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2020 Oregon Chub Investigations

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ANNUAL PROGRESS REPORT

FISH RESEARCH PROJECT

OREGON

PROJECT TITLE: 2020 Oregon Chub Investigations

PROJECT NUMBERS: F19AC00380 (USFWS) & W9127N20C0034 (USACE)

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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 (ESA) in 1993. 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 affected by predation and competition from nonnative species such as Largemouth Bass *Micropterus salmoides*, crappies *Pomoxis sp.*, sunfishes *Lepomis sp.*, bullheads *Ameiurus sp.*, and Western Mosquitofish *Gambusia affinis*. In February 2015, Oregon Chub became the first fish removed (delisted) from the ESA due to recovery (Federal Register 2015). Efforts to improve the status of Oregon Chub included long-term habitat protection, restoration, and management; improved in-stream flow management; creation of new populations through translocations; and the discovery of previously undocumented populations, amongst other actions.

Prior to the delisting, the U.S. Fish and Wildlife Service (USFWS) led a multiagency group to develop a Post-Delisting Monitoring Plan (PDM) for the Oregon Chub (U.S. Fish and Wildlife Service 2014). This document outlines a nine-year monitoring program consisting of the following three components: 1) population abundance and distribution, 2) the distribution of co-occurring nonnative species, and 3) habitat. Monitoring occurs every three years in each of three recovery areas (the Santiam, Mainstem Willamette, and Middle Fork Willamette), such that each recovery area will be monitored every three years over the length of the PDM. The methods and guidelines of the PDM are built on the monitoring program that was initiated in 1991 as part of the Oregon Chub Recovery Plan (U.S. Fish and Wildlife Service 1998).

The purpose of this project was to conduct the monitoring efforts laid out in the PDM; 2020 was year six of this monitoring. In addition to the recovery areas defined in the PDM, we sampled locations in other basins included in our ongoing floodplain study or that were of management or conservation interest. In 2020, we sampled a total of 99 locations, 19 of which had not been sampled before. We discovered one new populations of Oregon Chub in the Mainstem Willamette River Recovery Area. We confirmed the continued existence of Oregon Chub at 46 locations, including 36 naturally occurring and 10 introduced populations. We obtained abundance estimates for 31 naturally occurring populations and five introduced populations of Oregon Chub that were located throughout the Willamette basin. We documented 25 populations of Oregon Chub ≥ 500 individuals; four of these populations were in the Santiam Recovery Area, five in the Mainstem Willamette Recovery Area, and 16 in the Middle Fork Willamette Recovery Area. We documented nonnative fish at 54% of all occupied Oregon Chub habitats sampled in 2020. Our results confirm that habitat conditions continue to support populations of Oregon Chub in habitats hydrologically connected to mainstem rivers in each recovery area. Our results support the conclusion that Oregon Chub remain secure in the areas sampled without the protection of the ESA.

INTRODUCTION

Oregon Chub are endemic to the Willamette River drainage of western Oregon (Markle et al. 1991). The species was formerly distributed throughout the Willamette River Valley (Snyder 1908) in off-channel habitats such as beaver ponds, oxbows, 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 concealment and spawning. In the past 100 years off-channel habitats have largely 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).

Since 1991, the Oregon Department of Fish and Wildlife - Native Fish Investigations Program (ODFW) has worked to implement the research and recovery objectives listed in the Oregon Chub Recovery Plan (U.S. Fish and Wildlife Service 1998; Bangs et al. 2014a). In 2009, ODFW initiated an additional, ongoing study to assess the effects of flow and temperature modifications and proposed reconnection of floodplain habitats on Oregon Chub and other floodplain fishes (Bangs et al. 2014b). Through the coordinated efforts of a multiagency working group, with the aid of private landowners and other non-governmental organizations, the status of the Oregon Chub has dramatically improved (Scheerer et al. 2007, Bangs et al. 2014a). Efforts to improve the status of Oregon Chub included long-term habitat protection, restoration, and management; improved in-stream flow management; creation of new populations through translocations; and the discovery of previously undocumented populations, amongst other actions. The USFWS downlisted the Oregon Chub to "threatened" status in 2010 (Federal Register 2010), and in February 2015 Oregon Chub became the first fish delisted from the ESA due to recovery (Federal Register 2015).

Prior to delisting, the USFWS led a multiagency group that developed the Post-Delisting Monitoring Plan (PDM) for the Oregon Chub (U.S. Fish and Wildlife Service 2014). The purpose of this document was to lay out a monitoring strategy for the period following delisting, with guidelines for what monitoring data would justify renewed concern for Oregon Chub, and how to respond should that happen. Monitoring will cover, at a minimum, a period of nine years (through 2023), and will focus on three recovery areas that encompass the range of Oregon Chub populations: the Santiam, Mainstem Willamette, and Middle Fork Willamette. One Recovery Area is to be sampled each year and each Recovery Area will be sampled three times during the PDM period (Table 1).

Table 1. Frequency of sampling in each Recovery Area from 2015 through 2023.

Recovery Area	Cycle 1			Cycle 2			Cycle 3		
	2015	2016	2017	2018	2019	2020	2021	2022	2023
Santiam	X			X			X		
Mainstem Willamette		X			X			X	
Middle Fork Willamette			X			X			X

The PDM provides guidelines for monitoring changes in distribution, abundance, habitat conditions, and threats. Section 5 of the PDM identifies criteria that indicate Oregon Chub populations are stable or increasing (Box 1). Should ongoing monitoring indicate that these criteria are *not* being met, the PDM outlines a range of possible responses, including increasing the duration or frequency of monitoring, actions which may improve the status of the species, and when to assess the status of Oregon Chub for potential relisting under the ESA.

This report summarizes the surveys conducted in 2020 and evaluates the status of Oregon Chub relative to the triggers listed for conclusion of the PDM. In addition, we discuss the history of, and additional opportunities for, introductions of Oregon Chub into new habitats.

METHODS

The PDM defines the three Recovery Areas for the Oregon Chub: the Santiam, Middle Fork Willamette, and Mainstem Willamette. The Santiam and Middle Fork Willamette recovery areas include all locations within the Santiam River basin and Middle Fork Willamette River basin, respectively.

