Evaluation of Optical Lasers as Avian Predator Deterrents at McNary Dam, 2021

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1. Introduction

Multiple active and passive methods are used to reduce avian predation on juvenile salmonid migrants at mainstem dams on the Columbia and Snake rivers. Passive deterrents typically include bird wires, spikes, sprinklers, automated noise makers or other devices to reduce areas where birds can perch or easily prey on potentially disoriented salmonids. At McNary Dam, sprinklers were used to deter birds from congregating near the juvenile fish facility outfall pipe (JFOF) where fish diverted from turbine intakes are returned to the river. Operation of the sprinkler system has been limited in recent years because of debris, damage from high water events and general poor design. In 2018, damage from high water again removed the sprinkler system from operation, prompting the project to consider alternate deterrent systems that could be more easily implemented and maintained. This was the second sprinkler system lost since the outfall was installed in 2012. The project decided on a green laser designed to reduce bird damage to crops as a method to deter avian predators at the McNary Dam JFOF. A single laser mounted on the navigation lock guidewall, north and directly across the river from the outfall, was evaluated in 2019. The results of that limited test suggested the laser reduced the number of some feeding birds under some conditions but was not conclusive. For 2021, a second laser was added on the JFOF and the results of the 2021 evaluation are provided here.

2. Methods

The goal of the evaluation was to compare numbers of birds present at and near the JFOF with the green lasers on and off, focused during the periods when juvenile salmon are present, 15 April – 8 August.

McNary Dam purchased two Autonomic 500 Agrilasers with solar panel power supply. This is a green beam Class 3B laser (<500 mW) with projected coverage of 4.6 square miles (12 km^2) and maximum range of 2.2 miles (3.5 km). One unit was mounted on the north shore navigation guidewall, across the river and approximately 880 ft (268 m) from the JFOF (Figure1). The laser was programmed to move in a random pattern through an area of approximately 10 x 20 yd (9 x 18 m) on the river in front of the end of the JFOF. The second laser was mounted on a post on the JFOF facing the end of the outfall pipe (Figure 1).

The study plan included operating the laser in blocks of eight days with the laser on for four days and off for four days. The order of treatments within blocks was selected at random. Counts of birds in the JFOF zone were made twice per day, generally morning and evening, by project biologists. A biologist recorded date, day of week, time, block, laser treatment (on, off), numbers of gulls, cormorants, terns and pelicans observed, weather condition, and if boat hazing was occurring. Differences in bird abundance between treatments was tested for using randomized block analyses of variance (ANOVA) in the R statistical package. All models included laser treatment (on/off), block (1-18) and the treatment*block interactive terms as independent variables. The interactive term was found to be non-significant in all analyses and so was dropped and all models were repeated with just the laser and block terms. Six different models were used; one multivariate ANOVA including counts of the four bird species as dependent variables, and five univariate models, one each for the four bird species, and the sum of all birds per observation.

3. Results

In early spring, April and May, when age 1 Chinook salmon smolts were abundant, gulls were the most abundant group observed followed by cormorants (Figure 2). During June and early July, when age 0 Chinook salmon were the dominate smolts present, relatively few birds were observed in the McNary JFOF. Relatively few terns and pelicans were seen. The latter part of the study bird numbers were increasing while fish numbers were declining.

Although the mean numbers of birds observed were lower during blocks when the laser was on vs. off (Figure 3 and Table 1), these differences were not significant (see below). The mean number of birds counted was lower when lasers were on during 10 of the 18 blocks but bird counts varied widely among blocks, contributing to the lack of significant differences. The blocks term was significant in all tests. There were slightly fewer birds observed in the afternoon/evening counts with laser on (mean = 31.9 birds with laser off; 26.5 with laser on) but there were no difference in bird counts during mornings (mean = 24.4 birds) or at midday (25.9 birds; Figure 4).

