setline gear has been used exclusively for pikeminnow capture (prior to 2002, hook-and-line techniques were also utilized). Thus, the 2002 to 2011 data represent pikeminnow that have been captured on similar sampling gear within the Wells Project Area (excluding 622 fish that were caught on hook-and-line gear in 2012). It should be noted that the catch distribution within the project area was not consistent from 2002 to 2012 (Figure 5). From 2004 to 2012, a much higher proportion of fish were captured in Wells Reservoir than in 2002 and 2003, because productive fishing locations within Wells Reservoir were discovered after 2003. Beginning in the early spring months of March and April 2004, crews were able to place setline gear in locations where pikeminnow overwinter, greatly improving catch rates in the reservoir.

Two interesting phenomena were identified during the 2012 project. First, 2012 was one of five years (other years include 2004, 2005, 2010, and 2011) in which catch within Wells Reservoir was higher than Wells Tailrace. Second, CPUE decreased dramatically within Wells Reservoir in 2012. This is a continuing trend that has been documented from 2009 to 2011(Figure 6).

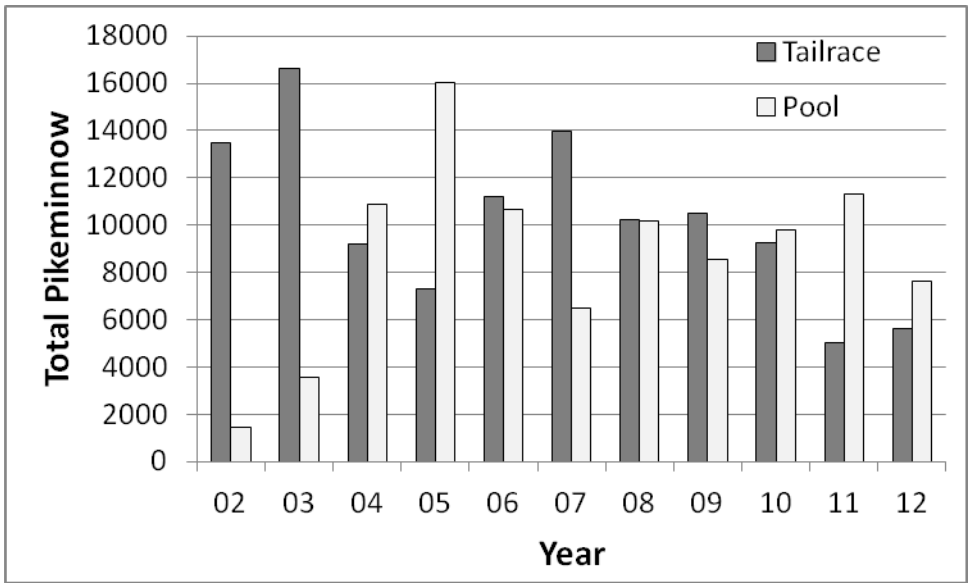

Figure 5. Catch distribution from 2002 to 2012 within Wells Tailrace and Wells Reservoir .

Yearly CPUE rates were noticeably lower in 2011and 2012 compared to previous years (Figure 6). We believe that the CPUE decline has been due to several factors. First, Wells Dam has recorded record spill volume and duration during the months of June and July in both 2011 and 2012, which are typically the most productive fishing months in the tailrace area (Jerald 2008, Jerald 2009). Setline crews could not set gear in the tailrace on a consistent basis in 2011. When they did, the gear was frequently moved or lost completely due to turbulent water conditions. In 2012 crews were not able to set gear at all within the tailrace from July 1 to July 26. Second, the annual salmon fishery commenced below Wells Dam on July 1, with record participation by anglers. There were frequent occurrences of recreational anglers becoming entangled in setline gear as well as tampering with that gear, which resulted in substantial setline gear loss. Combined, these two factors substantially affected total catch and CPUE during the months of June and July. A third factor in lower total catch / CPUE values is the documented occurrence of burbot predation on pikeminnow trapped on the setline gear in 2012.

Of final consideration is the substantial number of pikeminnow that have been removed from the Wells tailrace/Rocky Reach Reservoir from 2008 to 2013 through Chelan PUD and Douglas PUD sponsored efforts. These programs may have effectively reduced the population of pikeminnow in this location. Bickford and Skillingstad (2000) documented the migration of pikeminnow from middle and lower Rocky Reach Reservoir into the Wells tailrace for spawning and/or predation activities. A substantial reduction in the pikeminnow population within Rocky Reach Reservoir could result in decreased CPUE rates within the Wells tailrace.