Box 1. PDM Triggers

I. Population Abundance and Distribution Triggers

1. There are at least 25 populations with population abundance ≥ 500 individuals each; and
2. At least 5 populations with ≥ 500 individuals each exist in each of the three Recovery Areas; and

II. Nonnative Species Triggers

1. Fewer than 80 percent of all habitats occupied by Oregon Chub contain competitive or predatory nonnative species; and
2. New competitive or predatory nonnative species are absent or distributed in less than 30 percent of Oregon Chub habitat within each individual Recovery Area; and

III. Habitat Status Triggers

1. The U.S. Army Corps of Engineers does not conduct additional complete reservoir drawdowns upstream of Oregon Chub populations, or, if complete reservoir drawdowns occur, no significant adverse changes to the fish community or habitat are caused; and
2. At least 50 percent of the hydrologically connected Oregon Chub habitats in a subbasin continue to have sufficient habitat quality to support Oregon Chub populations; and
3. A 50-year interval flood event does not occur in the basins containing Oregon Chub or a 50-year interval flood event does occur, but does not cause a decline in Oregon Chub populations or habitat, or a significant increase in the distribution of nonnative fish.

The Mainstem Willamette Recovery Area includes the remainder of the Willamette River basin, including the Coast Fork Willamette River, Luckiamute River, Mary's River, McKenzie River, Molalla River, and Yamhill River tributaries. In 2020, we focused our monitoring on the Middle Fork Willamette Recovery Area. In addition, we sampled locations in other basins included in our ongoing floodplain study or that were of management or conservation interest. We conducted surveys at 99 locations in the Willamette River drainage. Sampling was conducted primarily by ODFW staff, with some help from volunteers and U.S. Army Corps of Engineers staff.

We primarily sampled off-channel habitats using baited minnow traps. We baited the traps with one third slice of bread and deployed them for three to 18 hours. Minnow traps were cylindrical, were 46 cm long and 23 cm in diameter, and were constructed of 3.2 mm wire mesh. In the Middle Fork Willamette River between Dexter Reservoir and the community of Jasper, we also used seines, dip nets, hoop nets, and boat electrofishing to survey for fish. Seines were 1 m tall and 5 m long and constructed of 6.4 mm mesh. Dip nets were constructed of 6.4 mm mesh (stretch measure). Hoop nets consisted of 4 hoops measuring 61 cm in diameter, were 3.1 m long, had two 0.6 m tall by 7.6 m long wings, and were constructed of 1.3 cm stretched mesh. Boat electrofishing was conducted using either a Smith-Root 5,000 W generator powered pulsator (model 5.0 GPP) or a Midwest Lakes Electrofishing Systems Infinity control box powered by a 3,000 W generator.

For each sampling site, we identified and counted all fish captured. We measured the total length (TL) of all Oregon Chub or a subsample of up to 50 individuals that were collected in the traps. We also recorded the presence and life stage of amphibian and reptile species that we encountered. We recorded biotic and abiotic characteristics at each location including substrate type, 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 location.

We used minnow traps to obtain mark-recapture population estimates for all fish species, when possible. On the first day of trapping, we marked all fish with a partial caudal fin clip and returned them to the water. On the second day, if the ratio of unmarked to recaptured fish exceeded 10:1, we repeated this procedure and marked all unmarked fish captured on the second day. We typically marked fish until a minimum of 15 percent of the population was marked, based on previous population estimates. 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 ratio of marked to unmarked fish from the last sample date. We calculated 95% confidence intervals using a Poisson approximation (Ricker 1975). Our minnow traps were unable to catch fish smaller than ≈ 30 mm (TL); these fish were assumed to be young-of-the-year (Scheerer and McDonald 2003) and were not included in the abundance estimates.

We defined a population as a group of Oregon Chub that occupies a single, defined waterbody. If there was an open-water connection and the potential for frequent movement of Oregon Chub between adjacent sloughs or ponds, then we considered adjacent locations to be part of a single population. We compared 2020 abundance estimated with our most recent previous abundance estimates (Collver et al. 2020). If the ranges of each 95% confidence intervals did not overlap, we defined these changes in abundance as significant.

RESULTS

Detailed descriptions of habitat characteristics and the fish species present at each of the 99 locations sampled in 2020 (Figure 1) are presented in **APPENDIX A**.

We estimated the abundance of Oregon Chub at 36 locations, and confirmed the continued presence of Oregon Chub at 46 locations (Tables 2 and 3). We estimated the population abundance of Oregon Chub at eight locations in the Santiam River Recovery Area, and identified four populations in the Santiam Recovery Area with ≥ 500 Oregon Chub. We noted significant increases in Oregon Chub abundance at South Stayton Pond, and Santiam Conservation Easement. We noted a significant decline in Oregon Chub abundance at Pioneer Park Pond. We were unable to document Oregon Chub at Chahalpam Slough.

We estimated the abundance of Oregon Chub at seven locations in the Mainstem Willamette River Recovery Area. There were five populations in the Mainstem Willamette Recovery Area with ≥ 500 Oregon Chub. We noted significant increases in Oregon Chub abundance at Bangs Bend and significant declines in Oregon Chub abundance at Lynx Hollow Side Channel, and Coast Fork Side Channel. We discovered a single Oregon Chub at Hileman Park, the second documentation of Oregon Chub in the Willamette River mainstem reach since 1967. We also gained access to additional habitat at Hillview Slough which resulting in the discovery of an estimated 1,060 previously undocumented Oregon Chub, nearly doubling the known population of Oregon Chub within the Coast Fork Willamette basin. We were unable to document Oregon Chub at Green Island in the McKenzie River basin.

We estimated the abundance of Oregon Chub at 21 locations in the Middle Fork Willamette River Recovery Area. There were 16 populations in the Middle Fork Willamette drainage with ≥ 500 Oregon Chub. We noted significant increases in Oregon Chub abundance at Fall Creek Spillway Ponds, Dougren Slough, Elijah Bristow Northeast Slough, Dexter Dam Slough, and Shady Dell Pond. We noted significant declines in Oregon Chub abundance at Dexter Reservoir Alcove "PIT1", Elijah Bristow North Gravel Pit, Elijah Bristow Island Pond, Haws Pond, and Wicopee Pond. We were unable to document Oregon Chub at Brewer Slough, Ziller's Slough, Hills Creek Pond, Jasper Railroad Bridge Slough, Baumann Slough, Salt Creek Diversion Canal, and Jasper Park Slough..

