Annual Fisheries Report
2018

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INTRODUCTION

This report summarizes the majority of the work the Mendocino Redwood Company's Fisheries Department conducted in 2018. In some cases, data from previous years is also presented.

Our major projects included the operation of a salmonid life cycle monitoring station in the North Fork Navarro River and the South Fork Albion River, red-legged frog breeding site monitoring and egg mass abundance estimates, stream temperature monitoring, precipitation monitoring, long term channel monitoring, salmonid presence in MRC's major drainage basins, and providing assistance to forestry staff regarding stream classification and compliance with state 1600 permits.

SALMONID LIFE CYCLE MONITORING

In 2013 MRC entered a partnership with California Department of Fish and Wildlife and Pacific States Marine Fisheries Commission to operate a life cycle monitoring (LCM) stream in the North Fork Navarro River as part of the California Coastal Salmonid Monitoring Program (CMP). The goal of the CMP and associated LCM streams is to estimate the number of adults returning to the region annually and monitor their numbers over an extended period of time to help understand regional population trends.

For more information about the CMP, visit the CDFW website:
https://nrm.dfg.**ca**.gov/FileHandler.ashx?DocumentID=78444

In addition to our partnership on the North Fork Navarro River, MRC has conducted a similar study in the South Fork Albion River since 2012.

The operation of a life cycle monitoring station requires survey methods that focus on the multiple life stages of salmon and steelhead trout. The two main surveys employed by MRC are spawning surveys to estimate the number of adults returning from the ocean, and out-migrant trapping to estimate the number of juvenile salmonids leaving the streams heading towards the ocean. With these two population estimates we can gather information about ocean and in-stream survival of these species.

METHODS

Spawning surveys were conducted bi-weekly on 31 stream segments ranging from 0.5 to 3 kilometers in North Fork Navarro River and the South Fork Albion River watersheds from November 13, 2017 through May 29, 2018. MRC Biologists hiked these segments searching for redds (salmonid nest), live adult salmonids, and carcasses. Encountered adult fish included species, sex, length, and fish condition. Observed redds were flagged, GPS coordinates were recorded, redd dimensions were taken including pot and tail-spill area, depth and redd substrate size (Gallagher et al. 2007). Population estimates are generated using repeated live-fish count estimation and/or redd abundance estimation (Gallagher et al. 2010).

Out-migrant trapping of juvenile coho salmon and steelhead trout in the North Fork Navarro River and South Fork Albion River utilizes a rotary screw trap. The trap works by funneling fish into a live box located at the rear of the trap by a large rotating drum lined with steps similar to a corkscrew. Stream hydrology rotates the drum when there is normal to high flow conditions. When low flow conditions occur, a battery powered 12 volt DC motor rotates the drum through a chain driven system (Figure 1). The method for out-migrant trapping of juvenile coho salmon and steelhead trout in the South Fork Albion River for 2012 and 2013 utilized a pipe trap. A full-channel weir was constructed with a 1-m opening on the right bank to allow for passage of adult fish. At the apex of the weir, water flowed into an 8 inch diameter PVC pipe. Fish were transported through the 60 foot length of pipe and delivered into a live box (Figure 2).

The traps are checked each day during the season and sometimes visited more than once a day if high amounts of fish are collected. Captured fish are anesthetized, identified by species, measured, and released downstream of the trap. A percentage of coho salmon smolts and steelhead trout age 1+ or greater are marked and released upstream of the trap. Population estimates are generated using mark and recapture methodology based on the total number of fish captured and the weekly recapture efficiency. This data is then analyzed with a statistical program called DARR v2.02 r (Bjorkstedt 2005). Beginning in 2016, 12mm half-duplex passive integrated transponder (PIT) tags were inserted into juvenile coho salmon and steelhead trout in the North Fork Navarro River. An antennae array designed to recapture the PIT tagged salmonids was installed downstream of the trapping location in the fall of 2016.

Figure 1. A motorized rotary screw trap in the North Fork Navarro River 2015.

Figure 2. A pipe trap installed in South Fork Albion River 2012.

NORTH FORK NAVARRO RIVER

RESULTS

The 2018 spawning survey population estimates for the North Fork Navarro River are 229 coho salmon adults, 56 coho salmon redds (Table 1), 726 steelhead trout adults and 383 steelhead trout redds (Table 2). The absence of coho salmon adults in 2014 is a result of the lack of early winter rains that would typically open up the Navarro River mouth.