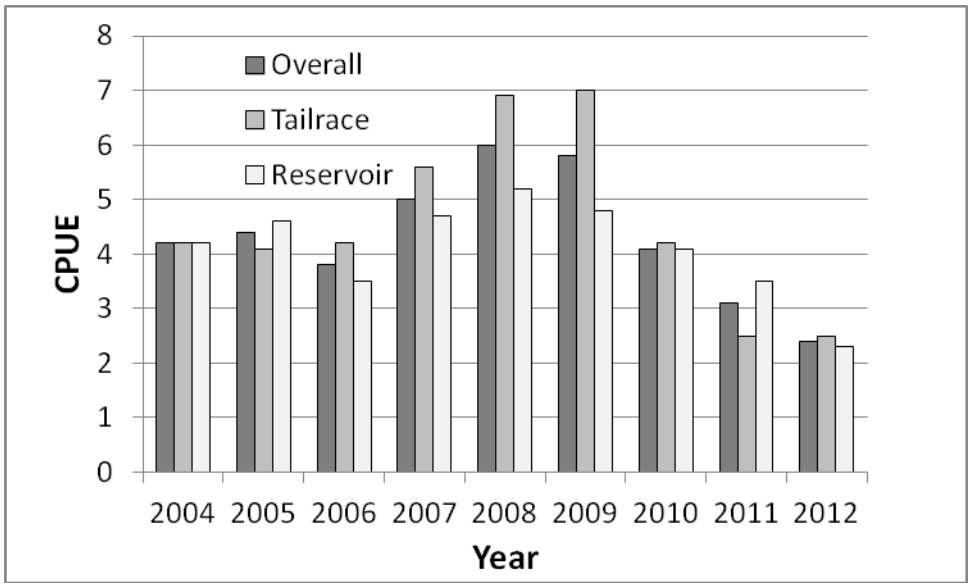

Figure 6. CPUE values by location for Wells Project pikeminnow removal program, 2004 to 2012.

A decreasing trend in average lengths is observed from 2002 to 2009 (Figure 7). The lowest average pikeminnow length and weight was recorded during 2009 at 273 mm in length and 243 grams in weight. From 2004 to 2009 (similar fisheries with similar effort within reservoir and tailrace areas) the average pikeminnow length decreased by 29 mm and weight by 53 grams[2].

During 2010 and 2011 a slight increase was recorded in average length and average weight, but both weights and lengths dropped in 2009 to more closely match the 2009 data. From 2008 to 2012 average fish lengths have only varied within 7 mm (278 mm in 2008, 273 mm in 2009, 277 mm in 2010, 280 mm in 2011, and 274 mm in 2012). This may be an indication that yearly pikeminnow removal efforts have reduced the population to an equilibrium level where fishing effort has offset recruitment.

[2] The apparent 27-mm increase in average length from 2003 to 2004 is likely because most pikeminnow were captured in the Wells tailrace in 2003, but in 2004 (and each subsequent year), substantially more pikeminnow were captured in Wells Reservoir than during 2003. Fish captured in Wells Reservoir during 2004 were noticeably larger than those captured in the tailrace.