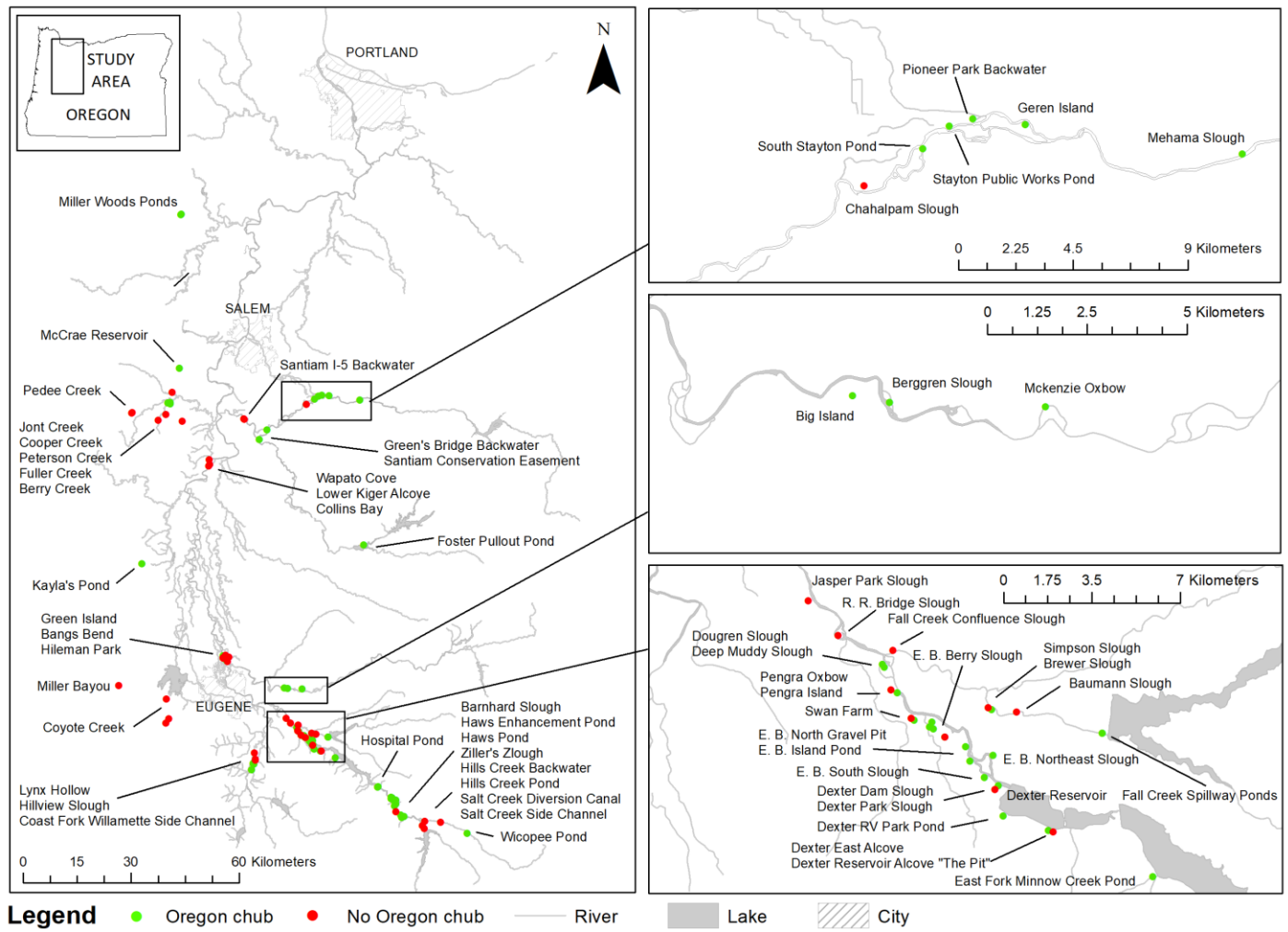


Figure 1. Survey locations for Oregon Chub in the Willamette River basin in 2020. Green circles indicate locations where Oregon Chub were detected during sampling. Red circles indicate locations where Oregon Chub were not detected during sampling. Overlapping symbols represent multiple locations occurring at or near the same survey location.

Table 2. Oregon Chub population abundance estimates from 2014-2020, 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, YAM= Yamhill. We also included a summary of data prior to 2015, 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. Location names in bold italics are locations where Oregon Chub were introduced. The numbers of fish stocked at introduction locations are shown in parentheses. Estimates exceeding one hundred are rounded to the nearest ten.

Recovery Area	Basin	Location name	First discovered/ introduced	Range through 2015	Year				
					2016	2017	2018	2019	2020
Mainstem	MCK	Big Island	2002	190 – 2,160	820	2,550	2,080	1,920	1,780
Willamette	CFW	Hillview Slough	2019					7	1,060
	MCK	McKenzie Oxbow	2009	2,420 – 9,030	430	1,830	1,329	1,000	930
	MCK	Berggren Slough	2009	290 – 920	1,090	950	950	770	720
	WIL	Bangs Bend	2019					360	710
	CFW	Coast Fork Willamette Side Channels	2002	16 – 240	700	410	650	210	92
	LUCK	McCrae Reservoir	2013	0 – 208	(9) 260		50	2	82
	MARY	Kayla's Pond	2019					(60)	50
	LUCK	Auer's Enhancement Pond	2020						(41)
	LUCK	Auer's Moms Pond	2020						(41)
	CFW	Lynx Hollow Side Channels	2005	0 – 4	40	5	50	80	14
	YAM	Miller Woods Frieda's Pond	2019					(60)	10
	YAM	Miller Woods Otter Pond	2019					(59)	4
	LUCK	Jont Creek	2012	4 – 370	90		4	0	1
	WIL	Hilemen Park Over Pond	2020						1
	MCK	Green Island	2007	0 – 22	0	1	0	1	0
	MS	Dunn Wetland	1997	200 – 47,350	20,859			46,850	
	MOL	Ellis Slough	2014	1,100 – 6,580	7,510			6,590	
	MARY	Nagy-Burgato Pond	2011	0 – 1,080	0	(37)	(50) 65	2,000	
	MARY	Finley Field-22 Pond	2017			(150)	100	1700	
	MCK	Shetzline Pond	2002	120 – 9,270	3,820			1,350	
	CFW	Sprick Pond	2008	12 – 700	(75) 1,190	(41)	(29)	1,230	
	MS	Ankeny Willow Marsh	2004	500 – 96,810	15,730	11,410		1,120	
	MARY	Fairchild Pond	2015	150	650	65		890	
	MS	Dry Muddy Creek	1994	2 – 500	28			690	
	MCK	Springfield Oxbow	2012	4	53	96		690	

Table 2 (continued).