Table 1. Estimated number of coho salmon adults in NF Navarro River during the 2014-2018 spawning seasons.

Year	Species	Estimated Population	High Estimate	Low Estimate
2018	Coho Salmon *O. kisutch*	229	246	215
2017	Coho Salmon *O. kisutch*	124	133	116
2016	Coho Salmon *O. kisutch*	217	234	204
2015	Coho Salmon *O. kisutch*	124	133	116
2014	Coho Salmon *O. kisutch*	0	0	0
2013	Coho Salmon *O. kisutch*	140	150	132

Table 2. Estimated number of steelhead trout adults in NF Navarro River during the 2014-2018 spawning seasons.

Year	Species	Estimated Population	High Estimate	Low Estimate
2018	Steelhead Trout *O. mykiss*	726	918	600
2017	Steelhead Trout *O. mykiss*	182	231	151
2016	Steelhead Trout *O. mykiss*	185	233	153
2015	Steelhead Trout *O. mykiss*	286	362	236
2014	Steelhead Trout *O. mykiss*	592	749	489
2013	Steelhead Trout *O. mykiss*	251	266	235

The number of juvenile coho salmon out-migrating during the 2018 trapping season was estimated at 5809 +/- 5025 (Table 3). A total of 150 juvenile coho salmon were captured ranging from 77-130 mm in size. The weekly trapping efficiency (probability of capturing fish) was 2%. 147 of the 150 juvenile coho salmon captured had PIT tags inserted.

Table 3. Estimated number of juvenile coho salmon showing the 95% confidence interval for each trapping season 2014-2018 in North Fork Navarro River.

Year	Species	Estimated Population
2018	Coho Salmon *O. kisutch*	5809 +/- 5025
2017	Coho Salmon *O. kisutch*	96714 +/- 29322
2016	Coho Salmon *O. kisutch*	9164 +/- 655
2015	Coho Salmon *O. kisutch*	2610 +/- 870
2014	Coho Salmon *O. kisutch*	5423 +/- 1020

The number of juvenile steelhead trout at the trapping site during the 2018 season was estimated at 88919 +/- 21493 (Table 4). A total of 2929 juvenile steelhead trout were captured ranging from 69-269 mm in size. The weekly trapping efficiency (probability of capturing fish) ranged from 2-5%. 2393 of the 2929 juvenile steelhead trout captured had PIT tags inserted.

Table 4. Estimated number of juvenile steelhead trout showing the 95% confidence interval for each trapping season 2014-2018 in North Fork Navarro River.

Year	Species	Estimated Population
2018	Steelhead *O. mykiss*	88919 +/- 21493
2017	Steelhead *O. mykiss*	75759 +/- 27510
2016	Steelhead *O. mykiss*	37529 +/- 6525
2015	Steelhead *O. mykiss*	30273 +/- 4586
2014	Steelhead *O. mykiss*	16730 +/- 227

SOUTH FORK ALBION RIVER

RESULTS

The 2018 spawning survey population estimates for the South Fork Albion River are 32 coho salmon adults, 17 coho salmon redds (Table 5), 15 steelhead trout adults and 13 steelhead trout redds (Table 6). Steelhead trout adults were not observed during the 2017 and 2018 spawning survey seasons, so the annual fish to redd ratio was used to estimate adults. The absence of coho salmon adults in 2014 is a result of the lack of early winter rains that would allow access in the South Fork Albion River.

Table 5. Estimated number of coho salmon adults in South Fork Albion River during the 2014-2018 spawning seasons.

Year	Species	Estimated Population	High Estimate	Low Estimate
2018	Coho Salmon *O. kisutch*	32	35	30
2017	Coho Salmon *O. kisutch*	35	38	33
2016	Coho Salmon *O. kisutch*	88	94	82
2015	Coho Salmon *O. kisutch*	266	285	249
2014	Coho Salmon *O. kisutch*	0	0	0

Table 6. Estimated number of steelhead trout adults in South Fork Albion River during the 2014-2018 spawning seasons.

Year	Species	Estimated Population	High Estimate	Low Estimate
2018	Steelhead Trout *O. mykiss*	15	39	12
2017	Steelhead Trout *O. mykiss*	0	0	0
2016	Steelhead Trout *O. mykiss*	10	12	8
2015	Steelhead Trout *O. mykiss*	7	9	6
2014	Steelhead Trout *O. mykiss*	12	15	8

The number of juvenile coho salmon out-migrating during the 2018 trapping season was estimated at 5675 +/- 325 (Table 7). A total of 2301 juvenile coho salmon were captured ranging from 64-185 mm in size. The weekly trapping efficiency (probability of capturing fish) ranged from 27-65%.

