ANNUAL PROGRESS REPORT

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OREGON

PROJECT TITLE: 2013 Oregon Chub Investigations

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SUMMARY

Oregon chub *Oregonichthys crameri,* a small minnow endemic to the Willamette Valley, was listed as endangered under the federal Endangered Species Act in 1993. In 2010, the species status was upgraded to threatened (Federal Register 2010). Factors implicated in the decline of this species included 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 was further impacted 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*. In 2013, we continued surveys in the Willamette River drainage that we initiated in 1991 to quantify the abundance and describe abundance trends 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).

In 2013, we sampled a total of 126 sites, 21 of which we visited for the first time. We discovered six new populations of Oregon chub; three in the Santiam recovery area, two in the Mainstem Willamette recovery area, and one in the Middle Fork Willamette recovery area. These include two populations in the Molalla subbasin, where Oregon chub had not been previously documented. We confirmed the continued existence of Oregon chub at 71 sites, including 51 naturally occurring and 20 introduced populations. We obtained abundance estimates for 37 naturally occurring populations and 19 introduced populations of Oregon chub which were located throughout the Willamette Basin. We introduced Oregon chub into McCrae Reservoir in the Mainstem Willamette recovery area (Ash Creek subbasin, adjacent to the Luckiamute River subbasin).

The Oregon Chub Recovery Plan (U.S. Fish and Wildlife Service 1998) set the following criteria for delisting the species: 1) establish and manage 20 populations of at least 500 adult fish, which 2) 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 mainstem Willamette River tributaries). We met the delisting criteria for the first time in 2012. In 2013, we identified 41 populations with 500 or more individuals. Twenty-three of these populations met the second criterion. Of the populations meeting both criteria 1 and 2, ten were located in the Middle Fork Willamette recovery area, seven were located in the Santiam recovery area, and six were located in the Mainstem Willamette recovery area. In 2013, we again confirmed that Oregon chub met the delisting criteria.

The status of Oregon chub has improved dramatically since listing, resulting primarily from successful introductions and the discovery of previously undocumented populations. Individual populations 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.

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 and 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 downlisted to threatened (Federal Register 2010). In 2012, we met the delisting criteria outlined in the Oregon Chub Recovery Plan.

The Oregon Department of Fish and Wildlife's Native Fish Investigations Project (ODFW) conducted surveys in April through December 2012, building upon similar surveys conducted since 1991 (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; 2010a; 2011a; 2012). The objectives of these surveys were to collect information on the status, distribution, and abundance trends of Oregon chub, the presence of nonnative and native species, the characteristics of the habitat occupied by Oregon chub and potential introduction sites, and to evaluate the success of Oregon chub introductions. In addition, we initiated a research project in 2009 to assess the effects of flow and temperature modifications and proposed reconnection of floodplain habitats on Oregon chub and other Willamette floodplain fishes (Bangs et al. 2010b; 2011b); results from this study will be reported in a separate document that will be completed later this year.

In this report, we summarize the results of population and distribution surveys conducted in 2013 and describe the conservation status of Oregon chub relative to criteria listed in the recovery plan. In addition, we discuss proposed post-delisting monitoring and the evaluation of an alternative catch-per-unit-of-effort approach to tracking chub abundance over time.

METHODS

We conducted surveys at 126 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 with 6.4 mm mesh, and hoop nets consisting of four hoops measuring 61 cm in diameter, 3.1 m long with 1.3 cm stretched mesh. The 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 the life stages of the species that we encountered.

We recorded physical and biological habitat parameters at each site including substrate type, genus and percent of wetted surface area with aquatic vegetation, mean and maximum depth, water temperature, and total wetted surface area. Substrate was categorized as percent fines (<1/16th mm), sand (1/16th-2 mm), gravel (3-64 mm), cobble (65-256 mm), boulder (>256 mm), and bedrock. We photographed and assigned a unique map code to each new site.

We used minnow traps to obtain mark-recapture population estimates for all fish species, when possible. We baited the traps with one third slice of bread and fished them for 3 to 18 hours. We measured the total length (TL) of a subsample (n=50) of the Oregon chub that we collected in the traps. We marked all fish with either a partial caudal fin clip or a visible implant elastomer