Recovery Area	Basin	Location name	First discovered/ introduced	Range through 2015	Year				
					2016	2017	2018	2019	2020
Mainstem	YAM	Salt Creek	2018				199	670	
Willamette	MARY	<i>Finley Display Pond</i>	1998	5 – 1,750	130	13		650	
	MOL	<i>Maguire Pond</i>	2015	510		650	397	500	
	MCK	Chub Slough	2005	6 – 140	140	131	500	460	
	MARY	Finley Gray Creek Swamp	1993	5 – 2,350	220	(65) 270		340	
	MCK	<i>Russell Pond</i>	2001	130 – 2,780	220			280	
	MARY	<i>Finley-Buford Pond</i>	2011	460 – 1,010	740	770	500	270	
	MARY	Finely Beaver Pond	2010	10 – 1,600	200	1,990	9	(65) 70	
	MCK	<i>Finn Rock Slough</i>	2018				(90)	(70)	
	MOL	Labeled Slough	2013	29 – 100	30			60	
	MARY	<i>Pearcy Pond</i>	2019					(60)	
	MARY	<i>Schmedding Beaver Creek Swamp</i>	2015	150	30			30	
	MOL	Hwy 211 Bridge	2019					21	
	MOL	Dalmation Corner	2019					20	
	MS	Camous Creek	1993	5 – 56	42			11	
	MCK	Hendrick's Bridge Slough	2011	22 – 70	3			10	
	MOL	Heisinger Inlet	2019					5	
	YAM	Hoekstre Slough	2018				5	3	
	MCK	Vickery Park Slough	2011	12 – 80	110			3	
	MCK	<i>Ellison Pond and Slough</i>	2012	1 – 9	0			2	
	MOL	Marshall Meander Bend	2019					2	
	MCK	Brick Slough	2016		2			1	
	MCK	Hazelnut Slough	2019					1	
	MOL	Holme's River Left	2019					1	
	MOL	Holme's River Right	2019					1	
	MCK	McKenzie Oxbow Upstream Slough	2019					1	
	MS	Muddy Creek	2007	0 – 46	2			1	
	MCK	Cedar Creek	2012	25 – 170	26			0	
	MS	Dunawi Creek	2012	0 – 5	0				
	MS	Little Muddy Creek tributary	2004	0 – 5					
	CFW	Herman Pond	2002	0 – 420		1			
	MOL	Milk Creek	2014	1		1			
	CFW	Camas Swale	1992	0 – 2	0	0			

Table 2 (continued).

Recovery Area	Basin	Location name	First discovered/ introduced	Range through 2015	Year				
					2016	2017	2018	2019	2020
Mainstem	MCK	Bovine Slough	2016		1				
Willamette	MS	Bull Run Creek	2005	0 – 2	0				
	MARY	<i>Finley Cheadle Pond</i>	2002	20 – 3,520	0				
	MOL	Feyrer Park Slough	2013	0 – 1					
	MS	<i>St. Paul Ponds</i>	2008	2 – 510					
	MOL	Wagonwheel Park	2014	25					
	MS	<i>Jampolsky Wetlands</i>	2004	0 – 8,320					
	MCK	Grant Farm Channel	2012	8					
Santiam	NS	<i>South Stayton Pond</i>	2006	54 – 6,230	610	1,020	590	1,240	2,560
	NS	Pioneer Park Pond	1997	0 – 3,880	280	600	770	2,420	1,430
	NS	Geren Island North Channel	1996	210 – 8,660	770	1,640	680	1,070	910
	NS	Mehama Slough	2010	15 – 2,800	1,240	910	810	390	500
	NS	<i>Foster Pullout Pond</i>	1999	85 – 5,050	970	900	650	330	350
	NS	Santiam Conservation Easement	1994	0 – 1,250	920	490	130	160	280
	NS	Stayton Public Works Pond	1998	0 – 1,530	300	1,300	310	230	260
	NS	Green's Bridge Slough	1993	0 – 690	170	70	6	7	50
	NS	Chahalpam Slough	1995	0 – 2,430	90	10	10	2	0
	SANT	Santiam I-5 Side Channels	1997	2 – 420	1	0	0	0	0
	NS	<i>Budeau North Pond</i>	2010	310 – 11,260	480		4,550		
	NS	Birdhaven Slough	2014	5,350 – 5,980	3,780	500	3,260		
	NS	<i>North Stayton Pond</i>	2010	50 – 4,370			2,290		
	NS	<i>Budeau South Pond</i>	2010	312 – 6,180	(200) 0		1,360		
	NS	Koenig Slough	2011	443 – 2,410			1,170		
	NS	Stout Creek	2013	39 – 420			800		
	SS	<i>Dragonfly Ranch Barn Pond</i>	2018		0	0	(389)		
	SS	<i>Rummel Pond</i>	2016		(92)		320		
	NS	Buell-Miller Slough	2010	2 – 760			100		
	SS	<i>Dragonfly Ranch Upslope Pond</i>	2018		0	0	(41)		
NS	Eck Slough	2015	43			40			
NS	Taloali Slough	2013	4 – 581			17			
NS	Lower Bennett Slough	2018				13			
NS	Chankawan East Pond	2018				7			
NS	Harris Slough	2011	18 – 80			2			

Table 2 (continued).