Table 7. Estimated number of juvenile coho salmon showing the 95% confidence interval for each trapping season 2012-2018 in South Fork Albion River.

Year	Species	Estimated Population
2018	Coho Salmon *O. kisutch*	5675 +/- 325
2017	Coho Salmon *O. kisutch*	6404 +/- 590
2016	Coho Salmon *O. kisutch*	3669 +/- 870
2015	Coho Salmon *O. kisutch*	1738 +/- 110
2014	Coho Salmon *O. kisutch*	5975 +/- 1345
2013	Coho Salmon *O. kisutch*	1789 +/- 241
2012	Coho Salmon *O. kisutch*	2579 +/- 374

The number of juvenile steelhead trout at the trapping site during the 2018 season was estimated at 863 $\pm$ 324 (Table 8). A total of 233 juvenile steelhead trout were captured ranging from 64-189 mm in size. The weekly trapping efficiency (probability of capturing fish) ranged from 21-47%.

Table 8. Estimated number of juvenile steelhead trout showing the 95% confidence interval for each trapping season 2012-2018 in South Fork Albion River.

Year	Species	Estimated Population
2018	Steelhead *O. mykiss*	863 +/- 324
2017	Steelhead *O. mykiss*	2060 +/- 547
2016	Steelhead *O. mykiss*	465 +/- 149
2015	Steelhead *O. mykiss*	477 +/- 76
2014	Steelhead *O. mykiss*	408 +/- 225
2013	Steelhead *O. mykiss*	545 +/- 398
2012	Steelhead *O. mykiss*	519 +/- 339

FISH PRESENCE IN MAJOR DRAINAGE BASINS

During the years 1994-1996 and 2000-2002 MRC (and the former property owner L-P) conducted intensive sampling for fish distribution (450 sites sampled throughout the property for 3 consecutive years). MRC intends on repeating another round of this 3-year effort in the future. To monitor the distribution of fish more frequently, but on a reduced scale, MRC conducts surveys in each of all of the major drainage basins owned. Basins were selected for annual monitoring if MRC owned a majority of the land to ensure the results reflect MRC's management as opposed to factors outside of MRC's control.

The major drainage basins identified for annual monitoring are listed below (Table 9). Steelhead trout were detected every year within all major drainage basins sampled. If coho salmon were detected during a particular sampling year it is denoted with the word 'Coho' in the pertinent table cell.

There have been two noteworthy detections of coho salmon in watersheds that the species have not been seen in for decades. Surveys conducted in Greenwood Creek and Juan Creek the last few seasons have yielded coho salmon young of year (fry). In addition, coho salmon have returned to Cottaneva Creek after a six year absence. Their successful return demonstrates the resilience of the species and MRC's commitment to improve riparian and stream habitat.

Table 9. Results of fish distribution surveys combined from the 1994-1996; 2000-2002; and current annual studies within each major drainage basin identified for annual monitoring.

Basin	1994	1995	1996	2000	2001	2002	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Hollow Tree	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho
Cottaneva	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	*		Coho							Coho
Hardy							Coho**	Coho			*									
Juan											*						Coho	Coho	Coho	Coho
Howard											*									
NF Noyo	Coho		Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho
Big River (above SF)					Coho	Coho	Coho	Coho	Coho	Coho	*	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho
SF Big River		Coho	Coho			Coho	Coho	Coho	Coho	Coho	*		Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho
Albion (above SF)	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	*	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho
SF Albion	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho
NBNF Navarro	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho	Coho
SBNF Navarro	Coho		Coho			Coho	Coho		Coho	Coho	*	Coho	Coho	Coho	Coho		Coho	Coho		
Greenwood											*						Coho	Coho		Coho
Elk		Coho				Coho					*						Coho	Coho		Coho
Mallo Pass											*									
Alder											*									
SF Garcia	Coho		Coho			Coho	Coho	Coho	Coho	Coho	Coho		Coho	Coho	Coho		Coho	Coho	Coho	Coho
Wheatfield Fork											*									
Ackerman											*									

*Surveys were not conducted
**Coho salmon detected immediately downstream of MRC property

STREAM TEMPERATURE

Stream temperature is a key water quality parameter that can be altered as a result of streamside forest management practices. Concern over abnormal warming of stream temperatures as a result of streamside vegetation removal has generally focused on the impacts to cold water inland fisheries. The California Forest Practice Rules addresses the effects of streamside timber harvesting activities on water temperatures and dictates the implementation of Best Management Practices to minimize impacts on water quality within forested watersheds. With recent attention to coho salmon and pressure to develop Total Maximum Daily Loads (TMDLs) for coastal watersheds, monitoring stream temperatures is becoming increasingly important. Tailoring land management to meet water quality requirements has come to the forefront.

