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2010 Oregon Chub Investigations

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SUMMARY

Oregon chub *Oregonichthys crameri,* small minnows endemic to the Willamette Valley, were federally listed as endangered under the Endangered Species Act in 1993. In 2010, the species status was upgraded to threatened (Federal Register 2010a). Factors implicated in the decline of this species include changes in flow regimes and habitat characteristics resulting from the construction of flood control dams, revetments, channelization, diking, and the drainage of wetlands. The Oregon chub is further threatened by predation and competition by nonnative species such as largemouth bass *Micropterus salmoides*, crappies *Pomoxis* sp., sunfishes *Lepomis* sp.*,* bullheads *Ameiurus* sp*.,* and western mosquitofish *Gambusia affinis*. We continued surveys initiated in 1991 in the Willamette River drainage to quantify the abundance of known Oregon chub populations, search for unknown populations, evaluate potential introduction sites, and monitor introduced populations to implement recovery objectives listed in the Oregon Chub Recovery Plan (U.S. Fish and Wildlife Service 1998).

We sampled a total of 73 sites in 2010. Three new populations of Oregon chub were discovered in the North Santiam (n=2) and Marys River drainages (n=1). We confirmed the continued existence of Oregon chub at 44 locations. These included locations that support 32 naturally occurring and 12 introduced populations. We did not find Oregon chub at three locations where they were collected on at least one occasion between 1991 and 2009. Nonnative fish were collected at these locations.

We obtained abundance estimates of 30 naturally occurring populations and 10 introduced populations of Oregon chub located in the Middle Fork Willamette, Santiam, McKenzie, Coast Fork Willamette, and Mid-Willamette drainages. We introduced Oregon chub into four new locations: Budeau North and South Ponds, North Stayton Pond in the Santiam drainage, and Hills Creek Pond in the Middle Fork Willamette drainage. We supplemented prior Oregon chub introductions with additional fish at seven locations: St. Paul Ponds in the Lower Willamette drainage, South Stayton Pond in the Santiam drainage, Display and Cheadle Ponds in the Mid-Willamette drainage, Shetzline North Pond in the McKenzie drainage, Haws Enhancement Pond in the Middle Fork Willamette drainage, and Sprick Pond in the Coast Fork Willamette drainage.

The Oregon Chub Recovery Plan (U.S. Fish and Wildlife Service 1998) set recovery criteria for delisting the species. The criteria for delisting the species are: 1) establish and manage 20 populations of at least 500 adult fish, 2) all of these populations must exhibit a stable or increasing trend for seven years, and 3) at least four populations meeting criterion 1 and 2 must be located in each of the three recovery areas (Middle Fork Willamette River, Santiam River, and Mid-Willamette River tributaries). In 2010, there were 32 populations totaling 500 or more individuals. Nineteen of these populations met the second criterion. Of the populations meeting criteria 1 and 2, nine were located in the Middle Fork Willamette drainage, seven were located in the Mid-Willamette drainage, and three were located in the Santiam drainage.

Findings to date indicate that Oregon chub remain at risk due to the loss of suitable habitat and the continued threats posed by the proliferation of nonnative fishes, illegal water withdrawals, accelerated sedimentation, and potential chemical spills or careless pesticide applications. Their status has improved in recent years, resulting primarily from successful introductions and the discovery of previously undocumented populations.

INTRODUCTION

Oregon chub are endemic to the Willamette River drainage of western Oregon (Markle et al. 1991). This species was formerly distributed throughout the Willamette River Valley (Snyder 1908) in off-channel habitats such as beaver ponds, oxbows, stable backwater sloughs, and flooded marshes. These habitats usually have little or no water flow, have silty and organic substrate, and have an abundance of aquatic vegetation and cover for hiding and spawning. In the past 100 years, off-channel habitats have disappeared because of changes in seasonal flows resulting from the construction of dams throughout the basin, channelization of the Willamette River and its tributaries, and agricultural practices. This loss of habitat, combined with the introduction of nonnative fish species to the Willamette Valley, resulted in a restricted distribution and sharp decline in Oregon chub abundance.

The reduction of habitat and the restricted distribution of the Oregon chub resulted in a determination of "endangered" status under the federal endangered species act in 1993 (Markle and Pearsons 1990; Rhew 1993). In 2010, the species' status was improved to threatened (Federal Register 2010a). To evaluate population abundance and distribution of Oregon chub, the Oregon Department of Fish and Wildlife (ODFW) conducted surveys in April through October 2010. We conducted similar surveys in 1991-2009 (Scheerer et al. 1992; 1993; 1994; 1995; 1996; 1998; 1999; 2000; 2001; 2002; 2003; 2004a; 2004b; 2005; 2006; 2007; Scheerer and Jones 1997; Bangs et al. 2008; 2009). The objectives of these surveys were to collect information on the status, distribution, and abundance of Oregon chub, the presence of nonnative and native species, the characteristics of Oregon chub habitats and potential introduction sites, and to evaluate the success of Oregon chub introductions. In addition, new research was initiated in 2009 to better understand the effects of flow and temperature modifications and the proposed reconnection of floodplain habitats on Oregon chub and other Willamette floodplain fishes (Bangs et al. 2010).

This report summarizes the results of population and distribution surveys conducted in 2010 and evaluates conservation status relative to criteria listed in the recovery plan. In addition, we discuss increased opportunities for chub introductions afforded by the recent Programmatic Safe Harbor Agreement (Federal Register 2009), and the objectives of future studies.

METHODS

We conducted surveys at 73 locations in the Willamette River drainage (Figures 1 and 2). We sampled off-channel habitats using baited cylindrical minnow traps measuring 23 cm by 46 cm with 3.2 mm mesh, a 1 m x 5 m seine with 6.4 mm mesh, dip nets, and treated hoop nets consisting of four hoops measuring 61 cm in diameter, 3.1 m long with 1.3 cm stretched mesh. Hoop nets had two wings measuring 0.6 m tall by 7.6 m long with 1.3 cm stretched mesh. We indentified and enumerated all fish captured. We recorded the presence of amphibian and reptile species and their life stages that we encountered.

We recorded physical and biological habitat parameters at each site including substrate type, type (genus) and abundance (percent of wetted surface area) of aquatic vegetation, mean and maximum depth, water temperature, and total wetted surface area. We photographed and assigned a unique map code to each new site.

