

October 16, 2025

Laura Paye
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Maine Department of Environmental Protection
17 State House Station
Augusta, ME 04333-0017

Submitted via email to: DEP-Hydropower@maine.gov

Re: Comments of Kennebec Coalition, Conservation Law Foundation, Penobscot Nation, and Houlton Band of Maliseet Indians on DEP’s Draft Decision Regarding the Water Quality Certification Applications for the Lockwood, Hydro-Kennebec, Shawmut, and Weston Hydroelectric Projects

Dear Ms. Paye:

The Kennebec Coalition¹, Conservation Law Foundation, Penobscot Nation, and Houlton Band of Maliseet Indians (the “Conservation Groups and Tribes”) submit these comments on Maine Department of Environmental Protection’s (“DEP”) Draft Decision (the “Draft Decision”) regarding the Water Quality Certification applications for the Lockwood, Hydro-Kennebec, Shawmut, and Weston Hydroelectric Projects (the “Lower Kennebec Dams”) filed by Merimil Limited Partnership, Hydro-Kennebec, LLC, and Brookfield White Pine Hydro LLC (collectively “Brookfield”). Although we support certain aspects of the Draft Decision, we firmly maintain that the Lower Kennebec Dams and their discharges, as proposed in these applications, will cause or contribute to the failure of the Kennebec River to meet applicable Maine water quality standards. Brookfield has not met its burden to prove otherwise, and the conditions imposed by DEP in the Draft Decision, while beneficial, do not alter this conclusion. Accordingly, DEP should deny the applications.

We commend several aspects of DEP’s Draft Decision. First, the Draft Decision correctly finds that Brookfield’s “proposed measures and standards for fish passage at the Lower Kennebec Dams will not provide effective fish passage to all indigenous diadromous fish species and life stages without additional measures.”² The Draft Decision also aptly reaches the well-

¹ The “Kennebec Coalition” consists of the Atlantic Salmon Federation (including the Maine Council of the Atlantic Salmon Federation), Maine Rivers, the Natural Resources Council of Maine, Trout Unlimited and the Kennebec Valley Chapter of Trout Unlimited. Each member, except Maine Rivers, is a signatory to the “KHDG Agreement”, i.e., the *Agreement Between Members of the Hydro Developers Group, the Kennebec Coalition, the National Marine Fisheries Service, the State of Maine, and the U.S. Fish and Wildlife Service* dated May 27, 1998 (“KHDG Agreement”). A FERC order issued on September 16, 1998, approved the KHDG Agreement and incorporated the State’s fish “rapid restoration” goals into the licenses of the four projects – Lockwood, Hydro-Kennebec, Shawmut, and Weston. *Edwards Manufacturing Co., Inc., and City of Augusta, Maine*, 84 FERC ¶ 61,227 (1998) (incorporating KHDG Agreement); *see also* KHDG Agreement Part II at 2. The KHDG Agreement, Part I(B), coins the term “Kennebec Coalition” to name the respective conservation groups that make up the coalition. 84 FERC ¶ 61,227 & n.1. Maine Rivers has since joined the Kennebec Coalition in filings before FERC. *See, e.g.*, FERC Order, FERC Accession No. 20200713-3034 (July 13, 2020), at ¶ 14. For a further overview of the KHDG Agreement and the procedures leading to its incorporation into the licenses in issue, *see* 155 FERC ¶61,185 at PP 4 & n.10.

² Draft Decision at 59.

supported conclusion that 0.75-inch full-depth, angled or inclined racks must be installed at each of the projects to reduce entrainment and improve survival of downstream migrating fish. And while the Draft Decision's performance standards for Atlantic salmon passage are too low, the Draft Decision correctly imposes upstream and downstream performance standards at each project for *all* indigenous diadromous species, as opposed to the more limited set of performance standards proposed by Brookfield. These findings and requirements are clearly compelled by the evidence, as the Conservation Groups and Tribes demonstrated in our prior comments regarding these Water Quality Certification applications, and the exhibits, references, and attachments thereto, including the expert comments of Dr. Gail Wippelhauser, Don Pugh, and Dr. Robert Lusardi.³ We reiterate and incorporate by reference here those prior comments.

Despite these points of agreement, we oppose—and assert that the evidence does not support—DEP's Draft Decision to approve the applications with conditions. As we showed in our prior submissions, and as the Draft Decision itself confirms, the dams and their discharges, as proposed in these applications, would significantly impair upstream and downstream passage for salmon and other diadromous fish indigenous to the Kennebec. The Draft Decision finds that the dams and their discharges will not meet—or even come close to meeting—the passage performance standards that the Draft Decision deems necessary to “ensur[e] the receiving waters are of sufficient quality to support all species of fish indigenous to the receiving waters and to maintain the structure and function of the resident biological community.”⁴ These findings should compel denial of the applications.

The Draft Decision's almost complete reliance on the assumption that adaptive management measures will enable the projects to achieve the Draft Decision's performance standards is misplaced and unsupported. The evidence in the record does not demonstrate that the measures identified in the Draft Decision's adaptive management conditions would be feasible and sufficiently effective to meet the performance standards when implemented under the site-specific conditions at each of the projects. While the Draft Decision points to calculations from the Federal Energy Regulatory Commission's (“FERC”) Final Environmental Impact Statement (“FEIS”) estimating upstream passage rates with two upstream fishways at each of the projects, the FEIS did not purport to perform site-specific assessments of the feasibility or effectiveness of a second upstream fishway at each of the projects.⁵ Moreover, the calculations from the FEIS that the Draft Decision relies on still show the dams failing to meet performance standards for numerous species. The FEIS estimates, for example, upstream passage rates of 44.1%–52.2% for American shad at each project even with *three* fishways at Lockwood and two at the other projects, for a cumulative upstream passage rate of 6.2%.⁶

Similarly, while the Draft Decision relies on passage efficiency and timing for Pacific salmonids through dams on the Columbia River system, many of which have multiple fishways, we showed in our previous comments—and particularly the expert comments of Dr. Robert

³ See Conservation Groups and Tribes' June 13, 2025 Comments on Lower Kennebec Dams Water Quality Certifications, with attachments and copies of cited references; August 7, 2025 Comments of Dr. Robert Lusardi (“Comments of Dr. Robert Lusardi”). The Comments of Dr. Lusardi, which were previously submitted to DEP on August 7, 2025, are also annexed hereto as Attachment 1.

⁴ Draft Decision at 42 (citing 38 M.R.S. § 465(3)(C), (4)(C)).

⁵ See *id.* at 68, 71; FERC FEIS at 238–43, 387 (Tables 3-8 through 3-13, and Table 5-8).

⁶ See FERC FEIS at 238–39 (Tables 3-8 and 3-9).

Lusardi, submitted August 7, 2025 and resubmitted here—why it is inappropriate to assume that the upstream passage performance of Pacific salmonids through the Columbia River system dams would be replicable for Atlantic salmon at the lower Kennebec dams if an additional fishway were built. For example, “life history and physiological differences between Atlantic and Pacific salmon” undermine such assumptions.⁷ Moreover, “[m]any Pacific salmon experience lengthy upstream passage delays in the Columbia River system, and the Columbia River system dams do not meet Brookfield’s proposed passage standard of 96% upstream passage per dam within 48 hours.”⁸ In fact, “[a]daptive management in the Columbia River system has been going on for more than 40 years and those dams still do not meet the goals of that adaptive management program, nor have they achieved the standards that” the Draft Decision includes.⁹

Further, the Draft Decision does not point to evidence supporting the likely effectiveness of the other measures (aside from additional fishways) that are included as options in the adaptive management conditions. And while the Draft Decision requires Brookfield to continue trying adaptive management measures until the required performance standards are achieved, there is no express, final deadline by which the performance standards must be met or else the certification is withdrawn. Rather, the Draft Decision appears to allow the adaptive management process to theoretically go on forever, even if the performance standards are never met. In addition, the “10%” trigger for determining when certain adaptive management measures will be required is ambiguous.¹⁰

Finally, there are several provisions, including provisions governing the scope of testing and potential alternative adaptive management measures, which the Draft Decision makes subject to “review and approval by the Department.” DEP should make clear that any such decisions subject to future review and approval by DEP will only be made after a robust opportunity for consultation and comment by agencies, Tribes, and the public.

Accordingly, because Brookfield has failed to demonstrate that the dams and their discharges will comply with Maine’s water quality standards and the Draft Decision’s conditions do not rectify that failure, DEP should deny the requested water quality certifications.

