

**2014 PUBLIC UTILITY DISTRICT NO. 1 OF DOUGLAS COUNTY
NORTHERN PIKEMINNOW REMOVAL AND RESEARCH PROGRAM**

WELLS HYDROELECTRIC PROJECT

FERC NO. 2149

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ABSTRACT

Public Utility District No. 1 of Douglas County's (Douglas PUD) 2014 Northern Pikeminnow (*Ptychocheilus oregonensis*) removal efforts were conducted from April 26, 2014 to November 7, 2014. The designated capture area was from 2 miles below Wells Dam upstream to the boat-restricted zone (BRZ) of Chief Joseph Dam. A total of 14,826 pikeminnow were captured on setlines and 1,764 pikeminnow were captured on hook-and-line gear. Of the 16,590 northern pikeminnow captured, 15,875 were equal to or greater than 229 mm in total length and 715 were less than 229 mm in total length. These fish were captured during 6,122 hours of angling effort translating into an overall catch-per-unit-effort (CPUE) of 2.7 pikeminnow per hour. Within the lower Wells Reservoir from the Methow River confluence area to the forebay of Wells Dam, 6,915 fish were captured during 2,821 hours of effort translating into a CPUE of 2.5. Set-line efforts in the lower 1-mile section of the Methow River captured 463 fish during 157 hours of effort (CPUE = 2.9). Within Wells Reservoir from the mouth of the Methow River to Chief Joseph Dam, 1,513 pikeminnow were captured during 632 hours of effort, a CPUE of 2.4. The remaining fish were captured in the Wells Tailrace (7,699 pikeminnow) during 2,512 hours (CPUE = 3.1). The 16,590 pikeminnow were captured over 9,540,000 hook hours, translating into an overall CPUE of 0.0017 fish per hook hour. From 1995 to present, pikeminnow removal programs sponsored by Douglas PUD have resulted in the capture of approximately 269,000 pikeminnow from the Wells Project.

A total of 3,928 non-target fish were captured and released representing 19.2% of the overall catch. Incidental encounters consisted of nine taxa: 1,831 burbot (*Lota lota*), 652 Peamouth (*Mylocheilus caurinus*), 557 Chiselmouth (*Acrocheilus alutaceus*), 326 suckers spp. (*Catostomus* spp.), 129 Northern Pikeminnow / Chiselmouth hybrids, 100 sculpins (*Cottus* spp.), 42 Redside Shiner (*Richardsonius balteatus*), 23 hatchery-origin White Sturgeon (*Acipenser transmontanus*), and 6 Brown Bullhead catfish (*Ameiurus nebulosus*). All non-target fish were released alive. No salmonids were encountered during the project. The presence of White Sturgeon bycatch during the 2014 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 these releases by PIT tag and scute mark identification. The setline removal system has consistently produced low levels of by catch, especially in regards to salmonids, over the previous 10 years.

Gonad analysis indicated that the peak spawning period for pikeminnow occurred during the period of July 6th to July 21st, during which time 43% of the sub-sampled pikeminnow were classified as ripe.

Analysis of digestive tracts was performed on a sample (5.1%) of the captured pikeminnow to assess their dietary preferences and predation rates on juvenile salmonids. Forty-Seven percent of the dissected pikeminnow digestive tracts were empty, 15% contained crayfish, 18% contained unidentified plant matter, 7% unidentified fish, 6% unidentified insect, 6% salmonids, and 1% sculpins.

Environmental conditions in 2014 provided crews with better access and fishing conditions than in recent fishing years. In 2012 and 2013 significant environmental events hampered CPUE and

total catch levels (Jerald 2014). As a result total catch and CPUE increased in 2014 compared to 2012 and 2013.

The percentage of large (>350 mm) pikeminnow has declined from 23% in 2002, reaching a low of 14% in 2009 and 2014. 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*; hereafter, “pikeminnow”) 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, 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 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 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 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 pikeminnow throughout the Wells Reservoir and tailrace. Migration patterns, spawning locations, and preferred habitats of 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 pikeminnow, Douglas PUD hired Columbia Research 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 20,065¹ pikeminnow, in 2002, 2003, and 2004, respectively. From 2005 to 2011 catch per year ranged from approximately 16,000 to 20,000 fish annually. In 2012 and 2013 total pikeminnow catch decreased to 13,218, and 11,888 fish respectively. During 2014 a total of 16,590 pikeminnow were captured. Decreased total catch and CPUE during recent years may be a result of the annual fishery impacting the existing pikeminnow population and environmental factors related to flow in the Columbia River. 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 pikeminnow from the Project.

To date, pikeminnow removal programs sponsored by Douglas PUD have resulted in the capture and removal of approximately 269,000 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 2014 pikeminnow removal project implemented by Columbia Research, and compares the current data with those collected during previous removal efforts from 2002 to 2013.

2.0 MATERIALS AND METHODS

One vessel rotated three to five crewmembers during the project. Setline efforts were initiated on April 26 and were completed on November 27. Setline crews filled out daily data sheets specifying locations fished, number of fish caught per location, setline set times, and incidental catch.