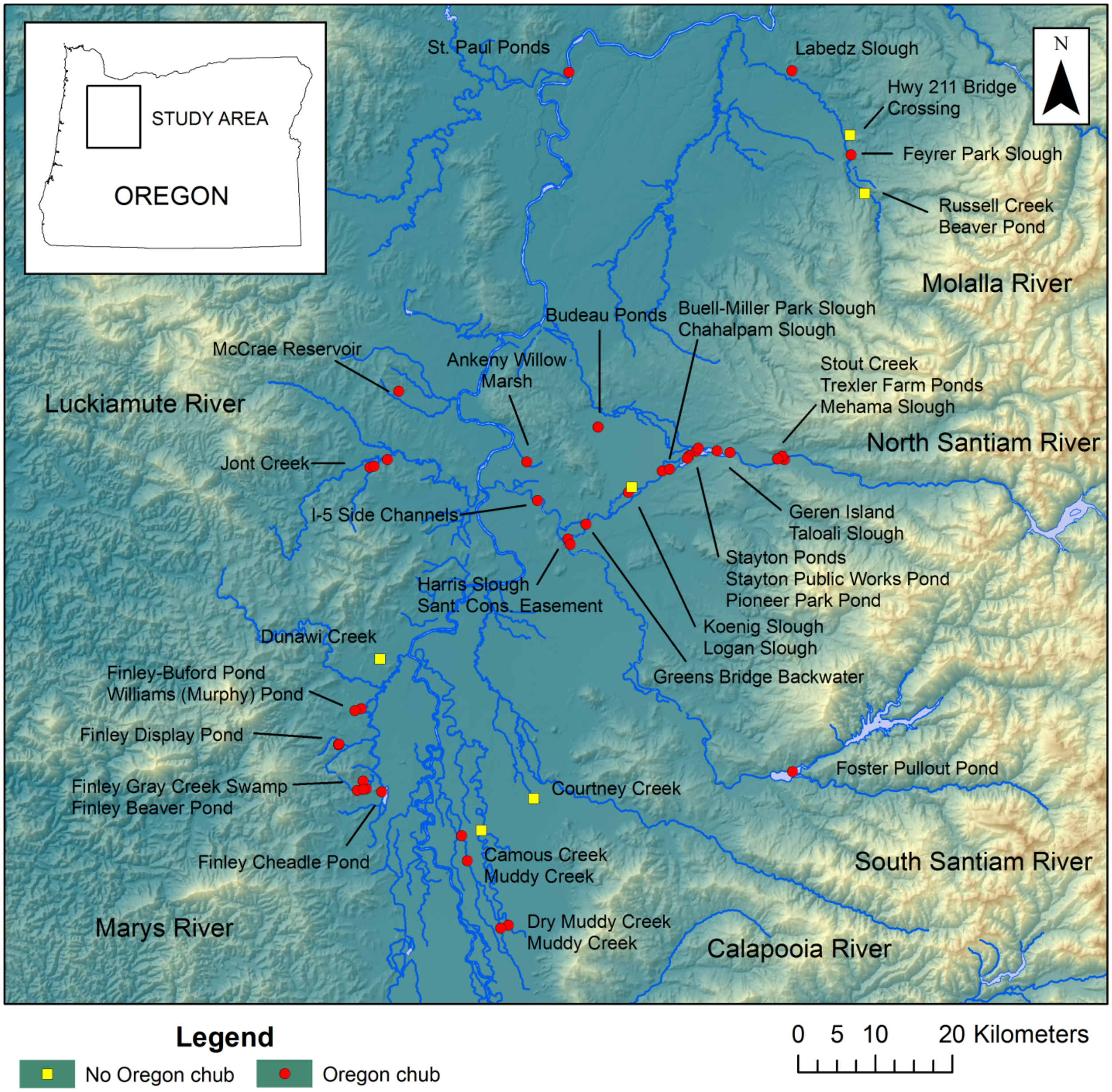

Figure 1. Survey locations for Oregon chub in the Lower Willamette, Santiam, and Mainstem Willamette River drainages in 2013. Red circles indicate sites where Oregon chub were collected. Yellow squares indicate sites where Oregon chub were not collected. Overlapping symbols represent multiple sites occurring at or near the same survey location.

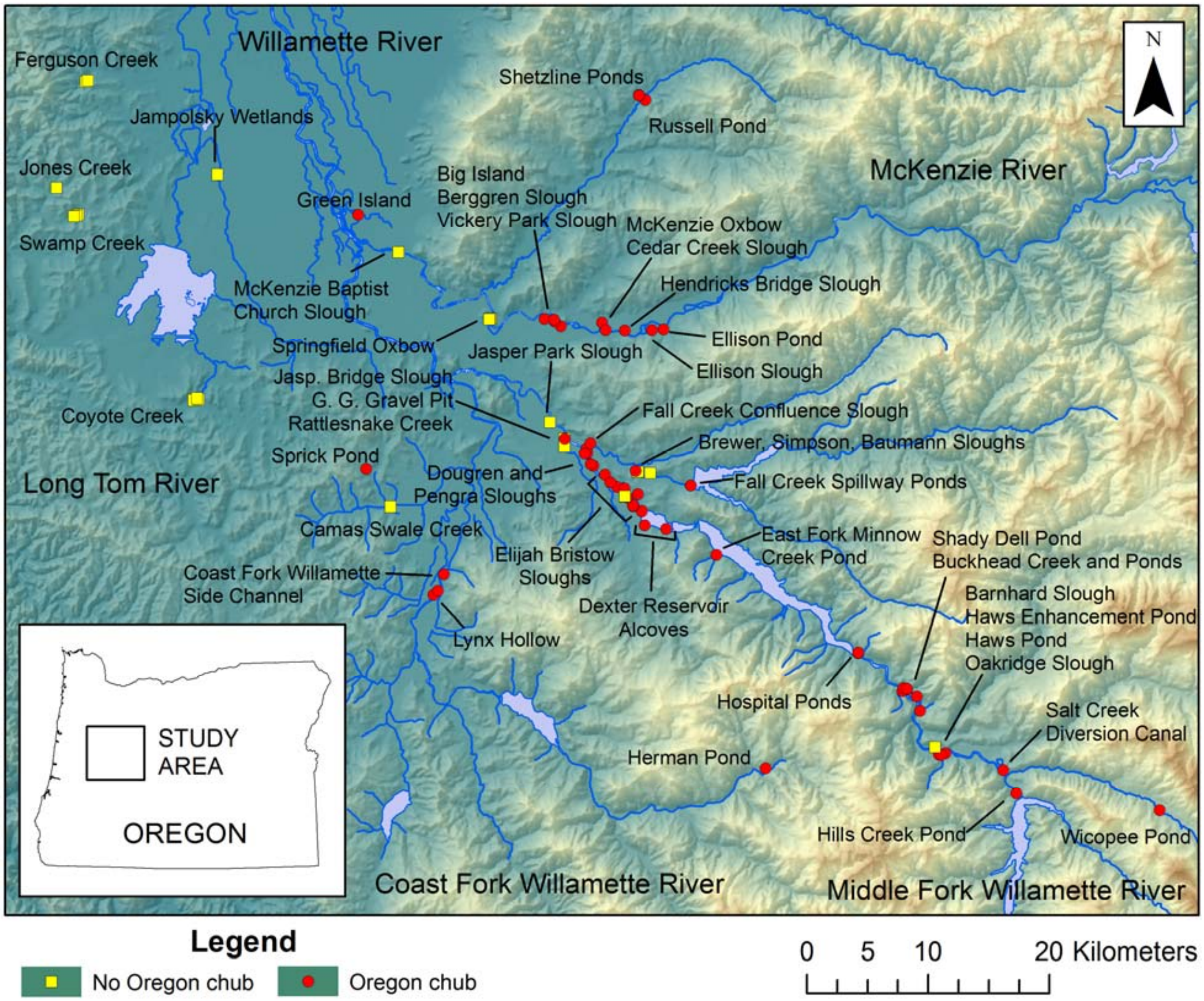

Figure 2. Survey locations for Oregon chub in the Upper Willamette River drainage in 2013. Red circles indicate sites where Oregon chub were collected. Yellow squares indicate sites where Oregon chub were not collected. Overlapping symbols represent multiple sites occurring at or near the same survey 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, Elijah Bristow Berry Slough, and Lost Creek Confluence Slough. The area labeled Dougren and Pengra Sloughs includes Pengra Island Slough, Pengra Oxbow Slough, MFW Deep Muddy Slough, Dougren Slough, and Dougren Island Slough.

(VIE) tag and returned them to the water. When catch rates were low, we repeated this procedure for a second day. On the second day, we marked all unmarked fish. We typically marked fish until a minimum of 15 percent of the population was marked. We estimated population abundance using a single-sample mark-recapture model (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). We did not include fish smaller than ~30 mm (TL) in the estimates. Excluded were young-of-the-year fish (Scheerer and McDonald 2003).

We defined a population as a group of chub that occupies a single, defined waterbody. 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 part of a single population. To assess the status of the species relative to recovery criteria, we defined abundance trends quantitatively as increasing, declining, stable, or unstable. We only assessed seven year abundance trends if the population abundance was ≥500 fish, if we had data for at least seven years. We calculated a linear regression of abundance over time for each abundant population (≥500 fish) for the past seven years (2007-2013). 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. When the slope was not significantly different from zero ($P > 0.10$), we then calculated the coefficient of variation of the abundance estimates for the past 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 126 sites sampled in 2013 are available on our web site: http://oregonstate.edu/dept/ODFW/NativeFish/OregonChub.htm.