⁷ Comments of Dr. Robert Lusardi at 1.

⁸ *Id.*

⁹ *Id.* at 2.

¹⁰ *See, e.g.*, Draft Decision at 86 (“If upstream and/or downstream performance standards have not been achieved and the results are not close (not within 10% of performance standard criteria for passage efficiency or timing for the tested species), the Applicant shall implement one or more of the following measures...”). While it appears that the intent is to require the additional measures if the percentage of fish successfully passing within the specified timeframe (e.g. 48 hours for upstream salmon passage) is less than 90% of the required passage percentage (e.g. less than 90% of the 96% rate required for upstream salmon passage), this should be clarified.

Respectfully submitted,



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Attachment 1

Comments of Dr. Robert Lusardi, Ph.D, to Maine Department of Environmental Protection on Brookfield’s water quality certification applications for the lower Kennebec dams, focusing on improper comparisons of the Kennebec River system to the Columbia River system regarding fish passage.

Qualifications

I, Dr. Robert Lusardi, Ph.D., submit these comments to the Maine Department of Environmental Protection regarding Brookfield’s water quality certification applications for the lower Kennebec dams. I am a freshwater ecologist and an Assistant Professor at the University of California, Davis, and an Associate Director at the UC Davis Center for Watershed Sciences. My research operates at the nexus of portfolio effects and life history theory and the application of such theories to applied research issues with important implications for management and the long-term persistence of salmon and other native fishes. My curriculum vitae is attached as Appendix A and lists all publications I have authored in the previous 10 years.

Introduction and Summary of Points

Dams lead to a host of effects on salmonids including migratory delays, reduced ecological performance, and mortality of adult spawner populations and outmigrant smolts, among other effects (Quinn 2018, Levin and Tolimieri 2001). Pacific salmonid passage results from the Columbia and Snake River dams (e.g., Keefer et al. 2004, 2021) were used in FERC’s Final Environmental Impact Statement (FEIS) and in NMFS’s Biological Opinion (BiOp) (both of which were submitted by Brookfield in support of its water quality certification applications) to support a conclusion that Brookfield will achieve proposed performance standards for Atlantic salmon either initially or through adaptive management in the Kennebec River.

Below, I detail numerous reasons why it is inappropriate to assume—as the FEIS and BiOp do without any supporting explanation—that the upstream passage results for Pacific salmon reported in Keefer et al. (2004) and (2021) from the Columbia River system (i.e. the Columbia and Snake River dams) would be replicable for Atlantic salmon at the lower Kennebec dams. In addition, the FEIS and BiOp ignore other fish passage results from the Columbia River system—such as for non-salmonids and smolts—that provide a far more cautionary lesson.

My key points, in summary, are:

- A. It is inappropriate to assume that the upstream passage results for Pacific salmon reported in Keefer et al. (2004) and (2021) from the Columbia River system would be replicable for Atlantic salmon at the lower Kennebec dams because:
 1. There are important life history and physiological differences between Atlantic salmon and Pacific salmon;
 2. Many Pacific salmon experience lengthy upstream passage delays in the Columbia River system, and the Columbia River system dams do not meet Brookfield’s proposed passage standard of 96% upstream passage per dam within 48 hours;
 3. Adaptive management in the Columbia River system has been going on for more than 40 years and those dams still do not meet the goals of that adaptive

management program, nor have they achieved the standards that Brookfield claims it will achieve at the lower Kennebec dams after a far shorter period of adaptive management. It is inappropriate to assume Brookfield could achieve better results in far less time; and

4. To my knowledge, Atlantic salmon have not achieved the proposed upstream passage standard at any hydroelectric project.
- B. By focusing solely on upstream salmon passage in the Columbia River system, the FEIS and BiOp ignore other cautionary fish passage outcomes from the Columbia River system, namely:
1. Non-salmonid species have much lower upstream passage rates on the Columbia River system;
 2. The Columbia River system provides very poor downstream passage for Pacific salmon smolts as well as non-salmonid juveniles (upstream and downstream passage); and
 3. Pacific salmonids have not been successfully recovered in the Columbia River system.

Detailed Comments

- A. *Upstream passage results for Pacific salmonids on the Columbia River do not support the conclusion that Atlantic salmon will meet proposed performance standards on the lower Kennebec.*

The FEIS and BiOp, which were submitted in support of Brookfield’s water quality certification applications, inappropriately rely on Keefer et al. (2021) (finding that tailrace to forebay passage efficiencies averaged 96.6% for adult Pacific salmonids in the Columbia River system) and Keefer et al. (2004) (finding that “most” adult Pacific salmonids passed dams on the Columbia River system within 48 hours). There are several reasons why it is inappropriate to assume that the upstream passage results for Pacific salmon reported in Keefer et al. (2004) and (2021) from the Columbia River system would be replicable for Atlantic salmon at the lower Kennebec dams. Those reasons are described below.

1. *Important life history and physiological differences between Atlantic salmon and Pacific salmonids.*

In light of the important life history and physiological differences between Atlantic salmon and Pacific salmonids that impact dam fishway passage, comparing Pacific salmon with Atlantic salmon for these purposes is like comparing apples to oranges. While Keefer et al. (2021) found that tailrace to forebay passage efficiencies averaged 96.6% of adult Pacific salmonids in the Columbia River system, the article notes that “*these estimates (regarding Pacific salmon) are among the highest recorded for any migratory species* (emphasis added), *which we attribute to the scale of evaluation, salmonid life history traits* (emphasis added) (e.g., philopatry), and a sustained adaptive management approach to fishway design, maintenance, and improvement.”

The FEIS states that “*While the reasons for the better passage efficiency on the Columbia River are unknown, as NMFS points out in its BO, many of the mainstem dams on the Columbia River have*

multiple upstream fishways providing multiple opportunities for salmon at any one dam to locate a fishway entrance and pass upstream. If multiple fishways are the reason for higher efficiencies, then it's possible that Brookfield might only be able to achieve a 48-hour delay standard if it constructed multiple fishways at each project.” The FEIS appears to leave a key part out of Keefer et al. (2021) regarding the reasons for improved passage performance of Pacific salmon on the Columbia River. Specifically, Keefer et al. (2021) note that “*The life history and physiology of **Pacific salmonids** (emphasis added) provide the foundation for their generally successful upstream passage through fishways at [Columbia River Basin] dams. Returning adults are strongly motivated by natal-site philopatry, have exceptional navigational and swimming capabilities, and benefit from the collective social cues of conspecifics during their seasonally synchronous migrations (citation therein).*” To assume that “multiple fishways” are the sole reason for recent improved passage on the Columbia River system does not consider the ecology and physiology of Pacific salmon.

- a) Salmon ecology. Pacific salmon are semelparous, meaning that they die after spawning. Atlantic salmon are iteroparous, meaning that they can repeat spawn. Evolutionarily speaking, iteroparous species tend to conserve more energy during migration in preparation for reproduction and outmigration (Bordeleau et al. 2019). Additionally, in comparison to Atlantic salmon, Pacific salmon are generally larger, have more fat reserves, exhibit greater leaping abilities and are typically reproductively mature during their adult freshwater migrations (Kraskura et al., 2024). Further, Atlantic salmon also exhibit weaker ladder attraction behavior than Pacific salmon (Gowans et al. 1999, Muir et al. 2001). All of this suggests that Atlantic salmon are, in general, less likely to use fishways with poor attraction flows or where significant energy is required.
- b) Delayed migration strategy. Atlantic salmon generally arrive months before spawning and hold in cool pools and tributaries prior to moving upstream. This behavior, as opposed to Pacific salmon, may increase delayed migration at migratory barriers and decrease motivation to enter fishways quickly. Conversely, Pacific salmon (particularly fall run Chinook, one of the primary species studied by Keefer et al. 2004, 2021) move quickly through fishways and reservoirs, eventually reaching natal spawning habitats.
- c) Physiological constraints. Due in part to iteroparity, Atlantic salmon tend to conserve more energy for spawning than semelparous Pacific salmon, which die after spawning and thus do not need to reserve energy for outmigration. This suggests that migratory delays associated with dams for Atlantic salmon will lead to greater energetic costs than Pacific salmon as they navigate and inspect fishway entrances and/or search for thermal refugia. For instance, Rubenstein et al. (2022) found that average delays associated with Penobscot and Kennebec dams of 16-23 days led to 11-22% reductions in fat reserves of Atlantic salmon and that delay was tightly correlated with thermal experience as perpetuated by dams. Rubenstein et al. (2022) found that Atlantic salmon experiencing delay below dams in Maine were exposed to warmer temperatures, which increase the depletion rate of energy reserves required for spawning and post-spawn survival. For these reasons, migration delays are likely far more impactful on Atlantic salmon than Pacific salmon, as delaying too long below dams may cause Atlantic salmon to run out of energy before successfully passing dams or reproducing, causing pre-spawn mortality.