The 2014 pikeminnow removal efforts were conducted throughout the Project from the below the BRZ (boat restricted zone) tailrace of Chief Joseph Dam downstream to the 2 mile tailrace area of Wells 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 outfall channel and the BRZ of Wells Dam. Captured 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.

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.

From 12 to 18 setlines were typically retrieved, baited and set each day by a crew of three individuals. Each line contained approximately 120 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 2014 of the pikeminnow program, allowing for easy comparison within and among years.

From 2012 to 2014 anglers conducted hook-and-line efforts within the Wells tailrace in addition to setline activities. Hook-and-line anglers focused on the rip-rap sections below the outflow of the east and west Wells fish ladders. It was not feasible to utilize setlines in these areas due to the large rocks that entangled gear as well as the turbulent flows experienced in these areas. 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.

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

Crews captured 16,590 pikeminnow over 6,122 hours of setline effort, equating to an overall CPUE of 2.7 fish per angling hour. Over the fishing season, setline efforts translated into 9,540,000 hook hours for an overall CPUE of 0.0017 fish per hook hour. Greater than 95% of the captured fish (15,875) were equal to or greater than 229 mm in total length, The balance, 715 (~4%), of captured pikeminnow were less than 229 mm. 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. Within the lower Wells Reservoir from the Methow River confluence area to the forebay of Wells Dam, 6,915 fish were captured during 2,821 hours of effort translating into a CPUE of 2.5. Set-line efforts in the lower 1-mile section of the Methow River captured 463 fish during 157 hours of effort (CPUE = 2.9). Within Wells Reservoir from the mouth of the Methow River to Chief Joseph Dam, 1,513 pikeminnow were captured during 632 hours of effort, a CPUE of 2.4. The remaining fish were captured in the Wells Tailrace (7,699 pikeminnow) during 2,512 hours (CPUE =3.1), and of these, 5,935 fish were captured on setlines and 1,764 fish were captured on hook-and-line gear. Figure 1 shows the 2014 pikeminnow catch numbers, and percentage of total catch number, by fishing location.

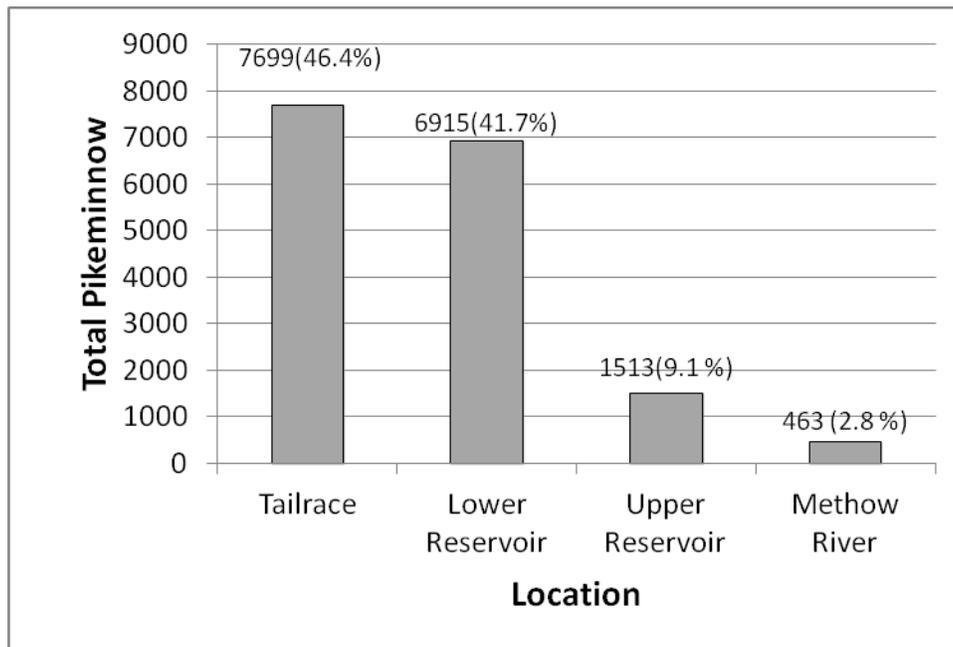


Figure 1. Catch (percentage of total catch) of pikeminnow by location.

Fishing effort in the beginning of the 2014 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. From June 1 to June 15 anglers fished in the upper Wells Reservoir. CPUE rates dropped within Wells Reservoir around the middle of June at which time crews focused effort within the Wells tailrace area. Setline crews and hook and line angling crews focused effort within the tailrace area until October 6th at which time crews returned to Wells Reservoir.

Analysis of digestive tracts was performed on a sample (5.1%) of the captured pikeminnow to assess their dietary preferences and predation rates on juvenile salmonids. This random sample was collected throughout the entire 2014 effort and on all size classes (pikeminnow over and under 229 mm). Of the 842 pikeminnow digestive tracts sampled, 47% were empty, 15% contained crayfish, 18% contained unidentified plant matter, 7% unidentified fish, 6% unidentified insect, 6% salmonids, and 1% sculpins (Figure 2). “Unidentified fish” may include

salmonids that were unrecognizable in their digested state, and/or would require laboratory techniques to provide a positive identification. The presence of salmonids in sampled digestive tracts was recorded from the onset of fishing efforts in April through the end of September.