Population Estimates

In 2013, we obtained population estimates for Oregon chub at 56 locations (Tables 1 and 2). We estimated the population abundance of Oregon chub at 16 locations in the Santiam River recovery area. In 2013, there were 13 populations in the Santiam drainage with ≥500 adult Oregon chub. Seven of these populations had a stable or increasing trend in abundance for the past seven years (Table 1). We noted significant increases in Oregon chub abundance at Budeau North Pond, Foster Pullout Pond, Chahalpam (Gray) Slough, Buell-Miller Park Slough, Green's Bridge Slough, and Santiam I-5 Side Channels. We noted significant declines in Oregon chub abundance at Budeau South Pond, Koenig Slough, Pioneer Park Pond, South Stayton Pond, and Harris Slough.

We estimated the population abundance of Oregon chub at 14 locations in the Mainstem Willamette River recovery area, which includes the McKenzie River. In 2013, there were 10 populations in the Mainstem Willamette drainage with ≥500 adult Oregon chub. Six of these populations exhibited a stable or increasing abundance trend over the past seven years (Table 1). We noted significant increases in Oregon chub abundance at McKenzie Oxbow, Big Island, Williams (Murphy) Pond, Finley-Buford Pond, Jont Creek, and Finley Cheadle Pond. We noted significant declines in Oregon chub abundance at Ankeny Willow Marsh, Dunn Wetland, Shetzline Pond, Berggren (Hunsaker) Slough, Russell Pond, and Finley Display Pond. The declines in

Table 1. Oregon chub population abundance estimates from 2007-2013, listed by recovery area. Basins: CFW= Coast Fork Willamette, FALL= Fall Creek, LONG = Long Tom, LUCK= Luckiamute, MARY= Mary's, MCK= McKenzie, MFW= Middle Fork Willamette, MILL= Mill Creek, MOL= Molalla, MS= Mainstem Willamette and tributaries, MOL= Molalla, NS= North Santiam, SANT= Mainstem Santiam, SS= South Santiam. We also included a summary of data prior to 2007, including the years when we first discovered or introduced each population and the ranges of abundance. Abundance was calculated using a mark-recapture model, except where numbers are shown in bold, which only represent the number of fish captured. Site names in bold italics are locations where Oregon chub were introduced. The numbers of fish stocked at introduction sites are shown in parentheses. See the *Methods* for definitions of seven year abundance trends. We did not assessed seven year trends if the population abundance was less than 500 fish in 2013.

Site Name	Basin	First discovered/ introduced	Range through 2006	2007	2008	2009	2010	2011	2012	2013	7 year trend
					Santiam						
Budeau North Pond	MILL	2010					(310)	2,240	5,730	8,350	
North Stayton Pond	NS	2010					(620)	300	4,370	3,720	
Foster Pullout Pond	SS	1999	85 - 640	980	2,640	2,640	2,010	2,360	2,240	3,410	increasing
Budeau South Pond	MILL	2010					(312)	890	4,160	2,810	
Chahalpam (Gray) Slough	NS	1995	0 - 700	560	660	...............denied access	....	....	520	2,430	stable
Geren Island North Channel	NS	1996	360 - 8,660	510	210	560	2,230	3,030	1,940	2,280	increasing
Koenig Slough	NS	2011						**443**	2,410	1,780	
Pioneer Park Pond	NS	1997	0 - 110	420	320	830	540	1,470	2,710	1,630	increasing
Stayton Public Works Pond	NS	1998	0 - 530	270	70	30	**3**	110	1,100	1,530	stable
Mehama Slough	NS	2010					**15**	1,240	1,080	1,380	
South Stayton Pond	NS	2006	54	(67) 560	1,710	(142) 4,970	(232) 6,230	2,210	2,000	1,100	stable
Buell-Miller Slough	NS	2010					**2**	710	170	760	
Green's Bridge Slough	NS	1993	0 - 7	**1**	**8**	240	610	370	190	670	increasing
Santiam I-5 Side Channels	SANT	1997	2 - 350	**22**	**2**	100	160	280	100	420	
Santiam Easement	NS	1994	0 - 1,250	**0**	**2**	**22**	530	**54**	260	310	
Trexler Farm Ponds	NS	2013								**53**	
Stout Creek	NS	2013								**39**	
Harris Slough	NS	2011						**18**	80	32	
Taloali Slough	NS	2013								4	
Logan Slough	NS	1997	0 - 2					**1**	**0**	**0**	
Hospital Slough	SS	2009				**2**			**10**		
Cold Creek Slough	NS	2011						**59**	**0**		
Menear's Bend	SS	2000	0 - 29	....	....	....	pond dried up	....	....	....	
					Coast Fork Willamette						
Sprick Pond	CFW	2008			(12)	(10) **12**	(31) **22**	(12) 80	700	610	
Herman Pond	CFW	2002	40 - 420	180	**3**	**0**	200	130	190	150	
Coast Fork Side Channels	CFW	2002	16 - 150	80	130	100	190	80	70	60	
Lynx Hollow Side Channels	CFW	2005	2	**2**	**0**	**4**	**2**	**2**	**2**	**4**	
Camas Swale	CFW	1992	0 - 2	**0**		**0**			**0**		

Table 1 (continued).

Site Name	Basin	First discovered/ introduced	Range through 2006	2007	2008	2009	2010	2011	2012	2013	7 year trend
				Mainstem Willamette							
Ankeny Willow Marsh	MS	2004	500 - 35,650	(1,525) 26,420	36,460	46,560	21,790	96,810	82,800	47,920	stable
Dunn Wetland	MS	1997	200 - 28,740	34,530	46,330	34,300	28,510	47,350	44,160	6,440	stable
McKenzie Oxbow	MCK	2009				2,420	3,000	3,550	2,880	6,180	
Shetzline Pond	MCK	2002	120 - 1,050	210	130	300	350	5,750	9,270	3,240	increasing
Finley Beaver Pond	MARY	2010			**0**		420	310	1,340	1,600	stable
Finley Gray Creek Swamp	MARY	1993	230 - 1,390	1,400	2,140	1,700	2,350	2,150	1,720	1,370	stable
Big Island	MCK	2002	310 - 940	190	200	610	1,240	400	330	1,160	stable
Williams (Murphy) Pond	MARY	2011						(32)	(182) **7**	1,080	
Finley-Buford Pond	MS	2011						(160)	460	1,010	
Berggren (Hunsaker) Slough	MCK	2009		**0**		520	520	640	920	610	
St. Paul Ponds	MS	2008			(25)	(64) **2**	(106) **32**	4,430	510	440	
Jont Creek	LUCK	2012							90	370	
Finley Cheadle Pond	MARY	2002	50 - 1,300	(53) 1,740	3,520	(85) 1,140	(118) 1,130	(30) **0**	(184) 20	160	
Russell Pond	MCK	2001	350 - 1,000	1,400	650	1,290	2,780	340	340	130	
Finley Display Pond	MARY	1998	60 - 1,750	(75) 230	830	(85) 320	(119) 500	(67) 420	220	120	
Camous Creek	MS	1993	5							**56**	
Dry Muddy Creek	MS	1994	0 - 26	**0**				**20**	500	**52**	
Muddy Creek	MS	2007		**3**				**33**	**0**	**46**	
Labedz Slough	MOL	2013								**29**	
McCrae Reservoir	LUCK	2013								(29)	
Cedar Creek	MCK	2012							170	**25**	
Hendrick's Bridge Slough	MCK	2011						**2**	70	**22**	
Vickery Park Slough	MCK	2011						**22**	60	**12**	
Ellison Pond and Slough	MCK	2012							(110) **1**	**9**	
Green Island	MCK	2007		**12**	12	**2**	**0**	10	**8**	**3**	
Feyrer Park Slough	MOL	2013								**1**	
Dunawi Creek	MARY	2012							**5**	**0**	
Jampolsky Wetlands	LONG	2004	500 - 8,320	4,160	………………………	……denied access……		………………………	………	**0**	
Springfield Oxbow	MCK	2012							**4**	**0**	
Ezell Slough	MCK	2005	6					**29**	140		
Grant Farm Channel	MCK	2012							**8**		
Bull Run Creek	MARY	2005	2	**0**	**0**						
Little Muddy Creek tributary	MS	2004	0 - 5	**0**							