METHODS

Louisiana-Pacific initiated stream temperature monitoring within forestlands now owned by MRC in the summer of 1989. Stream temperatures were not monitored in 1998 as MRC was in the process of purchasing this timberland. Monitoring continued in 1999 and was expanded to include Class II streams in 2001. Additional monitoring began in 2002 on all major streams on the property where coho salmon were detected during aquatic species distribution studies. Air temperatures were also monitored at more than half of the stream temperature sites. Air temperature data loggers were placed within 50 feet of the water temperature data loggers out of direct sunlight along the stream bank.

Stream water temperatures were monitored continuously (2-hour interval used from 1989-2004, 1-hour interval used from 2005-2008, and 30 minute interval used from 2009-2018) during summer and early fall (May-October) each year using remote electronic temperature recorders. The stream temperature recorders were placed in shallow pools (< 1 m in depth) directly downstream of riffles and out of direct sunlight. Placement of temperature recorders in these areas ensured monitoring water that was adequately mixed and prevented de-watering of the monitoring devices. Each data recorder was held in place with a piece of rebar that was driven into the streambed substrate with a sledge hammer and a post driver. Wire was used to attach the data recorders to the rebar stakes.

Data Analysis

Three different indices were used to characterize the water temperature regime in streams. We averaged daily maximum temperatures and daily mean temperatures for 7-day periods and then reported the highest average for the entire summer. These metrics are commonly called Maximum Weekly Maximum Temperature (MWMT) and Maximum Weekly Average Temperature (MWAT) and reflect 7-day moving averages. These weekly average temperatures are widely used as indicators of long-term exposure. We also reported the absolute maximum value for the entire summer. The absolute maximum temperatures are useful however, these values may only occur briefly. Long-term exposure to sub-lethal temperatures may do more physiological damage than short-term exposure to higher temperatures.

RESULTS

Stream temperature was monitored in 103 streams at 141 sites. Climatic variability causes stream temperatures to fluctuate; this fluctuation requires many years of data in order to determine trends. A simple Mann-Kendall analysis of property-wide MWAT's for the last 16 years of data suggests there is a slight decreasing trend, however this trend is not statistically significant meaning more data and/or in-depth statistical analysis is needed. A graphical representation of MWAT values for the 16 years of continuous monitoring is shown in Figure 3. Responsible land management is necessary to maintain or decrease stream temperatures. Because of recent emphasis on land management and increasing scrutiny by regulatory agencies, stream temperature monitoring should continue and this data should be used to tailor management needs to specific water quality issues.