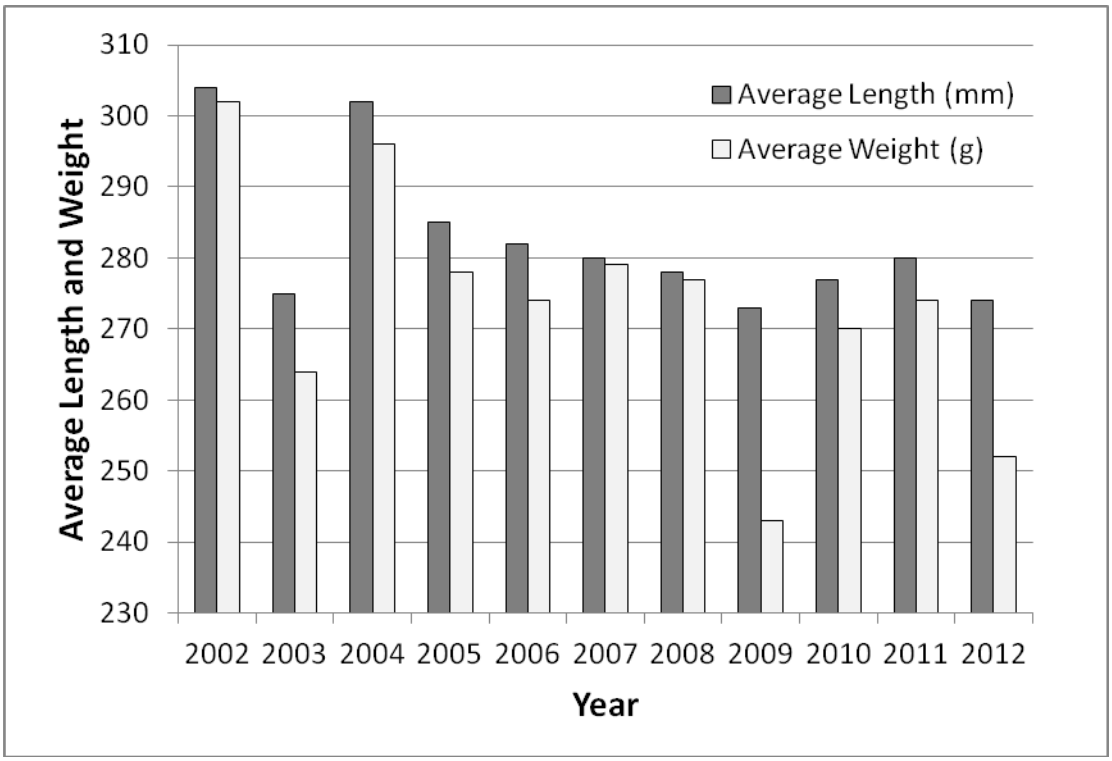

Figure 7. Average pikeminnow length (mm) and weight (g) from sampled pikeminnow in Wells Tailrace and Wells Reservoir 2002 to 2012.

Average fish weight is an unreliable indicator of trends in average fish size in the pikeminnow population over time, as the observed weight per length of pikeminnow varies seasonally (data not shown). Factors affecting fish weight during the fishery likely include fish condition going into the previous winter, winter water temperatures, and the rate of increase in spring water temperature. Additional factors may include the influence of environmental variables on the availability of prey, such as the timing of salmonid fry emergence and smolt migrations or the recruitment rate of larval resident fish from the previous year class. Timing of the commencement of the annual fishery also influences fish weight per length. For example, fishing began much later in 2007 (May 6), 2008 (April 22), 2011 (April 7) and 2012 (April 12) than in 2004, 2005, 2006, 2009, and 2010 (March 8, 3, 21, 19, and 16, respectively), and we observed apparently anomalous average pikeminnow weights in 2007 and 2008, despite the annual decline in average length and overall decrease in average weights over the 2004-2009 period. Fish of all lengths captured in April and May would have experienced several additional weeks of foraging before the commencement of fishing relative to the fish subjected to those fisheries that began in March. Thus, fish captured late in the fishery would have exhibited an overall improvement in condition factor relative to those fish of equal length captured early in those fisheries that began in March. In 2009 body masses were approximately 10% lower than in previous years and are likely attributed to overwinter conditions rather than timing of capture (see Figure 7). Fluctuations in the duration of the annual pikeminnow removal program may also affect the displayed catch data, with the longer fishing periods in 2010, 2011, and 2012 inevitably effecting catch data when comparing on an annual basis. Finally, the reservoir yields

relatively larger fish than the tailrace, and a greater proportion of the catch over the last three years has been from the reservoir (see Figure 7).

No trends have emerged in the percentages of the total annual catch that are either <229 mm or ≥229 mm in length (Figure 8). Therefore, the observed decline in average fish size since 2002 cannot be explained by a disproportionate reduction in the numbers of fish ≥229 mm, but rather by a reduction in the average size of fish in that category.