Table 1 (continued).

Site Name	Basin	First discovered/ introduced	Range through 2006	2007	2008	2009	2010	2011	2012	2013	7 year trend
					Middle Fork Willamette						
Hills Creek Pond	MFW	2010					(1,127)	23,000	13,460	14,610	
Fall Creek Spillway Ponds	MFW	1996	480 - 7,770	2,740	3,050	2,930	4,110	6,690	6,750	9,110	increasing
Buckhead Creek	MFW	1992	2 - 7,140	2,030	1,260	3,600	1,280	1,900	3,180	4,600	stable
Wicopee Pond	MFW	1992	0 -4,860	3,130	5,430	3,040	2,200	3,390	(128) 5,620	4,380	stable
Dexter Reservoir RV Alcove - DEX3	MFW	1992	15 - 3,310	4,020	2,450	2,280	1,800	940	190	3,550	stable
Shady Dell Pond	MFW	1993	1,630 - 5,430	7,250	7,250	2,070	3,110	1,760	1,600	2,890	declining
Dexter Reservoir Alcove - PIT1	MFW	1992	40 - 1,440	1,130	680	1,370	1,020	350	680	2,590	stable
Elijah Bristow Island Pond	MFW	2003	420 - 2,780	1,620	550	870	2,050	1,400	840	2,250	stable
Dougren Island Slough - RM 198.5	MFW	2011						**34**	**280**	1,700	
Hospital Pond	MFW	1993	690 - 5,040	1,520	3,680	730	1,330	2,860	2,110	1,360	stable
East Fork Minnow Creek Pond	MFW	1993	1,730 - 8,770	1,770	2,160	1,340	2,980	2,170	3,330	1,340	stable
Elijah Bristow Berry Slough	MFW	1993	1,190 - 5,350	6,580	5,460	8,130	2,360	1,040	1,440	1,170	declining
Dexter Dam Slough	MFW	2009				640	510	820	920	1,090	
Elijah Bristow Northeast Slough	MFW	1999	210 - 1,340	350	230	550	670	670	1,280	890	increasing
Haws Enhancement Pond	MFW	2009				(47)	(86) **1**	3,150	900	790	
Dougren Slough - RM 198.5	MFW	2008			**1**	1,640	830	1,730	1,070	522	
Haws Pond	MFW	2005	120 - 440	380	280	470	810	350	600	510	stable
Elijah Bristow North Gravel Pit	MFW	2011			**0**	**0**	**0**	**3**	60	450	
Elijah Bristow South Slough	MFW	2008			**1**	880	640	380	230	280	
Pengra Oxbow Slough - RM 199.4	MFW	2008			**1**	**9**	60	80	20	160	
Pengra Island Slough - RM 199.5	MFW	2003				200	60	40	60	40	
Lost Creek Slough	MFW	2012							**13**	**21**	
Deep Muddy Slough - RM 198.6	MFW	2009			**0**	**10**	40	10	10	10	
Green Grass Gravel Pit	MFW	2012							**24**	**7**	
Oakridge Slough	MFW	1994	0 - 480	**0**	**0**	**0**		**1**	**4**	**3**	
Salt Creek Diversion Canal	MFW	2012							150	**2**	
Hospital Impoundment Pond	MFW	1995	0 - 6				80	70	20	**1**	
Fall Creek Confluence Slough	FALL	2012							**5**	**1**	
Brewer Slough	FALL	2013								**1**	
Railroad Bridge Slough - RM 197	MFW	2009			**0**	80	20	30	20	**0**	
Baumann Slough	FALL	2012							**1**	**0**	
Simpson Slough	FALL	2012							**1**	**0**	
Barnhard Slough	MFW	2000	0 - 7	**4**	**0**	**2**	**1**	**0**	**0**	**0**	
Rattlesnake Creek	MFW	1992	0 - 5	**0**		**2**			**0**	**0**	
Elijah Bristow Large Gravel Pit	MFW	1992	0 - 8							**0**	
Elijah Bristow Small Gravel Pit	MFW	1992	0 - 31							**0**	
TNC Island Slough	MFW	2012							**2**		
Lookout Point Reservoir	MFW	2012							**1**		
Pudding Creek	MFW	2011						**1**	**0**		
Jasper Park Slough	MFW	1994	0 - 3	**1**	**1**	**0**		**0**			
Springfield Millrace Slough	MFW	2009				**8**	**0**				
East Ferrin Pond	MFW	1994	0 - 7,160	**0**	**0**	**0**	**0**				
Dexter East Alcove	MFW	1992	0 - 40	**0**	**0**	**0**					
Wallace Slough	MFW	1997	0 - 3	**0**	**0**						
Dexter Reservoir	MFW	2002	1								
West Ferrin Pond	MFW	1992	0 - 525								

Table 2. 2013 Oregon chub abundance estimates and 95% confidence limits obtained at locations in the Willamette Valley, Oregon. Note: sites in Luckiamute River and McKenzie River drainages are part of the Mainstem Willamette recovery area.