Recovery Area	Basin	Location name	First discovered/ introduced	Range through 2015	Year				
					2016	2017	2018	2019	2020
Santiam	NS	Alder Creek	2015	1			1		
	NS	Cold Creek Slough	2011	0 – 59			1		
	NS	Solo Slough	2018				1		
	NS	Trexler Farm Ponds	2013	4 – 53			1		
	NS	Boomer Slough	2014	0 – 6	0		0		
	NS	Logan Slough	1997	0 – 1			0		
	NS	Hatch Side Channels	2015	33					
	NS	Foster Reservoir	2014	9					
	SS	Hospital Slough	2009	10					
	NS	<i>Menear's Bend</i>	2000						
Middle Fork	MFW	Elijah Bristow Island Pond	2003	420 – 3,950	6,380	2,480	1,570	5,630	5,810
Willamette	MFW	Shady Dell Pond	1993	2 – 7,250		1,980			5,330
	MFW	<i>Wicopee Pond</i>	1988	0 – 5,620	20	6,610			4,470
	MFW	Buckhead Creek	1992	2 – 7,140		3,170			3,470
	MFW	Elijah Bristow North Gravel Pit	2011	0 – 1,870	3,440	4,360	4,120	6,690	2,640
	MFW	East Fork Minnow Creek Pond	1993	1,340 – 8,770		2,660			2,500
	MFW	Lil Yeti Slough	2018				1,500		2,400
	MFW	<i>Fall Creek Spillway Ponds</i>	1996	480 – 13,400	6,610	670	3,380	1,020	2,320
	MFW	Yeti Slough	2014	1,059 – 1,060		985			2,181
	MFW	Dougren Slough	2008	1 – 1,730	2,470	1,080	2,230	620	1,980
	MFW	<i>Haws Enhancement Pond</i>	2009	1 – 3,220	1,040	1,950	660	1,370	1,590
	MFW	Dexter Reservoir RV Alcove - DEX3	1992	15 – 6,550	6,900	1,460	2,400	1,160	1,040
	MFW	Dexter Reservoir Alcove - PIT1	1992	40 – 2,590	2,100	590	1,840	1,220	800
	MFW	Dexter Dam Slough	2009	510 – 2,120	1,050	380	210	120	580
	MFW	Hospital Pond	1993	690 – 5,040	1,410	2,340	3,810	5,140	530
	MFW	Elijah Bristow Northeast Slough	1999	210 – 1,360	710	410	230	310	500
	MFW	Elijah Bristow Berry Slough	1993	330 – 8,130	3	100	17	410	460
	MFW	Pengra Island Slough	2003	40 – 200	440	230	280	430	420
	MFW	Elijah Bristow South Slough	2008	1 – 1,550	1,510	4,690	670	250	290
	MFW	Haws Pond	2005	120 – 810	1,190	440	650	490	170
	MFW	Hospital Impoundment Pond	1995	0 – 80	158	300			103
	MFW	Swan Farm	2015			34			21
	MFW	Barnhard Slough	2000	0 – 7	0	0	0	1	9

Table 2 (continued).

Recovery Area	Basin	Location name	First discovered/ introduced	Range through 2015	Year				
					2016	2017	2018	2019	2020
Middle Fork	MFW	Deep Muddy Slough	2009	0 – 90	50	21	50	30	4
Willamette	FALL	Simpson Slough	2012	0 – 2	13	2	2	1	2
	MFW	Oakridge Slough	1994	0 – 480	5	2			1
	FALL	Brewer Slough	2013	1 - 40	0	10	0	10	0
	MFW	Ziller’s Slough	2019					4	0
	MFW	Hills Creek Pond	2010	330 – 23,000	500	310	0	3	0
	MFW	Jasper Railroad Bridge Slough	2009	0 – 80	20	30	10	1	0
	FALL	Baumann Slough	2012	0 – 90	1	1	2	1	0
	MFW	Pengra Oxbow Slough	2008	1 – 160	8	1	0	0	0
	FALL	Fall Creek Confluence Slough	2012	1 – 5	0	1	0	0	0
	MFW	Rattlesnake Pond	2019					90	
	MFW	Rattlesnake Creek	1992	0 – 5				9	
	MFW	Dexter Reservoir	2002	1				0	
	MFW	Lost Creek Confluence Slough	2012	13 – 500		710	380		
	MFW	Lost Creek	2018				2		
	MFW	Potamus Slough	2016		15	250			
	MFW	Dougren Island Slough	2011	34 – 1,700		231			
	MFW	Bead Slough	2016		17	75			
	MFW	Campers Cove	2017			33			
	MFW	Indigo Slough	2017			27			
	MFW	Hippo Slough	2015	9		20			
	MFW	Salt Creek Diversion Canal	2012	150		9			
	MFW	Summer Side Channel	2016		4	7			
	MFW	Short Slough	2016		2	6			
	MFW	Green Grass Gravel Pit	2012	0 – 24	0	5			
	MFW	Springfield Millrace Slough	2009	0 – 8		5			
	MFW	Jasper Park Slough	1994	0 – 3		1			
	MFW	Dexter East Alcove	1992	0 – 40		0			
	MFW	TNC Island Slough	2012	2		0			
	FALL	Fall Creek	2016		1				
	MFW	East Ferrin Pond	1994	0 – 7,160					
	MFW	Elijah Bristow Large Gravel Pit	1992	0 – 8					
	MFW	Elijah Bristow Small Gravel Pit	1992	0 – 31					

Table 2 (continued).

Recovery Area	Basin	Location name	First discovered/ introduced	Range through 2015	Year				
					2016	2017	2018	2019	2020
	MFW	Lookout Point Reservoir	2012	1					
	MFW	Pudding Creek	2011	0 – 1					
	MFW	Wallace Slough	1997	0 – 3					
	MFW	<i>West Ferrin Pond</i>	1992	0 – 525					

Table 3. 2020 Oregon Chub abundance estimates and 95% confidence limits. Locations are grouped by Recovery Area and drainage. Note: the Mainstem Willamette Recovery Area contains multiple river drainages.

Location	Estimate	<u>95% Confidence limits</u>	
		Lower	Upper
Mainstem Willamette Recovery Area			
McKenzie River Drainage			
Big Island	1,778	1,519	2,092
McKenzie Oxbow	925	522	1,590
Berggren Slough	724	609	860
Willamette River Drainage			
Bangs Bend	706	584	853
Coast Fork Willamette River Drainage			
Coast Fork Willamette Side Channels	92	51	160
Hillview Slough	1,064	885	1,279
Santiam Recovery Area			
Pioneer Park Pond	1,433	1,130	1,816
South Stayton Pond	2,562	2,162	3,036
Geren Island North Channel	908	777	1,060
Mehama Slough	496	418	588
Foster Pullout Pond	352	294	422
Stayton Public Works Pond	264	175	394
Santiam Conservation Easement	276	213	357
Green's Bridge Slough	50	29	83
Middle Fork Willamette Recovery Area			
Elijah Bristow North Gravel Pit	2,639	2,295	3,036
Elijah Bristow Island Pond	5,808	4,660	7,236
Shady Dell Pond	5,332	4,739	5,999
East Fork Minnow Creek Pond	2,497	2,220	2,809
Hospital Pond	534	435	655
Haws Enhancement Pond	1,591	1,269	1,994

Table 3 (continued).