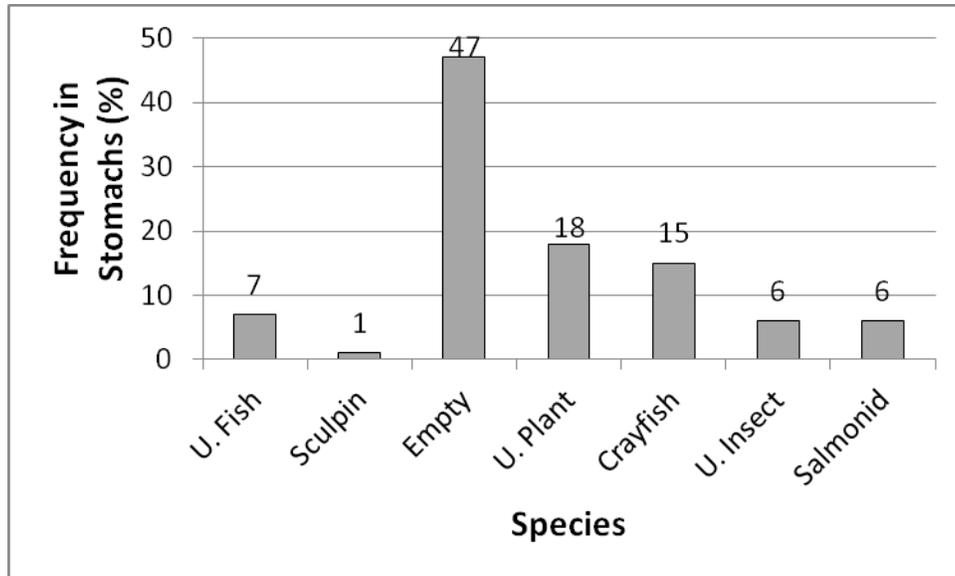


Figure 2. 2014 digestive-tract contents, as determined from analysis of 842 pikeminnow digestive tracts. The abbreviation “U.” indicates “unidentified” items within the respective categories. In the case of “U. Fish,” this category encompasses any fish other than identified lampreys, sculpins, or salmonids; “U. Plant” comprises all plant matter and “U. Insect” all arthropods other than crayfish.

Gonad analysis indicated that the 2014 peak spawn period for pikeminnow occurred from July 6 to July 21, at which time 43% of the sampled fish were classified as ripe.

A total of 3,928 non-target fish were captured and released representing 19.2% of the overall catch. Incidental encounters consisted of nine taxa: 1,831 burbot (*Lota lota*), 652 Peamouth (*Mylocheilus caurinus*), 557 Chiselmouth (*Acrocheilus alutaceus*), 326 suckers spp. (*Catostomus* spp.), 129 Northern Pikeminnow / Chiselmouth hybrids, 100 sculpins (*Cottus* spp.), 42 Redside Shiner (*Richardsonius balteatus*), 23 hatchery-origin White Sturgeon (*Acipenser transmontanus*), and 6 Brown Bullhead catfish (*Ameiurus nebulosus*). All non-target fish were released alive. No salmonids were encountered during the project.

In regards to incidental encounters using hook-and-line angling techniques, the following non-target species were encountered (these fish are reflected in the totals outlined above): 168 Peamouth, 53 burbot, 48 suckers, and 23 Northern Pikeminnow / Chiselmouth hybrids.

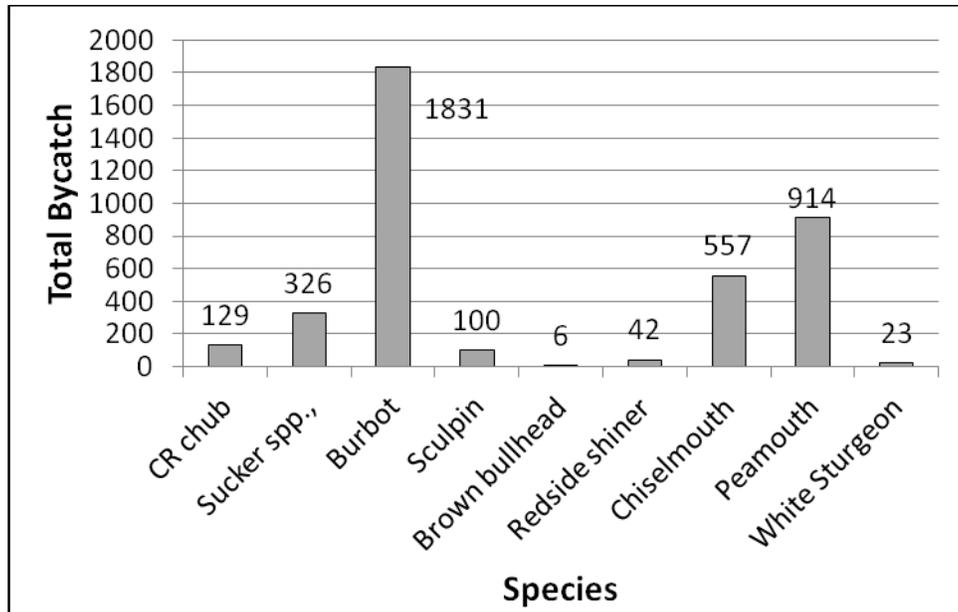


Figure 3. Numbers of non-target (incidental) fish by taxa captured in 2014.