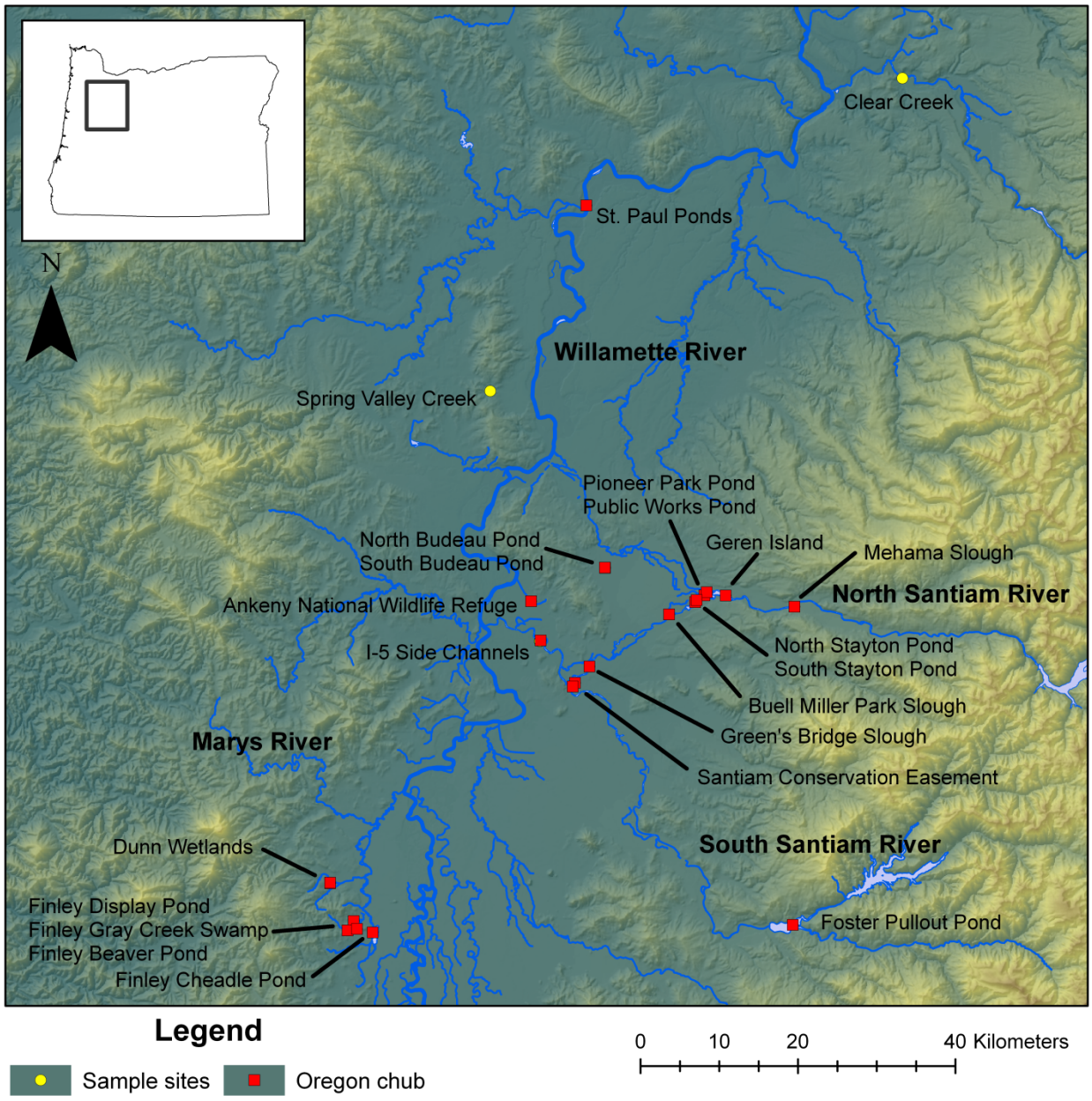

Figure 1. Survey locations for Oregon chub in the Santiam, Lower Willamette, and Mid-Willamette River drainages in 2010. Red squares indicate sites where Oregon chub were collected. Yellow circles indicate sites where Oregon chub were not collected. Overlapping symbols denote multiple sites occurring at or near the same survey location. Note: presence of chub at Budeau Ponds and North Stayton Pond were the result of 2010 introductions.

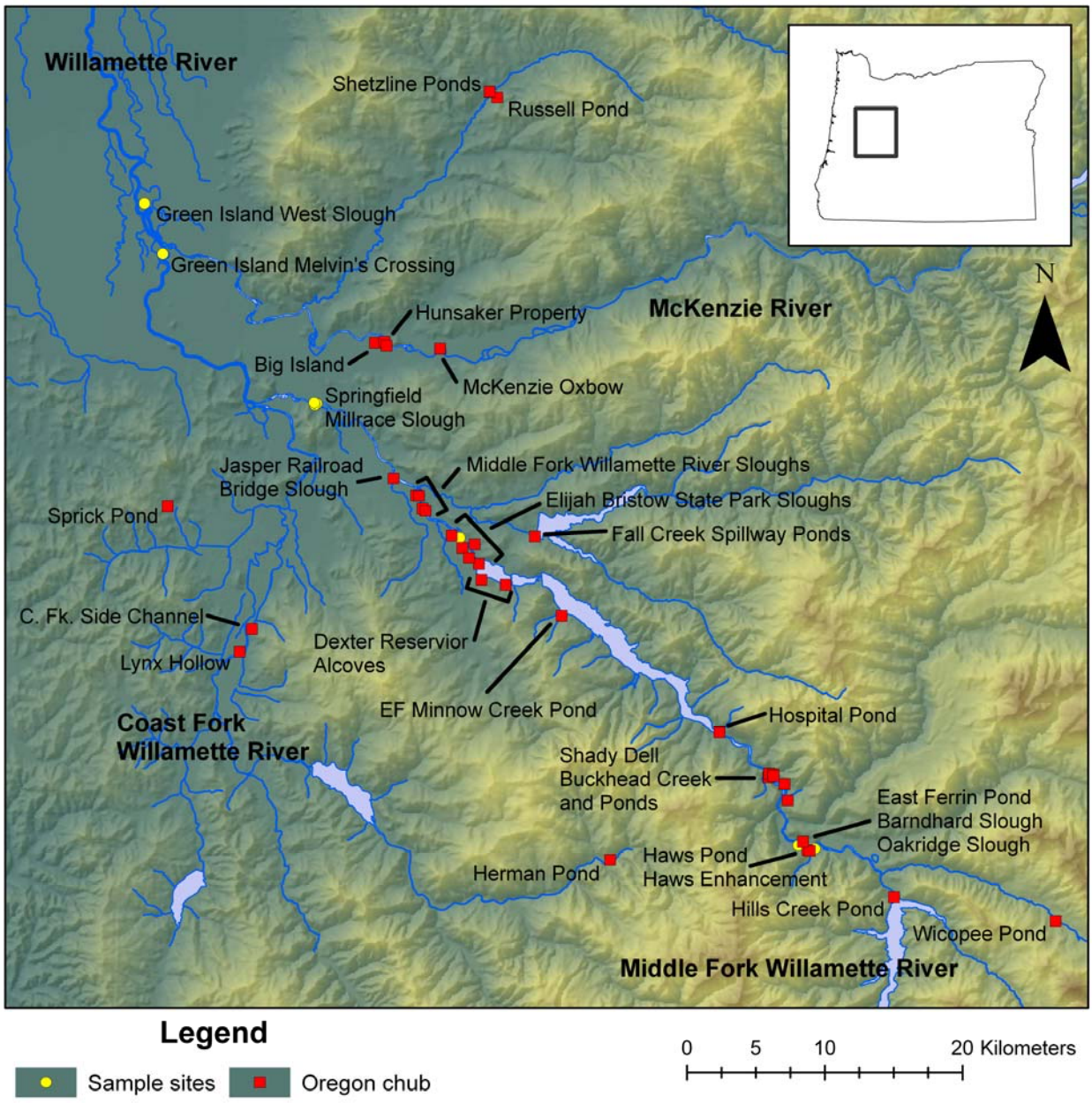

Figure 2. Survey locations for Oregon chub in the Upper Willamette River drainage in 2010. Red squares indicate sites where Oregon chub were collected. Yellow circles indicate sites where Oregon chub were not collected. Overlapping symbols denote multiple sites occurring at or near the same survey location. The bracketed area labeled Dexter Reservoir Alcoves includes Dexter Reservoir Alcoves DEX3 and PIT1. The bracketed area labeled Elijah Bristow State Park includes Dexter Dam Slough, Elijah Bristow South Slough, Elijah Bristow Northeast Slough, Elijah Bristow Island Pond, Elijah Bristow Northeast Gravel Pit 1, and Elijah Bristow Berry Slough. The bracketed area labeled Middle Fork Willamette River Sloughs includes Pengra Island Slough, Pengra Oxbow Slough, MFW Deep Muddy Slough, Dougren Slough, and Railroad Bridge Slough. . Note: presence of chub at Hills Creek Pond was the result of a 2010 introduction.