2. *Pacific salmon on the Columbia River system do not meet Brookfield's proposed upstream passage delay standard for the lower Kennebec dams.*

While the results of Keefer et al. (2004) suggested that “most” salmonids transversed dams in less than 48 hours, the results did not demonstrate that 96% percent did so. Many Pacific salmon experience lengthy upstream passage delays in the Columbia River systems, and the Columbia River system dams do not meet Brookfield’s proposed passage standard of 96% upstream passage per dam within 48 hours. The following points regarding upstream passage delay are important to note.

- a) As referenced earlier, Keefer et al. (2004) studied Pacific salmonids (Chinook and steelhead) and did not study dam passage times of Atlantic salmon.
- b) Keefer et al. (2004) state that “*dam passage times were calculated from the first record at a tailrace receiver to the last record at a receiver at the top of the ladder.*” This does not account for delayed migration below dams, which has been shown to negatively affect reproduction, survival, and fitness, see Rubenstein et al. (2022), prior to entering the dam tailrace. As mentioned earlier, migratory delays associated with Atlantic salmon will likely lead to greater energetic costs and could lead to dam fallback or pre-spawn mortality. As such, applying the results of Keefer et al. (2004, 2021) to Atlantic salmon passage is significantly flawed.
- c) Keefer et al. (2004) quantified median passage times of salmonids at each of eight dams on the Columbia and Snake Rivers. While median times might make sense for a short publication, they do not fully reflect the data. Specifically, median times do not report variation in individual behavior, skewness, peaks and patterns, outliers, tail distribution behavior, or, of course, individual passage times. In short, median passage times are simply a summary statistic that does not account for individual passage times. Thus, while many *Pacific salmon* passed each of the eight dams in less than 2 days (48 hours), numerous individuals did not. Understanding individual passage times and defining full timing distributions is crucial in assessing dam passage. In some cases, even median passage times of Pacific salmon in Keefer et al. (2004) were longer than 2 days. For instance, both spring and summer Chinook salmon experienced significant delays at the Dalles Dam and John Day Dam with 785 individuals (approximately 6.4% of total individuals monitored) experiencing a median dam passage exceeding 2 days (48 hours). Further, Keefer et al. (2004) states that “*...more than 30% of spring Chinook salmon took more than 5 d to pass Dalles and John Day dams in 1997, the year with highest discharge, and 10-20% took that long at other dams and in other years. Similarly long passage times occurred for 5-15% of fall Chinook salmon and steelhead at John Day and Bonneville dams each year* (emphasis added).”
- d) Keefer et al. (2021) aptly notes that full dam passage times were more variable, ranging from 5 to 65 hours and that, cumulatively, survival of the studied fish

ranged between 67-69%. The authors also note that “*there were substantive uncertainties regarding effectiveness (of fishways)*” because natal origins confounded estimates of population specific survival and interpretation of apparent dam passage failure. Thus, the effect of dam passage (independent of time) could *not* fully be evaluated as acknowledged by the authors.

3. *Adaptive management in the Columbia River system has gone on for decades and still has not achieved its own goals, nor met Brookfield’s proposed performance standards for the Kennebec dams.*

Adaptive management in the Columbia River system started more than 40 years ago and those dams still do not meet the goals of that adaptive management program, nor have they achieved the standards that Brookfield claims it will achieve at the lower Kennebec dams after a far shorter period of adaptive management. It is inappropriate to assume Brookfield could achieve better results at the lower Kennebec dams, in far less time.

Fish passage attempts around Bonneville dam began in the 1930s, and adaptive management of Pacific salmon passage on the Columbia River began with the passage of the Northwest Power Act of 1980 and the subsequent release of the Columbia River Basin Fish and Wildlife Program in 1982. Despite the longevity of the plan, most quantifiable metrics pertaining to salmon in the Columbia River have not been met, nor have any of the 13 federally listed evolutionary significant units (ESUs) (Chinook) or distinct population segments (DPSs) (steelhead) been removed from the Endangered Species Act. Moreover, as noted above, those dams have not achieved the standard of 96% upstream salmon passage within 48 hours per dam that Brookfield claims it will achieve at the lower Kennebec dams.

The Columbia River Basin Fish and Wildlife Program began in 1982 and was the first major regional attempt to mitigate the ecological impacts of the federal Columbia River hydropower system, particularly the damage to salmon and steelhead runs, via adaptive management. It has since been updated many times as part of its adaptive management framework, with revisions in 1987, 1994, 2000, 2009, 2014, and ongoing work through 2020 and beyond. While there are several goals of the plan to improve habitat and hydrosystem reform, and improving wild self-sustaining populations, the primary quantitative goals, regarding salmon in the Columbia River basin, are to improve (i) adult returns (goal: 5 million annual returning adults) and (ii) smolt to adult ratios (SAR; goal: 2-6%). **After 44 years and an estimated 17 billion dollars**, most of the goals in the Columbia Basin Fish and Wildlife Program have not been met. For instance, regarding the goal of 5 million returning adult Pacific salmon, the Columbia River typically returns between 1.5 and 2.5 million salmonids (<1 million wild fish) annually. Additionally, most SAR ratios are far below the minimum requirement of 2%, with many populations still under 1%. Spring and summer Chinook SARs from the Snake River are as low as 0.5% (<https://damsense.org/salmon-survival-report/>).

4. *Atlantic salmon have not achieved the proposed upstream passage standard at any hydroelectric project.*

While there are several studies on Atlantic salmon as related to dam passage efficiency, delay, and migration timing, I am aware of no studies that show Atlantic salmon can consistently pass dams in less than 2 days. The scientific papers regarding adult upstream passage of Atlantic salmon described below are not meant to be exhaustive, but rather to provide a snapshot of some of the relevant study data that exist. These studies contribute to my firm opinion that Brookfield's proposal will not, even with adaptive management, achieve the proposed salmon passage standards but will, instead, subject significant numbers of endangered Atlantic salmon to harmful delay and mortality, threatening recovery efforts.

- a) Lundqvist et al. (2008). The authors studied fish passage movement of adult Atlantic salmon from 1995 through 2005 using radio tags, PIT tags, and Carlin tags on the Umealven and Vindelalven rivers in northern Sweden. Migration success to the fish ladder and above the dam ranged between 0-47%, indicating an “average loss of 70% of potential spawners.” Importantly, the authors note that fish were delayed, in part, due to difficulties passing rapids (unlike Pacific salmon) at high spills with additional hinderances found in the area of the fish ladder.
- b) Gowans et al. (1999). The authors radio tagged 39 Atlantic salmon to assess movement in a dammed river in Scotland. 29 of the fish ascended the fish ladder over the studied period, but migration delays were apparent. The authors note that “*many (of the tagged Atlantic salmon) did not approach the dam for several weeks, although there was great variation in this period. In 1996, ... fish tagged earlier in the year tended to delay longer before approaching than did individuals tagged later in the year.*” Instead of using median dam transverse time, such as Keefer et al. (2004), Gowans et al. (1999) found that mean time until the first detection at the dam was 28 days with a range of 7.25 hours to 91.6 days.
- c) Izzo et al. (2016). In studying Atlantic salmon passage at the Milford dam fish lift, the authors found high passage efficiency ($\geq 95\%$). However, long delays were observed at the Milford Dam fish lift. Tagged salmon frequently reached the fish lift soon after arrival but required several attempts—spanning days or even weeks—before successfully passing via fishways. Approximately 33% of migrating adult Atlantic salmon experienced delays greater than 1 week. The authors note that this migration metric is well below the FERC passage standard of 95% within 48 hours. The authors also found that individual fish made between 1 and 47 visits to the entrance of the fishway before passing, possibly consistent with the delayed migration strategy of Atlantic salmon as opposed to Pacific salmon discussed earlier. Most notably, the authors found that only 50% of Atlantic salmon passed through the fishlift within a 48 hour period during year 1. That number dropped during year two of the study to 34.7%.
- d) Hill et al. (2025). In studying adult Atlantic salmon migration and fish passage in the Wolastoq/Saint John River in New Brunswick, Hill et al. (2025) found that only a small percentage of tagged fish (19%) that reached the dam successfully moved upstream, and those that did often faced long delays—averaging 58

days—despite entering the fishway multiple times beforehand, with an average of eight visits.