Location	Estimate	95% Confidence limits	
		Lower	Upper
Middle Fork Willamette Recovery Area			
Dexter Reservoir Alcove "PIT1"	799	703	908
Dexter Reservoir RV Alcove "DEX3"	1,044	742	1,463
Fall Creek Spillway Ponds	2,315	1,975	2,707
Dougren Slough	1,976	1,687	2,313
Haws Pond	169	106	265
Pengra Island Slough	422	314	565
Swan Farm	21	13	34
Barnhard Slough	9	5	16
Elijah Bristow Berry Slough	458	303	694
Elijah Bristow Northeast Slough	502	430	586
Elijah Bristow South Slough	285	227	357
Dexter Dam Slough	578	508	659
Lil Yeti	2,395	2,065	2,779
Buckhead Creek	3,472	2,901	4,172
Wicoppe Pond	4,469	3,575	5,583

DISCUSSION

Status of Naturally Occurring Populations

In 2020, we documented 21 naturally occurring populations of Oregon Chub with ≥ 500 individuals in the Willamette River basin; 13 of these populations in the Middle Fork Willamette Recovery Area, 5 in the Mainstem Willamette Recovery Area, and 3 in the Santiam Recovery Area. Additionally, eight naturally occurring Oregon Chub populations, comprised of 500 or more individuals, have been previously documented across the range of Oregon Chub (Collver et al. 2020), but were not included in our 2020 sampling effort. There are five unsampled populations in the Mainstem Willamette Recovery Area, and three in the Santiam Recovery Area. There are currently 97 known naturally occurring Oregon Chub locations. Despite continued efforts, we have not found Oregon Chub populations in some areas where they were documented historically, such as downstream of Willamette Falls near the mouth of the Clackamas River, or in the Long Tom and Calapooia River basins.

In recent years we have documented a number of newly discovered populations in habitats that have frequent hydrologic connectivity to adjacent rivers. In 2020 we discovered Oregon Chub at two new hydrologically connected locations. One location, Hileman Park, is currently one of only two known sites in an off channel habitat of the Mainstem Willamette River. Until 2019, Oregon Chub had not been documented there since 1967. We also gained access to additional habitat at Hillview Slough which resulting in the discovery of an estimated 1,060 previously undocumented Oregon Chub, nearly doubling the known population of Oregon Chub within the Coast Fork Willamette basin. However, hydrologically connected populations of Oregon Chub are often small or ephemeral and difficult to detect on a year-to-year basis. Between 2019 and 2020 we had a net loss of 4 hydrologically connected populations. Currently, more than two-thirds (86 out of 129) of the locations containing Oregon Chub are hydrologically connected habitats.

Status of Introduced Populations and Habitat Restoration Projects

One of the key components to the successful recovery of the Oregon Chub was the implementation of a program to introduce Oregon Chub into suitable habitats within its historic range. Since 1988, 39 introductions have been attempted, and 31 new populations have been established (Table 4). In addition, several habitat restoration projects have been completed to increase the quantity of available habitat or enhance the suitability of habitat for Oregon Chub.

In 2020, we documented four introduced Oregon Chub populations with 500 or more individuals; one in the Santiam Recovery Area, and three in the Middle Fork Willamette Recovery Area. Additionally, 11 introduced populations, comprised of 500 or more individuals, have been previously documented (Collver et al. 2020), but were not included in our 2020 sampling effort. We introduced Oregon Chub into two new locations in the Mainstem Recovery Area: Auer's Enhancement Pond and Auer's Moms Pond.

Table 4. Oregon Chub introduction and habitat restoration locations, donor populations, ownership of the locations, and numbers of fish introduced. There were no Oregon Chub introductions between 1988 and 1996. Ownership codes: ACOE= U.S. Army Corps of Engineers, ODFW= Oregon Department of Fish and Wildlife, MRT= McKenzie River Trust, USFS= U.S. Forest Service, USFWS= U.S. Fish and Wildlife Service, and YSWCD= Yamhill Soil and Water Conservation District.

Basin	Location	Ownership	Donor site (introduced populations)	Number moved in 2020	Total number moved
Molalla River	Maguire Pond	Private	Ellis Slough		500
			Labeledz Slough		10
Yamhill River	Miller Woods Frieda's Pond	YSWCD	Salt Creek		60
	Miller Woods Otter Pond	YSWCD	Salt Creek		59
Luckiamute River	McCrae Reservoir	Private	Jont Creek		51
	Auer's Enhancement Pond	Private	Jont Creek	1	1
			McCrae Reservoir	40	40
Santiam River	Auer's Moms Pond	Private	McCrae Reservoir	41	41
	Budeau North Pond	Private	South Stayton Pond		310
			South Stayton Pond		312
	Budeau South Pond	Private	Budeau North Pond		200
			Birdhaven Slough		188
			Budeau South Pond		179
	Dragonfly Ranch Barn Pond	Private	Santiam Conservation Easement		12
			Birdhaven Slough		38
			Santiam Conservation Easement		3
	Foster Pullout Pond	ACOE	Geren Island		500
	Menear's Bend	ACOE	Geren Island		41
	North Stayton Pond	ODFW	South Stayton Pond		620
	Rummel Pond	Private	Santiam Conservation Easement		92
	South Stayton Pond	ODFW	Stayton Public Works Pond		73
			Geren Island		232
Pioneer Park Slough				134	
Dunn Wetland				500	
Jampolsky Wetlands ^a				1,525	
Mainstem Willamette	Ankeny Willow Marsh	USFWS	Dunn Wetland		500
			Jampolsky Wetlands ^a		1,525
Mary's River	Jampolsky Wetlands	Private	Dunn Wetland		500
	St. Paul Ponds	ODFW	Big Island		195
			Dunn Wetland		200
	Dunn Wetland	Private	Geren Island		200
			Elijah Bristow Berry Slough		300
Fairchild Pond	Private	Shady Dell		73	
		Finley-Buford Pond		150	
		Finley Field-22 Pond		65	
Fairchild Pond	USFWS	Finley Field-22 Pond		65	
		Finley Field-22 Pond		65	

Table 4 (continued).