We used minnow traps to obtain mark-recapture population estimates for all fish species at selected sites. We baited the traps with one third slice of bread and fished them for 3-18 hours. We measured total lengths (TL) of a subsample (n=50) of the Oregon chub that we collected in the traps. We marked all fish with a partial caudal fin clip and returned them to the water. When catch rates were low, we repeated this procedure for a second day. On the second day, all unmarked fish were marked. We typically marked fish until approximately 15 percent of the anticipated population was marked. We estimated population abundance using single-sample mark-recapture procedures (Ricker 1975). To calculate population abundance, we used the total number of marked fish, and the catch and recaptures from the last sample date. We calculated 95% confidence intervals using a Poisson approximation (Ricker 1975). Because we did not capture fish smaller than ~35 mm (TL) in the minnow traps, these fish were not included in the estimates. Excluded fish were young-of-the-year (Scheerer and McDonald 2003).

We defined a population as a group of chub that occupies a single location. If there was an open connection and the potential for frequent movement of chub between adjacent sloughs or ponds, then we considered adjacent sites to be a single population. We defined abundance trends quantitatively as increasing, declining, stable, or unstable. We calculated a linear regression of abundance over time for each abundant population ($\geq$500 fish) for the most recent seven years (2004-2010). Seven year abundance trends were assessed if the population abundance was $\geq$500 fish, data were available for at least seven years, and if abundance estimates were available for at least four of the seven years. When the slope of this regression was negative and significantly different from zero ($P \leq 0.10$), we defined the population as exhibiting a declining trend in abundance. When the slope was positive and significantly different from zero ($P \leq 0.10$), we defined the population as exhibiting an increasing trend in abundance. If the slope was not significantly different from zero ($P > 0.10$), we then calculated the coefficient of variation of the abundance estimates for the most recent seven years. When the coefficient of variation was less than 1.0, then we defined the population as stable. Otherwise, we defined the population as unstable.

RESULTS

Detailed descriptions of habitat characteristics and the fish species present at each of the 73 sites sampled in 2010 are available on our web site: http://oregonstate.edu/dept/ODFW/NativeFish/OregonChub.htm.

Population Estimates

In 2010, we obtained population estimates for Oregon chub at 40 locations (Tables 1 and 2). We estimated the population abundance of Oregon chub at 20 locations in the Middle Fork Willamette River drainage. The Middle Fork Willamette drainage contains the greatest concentration of large Oregon chub populations (>500 fish) in the Willamette Valley. In 2010, there were 16 populations in the Middle Fork Willamette drainage that totaled 500 or more adult Oregon chub. Nine of these populations have been stable or increasing in abundance for the past seven years (Table 1). The largest population of Oregon chub in the Middle Fork Willamette drainage was located at Fall Creek Spillway Ponds. Significant increases in Oregon chub abundance occurred at Fall Creek Spillway Ponds, Shady Dell Pond, Elijah Bristow Island Pond, and Hospital Pond. Significant decreases in Oregon chub abundance occurred at Elijah Bristow Berry Slough, Buckhead Creek, Dougren Slough, Pengra Island Slough, and Railroad Bridge Slough.

Table 1. Oregon chub population abundance estimates from 2004-2010, year of first discovery or introduction of the population, and ranges of abundance prior to 2003. Abundances are mark-recapture estimates, except those shown in bold, which are the number of fish captured. Site names in bold italics are locations where Oregon chub were introduced. The number of fish stocked at introduction sites is shown in parentheses. See *Methods* for definitions of seven year abundance trends. Seven year trends were not assessed if data were not available in 2004 or prior, if abundance estimates were available for fewer than four of the seven years, or if the population abundance was less than 500 fish.

Site Name	First discovered / introduced	Range through 2003	2004	2005	2006	2007	2008	2009	2010	7 year trend
					Santiam					
South Stayton Pond	2006				(54)	(67) 560	1,710	(142) 4,970	(232) 6,230	
Geren Island North Channel	1996	360 - 8,340	2,290	2,630	1,020	510	210	560	2,230	stable
Foster Pullout Pond	1999	80 - 640	(112) 570	200	470	980	2,640	2,640	2,010	increasing
North Stayton Pond	2010								(620)	
Green's Bridge Slough	1993	0 - 5	**0**	**7**	**6**	**1**	**8**	240	610	
Pioneer Park Pond	1997	0 - 9	**0**	**4**	110	420	320	830	540	increasing
Santiam Easement	1994	0 - 1,250	**1**	**0**	**3**	**0**	**2**	**22**	530	
South Budeau Pond	2010								(312)	
North Budeau Pond	2010								(310)	
Santiam I-5 Side Channels	1997	2 - 350	320	580	330	**22**	**2**	100	160	
Mehama Slough	2010								**15**	
Stayton Public Works Pond	1998	0 - 4	**21**	530	440	270	70	30	**3**	
Buell-Miller Slough	2010								**2**	
Hosptial Slough	2009							**2**		
Gray Slough	1995	0 - 270	340	260	700	560	660	.....denied access.....		
Menear's Bend	2000	0 - 29	**0**.....pond dried up.....							
Logan Slough	1997	0 - 2								
					Mainstem Willamette					
Dunn Wetland	1997	200 - 28,740	25,810	28,290	21,530	34,530	46,330	34,300	28,510	stable
Ankeny Willow Marsh	2004		(500)	10,110	35,650	26,420	36,460	46,560	21,790	stable
Finley Gray Creek Swamp	1993	230 - 730	520	240	1,390	1,400	2,140	1,700	2,350	increasing
Finley Cheadle Pond	2002	50	220	1,300	900	(53) 1,740	3,520	(85) 1,140	(118) 1,130	stable
Finley Display Pond	1998	60 - 1,750	70	240	240	(75) 230	830	(85) 320	(119) 500	stable
Finley Beaver Pond	2010		**0**	**0**	**0**		**0**		420	
St. Paul Ponds	2008						(25)	(64) **2**	(106) **32**	
Jampolsky Wetlands	2004		(500)	1,230	8,320	4,160	.....denied access.....			
Muddy Creek	2007					**3**				
Dry Muddy Creek	1994	2 - 26	**1**	**4**	**0**	**0**				
Bull Run Creek	2005			**2**	**0**	**0**	**0**			
Little Muddy Creek tributary	2004		**5**	**0**	**0**	**0**				
Camous Creek	1993	5.....denied access.....			**0**					
					McKenzie					
McKenzie Oxbow	2009							2,420	3,000	
Russell Pond	2001	350 - 470	720	810	1,000	1,400	650	1,290	2,780	increasing
Big Island	2002	620 - 940	310	430	380	190	200	610	1,240	stable
Hunsaker Slough	2009					**0**		520	520	
Shetzline Pond	2002	120 - 650	1,050	730	390	210	130	300	350	
Green Island	2007					**12**	12	**2**	**0**	
Ezell Slough	2005			**6**						

Table 1. (continued).