B. Many aspects of fish passage in the Columbia River system are a cautionary tale, not the model of success as depicted in the FEIS and BiOp

1. Non-salmonid species have much lower upstream passage rates than salmonids in the Columbia River System.

With respect to the passage of other migratory species on the Columbia River. Keefer et al. (2021) notes that “*other co-migrating species **have lower passage rates** (emphasis added), highlighting the need for species specific design and evaluation wherever passage facilities impact fish management and conservation goals*”. This caveat is particularly applicable to the proposed work on the Kennebec system where numerous other migratory species including American shad, Blueback herring, alewife, sea lamprey, and the American Eel require sustainable high passage rates on the Kennebec River system.

Importantly, Keefer et al. (2021) states that “*beyond the [Columbia River Basin], the technical pool-and-weir design (i.e., Pacific salmon fishways) (and several variants) **has proven unsuitable for passing native species groups at many sites around the world** (emphasis added). Given the rush to build hydropower facilities in many developing regions, there is a temptation to deploy existing fish passage designs. However, there is a high risk that such imports will be ineffective for the diverse fish faunas in many of the targeted river systems and alternative designs (e.g., nature-like fishways)...*”

Fish passage facilities on the Columbia River target salmonids and there is little information on the passage of co-occurring migratory species. However, a few publications suggest that passage efficiency for other species such as sturgeon, shad, and Pacific lamprey remain far below those observed for adult Pacific salmon as found in Keefer et al. (2004, 2021).

- a) Moser et al. (2002) studied the migration and passage of Pacific lamprey using radio tags at three dams on the Columbia River and found that the passage efficiency of lamprey at Bonneville Dam (one of the dams studied in Keefer et al. (2004, 2021)) was 38-47% and that the median time required to pass over the dam ranged from 4.4 to 5.7 days. At The Dalles Dam (another dam from Keefer et al. (2004, 2021)), the authors found that 50-82% of lampreys passed the dam with passage times ranging from 2-4 days. Finally, at the John Day Dam, Moser et al. (2002) found that 55% of lamprey passed the dam, though the authors note that these results were based on relatively few individuals. The authors concluded that “*Lamprey passage at the lower Columbia River fishways in all 4 years of the study was consistently low relative to salmonid passage and took over four times longer.*”
- b) Parsley et al. (2007) examined the passage of white sturgeon at The Dalles Dam in the Columbia River (another dam that Keefer et al. (2004, 2021) studied with

respect to adult Pacific salmonid passage). The authors implanted transmitters into 148 white sturgeon. Fish were released directly into the tailrace and forebay of the dam and observations of both upstream and downstream migration were reported. Parsley et al. (2007) found that of the 148 initial fish tagged, a total of 26 passage events by 19 individuals (representing about 13% of the tagged population) were attempted. There were eight successful upstream passage events (via fish ladders) and 18 downstream passage events (via spill gates). All attempts were made by 19 individuals of the study population. Residence time of white sturgeon in the fish ladders ranged from 1 minute to approximately 6 months.

- c) There is not a lot of information on the passage of migratory shad on the Columbia River, but Haro and Castro-Santos (2012) state that “*Over the last 250 years, some progress has been made in improving upstream passage for American shad in fishways and other structures, yet the performance of even the most advanced structures is still not as high as it is for adult salmonids. This has led to a generalized paradigm that high performance **cannot** (emphasis added) be achieved for American shad in any conventional fishway design, with 50% efficiency being viewed as “excellent” and 75% efficiency as “exceptional” (citations therein). The root causes of poor fishway performance for American shad are for the most part unknown and may lie as much in the lack of attraction to a fishway entrance as to passage efficiency within a fishway.*”

2. *The Columbia River system provides very poor downstream passage for Pacific salmon smolts and juvenile non-salmonids.*

Despite relatively recent high upstream passage rates on the Columbia River for adult Pacific salmon, Pacific salmon smolts have experienced numerous issues migrating downstream within the Columbia River. Both juvenile salmonids and non-salmonids (e.g., lamprey, sturgeon) have far lower success rates. In fact, downstream passage of Pacific salmon smolts is so poor that the Army Corps. of Engineers barges between 15 and 22 million fish annually downstream below Bonneville dam (Northwest Power and Conservation Council 2025) in order to improve survival and reduce mortality. This has led to a host of other effects including delayed mortality of Pacific salmon smolts (e.g., Budy et al. 2002).

Downstream passage problems caused by dams have been shown to harm Atlantic salmon as well, as illustrated, for example, in the following studies:

- a) Norrgard et al. (2013) found that juvenile Atlantic salmon experienced an 83% reduction in migration speed when traversing rivers with hydroelectric dams compared with congeners that outmigrated through unimpaired rivers. Creation of impoundments can affect juvenile salmon in two primary ways: (i) by increasing overall energy expenditures making it more difficult to energetically complete downstream migrations to the estuary or ocean and (ii) causing migration delays that lead to a mismatch between outmigration timing and critical phenological events.

- b) Marschall et al. (2011) found that impoundment delays in outmigration of Atlantic salmon caused a mismatch between movement timing and environmental conditions such as elevated water temperature downstream of dams.
 - c) In studying outmigration of Atlantic salmon on the Winooski River (and tributaries), Nyqvist et al. (2017a) radio tagged 81 individuals (both wild and hatchery) and found that, despite repeated attempts, only 65% of study fish present in the forebay passed the dam.
 - d) In another study on the Winooski River, Nyqvist et al. (2017b) radio tagged Atlantic salmon juveniles to study their outmigration behavior. Individual fish encountered three dams with bypass structures. Of the 50 individuals that migrated downstream, only 10% of the fish successfully reached the downstream lake. The authors note that “*migration success was low despite the presence of bypass solutions, underscoring the need for evaluations of remedial measures; **simply constructing a fishway is not synonymous with providing fish passage*** (emphasis added).
3. *Pacific salmon populations in the Columbia River system remain extremely low, compared to historical returns.*

As noted above, none of the 13 federally threatened or endangered ESUs or DPSs of Pacific salmonids in the Columbia River system have recovered enough to be removed from the endangered species list. Many of the evolutionary significant units (ESUs) in the Columbia River region are currently less than 2% of historical population size. (National Marine Fisheries Service, 2022). The Snake River dams, in particular, have been a colossal ecological failure and are currently being assessed for removal. The Columbia River system dams should not be looked to as a model of successful salmon recovery.

Conclusion

In summary, it would be inappropriate and short-sighted to rely on the rare, recent achievement of high adult passage of Pacific salmon on the Columbia River to conclude that Brookfield would achieve its proposed performance standards on the Kennebec River for Atlantic salmon. Pacific salmon strongly differ from Atlantic salmon in numerous pertinent ways including physiology, swimming ability, navigation behavior, and life history differences (e.g., iteroparity, life history timing, etc.). In addition, the Columbia River system differs from Kennebec in that adaptive management for salmonid passage has been ongoing since 1982. And even with this long history of adaptive management, the Columbia River system has not met its own goals for salmon passage, much less the performance standards (including for passage delay) being proposed for the Kennebec. Further, the ignored fish passage difficulties on the Columbia River system—particularly, the low passage rates of other migratory species, relatively lower downstream passage rates of Pacific salmon smolts, and overall failure to recover Pacific salmon—should not be ignored.

Dated: August 7, 2025

/s/ Robert Lusardi
Dr. Robert Lusardi, Ph.D

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Sloat, M. R., Fraser, D. J., Dunham, J. B., Falke, J. A., Jordan, C. E., McMillan, J. R., & Ohms, H. A. (2020). Ecological and evolutionary patterns of freshwater maturation in Pacific and Atlantic salmonines. *Canadian Journal of Fisheries and Aquatic Sciences*, 77(12), 1846–1859.