4.0 DISCUSSION

An increase in catch and CPUE was observed in 2014 relative to 2012 and 2013 (Figure 4). Significant environmental events hampered CPUE and total catch levels during 2012 and 2013. These years were two of the highest flow years on record within the Columbia River (Douglas PUD 2013). 2014 flows were closer to average, resulting in better fishing conditions for field crews.

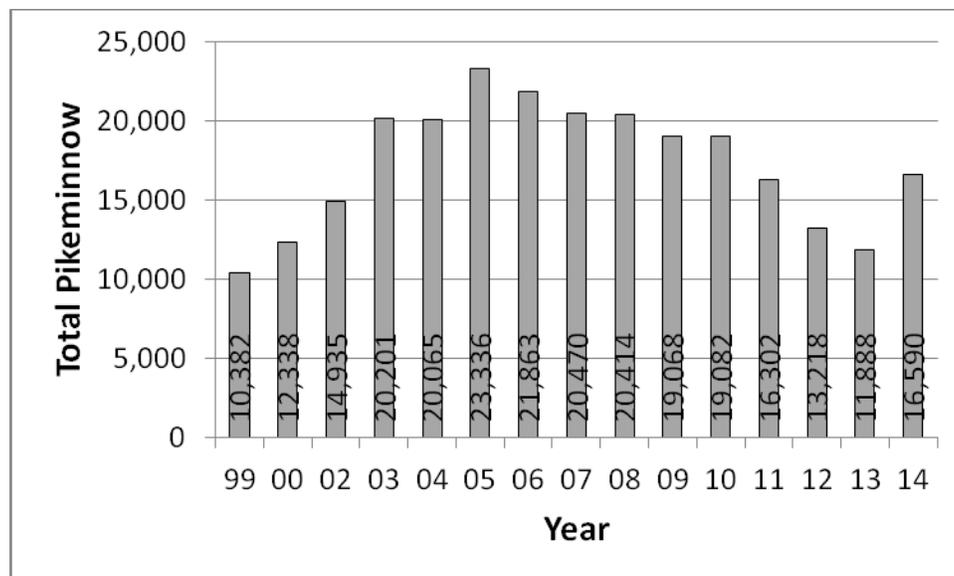


Figure 4. Douglas County PUD total pikeminnow catch by year.

4.1 Pikeminnow Diet

The timing of the peak migration of salmonid juveniles from the Methow, Okanogan, and mainstem Columbia rivers (May and June of 2014) corresponds with an increase in salmonids in pikeminnow diets as identified during stomach analysis (data on the timing of salmonid migrations from Columbia River DART <http://www.cbr.washington.edu/>). Interesting to note, a high incidence of salmonids were also identified in pikeminnow gut analysis during August and September of 2013 and 2014 in the Wells tailrace. This occurrence of salmonids in gut analysis has not been documented within previous year's data (Jerald 2011, Jerald 2012). During this time pikeminnow were seen actively feeding on juvenile salmonids and aggressively attacked lures presented by hook and line angling crews.

4.2 Incidental Catch

During the development stage of the setline removal approach, concerns were raised regarding the potential for high incidental catch and mortality. In contrast to those concerns, setline methods have proven to be highly selective for 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 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.

White Sturgeon were only encountered as bycatch within the Wells tailrace (upper end of Rocky Reach Reservoir). These encounters are 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 these releases by PIT tag and scute mark identification.

From 2012 to 2014, an atypically high number of burbot were encountered within Wells Reservoir. An increasing trend in burbot encounters from 2010 to 2013 has been documented, with declining catches in 2013 and 2014. Total burbot catch in 2010 was 146 fish, 579 fish in 2011, 3,203 fish in 2012, 2,416 fish in 2013, and 1,838 fish in 2014. Prior to 2012, much of the burbot catch was restricted to the deep China Ditch section of the reservoir below the Methow River confluence. From 2012 to 2014 burbot were encountered in large numbers throughout the reservoir area. A majority of the burbot have 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. 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 and in 2013.

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 catch data of intensive setline efforts. The 2002 to 2014 data represents 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, 1,666 fish in 2013, and 1,764 fish in 2014). It should be noted that the catch distribution within the project area was not consistent from 2002 to 2014 (Figure 5). From 2004 to 2014, 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.

A trend of decreasing catch can be observed from 2007 to 2013 (Figure 5). There are several suggestions for this decline within previous reports (Jerald 2013, Jerald 2014) These suggestions include the intense yearly fishery taking place in Wells reservoir, burbot predation on pikeminnow that are captured on the setline gear, and environmental factors related to high flows within the Columbia River. Current year 2014 marked an increase in catch from 11,888 fish in 2013 to 16,590 fish in 2014. This increase in catch could be attributed to relatively normal flows in 2014 related to extremely high flows in 2012 and 2013. Moderate flows in the Columbia River in 2014 allowed crews to effectively set and retrieve gear in both the Wells Pool and Wells tailrace. Within Wells Pool there was a noted decrease in debris coming out of the Methow River. In 2012 and 2013 the large amount of debris became entangled in setline gear and at times made it impossible to fish productive fishing locations. Below Wells project during 2012 and 2013 it was impossible during many weeks to set gear within the turbulent tailrace area.