Site Name	First discovered / introduced	Range through 2003	2004	2005	2006	2007	2008	2009	2010	7 year trend
			Middle Fork Willamette							
Fall Creek Spillway Ponds	1996	480 - 7,770	5,850	6,250	3,250	2,740	3,050	2,930	4,110	stable
Shady Dell Pond	1993	1,630 - 4,770	4,210	3,110	5,430	7,250	7,250	2,070	3,110	stable
East Fork Minnow Creek Pond	1993	3,270 - 8,770	3,140	1,850	1,730	1,770	2,160	1,340	2,980	stable
Elijah Bristow Berry Slough	1993	1,190 - 5,350	2,950	2,530	5,460	6,580	5,460	8,130	2,360	stable
Wicopee Pond	1992	0 - 4,580	4,780	6,300	4,860	3,130	5,430	3,040	2,200	declining
Elijah Bristow Island Pond	2003	2,780	420	1,700	2,310	1,620	550	870	2,050	stable
Dexter Reservoir RV Alcove - DEX3	1992	15 - 2,270	790	1,850	3,310	4,020	2,450	2,280	1,800	stable
Hospital Pond	1993	690 - 3,160	4,940	5,040	2,040	1,520	3,680	730	1,330	declining
Buckhead Creek	1992	2 - 7,140	3,600	3,130	2,500	2,030	1,260	3,600	1,280	stable
Hills Creek Pond	2010	0							(1,127)	
Dexter Reservoir Alcove - PIT1	1992	40 - 1,440	70	600	650	1,130	680	1,370	1,020	increasing
Dougren Slough - RM 198.5	2008						**1**	1,640	830	
Haws Pond	2005			120	440	380	280	470	810	
Elijah Bristow Northeast Slough	1999	610 - 1,170	1,340	790	210	350	230	550	670	stable
Elijah Bristow South Slough	2008						**1**	880	640	
Dexter Dam Slough	2009							640	510	
Hospital Impoundment Pond	1995	0 - 6	**0**	**0**	**0**				80	
Pengra Island Slough - RM 199.5	2003	13	**0**					200	60	
Pengra Oxbow Slough - RM 199.4	2008						**1**	**9**	60	
Deep Muddy Slough - RM 198.6	2009						**0**	**10**	40	
Railroad Bridge Slough - RM 197	2009						**0**	80	20	
Barnhard Slough	2000		**2**	**2**	**0**	**4**	**0**	**2**	**1**	
Springfield Millrace Slough	2009							**8**	**0**	
Rattlesnake Creek	1992	1 - 7	**0**	**0**	**5**	**0**		**2**		
Jasper Park Slough	1994	0 - 3	**0**	**0**	**0**	**1**	**1**	**0**		
Oakridge Slough	1994	1 - 480	**1**	**0**	**0**	**0**	**0**	**0**		
East Ferrin Pond	1994	0 - 7,160	**0**	**0**	**0**	**0**	**0**	**0**	**0**	
Dexter East Alcove	1992	0 - 40	**0**	**0**	**0**	**0**	**0**	**0**		
Wallace Slough	1997	0 - 3	**0**	**0**	**0**	**0**	**0**			
Elijah Bristow Large Gravel Pit	1992	0 - 8	**0**	**0**	**0**					
Elijah Bristow Small Gravel Pit	1992	0 - 31	**0**	**0**	**0**					
Dexter Reservoir	2002	1		**1**						
West Ferrin Pond	1992	0 - 525								
			Coast Fork Willamette							
Herman Pond	2002	400 - 420	350	110	40	180	**3**	**0**	200	
Coast Fork Side Channels	2002	16 - 130	190	**12**	150	80	130	100	190	
Sprick Pond	2008						(12)	(10) **12**	(31) **22**	
Lynx Hollow Side Channels	2005			**2**	**2**	**2**	**0**	**4**	**2**	
Camas Swale	1992	0 - 2	**0**	**2**	**0**	**0**		**0**		

Table 2. 2010 abundance estimates and 95% confidence limits of Oregon chub at locations in the Willamette Valley, Oregon. Note: sites in McKenzie River drainage are part of the Mid-Willamette recovery area.

Location	Estimate	95% Confidence limits lower	upper
Santiam River Drainage			
South Stayton Pond	6,230	5,050	7,670
Geren Island North Channel	2,230	1,960	2,540
Foster Pullout Pond	2,010	1,680	2,400
Green's Bridge Slough	610	400	930
Pioneer Park Pond	540	430	680
Santiam Conservation Easement	530	190	1,050
Santiam I-5 Side Channels	160	110	230
Mid-Willamette River Drainage			
Dunn Wetland	28,510	22,280	36,490
Ankeny Willow Marsh	21,790	19,980	23,750
Finley Gray Creek Swamp	2,350	1,890	2,920
Finley Cheadle Pond	1,130	1,000	1,270
Finley Display Pond	500	430	580
Finley Beaver Pond	420	320	550
McKenzie River Drainage			
McKenzie Oxbow	3,000	2,610	3,740
Russell Pond	2,780	2,060	3,740
Big Island	1,240	930	1,650
Hunsaker Property	520	440	610
Shetzline Pond	350	240	490

Table 2 (continued).

Location	Estimate	95% Confidence limits lower	upper
Middle Fork Willamette River Drainage			
Fall Creek Spillway Ponds	4,110	3,420	4,930
Shady Dell Pond	3,110	2,770	3,480
East Fork Minnow Creek Pond	2,980	2,030	4,360
Elijah Bristow Berry Slough	2,360	1,750	3,170
Wicopee Pond	2,200	1,630	2,570
Elijah Bristow Island Pond	2,050	1,630	2,570
Dexter Reservoir Alcove “DEX3”	1,800	1,350	2,380
Hospital Pond	1,330	1,080	1,650
Buckhead Creek	1,280	1,000	1,650
Dexter Reservoir Alcove “PIT1”	1,020	770	1,340
Dougren Slough	830	750	920
Haws Pond	810	540	1,210
Elijah Bristow Northeast Slough	670	540	840
Elijah Bristow South Slough	640	520	800
Dexter Dam Slough	510	390	670
Hospital Impoundment Pond	80	40	130
Pengra Island Slough	60	30	120
Pengra Oxbow Slough	60	30	100
Deep Muddy Slough	40	20	60
Railroad Bridge Slough	20	10	40
Coast Fork Willamette River Drainage			
Herman Pond	200	140	290
Coast Fork Side Channels	190	120	280

We estimated the population abundance of Oregon chub at seven locations in the Santiam River drainage. In 2010, there were seven populations in the Santiam drainage that totaled >500 adult Oregon chub. Three populations had a stable or increasing trend in abundance for the past seven years (Table 1). The largest Oregon chub population in the Santiam drainage was an introduced population located at South Stayton Pond. Significant increases in Oregon chub abundance occurred at Geren Island North Channel and Green's Bridge Slough. There was an apparent increase in Oregon chub abundance at Santiam Conservation Easement, where Oregon chub were captured in high enough abundance to obtain a population estimate for the first time since 1998. Significant declines in Oregon chub abundance occurred at Foster Pullout Pond, Pioneer Park Pond, and Public Works Pond. Two naturally occurring Oregon chub populations were discovered in 2010 in connected habitats in the North Santiam drainage (Mehama and Buell-Miller sloughs).