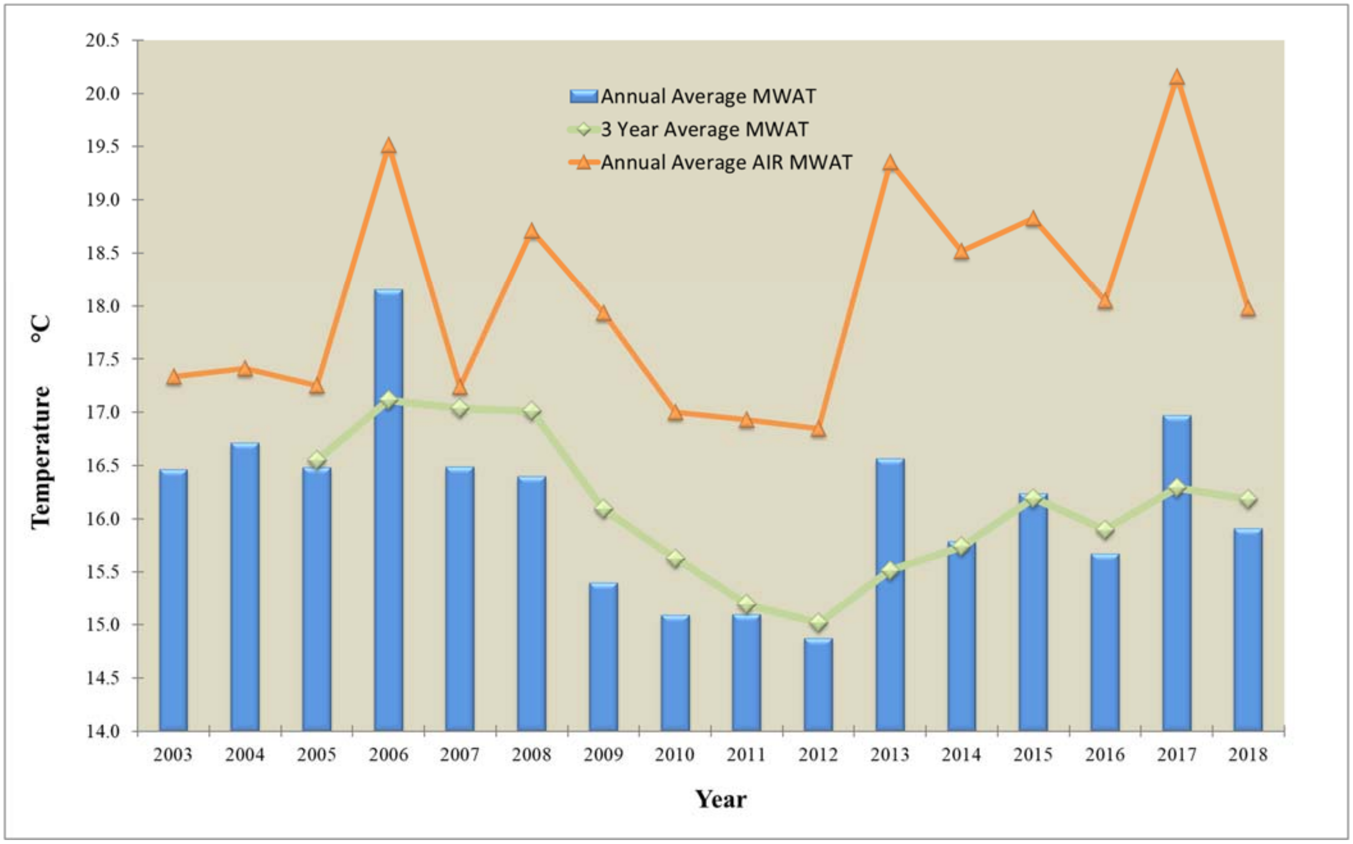

Figure 3. Annual Average and 3 Year Moving Average of MWAT for Stream and Air Temperature Sites Monitored Yearly on Mendocino Redwood Company Timberlands.

PRECIPITATION MONITORING

Rainfall and air temperature data was collected at ten locations throughout Mendocino Redwood Company forestlands. Rainfall was collected using an Onset® RG1 and RG3 tipping-bucket collectors. Rainfall and air temperature data was recorded using a HOBO® Event data logger. Each tipping bucket collection gauge was attached to a metal stake secured with guy wires. Rainfall collection stations were installed in existing forest openings (typically landings) having minimal obstruction to rainfall. Rainfall was measured in hundredths of an inch. Precipitation totals are reported through the 2018 water year (Table 10). Rainfall quantity where an asterisk is shown indicates the data logger encountered an electronic malfunction or a bear attack.

Table 10. Precipitation monitoring totals (inches) are summarized for MRC forestlands through the 2017 water year.

Gauging Station	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Rockport	76.85*	50.91	56.57	79.94	42.17*	26.30*	41.12	59.45	74.52	53.11	41.88	35.40	46.22	4.99*	78.12	47.24
Hollow Tree	92.19*	58.64	56.34	92.36	43.65*	44.38	33.40*	14.69*	60.08	60.73	50.79	32.04	43.55	63.75	85.95	46.00
Noyo	42.61*	50.27	58.77	79.5	36.26	41.86	8.44*	51.42	48.62*	45.36	43.28	32.25	40.10	63.34	83.75	39.42
Big River	22.62*	38.19	22.28*	47.25*	31.99	36.86	30.20	46.92	51.62	36.05	37.52	25.51	33.84*	0.00*	68.03	32.78
Albion	53.85*	38.64	49.68	65.8	32.83	27.52	29.60	44.61	49.47*	37.48	35.78	22.25	34.99	46.63	58.89	33.63
SBNF Navarro	51.99*	33.41	43.63	58.05	28.29*	30.45*	22.93	39.07*	47.74	29.89	29.45	21.05	30.54	40.14	54.77	27.39
Fashauer	51.19*	39.66*	20.75*	45.15*	35.27	41.92	32.77	51.59	60.30	37.95	38.91	29.87	38.07	59.55	70.71	34.21
Elk	47.73*	38.45	31.84*	59.88	29.11	34.98	29.76	36.24*	45.40	30.27	26.77	22.96	31.47	17.15*	59.15	34.90
Garcia	65.35*	30.82*	70.12	78.39*	46.58	50.74	46.12	64.41*	82.03	53.34	45.46	46.91	47.20	67.28	94.36	46.76
Annapolis	54.29*	50.08	57.18	75.94	37.19	41.55*	36.92	54.25*	69.01	39.95	41.94	32.63	39.57	52.88*	76.04	33.05