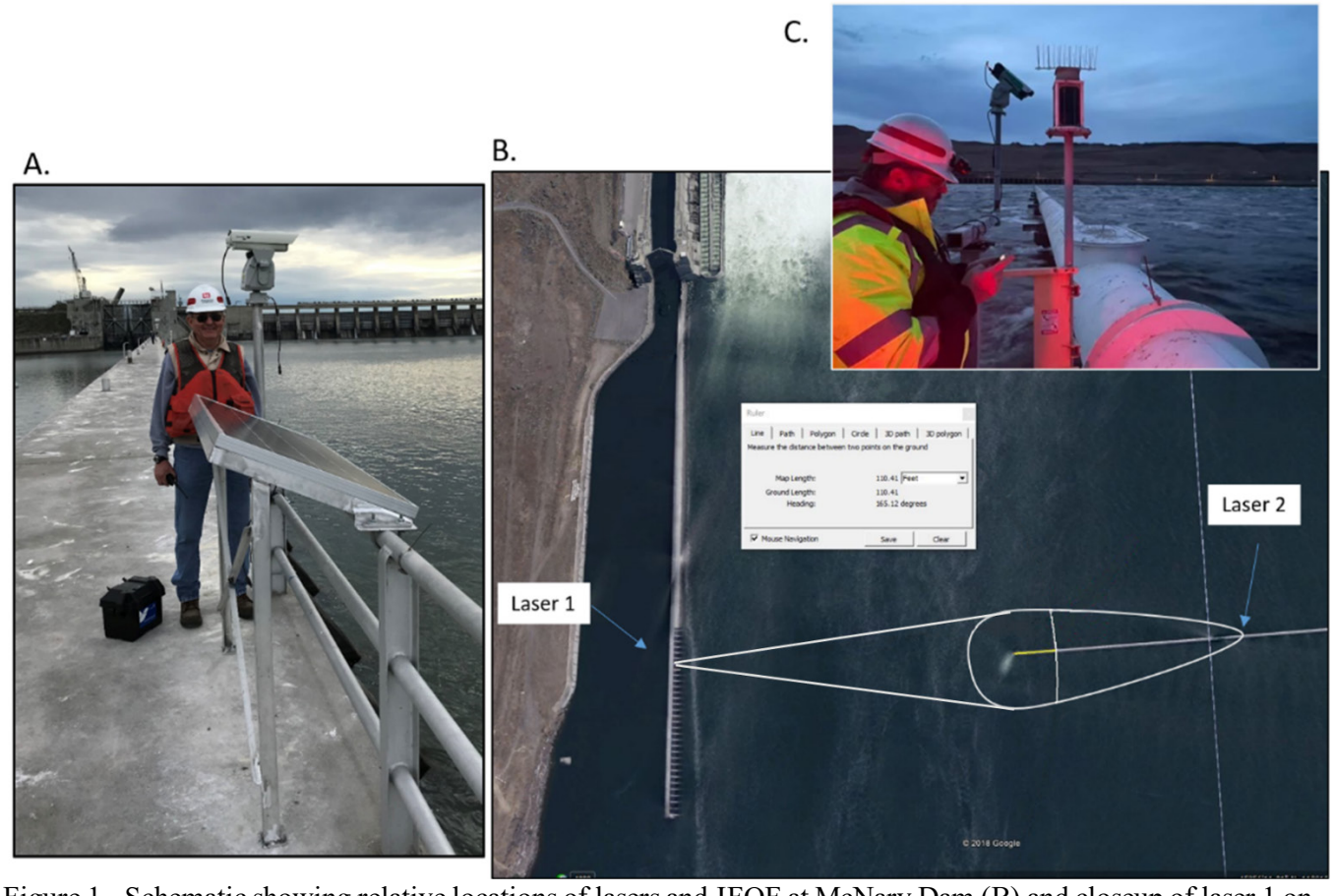


Figure 1. Schematic showing relative locations of lasers and JFOF at McNary Dam (B) and closeup of laser 1 on navigation lock guidewall (A) and laser 2 on JFOF (C).

Examples of analysis of variance test results.

MANOVA results using numbers of gulls, cormorants, terns and pelicans as dependent variables with blocks (1-18) and laser treatment (on, off) as independent variables.