We estimated the population abundance of Oregon chub at eleven locations in the Mid-Willamette River drainage (includes the McKenzie River). In 2010, there were ten populations in the Mid-Willamette drainage that totaled 500 or more adult Oregon chub. Seven of these populations have exhibited a stable or increasing abundance trend over the past seven years (Table 1). The two largest populations in this drainage were introduced populations (Dunn Wetland and Ankeny Willow Marsh). There was a significant increase in Oregon chub abundance at Finley Display Pond. There was a significant decline in Oregon chub abundance at Ankeny Willow Marsh. A naturally occurring Oregon chub population was discovered at Finley Beaver Pond in 2010, which colonized the site from upper Gray Creek.

We estimated the population abundance of Oregon chub at two locations (Herman Pond and Coast Fork Side Channels) in the Coast Fork Willamette drainage. Oregon chub were collected at Herman Pond in 2010, an introduction site where we believed Oregon chub had been extirpated in 2009.

DISCUSSION

Currently there are 19 populations totaling 500 or more individuals that have exhibited a stable or increasing trend for the past seven years and two populations totaling 500 or more individuals that have exhibited a declining trend for the past seven years (Figure 3). Nine of these 19 populations are located in the Middle Fork Willamette recovery area, seven populations are located in the Mid-Willamette recovery area, and three populations are located in the Santiam recovery area. Significant progress has been made in increasing both the number of known populations of Oregon chub and the number of large populations (>500 fish) in the Willamette drainage (Figure 4). Many populations of chub are currently isolated from other chub populations due to the reduced frequency and magnitude of flood events and the presence of migration barriers such as impassible culverts and permanent, high beaver dams. Genetic exchange between these populations is believed to be minimal.

Status of Naturally Occurring Populations

In 2010, there were 21 naturally occurring populations of Oregon chub that totaled 500 or more individuals in the Willamette River basin; 13 were located in the Middle Fork Willamette drainage (Table 1). Twelve of the abundant (>500 fish) naturally occurring chub populations have exhibited a stable or increasing trend for the past seven years.

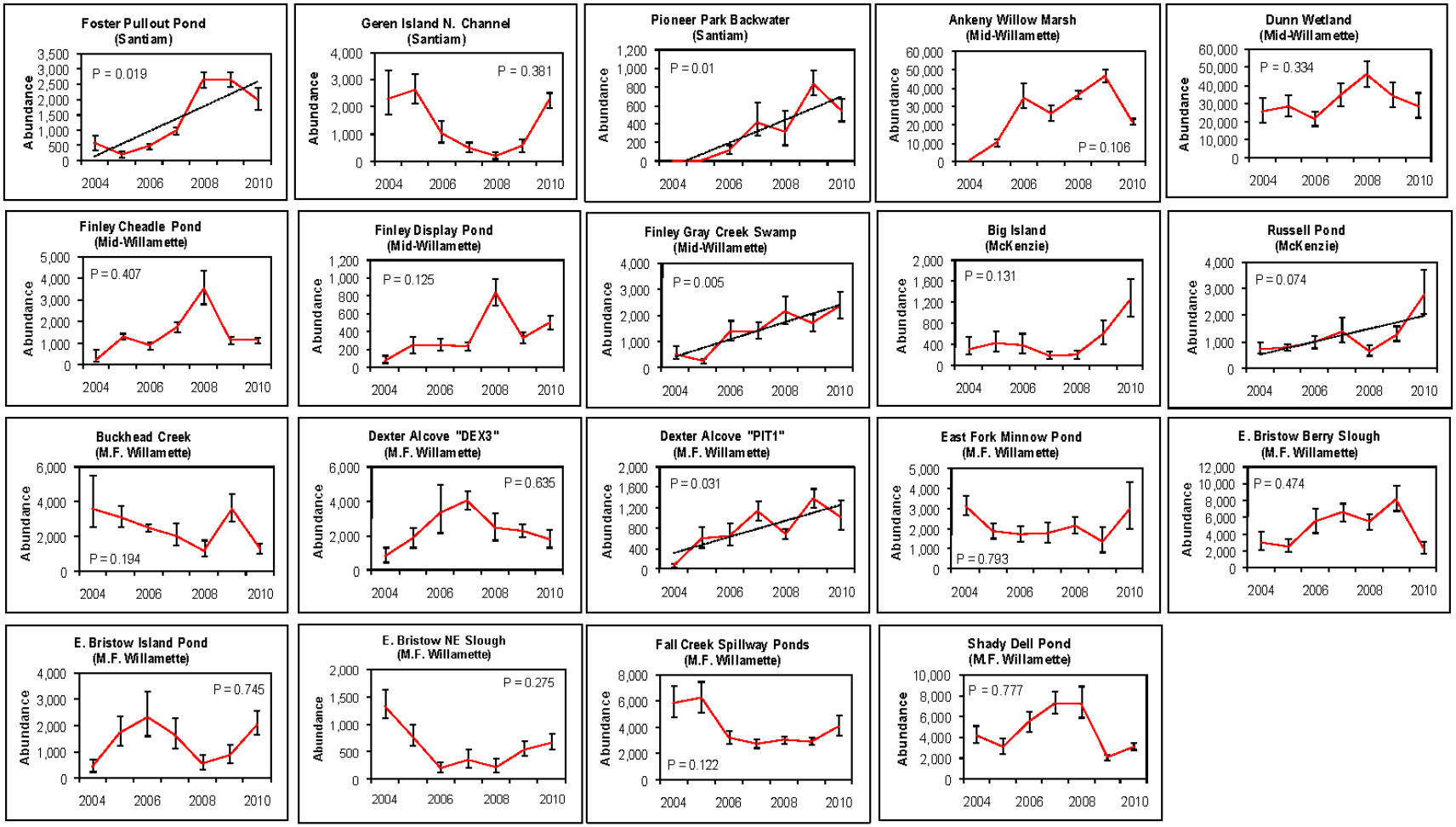

Figure 3. Abundance trends for Oregon chub populations from 2004 through 2010. Vertical bars represent 95% confidence intervals for each estimate. Fitted regression lines (dotted lines) are shown where significant slopes occur. Plots without dotted lines had stable 7-year abundance trends. Included are populations where the 2010 abundance exceeded 500 fish, abundance estimates were available for at least four years of the seven year period, and exhibited a stable or increasing 7-year abundance trend.