Basin	Location	Ownership	Donor site (introduced populations)	Number moved in 2020	Total number moved	
Mary's River	Finley-Buford Pond	Private	Finley Gray Creek Swamp		150	
			Finley Beaver Pond		10	
	Finley Cheadle Pond	USFWS	Finley Gray Creek Swamp		470	
			Finley Display Pond		50	
	Finley Display Pond	USFWS	Finley Gray Creek Swamp		500	
	Finley Field-22 Pond	USFWS	Finley Beaver Pond		100	
			Finley-Buford Pond		37	
			Finley Display Pond		13	
	Kaylas Pond	Private	Finley Field-22 Pond		60	
	Nagy-Burgato Pond	Private	Finley-Buford Pond		119	
			Finley Gray Creek Swamp		182	
	Pearcy Pond	Private	Finley Field-22 Pond		60	
	Schmedding Beaver Creek Swamp	Private	Finley-Buford Pond		150	
	McKenzie River	Ellison Pond	Private	McKenzie Oxbow		110
		Finn Rock Slough	MRT	McKenzie Oxbow		90
			Berggren Slough		70	
Russell Pond		Private	Buckhead Creek		500	
			St. Paul Ponds		53	
Middle Fork Willamette River	Shetzline North Pond	Private	Shetzline Pond		60	
	East Ferrin Pond	USFS	East Fork Minnow Pond		576	
	Fall Creek Spillway Ponds	ACOE	East Fork Minnow Pond		350	
			Shady Dell		150	
	Haws Enhancement Pond	Private	Haws Pond		133	
	Hills Creek Pond	ACOE	Dexter Alcove "PIT1"		507	
			Dexter Reservoir RV Alcove "DEX3"		620	
	Hospital Imound. Pond ^b	ACOE	-----		-----	
	Lower Buckhead Ponds ^b	USFS	-----		-----	
	West Ferrin Pond	USFS	Shady Dell Pond		525	
Wicopee Pond	USFS	Dexter Reservoir Alcove "PIT1"		50		
Coast Fork Willamette River			Salt Creek Diversion Canal		128	
	Herman Pond	USFS	Buckhead Creek		400	
	Sprick Pond	Private	Coast Fork Side Channels		207	
			Lynx Hollow		3	

^aWe removed Oregon Chub from Jampolsky Wetlands in 2007 at the landowner's request. These introductions originated from that donor.

^bThese sites are habitat enhancement projects where no Oregon Chub were introduced. Oregon Chub colonized these sites naturally.

Oregon Chub 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 location, whenever possible. Additional translocations of Oregon Chub from donor stocks into established introduced populations may occur in the future, especially at populations established with few individuals.

Distribution of Nonnative Species

We confirmed the presence of nonnative fish species in 27 locations containing Oregon Chub in 2020. Nonnative fish were captured at 60% (9 of 15), 75% (6 of 8), and 46% (12 of 26) of the locations containing Oregon Chub in the Mainstem Willamette, Santiam, and Middle Fork Willamette recovery areas, respectively. Combined with data from previous years, nonnative fish are present in 33% (19 of 57), 63% (19 of 30) and 52% (22 of 42) of the locations containing Oregon Chub in the Mainstem Willamette, Santiam, and Middle Fork Willamette recovery areas, respectively. Across all recovery areas and combining data from previous years, nonnative fish are present in 47% (60 of 129) of known Oregon Chub habitats. Interactions between nonnatives and Oregon Chub are complex and varied; see discussion of the floodplain study below.

In 2015 we discovered that nonnative Green Sunfish *Lepomis cyanellus* had colonized Oregon Chub populations in the McKenzie River basin and Middle Fork Willamette River basin (Table 5). Green Sunfish colonized Oregon Chub populations in the Coast Fork Willamette River basin and Santiam River basin in 2016 and the Luckiamute River basin in 2018. In 2020, Green Sunfish were captured at two Oregon Chub populations in the McKenzie River basin (McKenzie Oxbow, and Green Island), one population in the Coast Fork Willamette River basin (Hillview Slough), and one population in the Luckiamute River basin (Jont Creek).

Green Sunfish have a larger gape than similar sunfish, Bluegill and Pumpkinseed (Scott and Crossman 1979), and have been documented consuming Gila Chub *Gila intermedia* similar in size to young-of-the-year Oregon Chub (Dudley and Matter 2000). Green sunfish have also been documented consuming California roach *Hesperoleucus symmetricus*, a cyprinid of similar size to adult Oregon Chub, and have been attributed to localized extirpations (Moyle and Nichols 1974; Moyle 1976a, 1976b; Smith 1982). We believe that predation by Green Sunfish on Oregon Chub is possible, and populations where Oregon Chub and Green Sunfish co-occur should be monitored to evaluate potential impacts. Evaluating the impacts of Green Sunfish on Oregon Chub may take multiple years, because of the high interannual variability in the abundance of Oregon Chub.

Table 5. Green Sunfish presence at Oregon Chub populations from 2015-2019. Green Sunfish presence is noted with an X. Surveyed locations where Green Sunfish were not captured are noted with a dash, and locations that were not surveyed are blank. Populations where Green Sunfish have never been detected are not included in this table.

Basin	Site Name	2015	2016	2017	2018	2019	2020
Luckiamute River	Jont Creek	-	-		X	X	X
Santiam River	Geren Island North Channel	-	-	X	-	-	
	Santiam Conservation Easement	-	-	-	X	-	
McKenzie River	Santiam I-5 Side Channels	-	X	-	-	-	
	Green Island	X	X	X	X	X	X
	Berggren Slough	-	-	X	-	-	
	Springfield Oxbow		X	-		-	
	McKenzie Oxbow	-	X	X	X	X	X
	Vickery Park Slough		X			-	
Middle Fork Willamette River	Ellison Slough					X	
	Deep Muddy Slough	X	-	-	-	-	
Coast Fork Willamette River	Dougren Slough	X	X	-	-	-	
	Green Grass Gravel Pit	-	-	X			
Willamette River	Coast Fork Willamette Side Channels	-	X	X	-	-	
	Hillview Slough					X	X
	Lynx Hollow	-	X	-	-	-	
Willamette River	Bangs Bend					X	

In 2018, we discovered the nonnative, invasive, emergent aquatic plant, water primrose *Ludwigia hexapetala*, at the mouth of Alder Creek in the North Santiam River basin. Water primrose is widespread in mainstem Willamette sloughs and off-channel habitats, but this was the first confirmed sighting in a location containing Oregon Chub. We contacted managers working in the North Santiam River basin, and confirmed presence in several other off-channel locations. We reviewed pictures taken during sampling of other locations in the North Santiam River basin, and found water primrose was present at Pioneer Park Pond since 2015, but was misidentified as a native water-purslane *Ludwigia palustris* because of the growth habit at this location. In 2019, the North Santiam Watershed Council initiated efforts to eradicate the nonnative water primrose from multiple locations in the Santiam River basin. We are concerned about water primrose because it tends to dominate off-channel habitats in the Willamette basin, creating dense, peat-like mats of vegetation that reduce habitat availability, create anaerobic conditions, and hasten vegetative succession and sedimentation processes. We believe that water primrose could be a threat to Oregon Chub populations unless measures are taken to reduce its spread and dominance in off-channel habitats.