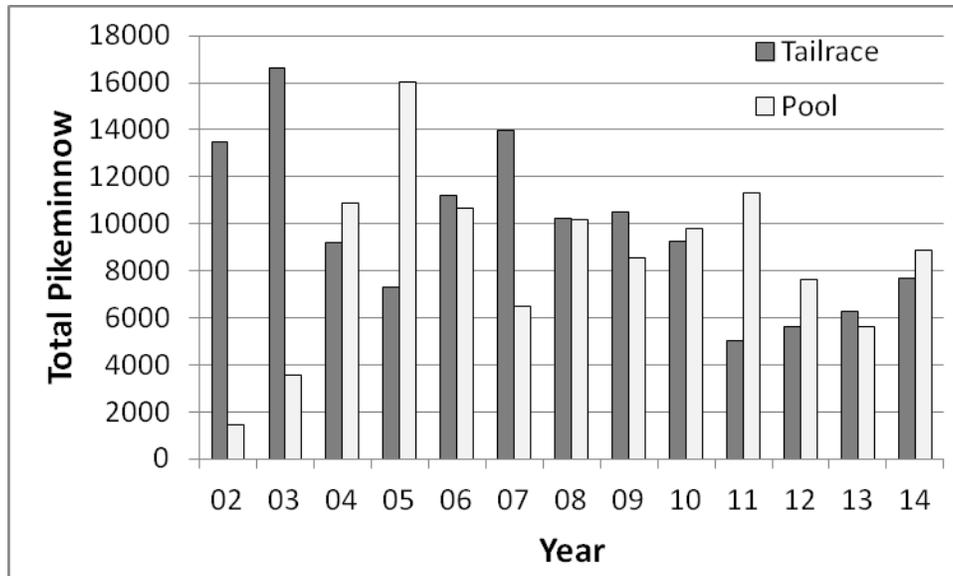


Figure 5. Catch distribution from 2002 to 2014 within Wells Tailrace and Wells Reservoir .

Decreasing CPUE rates were identified from 2009 to 2013 (Figure 6). We believe that the CPUE decline has been due to several factors. First, Wells Dam experienced record spill and duration in both 2011 and 2012 during the months of June and July, which are typically the most productive fishing months in the tailrace area (Jerald 2008, Jerald 2009). Above average flows also occurred in 2013 for the months of April, May, and July. Thus, setline crews could not set gear in the tailrace on a consistent basis from 2011 to 2013; and when they did, the gear was frequently moved or lost completely due to turbulent water conditions. As a result, in 2013 no fishing occurred at all from May 9 to May 22, June 30 to July 9, and July 18 to July 27. A slight increase in CPUE was observed during the current fishery of 2014. This increase in CPUE is attributed to the crew's ability to more efficiently work the setline gear in moderate flow conditions. Additionally, crews were able to conduct setline efforts during peak fishing periods of May, June and July resulting in higher catch CPUE and catch levels.

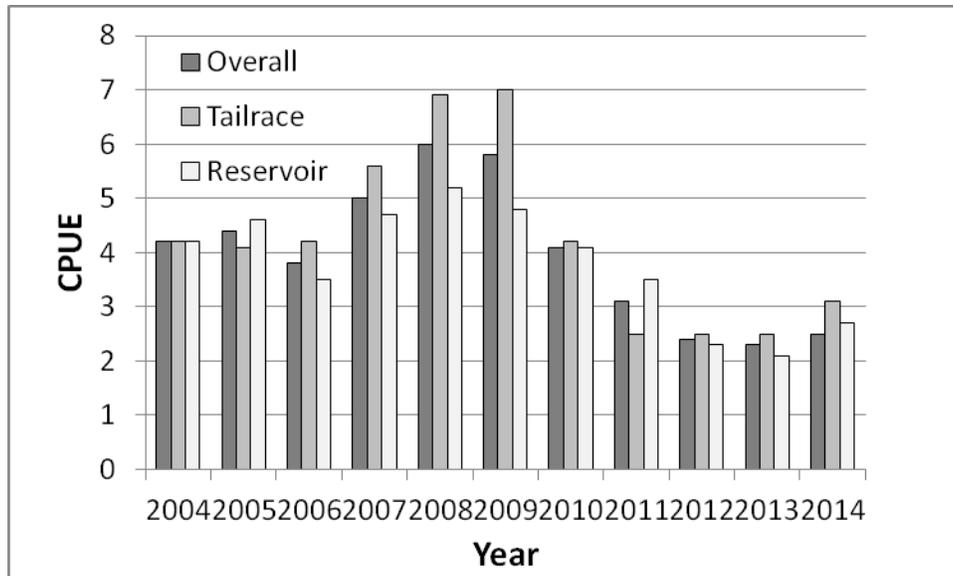


Figure 6. CPUE values by location for Wells Project pikeminnow removal program, 2004 to 2014.