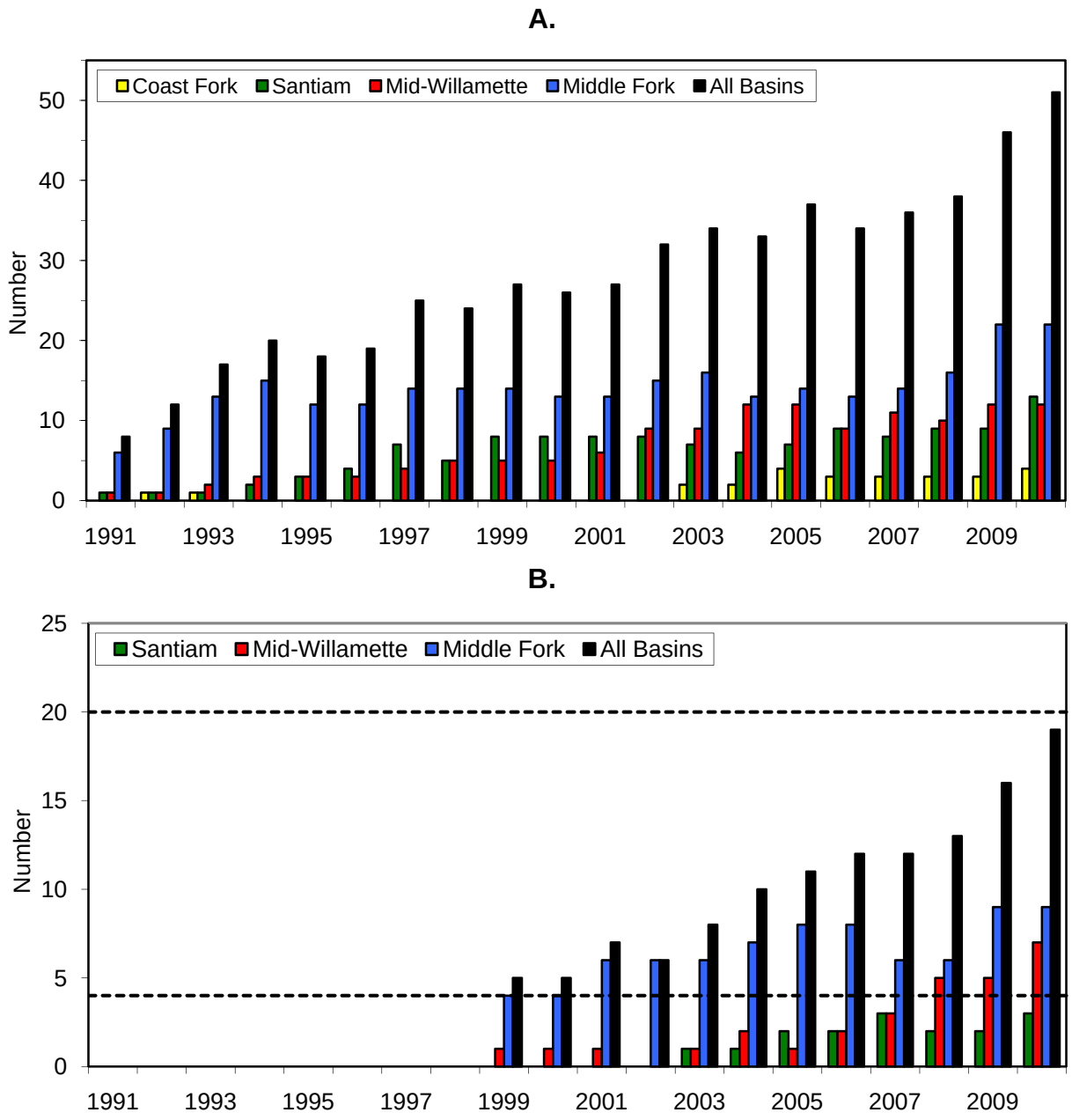

Figure 4. Status of Oregon chub recovery efforts for individual recovery areas and across all recovery areas, 1991-2010. **A**. Number of locations where Oregon chub were found by year. **B**. Number of viable Oregon chub populations by year. Seven-year abundance trends were not available prior to 1999. The Oregon Chub Recovery Plan (USFWS 1998) defines viable populations as exceeding 500 fish and exhibiting stable or increasing seven-year abundance trends. Trends were analyzed when abundance estimates were available for at least four years of the seven year period. The lower dotted line represents the criterion for the number of viable populations per recovery area for delisting, as defined by the Recovery Plan. The upper dotted line represents the total number of viable populations needed for delisting, per the Recovery Plan. Failed introductions (n=3) were not included in these figures.

We documented the successful colonization of Oregon chub at Finley Beaver Pond, which is located in the Gray Creek drainage on the Finley National Wildlife Refuge (Mid-Willamette Recovery Area). In 1990, one Oregon chub was collected from Beaver Pond (personal communication, Dr. Douglas Markle, Oregon State University), but Oregon chub were not found during sampling conducted periodically from 1993 through 2008.

Status of Introduced Populations and Habitat Restoration Projects

A major recovery effort for Oregon chub recovery has focused on the introduction of Oregon chub into suitable habitats within their historic range. Many new populations have been established since 1988. In addition, several habitat restoration projects have been completed to increase the quantity of habitat or enhance the suitability of habitat for Oregon chub. In 2010, there were eleven introduced populations that totaled 500 or more fish. Seven of these populations have exhibited a stable or increasing trend in abundance for the past seven years (Table 1).

Four new chub introductions occurred in 2010:

1. *Budeau North and South Ponds* - Six hundred and twenty-two adult Oregon chub were introduced from South Stayton Pond to the Budeau North Pond (n=320) and Budeau South Pond (n=322) in the Santiam recovery area. USFWS, Natural Resources Conservation Service, Marion Soil and Water Conservation District, ODFW, and contractors completed a restoration project in 2008 to replace the water control structure of an existing pond and create a new pond.

2. *Hills Creek Pond* - One thousand one hundred and twenty-seven adult Oregon chub were introduced from Dexter Reservoir Alcove “DEX3” (n=620) and Dexter Reservoir Alcove “PIT1” (n=507) to Hills Creek Pond in the Middle Fork Willamette recovery area. Hills Creek Pond was considered as a potential introduction site through much of the 1990s. The site reportedly contained nonnative fish in the past, prior to desiccation in the early 1990s. No fish species were collected when the site was sampled in 1993, 1998, or 2010.

3. *North Stayton Pond* - Six hundred and twenty adult Oregon chub were introduced from South Stayton Pond to North Stayton Pond in the Santiam recovery area. These ponds were constructed in 2005 We discovered that North Stayton Pond connects to the North Santiam during high winter flows, and nonnative fish were found during sampling in 2006. In 2009 a contractor was hired by the USFWS to increase the height of the berm around the site by approximately 1.5 meters. In August of 2010, we treated North Stayton Pond with rotenone to remove nonnative fish. We planned to introduce Oregon chub into North Stayton Pond from South Stayton Pond in 2011. In October 2010 we discovered western mosquitofish *Gambusia affinis* were present and highly abundant at South Stayton Pond, and decided to move forward earlier with our North Stayton Pond introduction. In October 2010, we transferred Oregon chub to North Stayton Pond from South Stayton Pond to start the new population and to remove a portion of the population from pressure and competition with the western mosquitofish. The Oregon chub we handled in South Stayton Pond appeared to be emaciated and many had physical injuries.

Table 3. Oregon chub introduction and habitat restoration sites, donor populations, ownership of the sites, numbers of fish introduced, and year of first introduction. Note: there were no chub introductions between 1988 and 1996. Ownership codes: ACOE= U.S. Army Corps of Engineers, USFS= U.S. Forest Service, ODFW= Oregon Department of Fish and Wildlife, and USFWS= U.S. Fish and Wildlife Service.