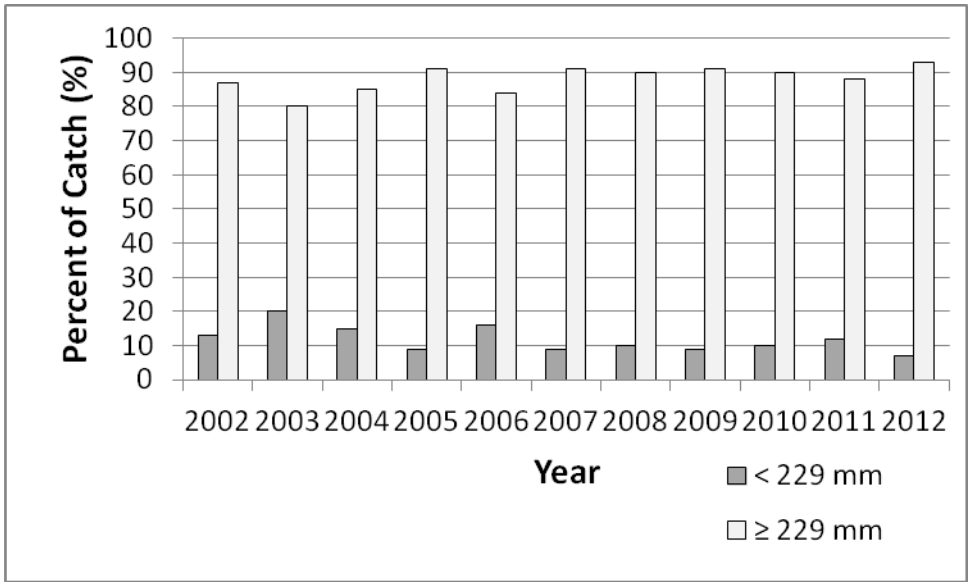

Figure 8. Catch composition by size category reported as the percentage of fish captured annually that were either <229 mm or ≥229 mm.

The size distribution of large pikeminnow over 350 mm was analyzed from 2002 to 2012 in an attempt to quantify any increase or decrease of very large pikeminnow within the population over time. During 2002, fish greater than 350 mm comprised 23% of the total catch (Figure 9). The occurrence of these larger fish decreased systematically from 2002 to 2009. In 2009 the lowest occurrence of sampled fish >350 mm was observed, comprising only 14% of the total catch. From 2006 to 2012 catch composition of these larger fish only varied from 14% to 16% of total catch, a further indication that the fishery may have reached an equilibrium point with recruitment. While the numbers of very large fish (>350 mm) have declined since 2002, smaller fish within the ≥229 mm category either remain numerous or have increased in numbers to the extent that a corresponding decrease has not occurred in the total numbers of fish within that length category (see Figures 8 and 9).

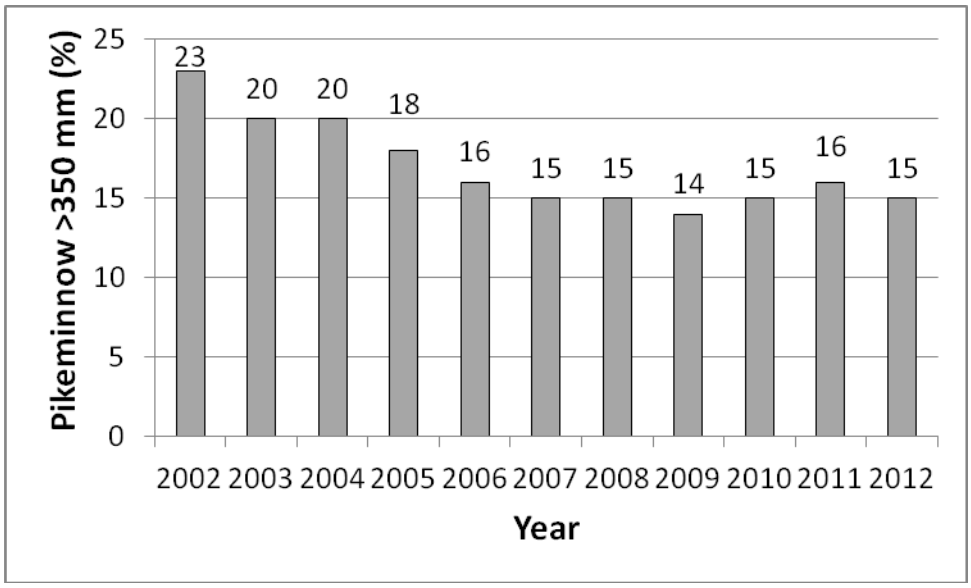

Figure 9. **Catch composition as the percentage of fish sampled annually that were >350 mm.**

There was no discernible trend in salmonid consumption by northern pikeminnow from 2002 to 2012 (Table 5). The highest occurrences of salmonid consumption were observed in 2004 and 2008, and the lowest incidences were documented in 2006, 2007 and 2012. High turbidity levels during those 3 years (documented high flow periods) may have decreased predator efficiency resulting in a low observance of salmonids during analysis of digestive tracts. The relatively late onset of fishing in 2007 (May 1; see discussion above) would have missed the majority of hatchery spring Chinook smolts that migrated in April, possibly explaining the low incidence of smolts in pikeminnow digestive tracts in 2007. Lamprey were first recorded during analysis of digestive tracts in 2009, which likely resulted from training technicians in lamprey identification prior to the onset of the fishing season, and the initiation of fishing effort in the Lower Methow area during the peak of the lamprey emigration. However, no lamprey were observed in the stomachs of the sampled pikeminnow in 2010, 2011 or 2012.