Overall catch per unit effort has declined from 2011 to 2014 compared to the average from 2004 to 2010 (Figure 6). The average CPUE in the tailrace for 2004-2010 is 5.17; the average CPUE for 2011 to 2014 is 2.6.

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.

Additionally, an annual salmon fishery is conducted below Wells Dam on July 1 of each year. In recent year an increase in participation has been observed. During recent years, recreational anglers have frequently become entangled in setline gear and tampered with that gear, resulting in substantial setline gear loss.

A third factor contributing to overall lower total catch / CPUE may be due to increased burbot predation on pikeminnow hooked on setlines. Burbot predation may have significantly decreased setline crew's ability to retrieve pikeminnow trapped on the setline gear from 2011 to 2014.

Of final consideration is that approximately 269,000 pikeminnow have been removed within the Wells Reservoir and tailrace from 1995 to 2014 through Douglas PUD sponsored efforts. These programs may have effectively reduced the population of pikeminnow in this location. Additionally, Chelan PUD conducts an extensive pikeminnow removal program in the lower Rocky Reach Pool. 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 the lower and mid-Rocky Reach Reservoir could result in decreased CPUE rates within the Wells tailrace.

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 grams².

During 2010 and 2011 a slight increase was recorded in average length and average weight, but both weights and lengths dropped in 2012 to more closely match the 2009 data. From 2008 to 2014 average fish lengths have only varied within 8 mm (278 mm in 2008, 273 mm in 2009, 277 mm in 2010, 280 mm in 2011, 274 mm in 2012, 281mm in 2013, and 277 mm in 2014). This may be an indication that yearly pikeminnow removal efforts have reduced the population to an equilibrium level where fishing effort has offset recruitment.

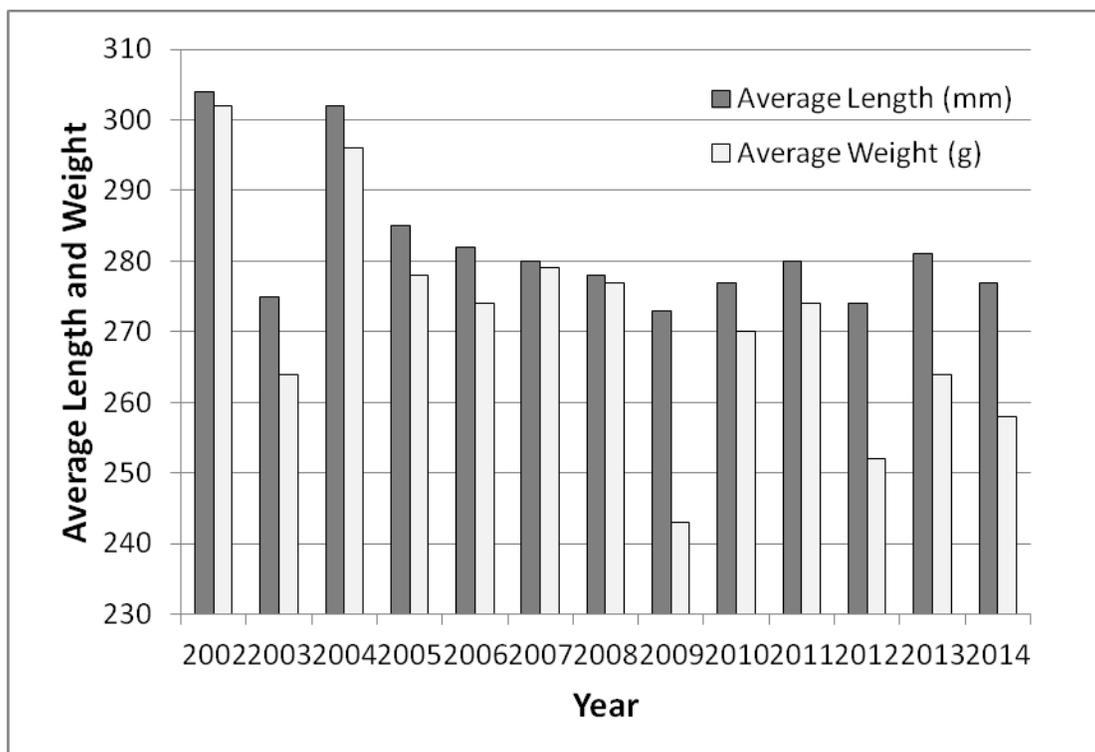


Figure 7. Average pikeminnow length (mm) and weight (g) from sampled pikeminnow in Wells Tailrace and Wells Reservoir 2002 to 2014.

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

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.

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 to 2014 inevitably effecting catch data when comparing on an annual basis.

No trends have emerged in the percentages of fish in the total annual catch that are either less than 229 mm or greater than or equal to 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 greater than or equal to 229 mm, but rather by a reduction in the average size of fish in that category.