Attachment A

Robert Andrew Lusardi

Curriculum Vitae

EDUCATION

University of California, Davis

PhD, Ecology, January 2015

University of California, Davis

M.A., Biogeography, May 2010

Advising professors: Peter Moyle and Jeffery Mount

Hamilton College, Clinton, NY

B.A. Biology with an economics minor

RESEARCH AND PROFESSIONAL EXPERIENCE

1. *Assistant Professor of Wetland Ecology* (step 6.5), University of California, Davis, Wildlife, Fish, and Conservation Biology, July 2023-present.
2. *Assistant Adjunct Professor* (step 4.5), University of California, Davis, Wildlife, Fish, & Conservation Biology, November 2019-2023.
3. *Assistant Professional Researcher* (step 4), University of California, Davis, Institute for the Environment, Center for Watershed Sciences, October 2017-2019.
4. *California Trout-UC Davis Wild and Coldwater Fish Scientist*, University of California Davis, Center for Watershed Sciences, January 2015-2023.
5. *Postdoctoral Research Fellow*, University of California, Davis, Institute for the Environment, Center for Watershed Sciences, January 2015-October 2017.
6. *Graduate Student Researcher*, University of California, Davis, Center for Watershed Sciences, September 2007-October 2014.

PEER REVIEWED PUBLICATIONS

33. Goss, B. Baskett, M.L., and **Lusardi, R.A.** 2025. Opportunities, research gaps, and risks in allogenic ecosystem engineer mimicry. *Conservation Biology*. In press.
32. Tallman, R.L., Wampler, A.N., Singer, G.P., Jeffres, C.A., Cocherell, D.E., Colby, J., Fangué, N.A., **Lusardi, R.A.**, and Rypel, A.L. 2024. Does method of field preparation affect survival and growth of juvenile Chinook salmon in agricultural floodplains? *River Research and Applications* xx: xxx-xxx.
31. Baruch, E.M., Yarnell, S.M., Grantham, T.E., Ayers, J.R., Rypel, A.L., and **Lusardi, R.A.** 2024. Mimicking functional elements of the natural flow regime promotes native fish recovery in a regulated river. *Ecological Applications* xx: xxx-xxx.
30. Ayers, J.R., Yarnell, S.M., Baruch, E., **Lusardi, R.A.**, and Grantham, T.E. 2024. Perennial and non-perennial streamflow regime shifts across California, USA. *Water Resources Research* 60(4): xxx-xxx.
29. Huber, E.R., Ryan, R.E., Johnson, R.C., Sturrock, A.M., **Lusardi, R.A.**, and Carlson, S.M. 2024. Seventy years of diminishing biocomplexity of California Central Valley hatchery steelhead, *Oncorhynchus mykiss*. *Canadian Journal of Fisheries and Aquatic Sciences* xx: xxx-xxx.
28. Corline, N.J., Bellido-Leiva, F. Alarcon, A., Dahlgren, D., Van Nieuwenhuyse, E.E., Beakes, M., and **Lusardi, R.A.** 2023. Reservoir-derived subsidies provide a potential management opportunity for novel river ecosystems. *Journal of Environmental Management* 345: xxx-xxx.

27. **Lusardi, R.A.**, Dahlgren, R.A., Van Nieuwenhuysse, E., Whitman, G., Jeffres, C., and R. Johnson. 2023. Does fine scale habitat diversity promote meaningful phenotypic diversity within a watershed network? *Ecology* xx: xxx-xxx.
26. Zillig, K., Fitzgerald, A., **Lusardi, R.A.**, Cocherell, D.E., and N.A. Fangué. 2023. Intraspecific variation among Chinook salmon populations indicates physiological adaptation to local environmental conditions. *Conservation Physiology* 11: xxx-xxx.
25. Lukk, A.K., **Lusardi, R.A.**, and A.W. Willis. 2023. Water management for conservation and ecosystem function: modelling the prioritization of source water in a working landscape. In press at the *Journal of Water Resources Planning and Management* 149(5): xxx-xxx.
24. Ogaz, M.H., Rypel, A.L., **Lusardi, R.A.**, Moyle, P.B., and C.A. Jeffres. 2022. Behavioral cues enable native fishes to exit a California floodplain while leaving non-native fishes behind. In press at *Ecosphere* 13(12): xxx-xxx.
23. Zillig, K.W., **Lusardi, R.A.**, Cocherell, D.E., and N.A. Fangué. 2022. Interpopulation variation in thermal physiology among seasonal runs of Chinook salmon. *Canadian Journal of Fisheries and Aquatic Sciences* 80: xxx-xxx.
22. Corline, N.J., Vasquez-Housley, P., Yokel, E., Gilmore, C., Stapleton, B., and **R.A. Lusardi**. 2022. When humans work like beavers: riparian restoration enhances gamma diversity and habitat resiliency. *Restoration Ecology* xx: xxx-xxx.
21. Peek, R., Irving, K., Yarnell, S.M., **Lusardi, R.A.**, Stein, E.D., and R. Mazor. 2022. Identifying functional flow linkages between stream alteration and biological stream condition indices across California. *Frontiers in Environmental Science* 9: xxx-xxx.
20. Grantham, T.E., Carlisle, D.M., Howard, J. Lane, B., **Lusardi, R.A.**, Obester, A., Sandoval-Solis, S., Stanford, B., Stein, E.D., Taniguchi-Quan, K.T., Yarnell, S.M., and J.K.H. Zimmerman. 2022. Modeling Functional Flows in California's Rivers. *Frontiers in Environmental Science* 9: xxx-xxx.
19. Bellido-Leiva, F.J., **Lusardi, R.A.**, and J.R. Lund. 2022. Quantification of off-channel inundated habitat for Pacific Chinook salmon (*Oncorhynchus tshawytscha*) along the Sacramento River, California, using remote sensing imagery. *Remote Sensing* 14 (6): xxx-xxx.
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17. Obester, A., **Lusardi, R.A.**, Santos, N., Peek, R.A., and S.M Yarnell. 2021. Conservation management over large geographic areas using suites of umbrella species. *Aquatic Conservation: Marine and Freshwater Ecosystems* 22: 112-128.
16. Stein, E.D., Zimmerman, J., Yarnell, S.M., Stanford, B., Lane, B., Taniguchi-Quan, K.T., Obester, A., Grantham, T.E., **Lusardi, R.A.**, and S. Sandoval-Solis. 2021. The California Environmental Flows Framework: meeting the challenges of developing a large-scale environmental flows program. *Frontiers in Environmental Science* 9: xxx-xxx.
15. **Lusardi, R.A.**, Nichols, A.L., Willis, A.D., Jeffres, C.A., Kiers, A.H., Van Nieuwenhuysse, E.E., and R.A. Dahlgren. 2021. Not all rivers are created equal: the importance of spring-fed rivers under a changing climate. *Water* 13 (12): xxx-xxx.
14. Bellido-Leiva, F.J., **Lusardi, R.A.**, and J.R. Lund. 2021 Modeling the effect of habitat availability and quality on endangered winter-run Chinook salmon (*Oncorhynchus tshawytscha*) production in the Sacramento Valley. *Ecological Modeling* 47: xxx-xxx.
13. Zillig, K.W., **Lusardi, R.A.**, and N.A. Fangué. 2021. One size does not fit all: variation in eco-physiology among Pacific salmonids. *Reviews in Fish Biology and Fisheries* 31: 95-114.

12. **Lusardi, R.A.**, B.G. Hammock, C.A. Jeffres, R.A. Dahlgren, and J.D. Kiernan. 2020. Oversummer Growth and Survival of Juvenile Coho Salmon (*Oncorhynchus kisutch*) Across a Natural Gradient in Stream Water Temperature and Prey Availability: an In Situ Enclosure Experiment. *Canadian Journal of Fisheries and Aquatic Sciences* 77: 413-424.
11. Nichols, A.L., **Lusardi, R.A.**, and Willis, A.D. 2020. Seasonal Macrophyte Growth Constrains Extent, but Improves Quality of Cold-Water Habitat in a Spring-fed River. *Hydrological Processes* 34(7): 1587-1597.
10. Durand, J.D., Manfree, A., Medellin-Azuara, J., Bombardelli, F., Fleenor, W., Henneberry, Y., Herman, J., Jeffres, C., Leinfelder-Miles, M., **Lusardi, R.A.**, Milligan, B., Moyle, P.B., and T. Young. 2020. Drought and the Sacramento-San Joaquin Delta, 2012-2016: Synthesis Review and Lessons. *San Francisco Estuary and Watershed Science* 18(2): 1-26.
9. Yarnell, S.M., Stein, E.D., Webb, J.A., Grantham, T., **Lusardi, R.A.**, Zimmerman, J., Peek, R.A., Grantham, T., Lane, B.A., Howard, J., and S.S. Sandoval-Solis. 2020. A Functional Flows Approach to Selecting Ecologically Relevant Flow Metrics for Environmental Flow Applications. *River Research and Applications* 36: 318-324.
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6. Steel, A.E, R.A. Peek, **R.A. Lusardi**, and S.M. Yarnell. 2017. Associating Metrics of Hydrologic Variability with Benthic Macroinvertebrate Communities in Regulated and Unregulated Snowmelt-dominated Rivers. *Freshwater Biology* 63: 844-858.
5. **Lusardi, R.A.**, and P.B. Moyle. 2017. Two-way Trap and Haul as a Conservation Strategy for Anadromous Salmonids. *Fisheries* 42(9): 478-487.
4. **Lusardi, R.A.**, M.T. Bogan, R.A. Dahlgren, and P.B. Moyle. 2016. Environment Shapes Invertebrate Assemblage Structure Differences between Volcanic Spring-fed and Runoff Rivers in Northern California. *Freshwater Science* 35(3): 1010-1032.
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2. Durand, J.R., **R.A. Lusardi**, D.M. Nover, R.J. Suddeth, G.C. Carmona-Catot, C.R. Connell-Buck, S.E. Gatzke, J.V. Katz, J.F. Mount, and J.H. Viers. 2011. Environmental Heterogeneity and Community Structure of the Kobuk River, Alaska, in Response to Climate Change. *Ecosphere* 2(4):1-19.
1. Herbst, D.B., M.T. Bogan, and **R.A. Lusardi**. 2008. Low Specific Conductivity Limits Growth and Survival of the New Zealand Mudsail from the Upper Owens River, CA. *Western North American Naturalist* 68(3): 324-333.