		95% Confidence limits	
Location	Estimate	Lower	Upper
Luckiamute River Drainage			
Jont Creek	370	110	190
Santiam River Drainage			
Budeau North Pond	8,350	7,610	9,160
North Stayton Pond	3,720	3,430	4,040
Foster Pullout Pond	3,410	3,080	3,780
Budeau South Pond	2,810	2,530	3,130
Chahalpam (Gray) Slough	2,430	2,060	2,870
Geren Island North Channel	2,280	2,010	2,590
Koenig Slough	1,780	1,530	2,070
Pioneer Park Pond	1,630	1,450	1,820
Stayton Public Works Pond	1,530	1,320	1,770
Mehama Slough	1,380	680	2,610
South Stayton Pond	1,100	1,000	1,220
Buell-Miller Park Slough	760	680	850
Green's Bridge Slough	670	560	800
Santiam I-5 Side Channels	420	190	830
Santiam Conservation Easement	310	230	410
Harris Slough	30	20	50
Mainstem Willamette River Drainage			
Ankeny Willow Marsh	47,920	44,450	51,660
Dunn Wetland	6,440	5,360	7,690
Finley Beaver Pond	1,600	1,290	1,990
Finley Gray Creek Swamp	1,370	970	2,870
Williams (Murphy) Pond	1,080	970	1,200
Finley-Buford Pond	1,010	920	1,110
St. Paul Ponds	440	330	590
Finley Cheadle Pond	160	130	190
Finley Display Pond	120	80	170
McKenzie River Drainage			
McKenzie Oxbow	6,180	5,000	7,620
Shetzline Pond	3,240	2,860	4,110
Big Island	1,160	1,010	1,340
Berggren (Hunsaker) Slough	610	540	700
Russell Pond	130	100	180

Table 2 (continued).

Location	Estimate	95% Confidence limits Lower	Upper
Middle Fork Willamette River Drainage			
Hills Creek Pond	14,610	12,740	16,770
Fall Creek Spillway Ponds	9,110	7,580	10,950
Buckhead Creek	4,610	4,120	5,180
Wicopee Pond	4,380	3,770	5,070
Dexter Reservoir Alcove "DEX3"	3,550	3,070	4,110
Shady Dell Pond	2,890	2,620	3,140
Dexter Reservoir Alcove "PIT1"	2,590	2,240	2,990
Elijah Bristow Island Pond	2,250	1,800	2,810
Dougren Island Slough	1,700	1,460	1,990
Hospital Pond	1,360	1,000	1,850
East Fork Minnow Creek Pond	1,340	1,120	1,600
Elijah Bristow Berry Slough	1,170	950	1,440
Dexter Dam Slough	1,090	1,000	1,200
Elijah Bristow Northeast Slough	890	780	1,020
Haws Enhancement Pond	790	710	870
Dougren Slough	520	430	630
Haws Pond	510	420	610
Elijah Bristow North Gravel Pond	450	340	580
Elijah Bristow South Slough	280	200	390
Pengra Oxbow Slough	160	110	240
Pengra Island Slough	40	20	70
Deep Muddy Slough	10	10	20
Coast Fork Willamette River Drainage			
Sprick Pond	610	550	670
Herman Pond	150	120	190
Coast Fork Side Channels	60	40	100

abundance at Ankeny Willow Marsh and Dunn Wetland were sizeable, with a loss of 34,880 and 37,720 individuals, respectively, from the 2012 estimates.

We estimated the population abundance of Oregon chub at 22 locations in the Middle Fork Willamette River recovery area, which contains the greatest concentration of large Oregon chub populations (>500 fish) in the Willamette Valley. In 2013, there were 17 populations in the Middle Fork Willamette drainage with ≥500 adult Oregon chub. Ten of these populations had a stable or increasing abundance trend for the past seven years (Table 1). The largest population of Oregon chub in the Middle Fork Willamette drainage was located at Hills Creek Pond, where Oregon chub were introduced in 2010. We noted significant increases in Oregon chub abundance at Buckhead Creek, Shady Dell Pond, Dexter Reservoir Alcove “DEX3”, Dexter Reservoir Alcove “The Pit”, Elijah Bristow Island Pond, Elijah Bristow North Gravel Pond, Pengra Oxbow. We noted significant declines in Oregon chub abundance at East Fork Minnow Creek Pond, Elijah Bristow Northeast Slough, and Dougren Slough. We discovered a new, naturally occurring Oregon chub population at Brewer Slough in the Middle Fork Willamette drainage.

We estimated the population abundance of Oregon chub at three locations (Coast Fork Side Channels, Herman Pond, and Sprick Pond) in the Coast Fork Willamette recovery area. Sprick Pond was the only population in the Coast Fork Willamette subbasin supporting 500 or more adult Oregon chub.

DISCUSSION

In 2013, there were 23 populations totaling 500 or more adult Oregon chub that had a stable or increasing trend for the past seven years (Figure 3). Ten of these 23 populations were located in the Middle Fork Willamette recovery area, six were located in the Mainstem Willamette recovery area, and seven were located in the Santiam recovery area. We met the recovery plan criteria for delisting the species for the second year in a row. A proposal to remove Oregon chub from the ESA list was submitted by the USFWS and published in the Federal Register in January 2014 (Federal Register 2014).

We have made significant progress in documenting and increasing the number of known populations, the number of large populations (≥500 fish), and the range of Oregon chub in the Willamette drainage since 1991 (Figure 4). In 2010, the species status was upgraded to threatened. In addition to the 23 current populations that meet delisting criteria, 31 different populations have met the criteria at least once between 2010 and 2013. We have discovered (n=32) and established via introduction (n=9) a substantial number of chub populations in the past five years. This was largely made possible by increased funding since 2009 from the Army Corps of Engineers under the Willamette Biological Opinion (Fish and Wildlife Service 2008b).

Status of Naturally Occurring Populations

In 2013, we documented 27 naturally occurring populations of Oregon chub with 500 or more individuals in the Willamette River basin. Seventeen of these populations have exhibited a stable or increasing trend for the past seven years.