* Missing data

LONG TERM CHANNEL MONITORING

As part of MRC's watershed analysis protocol, long-term channel monitoring (LTCM) reaches have been established throughout the property. Thalweg profiles and cross sections are surveyed from established benchmarks so that future surveys can be conducted in the exact location of stream. This method allows physical changes in stream morphology to be recognized over periods of time. The measurements collected during LTCM assess the quality of fish habitat including: pool spacing, pool frequencies, pool depths, large woody debris volume and distribution, spawning gravel quality, riparian canopy, and measuring the volume of pools which may be filled with fine sediment.

In 2018, 4 LTCM segments were surveyed throughout MRC's ownership. The data is currently being analyzed so that annual changes in the stream channel can be determined.

RED-LEGGED FROG MONITORING AND EGG MASS PRODUCTION

INTRODUCTION

It is generally agreed upon by most herpetologists that the number of egg masses deposited each season is indicative of the number of mature females in the red-legged frog meta-population. Monitoring estimates of the total number of egg masses deposited is useful in determining the status of the species as well as assessing the impacts of land management activities upon the frogs.

RESULTS

Red-legged frog egg masses are conspicuous, and presence can often be documented within one or two site visits. Planning watersheds with red-legged frogs are annually surveyed to determine successful egg mass production, noted as “Present” in Table 11.

Table 11. Egg mass production and abundance for planning watersheds known to support red-legged frog reproduction.

Planning Watershed	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Lower Albion (AL)	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Russian Gulch (AG)	2	3	19	23	5	23	34*	43	60	47	82	41	91	93	83
Ray Gulch (WR)	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Lower Greenwood (CG)	25	18	16	18	20	25	30*	45	41	39	12	30	19	25	5
Mallo Pass (CM)	Present	**	Present	**	Present	**	Present	Present	**	Present	Present	Present	Present	Present	Present
Lower Alder (CA)									Present	Present	Present	Present	Present	Present	***
Juan Creek (RJ)									Present	No	No	No	***	***	***

* Indicates that surveys began late in the breeding season
** Indicates that the site remained dry during the breeding season
*** Indicates that surveys were not conducted

FORESTRY ASSISTANCE

Class I – Class II Stream Delineation
Stream classification surveys required for timber harvest plans are conducted to determine the extent of suitable fish habitat. The surveyor examines the stream to identify barriers such as waterfalls or significant gradient (> 20% for 160 meters) that impedes fish passage. In 2018, MRC aquatic biologists assisted forestry staff with approximately 10 stream classification surveys.

CDFW 1600 Drafting Monitoring
Stream flow monitoring is required by the conditions stated in the California Department of Fish and Wildlife 1600 permits. Source flow measurements are needed when drafting water from Class I and Class II streams on MRC timberlands. These measurements are recorded and used to make the requires adjustments to the diversion rates according the conditions in the 1600 permit. In 2018, MRC aquatic biologist measured stream flow at 9 Class I sites beginning in May through October.

Foothill Yellow Legged Frogs Surveys
On June 17, 2017 the California Fish and Game Commission designated the foothill yellow legged frog (FYLF) as a California Endangered Species Act (CESA) “threatened” candidate species. The appropriate protection measures for the species and suitable habitat are required to follow the guidance by CDFW to avoid “take” during project activities. Bridge and culvert installations are the primary project activities that have the potential effect FYLF on MRC forestlands. MRC aquatic biologists are required to conduct visual encounter surveys at the project locations to determine if FYLF are present and if presence is confirmed then to consult with CDFW to implement the necessary take avoidance measures. Typically, the installation of exclusion fencing and monitoring the site during construction are recommended. In 2018, MRC aquatic biologist conducted 10 visual encounter surveys.

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