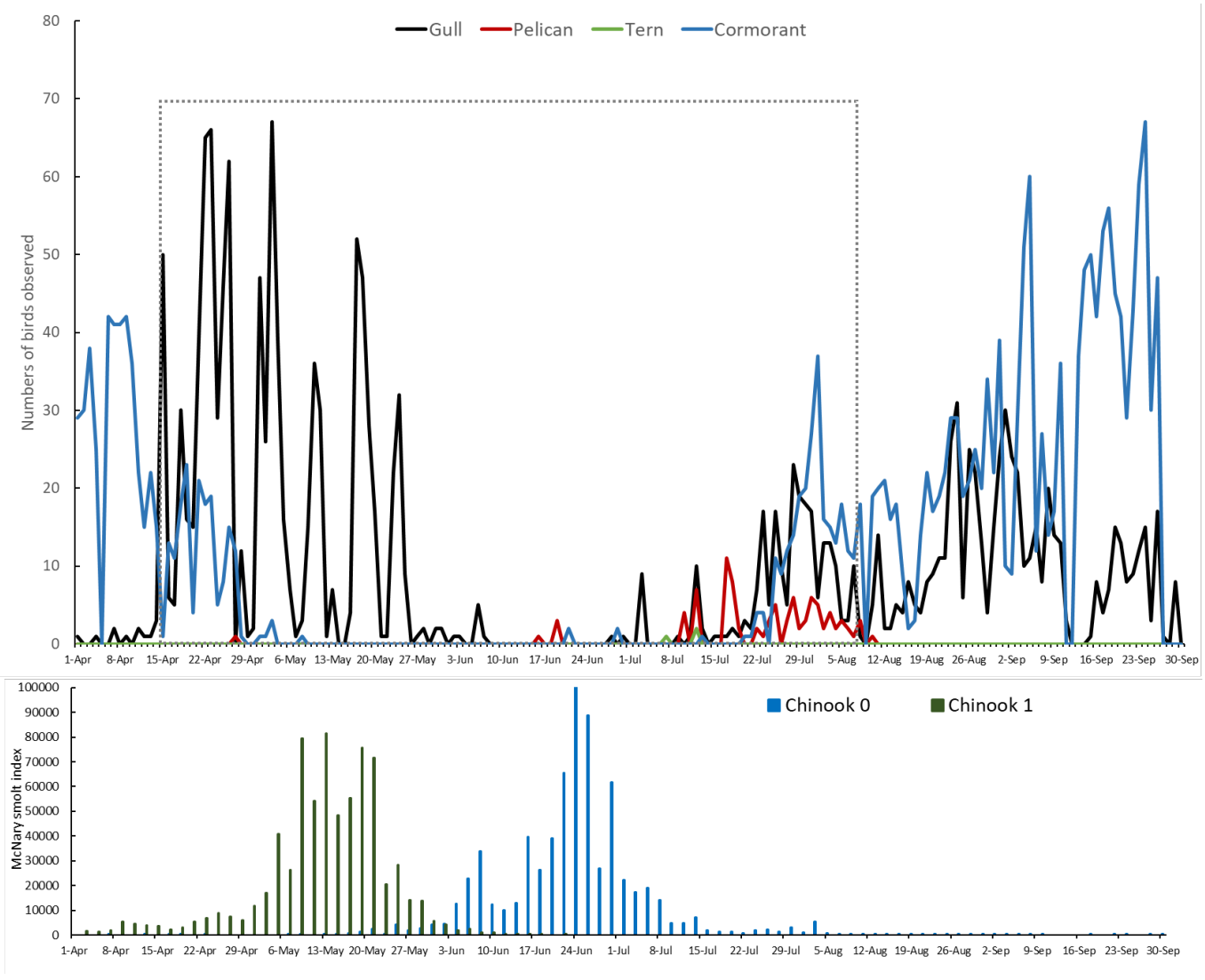
Variable	Df	Pillai	approx. F	num Df	den Df	P >
Blocks	1	0.61982	12.2277	4	30	0.001
Laser treatment	1	0.05022	0.3965	4	30	0.809
Residuals	33					

ANOVA results using all birds combined as dependent variable and with blocks (1-18) and laser treatment (on, off) as independent variables.

Variable	Df	Sum Sq	Mean Sq	F	P >
Blocks	1	1969	1969	10.09	0.003
Laser treatment	1	0	0	0	0.998
Residuals	33	6440	195.1		

ANOVA results using numbers of gulls counted as dependent variable and with blocks (1-18) and laser treatment (on, off) as independent variables.

Variable	Df	Sum Sq	Mean Sq	F	P >
Blocks	1	2646	2645.9	12.530	0.001
Laser treatment	1	3	2.6	0.012	0.911
Residuals	33	6968	211.2		