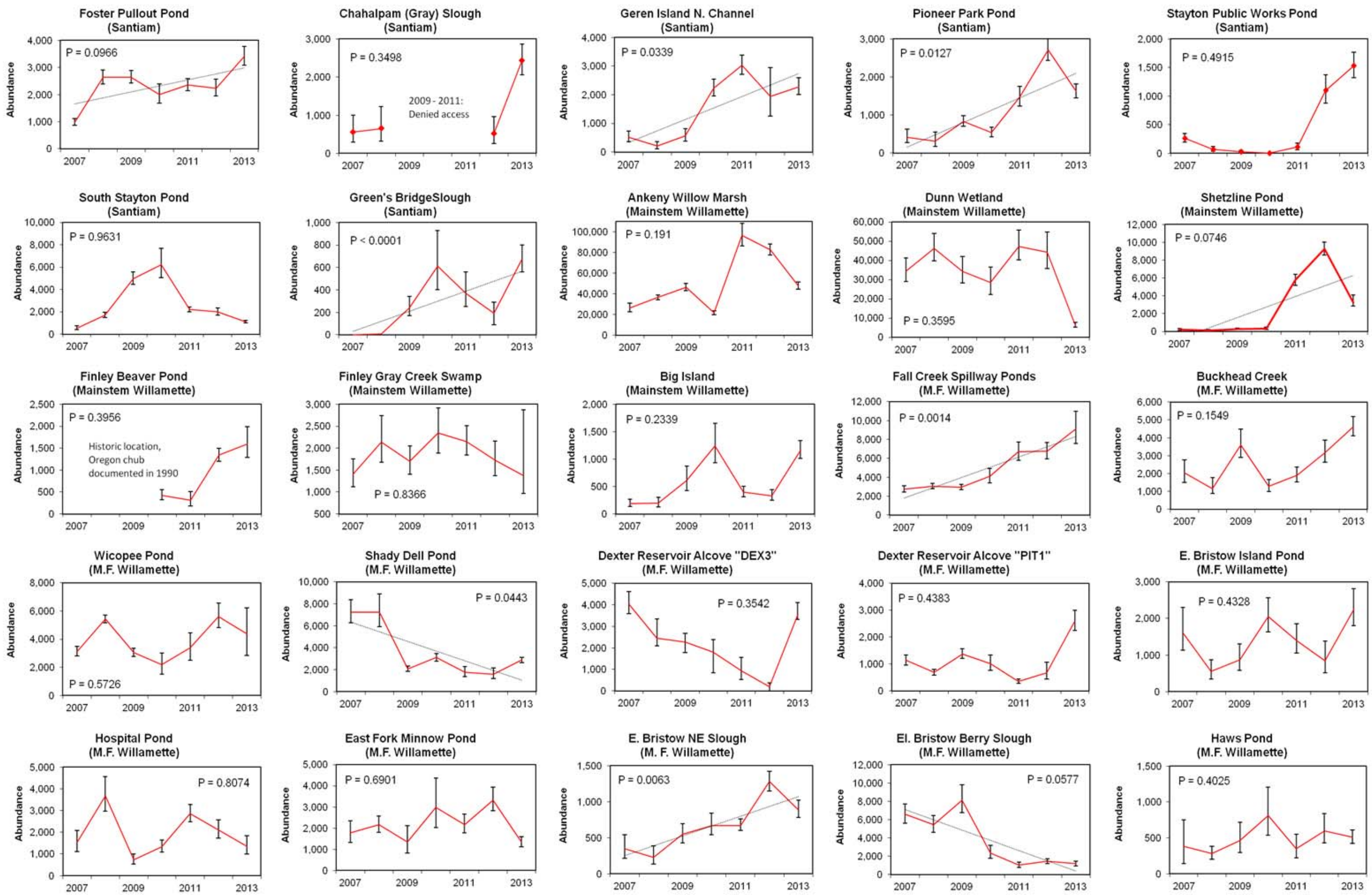

Figure 3. Seven-year abundance trends for Oregon chub populations with 500 or more adults which had a stable, increasing, or declining trend. The recovery area for each location is listed in parentheses under the site name. The horizontal bars represent 95% confidence intervals for each estimate. Fitted regression lines (dotted lines) are shown where significant slopes occur. Plots without dotted lines had stable 7-year abundance trends. Note, we were denied access to Chahalpam (Gray) Slough from 2009 through 2011, and we were not able to obtain abundance data during that time period. Note also, we documented Oregon chub presence, but were unable to estimate abundance, at Finley Beaver Pond prior to 2007. These data are not included in the graphs.

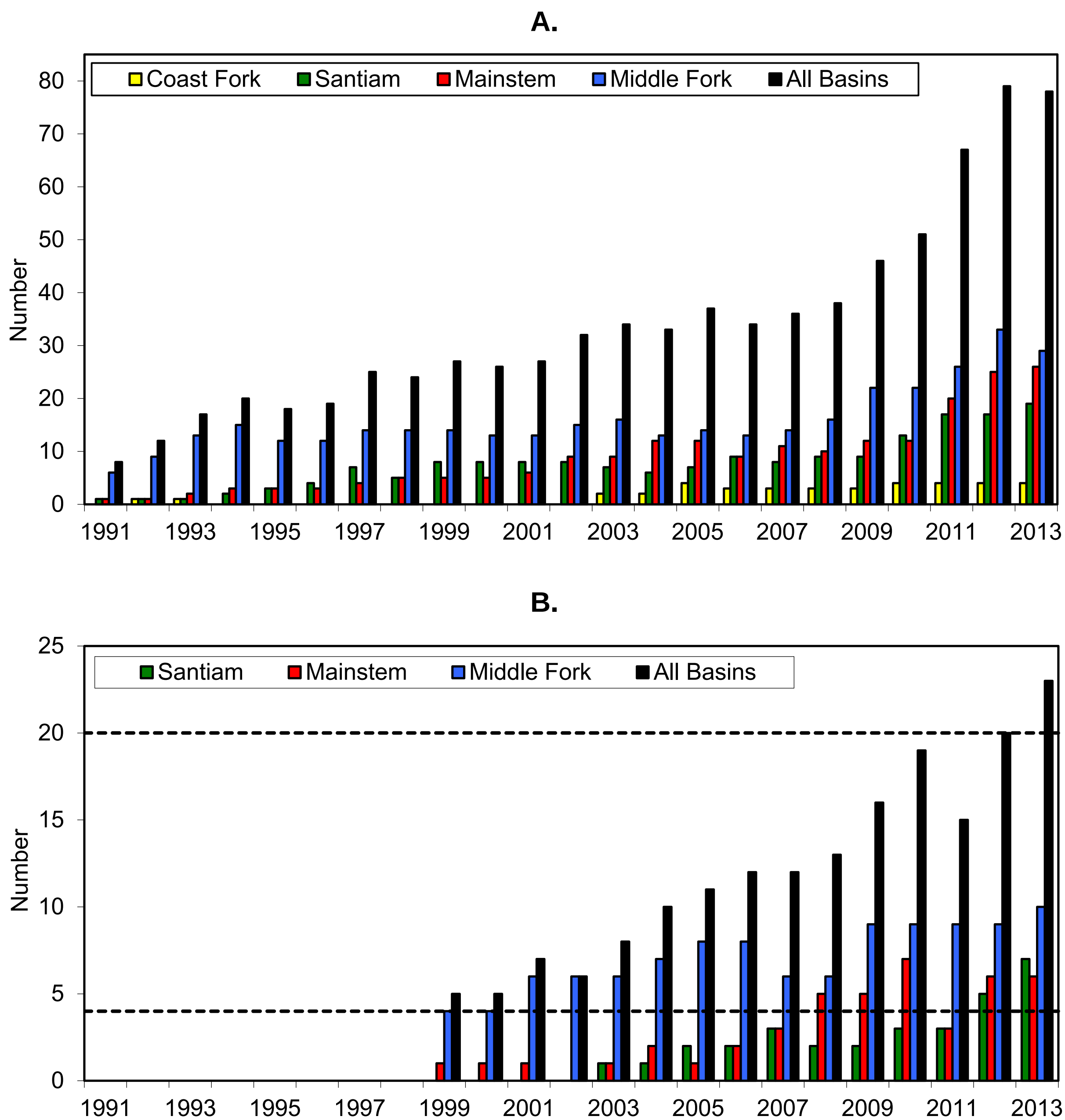

Figure 4. Status of Oregon chub recovery efforts for individual recovery areas and across all recovery areas, 1991-2013. **A**. The numbers of locations where we documented Oregon chub, by year. **B**. The numbers of Oregon chub populations that met the delisting criteria, by year. Seven-year abundance trends were not available prior to 1999. The lower dotted line represents the criterion for the number of populations (n=4) needed per recovery area for delisting. The upper dotted line represents the criterion for the total number of populations (n=20) needed for delisting. Note, we did not included failed introductions (n=3) in these figures.