Table 5 Digestive-tract contents (%) for pikeminnow captured in Wells Project from 2002 to 2012 (approximately 5% of the catch sampled each year).

Year	Empty	Smolt	Crayfish	Unidentified Fish	Unidentified Plant	Unidentified Insect	Sculpin	Lamprey
2002	69	7	6	7	7	1		
2003	60	8	9	8	7	6		
2004	66	10	4	7	9	3		
2005	61	7	14	6	9	2		
2006	74	5	6	4	6	4		
2007	76	4	4	6	5	4		
2008	64	10	7	8	7	2		
2009	42	7	10	7	21	11		2
2010	55	6	11	6	14	7	1	
2011	46	6	22	3	15	7	1	
2012	43	5	20	8	16	7	1	
Mean (02-12)	59.6	6.8	10.3	6.4	10.5	4.9	0.3	0.2

Peak spawning in 2012, as determined by gonad analysis, occurred during the week of July 27, which is outside the range of peak spawn dates observed from 2002 to 2012 (June 21 to July 22).

5.0 CONCLUSIONS

The northern pikeminnow removal program removed large numbers of pikeminnow from the Wells Project from 2003 to 2012 (ranging from 13,218 pikeminnow in 2012 to 23,336 pikeminnow in 2005)(see Figure 4). From 2008 to 2012, yearly catch of pikeminnow steadily decreased. In 2011 a significant decrease in catch and CPUE was recorded, and these decreasing trends continued in 2012. The 2012 CPUE rates were the lowest recorded to date for any of the annual setline fisheries (see Figure 6). Issues regarding water flow, interference by recreational anglers below Wells Dam, and burbot consumption of pikeminnow on the setline gear significantly reduced weekly catch and CPUE levels. However, we cannot ignore the potential that the intensive DPUD and CPUD-sponsored pikeminnow removal programs have appreciably reduced pikeminnow abundance in the study area, as it has been increasingly difficult for crews to capture pikeminnow in recent years.

Since 2002, the percentages of pikeminnow that are ≥ 229 mm in the annual catches have remained steady, while the percentage of large (>350 mm) pikeminnow (which are likely to be females due to sexual dimorphism) has declined from 23% in 2002, to consistently within the 14 to 16 percent range, reaching a low of 14% in 2009. The higher percentages of large fish observed in 2010, 2011, and 2012 likely reflects the larger numbers of fish caught in Wells Reservoir, which typically yields larger fish than the tailrace. Had we been able to match historical efforts in the tailrace in 2011 and 2012, we expect that the percentage of large fish in the catch may not have spiked in 2011 and might have continued the declining trend observed from 2002 to 2009. Regardless, the pikeminnow removal program has reduced the average size

of piscivorous and reproductive-sized pikeminnow >350 mm while not discernibly reducing the proportions of fish captured from the ≥ 229 mm and < 229 mm categories.

During 2009 and 2010, CPUE rates in March were the lowest recorded. CPUE rates did not increase to over 4.0 until mid-April. In 2011 and 2012, crews did not initiate fishing efforts until April, at which time relatively high CPUE levels were recorded when compared to monthly CPUE values during each specific year. It is suggested that in 2013, crews once again initiate fishing efforts in April, to avoid low CPUE levels that have previously been recorded in March.

In previous annual reports it has been suggested that the pikeminnow population within the study area has reached an equilibrium stage between the fishery and recruitment (Jerald 2012). The decreasing trend of captured pikeminnow from 2010 to 2012 (19082, 16302, and 13218 fish respectively) is a potential indicator of decreasing pikeminnow abundance in the study area. Analysis of future yearly catch data will provide further indication of the state of the pikeminnow population and the effects of the current fishery. An equilibrium state would be indicated by consistent CPUE levels analyzed on a multi-year rolling-average. Decreasing CPUE levels and total catch levels will be an indication that the pikeminnow population within Wells Reservoir and the Wells tailrace is being substantially affected by the annual removal efforts.

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