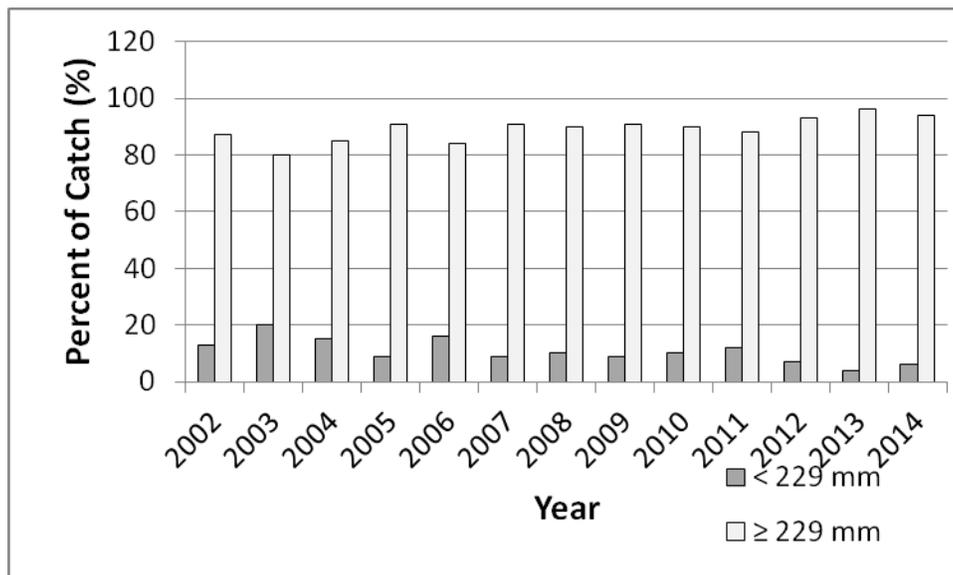


Figure 8. Catch composition by size category reported as the percentage of fish captured annually that were either <229 mm or ≥229 mm.

The size distribution of large pikeminnow over 350 mm was analyzed from 2002 to 2014 in an attempt to quantify any increase or decrease of very large pikeminnow within the population over time. In the 2002 fishery, 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, and again in 2014, the lowest occurrence of sampled fish greater than 350 mm was observed, comprising only 14% of the total catch. From 2006 to 2014 catch composition of these larger fish only varied from 14% to 17% 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 greater than or equal to 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).

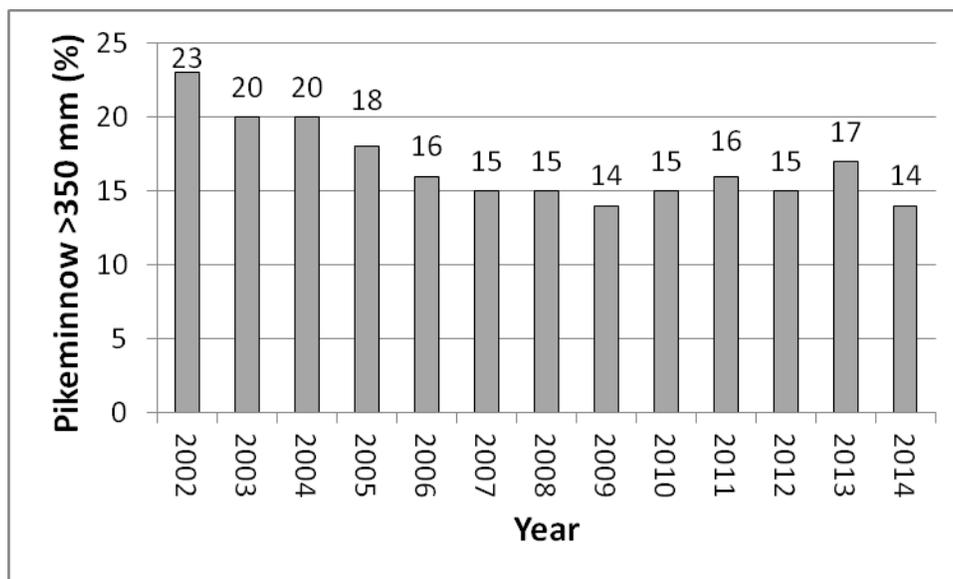


Figure 9. Catch composition as the percentage of fish sampled annually that were >350 mm.

There was no discernible trend in salmonid consumption by pikeminnow from 2002 to 2014 (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 from 2010 to 2014.

Table 2 Digestive-tract contents (%) for pikeminnow captured in Wells Project from 2002 to 2014 (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	
2013	45	6	18	9	15	6	1	
2014	51	8	16	9	11	4	1	
Mean (02-14)	57.8	6.8	11.3	6.8	10.9	4.9	0.3	0.15

5.0 CONCLUSIONS

The pikeminnow removal program has removed large numbers of pikeminnow from the Wells Project from 2002 to 2014, with catches ranging from 11,888 pikeminnow in 2013 to 23,336 pikeminnow in 2005. From 2003 through 2010, yearly catches of pikeminnow exceeded 19,000 fish. In 2011 a significant decrease in catch and CPUE and total catch was recorded, and the decreases continued through 2012 and 2013. The 2013 CPUE rates were the lowest recorded to date for any of the annual setline fisheries. Issues regarding water flow, interference by recreational anglers below Wells Dam, and burbot consumption of pikeminnow on the setline gear likely contributed to 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 crews have found it increasingly difficult to capture pikeminnow in recent years.