In 2013, we discovered two Oregon chub populations in the Molalla River basin. This discovery represented a major expansion of the currently known, naturally occurring range of Oregon chub by approximately 70 river miles. Despite finding Oregon chub in a greater extent of their historic range, we have not found Oregon chub populations in some areas where they were documented historically, such as below Willamette falls near the mouth of the Clackamas, in mainstem Willamette sloughs and backwaters, or in the Long Tom and Calapooia River basins.

Status of Introduced Populations and Habitat Restoration Projects

A major effort for Oregon chub recovery has been directed towards introducing Oregon chub into suitable habitats within their historic range (Table 3). Twenty-one 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 2013, there were 13 introduced populations with ≥500 fish: six of these populations have exhibited a stable or increasing 7-year abundance trend (Table 1).

We conducted one new Oregon chub introduction in 2013. We introduced 29 Oregon chub into McCrae Reservoir from the Jont Creek population in the Mainstem Willamette recovery area (Luckiamute River subbasin). This former farm pond was originally constructed by damming and partially excavating a small valley which is fed by a perennial spring. We conducted fish sampling in 2012 and 2013 and found no fish. The landowners performed a number of improvements to the pond, including installation of a modern water control structure. The landowners were issued a Certificate of Inclusion under ODFW's Programmatic Safe Harbor Agreement.

Oregon chub re-introduction guidelines for establishing new populations recommend that we transfer a minimum of 500 fish, but only remove a maximum of 10% from a donor population annually to minimize impacts to the donor population. When donor populations total <5,000 fish, it takes us multiple years to achieve this target. In addition, the guidelines also state that donor stocks should be from the same subbasin as the introduction site, whenever possible.

Identification and Evaluation of Potential Introduction Sites

Potential Oregon chub introduction sites were identified and evaluated using guidelines described by Scheerer et al. (2007). Following are descriptions of the locations that we evaluated in 2013 as potential introduction sites for Oregon chub:

1. *Auer Pond* – We initiated initial conversations with the landowner in the Jont Creek subbasin (Luckiamute basin) and with the USFWS Willamette Valley Partners Program to create an additional isolated pond for Oregon chub on the property. An existing pond contains both nonnative fish and Oregon chub population. Ideally, the new pond would ensure protection and long-term persistence of chub on the site and in the Luckiamute basin.

2. *Molalla basin* – In 2014, we plan to evaluate potential introduction sites in the Molalla River drainage to provide secure additional habitat and add redundancy to the populations that we discovered in the basin in 2013.

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	2011	2012	2013	Total moved
Luckiamute River																						
McCrae Reservoir	private	Jont Creek																			29	29
Santiam River																						
Budeau North Pond	private	South Stayton Pond																310				310
Budeau South Pond	private	South Stayton Pond																312				312
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
Mainstem Willamette River																						
Ankeny Willow Marsh	USFWS	Dunn Wetland										500										500
		Jampolsky Wetlands[a]													1,525							1,525
Dunn Wetland	private	Geren Island			200																	200
		Elijah Bristow Berry Slough				300																300
		Shady Dell				73																73
Finley Beaver Pond[b]	USFWS	--------																				--------
Finley-Buford Pond	private	Finley Gray Creek Swamp																	150			150
		Finley Beaver Pond																	10			10
Finley Cheadle Pond	USFWS	Finley Gray Creek Swamp													53		85	118	30	184		470
		Finley Display Pond								50												50
Finley Display Pond	USFWS	Finley Gray Creek Swamp				60	45		49						75		85	119	67			500
Jampolsky Wetlands	private	Dunn Wetland										500										500
Murphy Pond	private	Finley-Buford Pond																	32			32
		Finley Gray Creek Swamp																		182		182
St. Paul Ponds	ODFW	Big Island														25	64	106				195
McKenzie River																						
Ellison Pond	private	McKenzie Oxbow																		110		110
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[b]	ACOE	--------																				--------
Lower Buckhead Ponds[b]	USFS	--------																				--------
West Ferrin Pond	USFS	Shady Dell Pond								525												525
Wicopee Pond	USFS	Dexter Reservoir Alcove "PIT1"	50																			50
		Salt Creek Diversion Canal																		128		128
Coast Fork Willamette River																						
Herman Pond	USFS	Buckhead Creek								400												400
Sprick Pond	private	Coast Fork Side Channels														12	10	31	12			65

[a]Oregon chub colonized these sites naturally.We removed Oregon chub from Jampolsky Wetlands in the fall of 2007 at the landowner's request. These introductions originated from the same donor source.

[b]These sites are habitat enhancement projects where no Oregon chub were introduced.

Programmatic Safe Harbor Agreement

In 2009, the U.S. Fish and Wildlife Service completed a Programmatic Safe Harbor Agreement for Oregon chub introductions (Federal Register 2009). 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. At the end of the agreement period, participating landowners may return the enrolled property to the baseline conditions that existed when they signed on to the Safe Harbor Agreement. Under the Programmatic Safe Harbor Agreement, USFWS issued ODFW the permit and ODFW enrolls eligible landowners through individual Cooperative Agreements. ODFW issues landowners a Certificate of Inclusion, which allows 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 expedites the process of formalizing landowner agreements prior to introductions of Oregon chub on to private properties. To date, ODFW has issued six Certificates of Inclusion to the landowners of Haws Enhancement Pond, Budeau Ponds, Finley-Buford Pond, Williams (Murphy) Pond, Ellison Pond, and McCrae Reservoir. To date, all landowners have met the conditions of the agreements.

Prior to when the Programmatic Safe Harbor Agreement was in place, USFWS issued individual Safe Harbor Agreements to the landowners of Russell and Sprick Ponds, and issued a Conservation Agreement to the landowners of the Dunn Wetlands.