			Year																
Site name	Ownership	Donor site (introduced populations)	1988	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total moved
		Santiam River																	
Budeau Ponds	private	South Stayton Pond																622	622
Foster Pullout Pond	ACOE	Geren Island					85	20	75	50	158	112							500
Menear's Bend	ACOE	Geren Island						15		26									41
North Stayton Pond	ODFW	South Stayton Pond																620	620
South Stayton Pond	ODFW	Stayton Public Works Pond												44	26		3		73
		Geren Island																232	232
		Pioneer Park Slough												10	41		83		134
		Mid-Willamette River																	
Ankeny Willow Marsh	USFWS	Dunn Wetland										500							500
Dunn Wetland	private	Geren Island			200														200
		Elijah Bristow Berry Slough				300													300
		Shady Dell				73													73
Finley Beaver Pond[a]	USFWS	--------																	--------
Finley Cheadle Pond	USFWS	Finley Gray Creek Swamp													53		85	118	256
		Finley Display Pond								50									50
Finley Display Pond	USFWS	Finley Gray Creek Swamp				60	45		49						75		85	119	433
Jampolsky Wetlands	private	Dunn Wetland										500							500
St. Paul Ponds	ODFW	Big Island														25	64	106	195
		McKenzie River																	
Russell Pond	private	Buckhead Creek							350	150									500
Shetzline North Pond	private	Shetzline Pond															29	31	60
		Middle Fork Willamette River																	
East Ferrin Pond	USFS	East Fork Minnow Pond								576									576
Fall Creek Spillway Ponds	ACOE	East Fork Minnow Pond		350															350
		Shady Dell		150															150
Haws Enhancement Pond	private	Haws Pond															47	86	133
Hills Creek Pond	ACOE	Dexter Alcove "PIT1"																507	507
		Dexter Reservoir RV Alcove - DEX3																620	620
Hospital Imound. Pond[a]	ACOE	--------																	--------
Lower Buckhead Ponds[a]	USFS	--------																	--------
West Ferrin Pond	USFS	Shady Dell Pond								525									525
Wicopee Pond	USFS	Dexter Alcove "PIT1"	50																50
		Coast Fork Willamette River																	
Herman Pond	USFS	Fall Creek Spillway Ponds								400									400
Sprick Pond	private	Coast Fork Side Channels														12	10	31	53

[a]These sites are habitat enhancement projects where no Oregon chub were introduced. Oregon chub colonized these sites naturally.

In addition to the new introductions, we supplemented five existing Oregon chub introductions in 2010 to increase the number of fish used to found these populations (Table 3). We move a minimum of 500 fish to start new populations, but remove ≤10% from a donor population annually to minimize impacts to the donor population. Donor stocks are from thesame subbasin as the introduction site, whenever possible. Since the number of fish we move is limited by the size of the donor population, it often takes multiple years to achieve this target.

Identification and Evaluation of Potential Introduction Sites

Potential Oregon chub introduction sites were identified and evaluated using guidelines described by Scheerer and Jacobs (2007). Following are descriptions of the locations that were evaluated in 2010 as potential introduction sites for Oregon chub:

1. *Finley-Buford Pond* - This site is located on private property in the Muddy Creek subbasin of the Marys River drainage in Benton County (Mid-Willamette Recovery Area). The pond is an existing farm pond that is spring fed. The USFWS and NRCS completed a pond reconstruction project in 2009. Aquatic vegetation has become established in the pond and the habitat appears suitable to support an Oregon chub population. The landowners signed a Cooperative Agreement and were issued a Certificate of Inclusion under ODFW's Programmatic Safe Harbor Agreement. We will likely introduce Oregon chub into this site in 2011.

2. *Murphy Pond* - This site is located on private property in the Muddy Creek subbasin of the Marys River drainage in Benton County (Mid-Willamette Recovery Area). The USFWS excavated a pond in an upland area of the property in 2010. We will continue to monitor this site in 2011. An Oregon chub introduction will likely occur when the aquatic vegetation becomes well established and we confirm that the pond holds water year round.

3. *Ellison Pond* – This site is located on private property in the McKenzie River drainage in Lane County (Mid-Willamette Recovery Area). The pond was formed by damming and partially excavating a slough channel and is fed by a perennial spring. We conducted fish sampling in 2008 and collected only native fish. The water control structure at the site is in need of repair and we are assisting the landowner apply for grants to cover the construction costs.

4. *Teal Marsh* - This site is located on Ankeny National Wildlife Refuge in Marion County (Mid-Willamette Recovery Area). This is a large constructed wetland pond with site conditions that are very similar to those at Willow Marsh. Water can be pumped from Sidney Ditch to maintain adequate water levels. The pump is the same one that supplies water to Willow Marsh and is screened. The site currently contains nonnative fishes. The U.S. Fish and Wildlife Service Willamette Valley Refuges is attempting to secure internal funding to raise the pond levee and make pump/water delivery modifications. The site will be drawn down (desiccated) to remove nonnative fishes currently inhabiting the pond.

Programmatic Safe Harbor Agreement

In 2009, the U.S. Fish and Wildlife Service completed a Programmatic Safe Harbor Agreement for Oregon chub introductions. A Safe Harbor Agreement is a voluntary agreement involving private or non-Federal property owners whose actions contribute to the recovery of an ESA listed species. In exchange for their efforts, participating landowners receive formal

assurances from the USFWS that if they fulfill the conditions of the Safe Harbor Agreement, the USFWS will not require any additional or different management activities of the landowners without their consent. Participating landowners may return the enrolled property to the baseline conditions that existed at the beginning of the Safe Harbor Agreement at the end of the agreement period. Under the Programmatic Safe Harbor Agreement, USFWS issued ODFW the permit and ODFW can enroll eligible landowners through individual Cooperative Agreements. ODFW will issue landowners a Certificate of Inclusion, which will allow management activities that provide net benefits for Oregon chub. Prior to the Programmatic Safe Harbor Agreement, the drafting of individual Safe Harbor agreements for each landowner was a lengthy process that sometimes exceeded two years. The Programmatic Safe Harbor Agreement will expedite the process of formalizing landowner agreements prior to introducing Oregon chub on to private properties.

Before to the Programmatic Safe Harbor Agreement was in place, USFWS issued individual Safe Harbor Agreements prior to the introduction of Oregon chub at Russell Pond and Sprick Pond, and a Conservation Agreement prior to the introduction of Oregon chub at the Dunn Wetlands.

The Haws family, whose property is in the Middle Fork Willamette drainage, signed the first cooperative agreement under the Programmatic Safe Harbor Agreement. ODFW introduced chub in 2009 into a restored pond to increase the abundance of a population of chub that previously existed on their property. In 2010, ODFW issued a certificate of inclusion to the Budeau's prior to the introduction of Oregon chub into Budeau Ponds. The Finley-Buford's were issued a certificate of inclusion in 2010 and we plan to introduce chub into their pond in 2011. We are currently in the process of drafting cooperative agreements with the Ellison and Murphy families.

Impacts of the Unscheduled Corps of Engineers Maintenance Events

In 2009 and 2010 there were two unscheduled maintenance events at U.S. Army Corps of Engineers dams which impacted Oregon chub. On 27 July 2009, two of the three spillway gates at the ACOE's Big Cliff dam on the North Santiam failed. While repairing the gates, the outflow from Big Cliff Dam was reduced to a minimum of 770 cfs, well below the minimum summer base flow of 1,100 cfs. Record high air temperatures reaching 40^{o}C coincided with the low flow levels. We observed low water levels at Pioneer Park Pond, Santiam I-5 Side Channel, and Stayton Public Works Pond (Bangs et al. 2009) and documented chub mortality at the Pioneer Park site.