EDITED CHAPTERS, TECHNICAL REPORTS, OR MEDIA

1. Lukk, A., Howe, S., Elshoff, K., and Lusardi, R.A. 2024 Parks Creek fish passage and Cardoza Ranch efficiency implementation: post project monitoring summary. Prepared for Wildlife Conservation Board.
2. Howe, S., Goedde-Matthews, K., Alarcon, A., and Lusardi, R.A. 2024. Mill Creek 2019-2022 monitoring report. 7 pages. Prepared for California Trout.
3. California Water Blog. [Can large dams help feed downstream ecosystems?](#) (Authors: Bellido-Leiva, Corline, N., and Lusardi, R.A.). 2024

4. The Conversation. [Removing dam from the Klamath River is a step toward justice for Native Americans in northern California](#) (Authors: Middleton, B.R. and Lusardi, R.A.). March 2023.
5. Yarnell, S., Grantham, T., **Lusardi, R.**, Ayers, J., and Baruch, E. 2023. Resiliency of California fishes: Assessing native fish sensitivity to changes in wet and dry season baseflows. 179 pp. Prepared for California Dept. of Fish and Wildlife.
6. Ayers, J., Grantham, T., Yarnell, S. Baruch, E., and **Lusardi, R.A.** 2023. Dry season base flow characterization and model performance assessment. 42 pages. Prepared for California Dept. of Fish and Wildlife.
7. Lukk, A. and Lusardi, R.A. 2023. Hart Ranch riparian shade assessment. 4 pages. Prepared for California Trout.
8. Lukk, A., Vasquez-Housely, P., **Lusardi, R.A.**, and Willis, A.D. 2019. Little Shasta River 2017-2019: Pre Project Assessment of the Proposition 1 Ecosystem Restoration Grant Activities. 46 pp. Prepared for Wildlife Conservation Board.
9. Zillig, K. W., **Lusardi, R.A.**, and Fangue, N. A. 2018. Variation in Thermal Eco-Physiology among California Salmonids: Implications for Management. Sacramento, California. 39 pp. Prepared for California State Water Resources Board.
10. Yarnell, S., R. Peek, and **R. Lusardi**. 2018. Development of Tier 1 Environmental Flows for California. Prepared for the Nature Conservancy.
11. Nichols, A., **Lusardi, R.A.**, and A. Willis. 2017. Little Shasta Habitat Assessments 2016. Final Prepared for the Nature Conservancy.
12. Jeffres, C., R. Dahlgren, J. Kiernan, A. King, **R. Lusardi**, A. Nichols, S. Null, S. Tanaka, and A. Willis. 2009. Baseline Assessment of Physical and Biological Conditions within the Waterways on Big Springs Ranch, Siskiyou County, California. Prepared for the California State Water Resources Control Board.
13. Durand, J.D., **Lusardi, R.A.**, Suddeth, R., Caromona-Catot, G., Connell, C.R., Gatzke, S.E., Katz, J., Nover, D., Mount, J.F., Moyle, P.B., and Viers, J.H. 2009. Conceptual ecosystem model of subarctic river response to climate change: Kobuk River, Alaska. Prepared for the National Park Service and Alaska Department of Fish and Game.
14. **Lusardi, R.A.** 2009. Chapter 5: Aquatic Food Webs of the Tuolumne River. In J. Mount and S. Purdy (Eds.), *Confluence: A Natural and Human History of the Tuolumne River Watershed* (in publication with the Tuolumne River Trust).
15. Jeffres, C., A. Nichols, A. Willis, N. Corline, A. King, **R. Lusardi**, and R. Dahlgren. Longitudinal baseline assessment of salmonid habitat characteristics of the Shasta River, March through September, 2008. Prepared for the United States Bureau of Reclamation.

SELECTED PRESENTATIONS, PANEL DISCUSSIONS^{PD}, AND SYMPOSIUMS

1. Interagency Ecological Program (IEP) Annual Conference (2025). Exploring food-web subsidies from Shasta-Keswick Reservoirs as a potential management strategy for highly alternated downstream ecosystems (Bellido-Leiva, F., Corline, N., Beakes, M. McCormick, L., Israel, J., and **Lusardi, R.A.**)
2. American Fisheries Society, Oregon Chapter (2025). Survival of spring Chinook salmon (C'iyaaals) release in the upper Klamath River Basin (Authors: Tallman, R., Rypel, A., Hereford, M., Rich, S., Singer, G., Alcott, D., Wampler, A., Hause, C., and **Lusardi, R.A.**)
3. American Fisheries Society National Meeting (2024). Exploring the potential of food-web subsidies from reservoirs as an additional management strategy for novel ecosystems (Authors: Bellido-Leiva, F., Corline, N., Beakes, M., Israel, J., and **Lusardi, R.A.**). Oahu, HI.