Floodplain Study

In 2009, we initiated a floodplain monitoring study to assess those factors that may allow Oregon chub to co-exist with nonnative fishes in connected (non-isolated) habitats (Bangs et al. 2010b; 2011b). During this multi-year study, we have been assessing the effects of 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) (Bangs et al. 2011b). We will be using these data to assess the impacts of proposed floodplain restoration and reconnection projects on Oregon chub populations and their habitats. We are working to determine the combination of flows, temperatures, connectivity, and habitat modifications that will 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 contribute to the long-term recovery of the species by minimizing the inherent residual threat posed by nonnative fishes in these habitats.

To augment our understanding of the role of connectivity on patterns of Oregon chub distribution and abundance, we assessed the impacts of several tagging techniques to describe the movement patterns of Oregon chub. In 2009 we tested the feasibility of using passive integrated transponder (PIT) tags with small minnows, using redside shiners (*Richardsonius balteatus*) as a surrogate species for Oregon chub (Bangs et al. 2011b), and demonstrated the ability to mark small fish similar in size to adult Oregon chub. In 2011, we conducted a similar study using Oregon chub which we marked with two different sized PIT-tags (9 X 2.12 mm and 8.4 X 1.4 mm), visual implant elastomer (VIE) tags, and freeze branding (Bangs et al. 2013). We observed high survival rates (>98%) and high retention rates (>98%) with VIE and freeze brand marks in the laboratory. In 2012, we began using VIE marks to assess chub movement in the field. We marked a total of 4,229 Oregon chub with VIE marks in Middle Fork, McKenzie, and Santiam drainages in 2012 and 2013. We documented volitional movement of three Oregon chub in the Middle Fork Willamette: one from Dougren Slough to Deep Muddy (upstream 200 m), one from Dougren Slough to Pengra Oxbow (upstream 1,200 m), and one from Dexter Dam Slough to Elijah Bristow South Slough (downstream 950 m). In the McKenzie, we documented movement of two Oregon chub from Berggren Slough to McKenzie Oxbow (upstream 5,500 m). Thus, we demonstrated how colonization of new habitats and genetic exchange between populations may occur in the current landscape. Prior to this, evidence of Oregon chub movements among locations was limited to colonization of chub into previously unoccupied restoration sites (Buckhead Creek Enhancement Ponds, Finley Beaver Pond, Hospital Impoundment Pond, and lower Fall Creek Spillway Pond). In 2014, we are planning to continue our efforts to describe the timing and frequency of movement of Oregon chub among existing populations by marking additional chub at multiple locations within the Santiam, McKenzie, and Middle Fork Willamette floodplains.

Threats to Oregon Chub and Limitations to Their Recovery

Oregon chub continue to be affected 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 maintenance. However, the proliferation of nonnative fish is the largest residual threat to Oregon chub populations.

Nonnative fish are well established throughout the Willamette Valley. They threaten to invade sites containing Oregon chub and may affect 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 mainstem Willamette River drainages than in the Middle Fork Willamette and McKenzie River drainages. Nonnative fish have been observed at 47% of the 873 unique sites that we have sampled in the Willamette Valley since 1991. After the 1996 floods, nonnative fish were first collected from several sites containing Oregon chub in the Santiam River drainage; the two largest populations subsequently declined sharply in abundance (Scheerer 2002). Illegal planting of largemouth bass at East Ferrin Pond, 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.

In 2013, we documented nonnative fishes at 41% of the sampling locations where we found Oregon chub (naturally occurring and introduction sites), 52% of the 56 locations that support naturally occurring populations, and 14% of the 21 sites where Oregon chub were introduced (which were typically chosen because of their isolation). However, the abundance and proportion of nonnative fish in these habitats varied greatly. Of all the locations where we found Oregon chub in 2013, 64% have frequent open-water hydrologic connection to an adjacent river or waterbody; nonnative fishes were present at half of these locations. The floodplain study should determine what conditions allow Oregon chub to co-occur with, or minimize the dominance of, nonnative fish in connected habitats. The current paradox is that frequent interaction of the river with the floodplain habitats, conditions which historically created off-channel habitats and aided in the dispersal of chub and the interchange of individuals among populations, poses a potential threat to some Oregon chub populations by allowing dispersal of nonnative species (Scheerer 2002). Regardless of the size of the population, the opportunity for genetic exchange among connected populations, and the ability for fish from these populations to colonize of new habitats, should aid in the long-term recovery and persistence of Oregon chub.

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 some populations in isolation. This approach can have potentially severe genetic consequences. Genetic analyses completed in 2010 indicated that gene flow between populations was limited (DeHaan et al. 2012). While genetic diversity was high at most natural and introduced populations, isolation may eventually lead to reduced genetic diversity in some populations. However, most of the populations included in the 2010 genetics study had low levels of connectivity, which likely influenced our interpretation of the results. In 2014, the Abernathy Fish Technology Laboratory plans to assess the levels of gene flow among connected floodplain habitats, which will also complement our movement studies. We hope to find evidence of regular exchange of individuals among these populations, which could demonstrate that the species is functioning as a metapopulation, at least at within subbasins.

Evaluating Alternatives to Obtaining Annual Mark-recapture Estimates

Because we have been successful discovering new populations and introducing Oregon chub into new habitats, current funding is insufficient to cover costs associated with obtianing annual abundance estimates at each site. In the spring of 2013, we worked with ODFW statisticians to evaluate the potential use of catch-per-unit-of-effort (CPUE) data as an index of Oregon chub abundance to replace annual mark-recapture estimates in future years. Unfortunately, we found weak relationships between minnow trap catch and population size (high variability among populations and between years for individual populations). We were unable to predict abundance using catch data with good precision, despite adding covariates to the model that likely influence catch, including water temperature, average water depth, area of aquatic vegetation, and presence of nonnative fish. We found that water temperature influenced catch, but this covariate did not significantly improve the precision of our estimates. Thus, we concluded that mark-recapture estimates are still the best method for monitoring Oregon chub population abundance, and we will adjust the frequency that we obtain estimates for each population based on our ongoing research and monitoring needs.

Post-delisting Monitoring

In May 2013, the USFWS and ODFW began drafting the Post-delisting Monitoring Plan (PDM) for Oregon chub. This document provides monitoring guidance for Oregon chub after the species is delisted to track changes in distribution, abundance, habitat conditions, and threats. The PDM identifies circumstances that will trigger increased monitoring and identifies circumstances when there are no longer concerns for Oregon chub and the PDM requirements have been fulfilled. When (if) the species is delisted, we will describe the conservation status of Oregon chub relative to criteria listed in the final Oregon Chub Post-delisting Monitoring Plan in our future reports. During the PDM period, we will continue monitoring populations with the same sampling methods we have been using since 1992, except that we will monitor only a subset of populations annually. We plan to continue the floodplain study during the PDM period, including the annual abundance estimates of all populations influenced by Corps operations. In addition, we plan to continue collaboration with our partners to restore and enhance Oregon chub habitats and to identify additional research needs to inform managers and ideally ensure that Oregon chub remain secure without ESA protection.

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