In 2010, we confirmed Oregon chub presence at Santiam I-5 Side Channel, Stayton Public Works Ponds, and Pioneer Park Pond. There was a significant decline in the population abundance at Pioneer Park Pond from 830 Oregon chub in 2009 to 540 fish in 2010. Santiam I-5 Backwater population abundance remained unchanged. It is likely that our pumping of water into Pioneer Park Pond in 2009 prevented a complete failure of the Oregon chub population at that site.

In 2010, the U.S. Army Corps of Engineers identified structural flaws in the spillway gates at eleven of the thirteen dams operated in the Willamette basin. Repair work required the reservoirs to be drawn down during the summer of 2010. This led to uncharacteristically high summer flows in the managed Willamette tributaries and lowered reservoir elevations during the summer of 2010.

Low pool levels in Dexter Reservoir impacted two Oregon chub populations (Dexter Reservoir RV Alcove "DEX3" and Dexter Reservoir Alcove "PIT1"). Pond water volume was greatly reduced through the summer at these locations, and Oregon chub mortalities were observed on the surface of Dexter Reservoir RV Alcove. We moved a portion of each population to Hills Creek Pond, a site managed by the U.S. Army Corps of Engineers, to establish a refuge population that can be used for reintroductions, should these naturally occurring populations fail. The U.S. Army Corps of Engineers excavated a section of Dexter Reservoir Alcove "PIT1" to increase the availability of open water habitat and to provide deep water refuges for Oregon chub. The project was successful in increasing the surface area of the pond, but the habitat is likely too shallow, under the altered Dexter Reservoir management, to provide much benefit for Oregon chub. The Corps has proposed additional excavation to provide additional deep water refuge habitats for Oregon chub.

We monitored water levels, water temperatures, and the availability and suitability of Oregon chub spawning habitat in Hospital Pond from 2000 to 2008 (Scheerer et al. 2009). We determined that Oregon chub did not spawn successfully in Hospital Pond unless Lookout Point Reservoir filled. It is unlikely that Hospital Pond will fill while repairs are under way at Lookout Point dam. Consequently, recruitment in this population may be limited.

The Corps predicts that about 15% of the storage capacity of the Willamette Project's dams will be unavailable while repairs are underway (personal communication, Greg Taylor, U.S. Army Corps of Engineers), which will impact flood control and water management through the summer of 2011 and beyond. Reduction in storage capacity may lead to higher magnitude flows during seasonal storm events, which carries the risk that nonnative fish may invade Oregon chub sites, but also could aid in providing connectivity and increasing available habitat. During the summer months, the reduced storage capacity may result in reduced tributary flows. Reduced tributary flows, especially reductions below the base flow level, may cause a reduction in water volume and habitat quality at Oregon chub sites and may negatively impact these populations.

Critical Habitat Designation and Downlisting

In 2010, the US Fish and Wildlife Service designated Critical Habitat for Oregon chub (Federal Register 2010b). Mapping surveys that ODFW conducted in 2008 (Bangs et al. 2008) provided the basis for this effort. The USFWS included 25 Oregon chub sites in their designation. Habitats were selected based on their physical and biological features, as well as their ability to support large (>500) populations of Oregon chub. The critical habitat designation may afford better protection for the species and may aid in its recovery. State, Federal, and local agencies and municipalities will be able to use these data for management and planning purposes. For example, when issuing fill/removal permits in the floodplain, the US Army Corps of Engineers will be better able to assess the impacts of land use activities that are proposed near chub habitats. In addition, these data will be valuable when planning future floodplain restoration projects in Willamette subbasins.

In 2007, we met the recovery plan goals for downlisting the status of Oregon chub from endangered to threatened. In 2008 the USFWS completed the Five-Year Status Review of the species and recommended downlisting the species to "threatened" status. Oregon chub were downlisted in April 2010 (Federal Register 2010). The downlisting of Oregon chub marks a milestone in our efforts to recover the species and presents new opportunities and challenges. We plan to continue with the recovery efforts that have proven successful including: monitoring

populations, obtaining abundance trends, discovering naturally occurring populations, and establishing new populations through introductions.

Threats to Oregon Chub and Limitations to Their Recovery

Oregon chub continue to be impacted by human activities. During the past two decades, Oregon chub populations have been threatened by illegal water withdrawals, unauthorized fill and removal activities, certain timber management activities, highway and pipeline construction, roadside herbicide applications, chemical spills, and routine culvert cleaning operations. However, the proliferation of nonnative fish is the largest current threat to Oregon chub populations. Nonnative fish have been collected from 46% of the 755 unique sites we sampled in the Willamette Valley since 1991. After the 1996 floods, nonnative fish were first collected from several Oregon chub sites in the Santiam River drainage; the two largest populations subsequently declined sharply in abundance (Scheerer 2002). Illegal planting of largemouth bass at an introduction site in the Middle Fork Willamette River drainage coincided with the collapse of an Oregon chub population that had once totaled over 7,000 fish. Nonnative fish are well established throughout the Willamette Valley. They threaten to invade sites containing Oregon chub and limit the ability of Oregon chub to migrate from existing sites and colonize suitable habitats elsewhere. Nonnative fish are more common in off-channel habitats in the Santiam and Mid-Willamette River drainages than in the Middle Fork Willamette and McKenzie River drainages (Scheerer 2002).

Recovery of Oregon chub in the Santiam and Mainstem Willamette River subbasins is severely limited by the proliferation of nonnative fish in off-channel habitats. The resulting paradox is that the frequent interaction of the river with the floodplain habitats in these particular subbasins, conditions which historically created off-channel habitats and aided in the dispersal of chub and the interchange of individuals among populations, now poses a threat to Oregon chub by allowing dispersal of nonnative species (Scheerer 2002). Because of the threats posed by nonnative fish and the loss and fragmentation of suitable Oregon chub habitats, we have few options other than to manage chub populations in isolation. This approach has potentially severe genetic consequences. Genetic analyses completed in 2010 indicate that gene flow between populations is limited (DeHaan et al. 2010). While genetic diversity was high at most natural and introduced populations, isolation may eventually lead to reduced genetic diversity in some populations. Managers may be assigned the task of moving fish among certain populations, both natural and introduced, to maintain and enhance the genetic variability necessary for the persistence and recovery of this species.

Additional Research in Connected Floodplain Habitats

In 2009, we initiated floodplain monitoring investigations which also included a study in the Middle Fork Willamette subbasin to assess those factors that may allow Oregon chub to co-exist with nonnative fishes in connected (non-isolated) habitats (Bangs et al. 2010). We chose the Dexter to Jasper reach of the Middle Fork Willamette River basin because of the high density of naturally occurring Oregon chub populations in this reach, the high percentage of publically owned land, and because the Nature Conservancy Sustainable Rivers Project chose to focus efforts on the Coast and Middle Fork Willamette subbasins. During this multi-year study, we will assess the effects of modified flow and temperature regimes on the suitability of off-channel habitats for Oregon chub (availability of aquatic vegetation and temperatures conducive for successful spawning) and effects of the timing, frequency, magnitude and duration of site connectivity on the composition of fish assemblages (native and nonnative). Additionally, we began work in 2010 to test the feasibility of assessing the movement patterns of

larval and adult Oregon chub. We will also assess the impacts of proposed floodplain restoration and reconnection projects on Oregon chub populations and their habitats. We will attempt to determine the combination of flow, temperature, and habitat modifications that favor native fishes, including chub, over nonnative predatory fishes. Ideally, these data, when used by managers to enhance off-channel habitat conditions for Oregon chub, will lead to the delisting of the species.

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