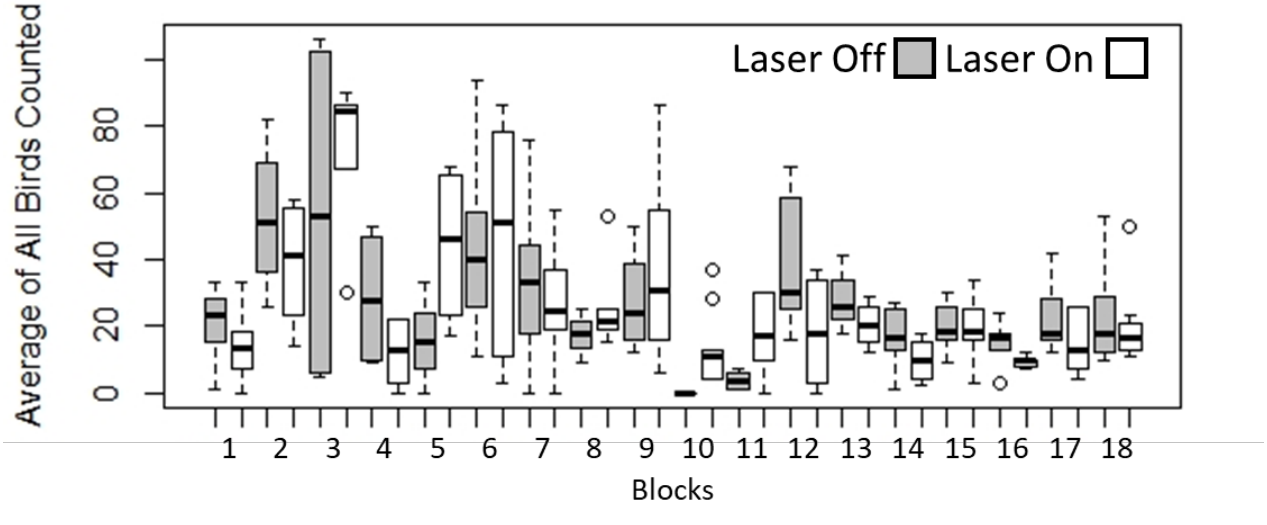


Figure 3. Box plots of number of birds observed at the McNary JFOF per block with lasers on and off in 2021.

Table 1. Mean per block of gulls, cormorants, terns, pelicans and all birds combined with lasers on and off in 2021.

Block	Laser	Gulls	Cormorants	Terns	Pelicans	All birds
1	OFF	5.1	15.5	0	0.4	21.0
1	ON	2.1	11.6	0	0.1	13.9
2	OFF	45.5	7.0	0	0	52.5
2	ON	20.9	18.0	0	0	38.9
3	OFF	52.8	1.5	0	0	54.3
3	ON	67.7	5.3	0	0.7	73.7
4	OFF	27.8	0.8	0	0	28.5
4	ON	11.8	0.3	0	0	12.2
5	OFF	16.0	0	0	0	16.0
5	ON	44.3	0	0	0	44.3
6	OFF	44.0	0.2	0	0	44.2
6	ON	46.7	0	0	0	46.7
7	OFF	33.1	0	0	0	33.1
7	ON	26.2	0.5	0	0	26.7
8	OFF	17.0	0.3	0	0	17.3
8	ON	24.7	1.0	0	0.2	25.8
9	OFF	13.5	14	0	0	27.5
9	ON	35.9	0.4	0	0.6	36.9
10	OFF	0	0	0	0	0
10	ON	7.7	5.4	0	0.3	13.4
11	OFF	0.8	2.5	0	0.3	3.7
11	ON	15.6	1.4	0	0.4	17.4
12	OFF	19.8	16.9	0	2.3	38.9
12	ON	10.0	7.5	0	0.8	18.3
13	OFF	19.3	7.7	0	1.3	28.3
13	ON	13.3	7.3	0	0	20.5
14	OFF	9.8	6.5	0	0.9	17.1
14	ON	3.0	6.2	0	0.7	9.8
15	OFF	8.3	9.3	0.3	1.7	19.7
15	ON	10.5	8.4	0	0.6	19.5
16	OFF	9.5	4.8	0	0.8	15.2
16	ON	5.8	3.7	0	0	9.5
17	OFF	16.2	3.5	2.2	0.3	22.2
17	ON	10.0	4.3	0	0.3	14.7
18	OFF	10.3	4.5	7.7	0.4	22.9
18	ON	2.5	6.9	10.3	0.5	20.1
All	**OFF**	**19.6**	**6.2**	**0.9**	**0.5**	**27.2**
All	**ON**	**19.0**	**5.3**	**0.7**	**0.3**	**25.3**