4. American Fisheries Society National Meeting (2024). Coming home: return of the C'yaals: a spring Chinook salmon study to inform Klamath River basin reintroduction (Authors: Rachelle Tallman, M. Hereford, S. Rich, T. Williams, G. Singer, D. Alcott, A. Wampler, C. Hause, A. Rypel, and **R.A. Lusardi**). Oahu, HI.
5. Department of Wildlife, Fish, and Conservation Biology Seminar Series, University of California, Davis (2024). Early life history of Klamath River Chinook Salmon before dam removal (Authors: **R.A. Lusardi**, F. Bellido-Leiva, R. Johnson, G. Whitman, and Malte Willmes. Davis, CA.
6. University of California, Davis, Law School. Klamath dam removal: the use of multiple tools to establish scientific baselines (Authors: **R.A. Lusardi**). Davis, CA. [Invited Talk](#).
7. Rewilding: the role of habitat restoration and species reintroduction in achieving climate resiliency^{PD}. University of California, Davis, Law School. Davis, CA. [Invited Panel Member](#).
8. Salmonid Restoration Federation Annual Meeting (2024). Coming home: return of the C'yaals: a spring Chinook salmon study to inform Klamath River Basin reintroduction (Authors: Tallman, R., Hereford, M. Rich, S., Williams, T.H., Singer, G., Alcott, D., Wampler, A., Hause, C., Rypel, A., and **R.A. Lusardi**). Santa Rose, CA.
9. Society for Freshwater Science (2024). Flow regime shifts in intermittent streams across California (Authors: Ayers, J.R., Yarnell, S.M., **Lusardi, R.A.**, Baruch, E., and Grantham T.E. Philadelphia, PA.
10. Salmonid Restoration Federation Annual Meeting (2024). Effects of Short-Term Flow Reductions on Juvenile Rainbow Trout (Authors: Goedde-Matthews, K., Hawkins, R. and **R.A. Lusardi**). Santa Rosa, CA.
11. California Dept. of Fish and Wildlife Anadromous Fisheries Branch (2024). Coming home: return of the C'yaals: a spring Chinook salmon study to inform Klamath River Basin reintroduction (Authors: Tallman, R., Hereford, M. Rich, S., Williams, T.H., Singer, G., Alcott, D., Wampler, A., Hause, C., Rypel, A., and **R.A. Lusardi**). Sacramento, CA.
12. Salmonid Restoration Federation Annual Meeting (2024). Food web reconstruction: what stable isotopes can teach us about coho trophic pathways in beaver dam analogues (BDAs) (Authors: B. Goss, E. Baruch, and **Lusardi, R.A.**). Santa Rosa, CA.
13. American Fisheries Society California-Nevada Annual Meeting (2024). Salvaging scrapped smolts for science (Authors: Sami Araya, Levi Lewis, Malte Wilmes, and **Lusardi, R.A.**). Redding, CA.
14. American Fisheries Society California-Nevada Annual Meeting (2024). Short-term surface water pumping is contributing to declines in native salmonids (Authors: Goedde-Matthews, K., Hawkins, R., and **Lusardi, R.A.**). Redding, CA.
15. American Fisheries Society California-Nevada Annual Meeting (2024). Behavioral cues enable native fishes to exit a California floodplain while leaving non-native fishes behind (Authors: Ogas, M., Rypel, M., **Lusardi, R.A.**, Moyle, P.B., and Jeffres, C.). Redding, CA.
16. Salmonid Restoration Federation Annual Meeting (2024). Quality over Quantity: Conservation hatchery diversifies outmigration of juvenile Coho Salmon (*Oncorhynchus kisutch*) (Authors: A. Johanson, P. Samuel, E. Ettlinger, M. Tonty, and **Lusardi, R.A.**). Santa Rose, CA.
17. American Fisheries Society California-Nevada Annual Meeting (2024). Aquatic invertebrate communities differ across a diversion dam in a northern California stream (Authors: K.C. Elshoff, **Lusardi, R.A.**, and Gerhart, L.M.). Redding, CA.
18. Department of Wildlife, Fish, and Conservation Biology Seminar Series, University of California, Davis (2024). Effects of short-term flow reductions on juvenile rainbow trout (Authors: Goedde-Matthews, K., Hawkins, R. and **Lusardi, R.A.**). Davis, CA.
19. Resource Legacy Foundation. Klamath dam removal: the use of multiple tools to establish scientific baselines (2024) (Authors: **Lusardi, R.A.** and McCovey, B.). Davis, CA. [Invited Talk](#).
20. Department of Wildlife, Fish, and Conservation Biology Seminar Series, University of California, Davis (2024). Food web reconstruction: what stable isotopes can teach us about coho trophic

pathways in beaver dam analogues (BDAs) (Authors: Goss, B., E. Baruch, and **R.A. Lusardi**). Davis, CA.

21. Klamath Basin Fisheries Collaborative (2024). Coming home: return of the C'yaals: a spring Chinook salmon study to inform Klamath River Basin reintroduction (Authors: Tallman, R., Hereford, M. Rich, S., Williams, T.H., Singer, G., Alcott, D., Wampler, A., Hause, C., Rypel, A., and **R.A. Lusardi**). Klamath Falls, OR.
22. Salmonid Restoration Federation Annual Meeting (2024). Influence of scale on predictability of beaver dam density and implications for habitat modeling (Authors: Gengo, C., S. Yarnell, **R.A. Lusardi**, and D. Kelt). Santa Rosa, CA.
23. Western Regional Honors Conference, California State University (2024). Aquatic invertebrate communities differ across a diversion dam in a northern California stream (Authors: K.C. Elshoff, **Lusardi, R.A.**, and Gerhart, L.M.). Long Beach, CA.
24. Stanford University (2023). Using river science to inform restoration and improve the status of native fishes (Authors: **R.A. Lusardi**). Palo Alto, CA. Invited Talk.
25. Watershed restoration and dam removal (2023)^{PD}. Stanford University, Palo Alto. Invited panel member.
26. American Geophysical Union (AGU) (2023). Food-web subsidies from large reservoirs provide a potential management opportunity for highly-altered downstream ecosystems (Authors: Bellido-Leiva, F., Corline, N.J., Alarcon, A., Dahlgren, R., Van Nieuwenhuysse, E., Beakes, M., and **Lusardi, R.A.**). San Francisco, CA.
27. Water Foundation Annual Meeting (2023). Klamath dam removal: the use of multiple tools to establish scientific baselines (Authors: **R.A. Lusardi**). Sacramento, CA. Invited Talk.
28. Dam removals in the west (2023)^{PD}. Water Foundation Annual Meeting, Sacramento, CA. Invited panel member.
29. The Klamath River, climate change, and the largest dam removal in the world (2023)^{PD}. University of California, Davis – Institute for the Environment. Invited panel member.
30. Department of Wildlife, Fish, and Conservation Biology Seminar Series, University of California (2023). Food-web subsidies from large reservoirs provide a potential management opportunity for highly-altered downstream ecosystems (Authors: Bellido-Leiva, F., Corline, N.J., Alarcon, A., Dahlgren, R., Van Nieuwenhuysse, E., Beakes, M., and **Lusardi, R.A.**). Davis, CA.
31. Salmonid Restoration Federation. Fish Passage Summit (2022)^{PD}. Klamath dam removal panel discussion. Yreka, CA. Invited panel member.
32. Salmonid Restoration Federation Tribal Summit (2022). Klamath dam removal: the use of multiple tools to establish a scientific baseline (Authors: **R.A. Lusardi** and R. Tallman). Yreka, CA. Invited Talk.
33. United States Bureau of Reclamation (2022). Defining the spatial and temporal extent of reservoir subsidies to regulated rivers and their role in riverine food webs: implications for managed ecosystems and water management flexibility (Authors: **R.A. Lusardi** and F.B. Leiva). Sacramento, California. Invited Talk.
34. International Congress on the Biology of Fish (2022). Local Adaptation in Thermal Performance of Chinook Salmon, *Oncorhynchus tshawytscha*, from eight hatchery populations (Authors: Zillig, K.W., **R.A. Lusardi**, Cocherell, D.E., and Fangue). Montpellier, France.
35. Joint Aquatic Sciences Meeting (JASM) (2022). Characterizing dry season streamflow to assess hydrologic changes and quantify ecological responses across California (Authors: Ayers, J., Grantham, T.E., Yarnell, S.M., Lusardi, R.A., and Baruch, E.). Grand Rapids, Michigan.
36. Seminar in Simulation and Analysis of Systems in Environmental Engineering 2022, University of Granada. Los usos ambientales como prioridad, y no limitación, en la planificación y gestión hídrica: ejemplos de reconciliación ecológica en California (Authors: Bellido-Leiva, F., **Lusardi, R.A.**, Corline, N., Murdoch, L., Alarcon, A., Yarnell, S., and Lund, J.R.). Granada, Spain.