Since 2002, the percentages of pikeminnow that are greater than or equal to 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) have declined from 23% in 2002, to consistently within the 14- to 17-percent range, reaching a low of 14 percent in 2009 and 2014. 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 greater than 350 mm

while not discernibly reducing the proportions of fish captured from the greater than or equal to 229 mm and less than 229 mm categories.

During 2009 and 2010, CPUE rates in March were the lowest recorded, and CPUE rates did not increase to over 4.0 until mid-April. From 2012 to 2014, 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 2015, 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 2013). The decreasing trend of captured pikeminnow from 2011 to 2013 (16,302, 13,218, and 11,888 fish, respectively) is a potential indicator of decreasing pikeminnow abundance in the study area. Additionally, environmental factors may limit the fishery. It is documented (Jerald 2012, Jerald 2013) that high spring flows prevent crews from effectively capturing pikeminnow and result in decreased CPUE rates within the study area. Analysis of future yearly catch data will provide further indication of the state of the pikeminnow population and the effects of environmental conditions. An equilibrium state of the fishery would be indicated by consistent CPUE levels analyzed on a multi-year rolling-average. Environmental factors that affect the fishery could be determined by analyzing long term patterns of CPUE in relation to water flows in the Columbia River. A continued trend of low CPUE during future years will be an indicator that the removal efforts have effectively controlled the pikeminnow population in the study area.

6.0 REFERENCES

- Beaty, R.E., B.L. Parker, K.C. Collis, and K. McRae. 1991. The use of controlled angling to manage northern squawfish populations at selected dams on the Columbia and Snake Rivers. Report C in 1994 BPA Annual Report: Development of a system-wide predator control program: Stepwise implementation of a predation index, predator control fisheries, evaluation plan in the Columbia River Basin.
- Bickford, S., and R. Klinge. 1996. Wells Dam northern squawfish removal efforts 1995. Douglas County Public Utility District No. 1, 1151 Valley Mall Parkway, East Wenatchee, WA. 98802.
- Bickford, S. 1997. Removal and Census of Northern Squawfish in the tailrace of Wells Dam, 1996. Douglas County Public Utility District No. 1, 1151 Valley Mall Parkway, East Wenatchee, WA. 98802.
- Bickford, S., and T. Skillingstad. 2000. Movements of Northern Squawfish in the reservoir, forebay, and tailrace of the Wells Hydroelectric Project, Mid-Columbia River, Washington. Douglas County Public Utility District No. 1, 1151 Valley Mall Parkway, East Wenatchee, WA. 98802
- Burley, C.C., and T. Poe. 1994. Significance of predation in the Columbia River from Priest Rapids Dam to Chief Joseph Dam. Washington Department of Fish and Wildlife and National Biological Survey. Prepared for Chelan County Public Utility District, Douglas County Public Utility District, and Grant County Public Utility District. Contract 430-486.
- Douglas PUD, 2014. Gas Abatement Plan 2013 Report. Utility No. 1 of Douglas County, East Wenatchee, WA.
- Douglas PUD, 2013. Gas Abatement Plan 2012 Report. Utility No. 1 of Douglas County, East Wenatchee, WA.
- Jerald, T. 1998. 1998 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497
- Jerald, T. 1999. 1999 Chelan PUD Northern pikeminnow Research and Removal within Rock Island and Rocky Reach Reservoirs. Columbia Research. 426 E. Woodin Ave. Chelan, WA 98816. Prepared for Chelan County Public Utility District, 327 N. Wenatchee Ave., Wenatchee, WA 98801.
- Jerald, T. 2000. 2000 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Jerald, T. 2005. 2004 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Jerald, T. 2006. 2005 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Jerald, T. 2007. 2006 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Jerald, T. 2008. 2007 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Jerald, T. 2009. 2008 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Jerald, T. 2010. 2009 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Jerald, T. 2011. 2010 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Jerald, T. 2012. 2011 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Jerald, T. 2013. 2012 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Jerald, T. 2013. 2012 Public Utility District No. 1 of Douglas County Northern pikeminnow Removal and Research Program. Prepared by Columbia Research for Public Utility District No. 1 of Douglas County, 1151 Valley Mall Parkway, East Wenatchee, WA 98802-4497.

Magnotti, M., and T. Jerald. 2001. Northern pikeminnow Removal Program Report for 2000. Prepared by Columbia Research for Grant County Public Utility District No. 2. P.O. Box 878 Ephrata, WA.

Matthews, S.B., T.K Iverson, J.M. Lynch, B.D. Mahoney, and R.W. Tyler. 1991. Evaluation of harvest technology for squawfish in Columbia River Reservoirs. Report D in 1991 BPA Annual Report: Development of a system-wide predator control program: Stepwise implementation of a predation index, predator control fisheries, evaluation plan in the Columbia River Basin.

Porter, R. 2000. Development of a system-wide predator control program: Stepwise implementation of a predation index, predator control fisheries, and evaluation plan in the Columbia River Basin. 2000 Annual Report. Project Number 90-077.

Vigg, S., C.C. Burley, D.L. Ward, C. Mallette, S. Smith, and M. Zimmerman. 1990. Development of a system-wide predator control program: Stepwise implementation of a predation index, predator control fisheries, and evaluation plan in the Columbia River Basin. BPA Annual Report. Project No. 90-077.