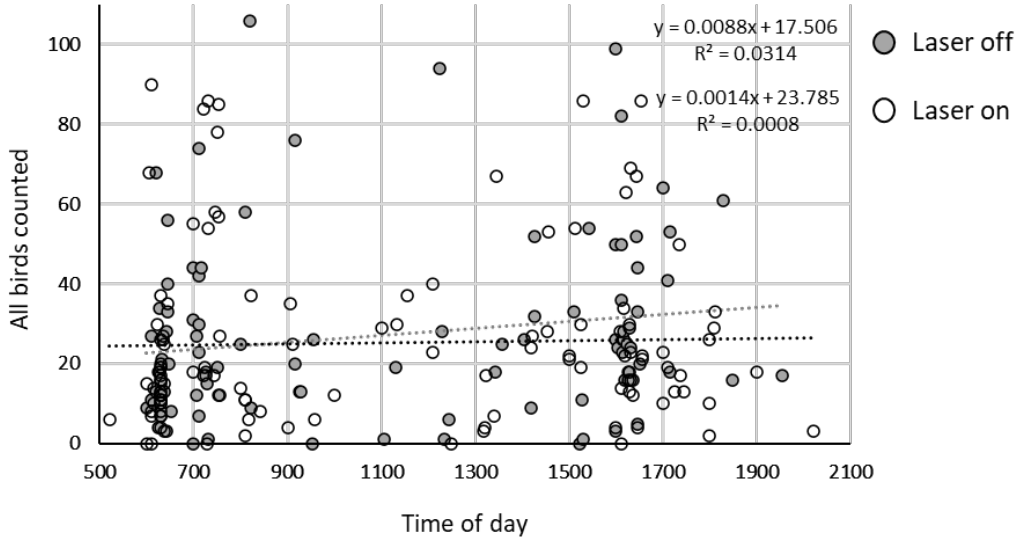


Figure 4. Numbers of birds counted at McNary JFOF in 2021 with lasers on and off, by time of day

4. Conclusion

Overall, it appears that lasers had some effect on reducing the numbers of birds counted around the McNary JFOF, but the measurable difference was small, on average, and not statically significant in the blocked trial conducted in 2021. The lack of statistical significance was caused from the high variability in daily bird numbers (within treatment effects) which was greater than the observable laser (among treatment) effect. This is the risk of conducting a field observational evaluation with treatments blocked through time. Aside from the variability in animal numbers, the lack of a strong measurable effect from lasers was likely related to a combination of environmental and operational conditions and the narrow focus of the laser application during this evaluation.

The lasers used at McNary were developed for use on land to reduce losses from birds feeding on agricultural crops. In that setting, lasers can produce a strong image on solid objects under relatively stable conditions. In the dam tailrace, lasers were primarily projecting onto moving and semi-transparent water surface, which may diminish the image and thus the effectiveness to affect the bird's behavior. As noted, difference in bird numbers were larger during later afternoon and evening periods, suggesting the influence of light conditions on the effectiveness of the laser.

Another factor that likely influenced the outcome of this evaluation is the difficulty of quantifying fish predation pressure from birds. Without a way to directly measure fish losses in the tailrace, we were forced to use bird counts to evaluate the effectiveness of the lasers. It is possible that lasers are effective at reducing fish predation but had less noticeable effect on the numbers of birds present at and near the JFOF. Anecdotally, observers indicated that it appeared more birds were in flight, versus roosting or resting on the water, when lasers were on. This distinction in behavior was not captured in the bird count data. Also, since lasers were focused at the outfall, birds could move to areas away from the laser and then back again as the laser moved on. Bird behavior at the outfall may have been noticeably more impacted if a larger area of the tailrace around the outfall was being scanned by lasers. Specifically, birds (dominated by gulls) are most abundant in the spillway tailrace. Expanding deterrents, such as lasers, to the spillway may have more of an impact on feeding behavior at the dam overall. Likewise, covering a greater length of the outfall, navigation lock walls and other potential roosting/resting areas may increase the amount of time birds spend flying and reduce the attractiveness of the tailrace as a feeding area.

Lasers did not significantly reduce numbers of avian predators counted at the McNary Dam JFOF in 2021. Lasers did appear to modify bird behavior somewhat near the JFOF. The relatively low cost and ability to program where and when the lasers operate may provide utility to reduce fish losses at dams if applied to a larger area and when combined with other passive measures, such as sound deterrents, bird wires, etc. In the coming year, the project plans to expand laser coverage to the spillway tailrace in combination with an LRAD device through the spring when birds and fish are typically most abundant to determine if these devices can be effectively applied to larger areas where birds reside.