Other Research and Monitoring:

Floodplain Study

In 2009, we initiated a floodplain monitoring study to assess factors that may allow Oregon Chub to co-exist with nonnative fishes in connected (non-isolated) habitats (Bangs et al. 2010; 2011; 2014b). 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 connectivity on the composition of fish assemblages (native and nonnative) (Bangs et al. 2014b). We will use 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 Oregon Chub, over nonnative predatory and competitor fishes. Ideally, these data, when used by managers to enhance off-channel habitat conditions for Oregon Chub, will contribute to the long-term conservation of the species by minimizing the inherent residual threat posed by nonnative fishes in these habitats.

Oregon Chub Population Trends

The status of Oregon Chub has improved remarkably since we began our studies in 1991 (Figure 3). The rate of discovery of previously undocumented populations and establishing new populations via introductions has remained relatively consistent over the past decade, coinciding with the initialization of studies funded by USACE and completion of the Programmatic Safe Harbor Agreement for the Oregon Chub. Since the species was delisted in 2015, 41 new populations have been discovered or established, representing 32% of the total populations of Oregon Chub.

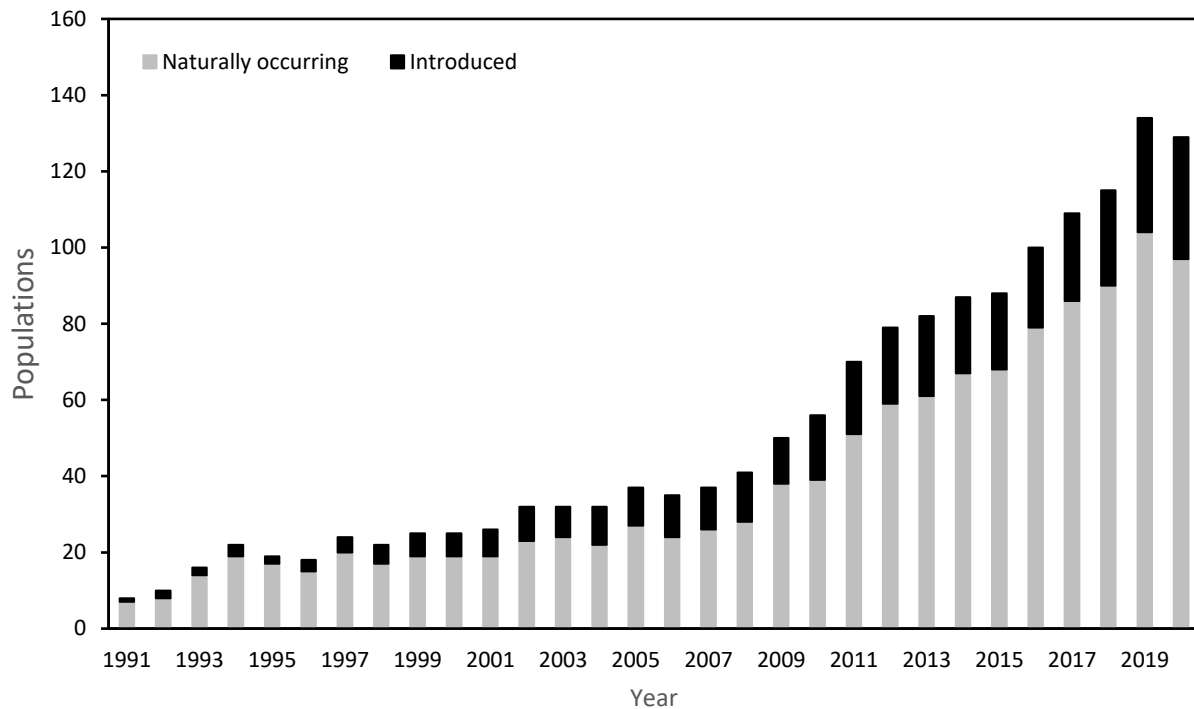


Figure 3. Number of known Oregon Chub populations, 1991-2020. Grey portions of the stacked bar graph represent the number of naturally occurring Oregon Chub populations. Black portions of the stacked bar graph represent the number of introduced Oregon Chub populations.

Status of Oregon Chub Relative to PDM Criteria

The PDM identifies criteria to determine whether Oregon Chub are secure, or if additional effort should be triggered, based on population abundance and distribution, the distribution of nonnative species, and habitat status (Box 1). Current estimates of population abundance and distribution exceed PDM criteria: there are 44 Oregon Chub populations with ≥ 500 individuals; 10 of these populations are in the Santiam Recovery Area, 18 in the Mainstem Willamette Recovery Area, and 16 in the Middle Fork Willamette Recovery Area. Likewise, the current distribution and abundance of non-natives do not justify concern for the future of Oregon Chub under the PDM: nonnative fish are present in 47% of the habitats containing Oregon Chub. While we found a new nonnative predatory fish invading Oregon Chub habitats (i.e., Green Sunfish), its current distribution is limited to 9% (5 of 57) of the Mainstem Willamette Recovery Area and 2% (1 of 42) of the Middle Fork Willamette Recovery Area. The current estimates of habitat availability and suitability likewise exceed PDM criteria: there are currently 86 habitats that contain Oregon Chub and that frequently connect to adjacent rivers. There were no additional complete reservoir drawdowns or 50-year flood events during the reporting period. Oregon Chub are currently exceeding the PDM fulfillment criteria in all categories, and remain secure without the protection of the ESA.

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APPENDIX A

Fish species and habitat characteristics at 2020 Oregon Chub survey locations.

Locations are sorted by subbasin then listed alphabetically by location name.

¹ Vegetation types are expressed as a percentage of the total surface area of the locations. The sum of all vegetation types cannot exceed 100 percent.

² Salmonid codes: CO= Coho Salmon *Oncorhynchus kisutch*; CH= Chinook Salmon *O. tshawytscha*; CT= Cutthroat Trout *O. clarki*; RB= Rainbow Trout *O. mykiss*, ST= steelhead *O. mykiss*, TF= unknown trout fry.

Continued appendix removed for data security purposes. Available upon request through Native Fish Investigations, ODFW.



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