37. Joint Aquatic Sciences Meeting (JASM) (2022). Dam Operations and Internal Reservoir Conditions Control Downstream Nutrient and Food Web Subsidies (Authors: Corline, Nicholas J., Bellido-Leiva, Francisco, Alarcon, Adriana, and **R.A. Lusardi**). Grand Rapids, Michigan.
38. Joint Aquatic Sciences Meeting (JASM) (2022). Identifying fish community response to seasonal components of streamflow regimes (Authors: E.M. Baruch, J.R. Ayers, **R.A. Lusardi**, T.E. Grantham, and S. M. Yarnell). Grand Rapids, Michigan.
39. California-Nevada American Fisheries Society Annual Meeting (2022). “Terning” trash into treasure – otolith geochemistry and coded wire tags track the origins of salmon preyed upon by an endangered avian piscivore (Authors: S. Araya, Lewis, L., Wilmes, Fichman, R., M., Eliot, M., and **R.A. Lusardi**). Folsom, CA.
40. Salmonid Restoration Federation Annual Meeting (2022). Beyond physical habitat: the importance of prey availability and productivity in recovering imperiled salmonid populations (Authors: **R.A. Lusardi**). Session coordinator. Santa Cruz, CA.
41. National Marine Fisheries Service (2022), Northwest Science Center. Abundant Prey Availability Improves Juvenile Coho Growth Under Warming Stream Temperatures (Authos: **R.A. Lusardi**). Invited Talk.
42. Salmonid Restoration Federation (2022). Defining a basin-scale restoration framework to recover an endangered species. An optimization-simulation approach using a life cycle model (Authors: Bellido-Leiva, F., **Lusardi, R.A.**, and Lund J.R. Santa Cruz, CA.
43. Bay-Delta Science Conference (2021). Physiological variation in thermal traits among eight populations of Chinook salmon from the West Coast (Authors: Zillig, K.W., **R.A. Lusardi**, Cocherell, D.E., and Fangué, N.A).
44. Western Society of Naturalists (2021). Decoding the diet of the CA Least Tern: coded wire tags track the origins of hatchery salmon consumed by an endangered piscivore (Authors: S. Araya, Lewis, L., Wilmes, M., Eliot, M., and **R.A. Lusardi**).
45. Klamath Basin Monitoring Program (2021). Ecosystem productivity and rare habitat features: why spring-fed rivers are poised to succeed under a changing climate (Authors: **R.A. Lusardi**). Invited Talk.
46. Salmonid Restoration Federation Annual Meeting (2021). Abundant Prey Availability Improves Juvenile Coho Growth Under Warming Stream Temperatures (Authors: **R.A. Lusardi** and J.D. Kiernan). Virtual Conference due to Covid-19. Invited Talk.
47. Salmonid Restoration Federation Annual Meeting (2021). The influence of food webs on salmonid growth and performance: a forgotten link to species resilience (Authors: **R.A. Lusardi**). Session coordinator. Santa Cruz, CA. Virtual Conference due to Covid-19.
48. United States Bureau of Reclamation (2021). Defining the spatial and temporal extent of reservoir subsidies to regulated rivers and their role in riverine food webs: implications for managed ecosystems and water management flexibility (Authors: **R.A. Lusardi**). Sacramento, California. Invited Talk.
49. Department of Fish, Wildlife, and Conservation Biology, University of California, Davis (2021). Growth of juvenile coho salmon across a gradient in stream water temperature and prey availability (Authors: **R.A. Lusardi**). Davis, CA. Invited Talk.
50. American Fisheries Society, California/Nevada Chapter, Annual Meeting (2021). Contrasting histological, genetic, and otolith indicators of growth and condition in an endangered estuarine fish (Authors: R.A. Fichman, W. Xieu, F. Zhao, M. Willmes, J.A. Hobbs, T.C. Hung, A. Schultz, B. Hammock, S. Teh, **R.A. Lusardi**, and L.S. Lewis. Virtual conference due to Covid-19.
51. Klamath River Renewal Corporation and California Trout (2020). Klamath Dam Removal Panel Discussion ^{PD}. Webinar. Invited Talk.
52. Public Policy Institute of California and California Trout (2020). Making the most of water for the environment: a functional flows approach for California’s rivers (Authors: **R.A Lusardi** and T. Grantham). Online seminar. Invited Talk

53. Sierra Streams Institute. Stream macroinvertebrates: vital tools to assess environmental change, instream flows, and prey availability for foraging fishes (Authors: **R.A. Lusardi**). Nevada City, CA. Invited Talk. *Cancelled due to Covid-19*
54. Department of Ecology and Evolution, University of California Santa Cruz (2020). Eating your way out of climate change? Metabolic compensation of juvenile coho salmon in the wild (Authors: **R.A. Lusardi** and J.D. Kiernan). Santa Cruz, CA. Invited Talk.
55. 38th Annual Salmonid Restoration Conference (2020). Abundant prey availability improves juvenile coho growth under warming stream temperatures (Authors: **R.A. Lusardi**, B.G. Hammock, C.A. Jeffres, R.A. Dahlgren, and J.D. Kiernan). Santa Cruz, CA. *Cancelled due to Covid-19*
56. 38th Annual Salmonid Restoration Conference (2020). The influence of food webs on salmonid growth and performance: a forgotten link to species resilience (Authors: **R.A. Lusardi**). Session coordinator. Santa Cruz, CA. *Cancelled due to Covid-19*
57. CalTrans Annual Fish Passage Partnership Meeting (2020). State of the Salmonids: Fish in Hot Water (Authors: **R.A. Lusardi** and P. Samuel). Symposium. Invited Talk.
58. Ecological Society of America (2020). Intraspecific variation in thermal physiology of West-Coast Chinook salmon (Authors: Zillig, K.W., **R.A. Lusardi**, Cocherell, D.E., and Fangue, N.A.). Virtual Conference due to Covid-19.
59. International Congress on the Biology of Fishes (2020). Patterns and variations in thermal performance of Chinook salmon, *Oncorhynchus tshawytscha*, from eight hatchery populations (Authors: Zillig, K.W., **R.A. Lusardi**, Cocherell, D.E., and Fangue, N.A.). Montpellier, France. *Cancelled due to Covid-19*
60. California Senate Joint Committee on Fisheries and Aquaculture; California Legislature (2019) - expert testimony. Fish passage concerns in California (Authors: **R.A. Lusardi**). State Capitol Building, Sacramento, CA. Invited Talk.
61. International Society for River Science (2019). Developing ecological flow recommendations for native fishes when quantifiable relationships are lacking (Authors: **R.A. Lusardi**, A. Obester, N. Santos, R. Peek, E. Stein, and S. Yarnell). Vienna, Austria.
62. International Society for River Science (2019). The environmental flow and water management nexus: implementation challenges, strategies, and outcomes of environmental flow programs. Session coordinator. Vienna, Austria.
63. American Fisheries Society (2019). Eco-physiological patterns in thermal performance among populations of Chinook salmon, *Oncorhynchus tshawytscha* (Authors: Zillig, K.W., **R.A. Lusardi**, Cocherell, D.E., and Fangue, N.A.). Reno, Nevada.
64. Society for Freshwater Science Annual Conference (2019). A California environmental flows framework (Authors: T. Grantham, B. Lane, **R.A. Lusardi**, J. Howard, E. Stein, S. Sandoval, S. Yarnell, and J. Zimmerman). Salt Lake City, Utah.
65. Society for Freshwater Science Annual Conference (2019). An Ecosystem approach for selecting flow metrics for environmental flow applications (Authors: S. Yarnell, E. Stein, **R.A. Lusardi**, J. Zimmerman, R. Peek, T. Grantham, B. Lane, J. Howard, and S. Sandoval). Salt Lake City, Utah.
66. American Geophysical Union Conference (2019). Optimization of restoration for non-natal rearing habitats using a population dynamic model (HaBPWM) for winter-run Chinook Salmon along the Sacramento River (Authors: F.J. Bellido-Leiva, **R.A. Lusardi**, and J.R. Lund). Washington, D.C.
67. Sacramento River Science Workshop (2019). Biogeochemistry and food webs in the Upper Sacramento River (Authors: **R.A. Lusardi**). Library Galleria, Sacramento, CA. Invited Talk.
68. Sacramento River Science Workshop (2019)^{PD}. Habitat restorations efforts in the Sacramento River, CA. Library Galleria, Sacramento, CA. Invited Talk.
69. One Health Institute Symposium (2019). California epidemic: the rise and fall (and rise again?) of salmonids (Authors: **R.A. Lusardi**). University of California, Davis. Symposium. Invited Talk.

70. Scott River Watershed Forum (2019). Food Web Analysis and Coho Salmon Response at Scott River Beaver Dam Analogue Sites (Authors: **R.A. Lusardi** and E. Yokel). Fort Jones, CA. Invited Talk.
71. International Symposium on Ecohydraulics (2018). Establishing environmental flow targets in complex environments (Authors: E. Stein, S. Yarnell, S. Sandoval-Solis, **R.A. Lusardi**, B. Lane, J. Zimmerman, J. Howard, and T. Grantham. Tokyo, Japan
72. International Symposium on Ecohydraulics (2018). An ecologically based approach for selecting flow metrics for environmental flow applications (Authors: S. Yarnell, E. Stein, **R.A. Lusardi**, J. Zimmerman, R. Peek, T. Grantham, B. Lane, J. Howard, and S. Sandoval). Tokyo, Japan.
73. Bay-Delta Science Conference (2018). Differences in thermal performance between populations of Chinook salmon, *Oncorhynchus tshawytscha* (Authors: K.W. Zillig, **R.A. Lusardi**, D.E. Cocherell, and N.A. Fangué). Sacramento, CA.
74. Shasta Fish Passage Steering Committee (2018). Assessment of Stream Food Webs and Salmonid Growth Rates in the Upper Sacramento River Watershed (Authors: **R.A. Lusardi**). EPA Building, Sacramento, CA. Invited Talk.
75. International Congress on the Biology of Fishes (2018). Interpopulation variation in the thermal performance of Chinook salmon, *Oncorhynchus tshawytscha* (Authors: Zillig, K.W., **R.A. Lusardi**, Cocherell, D.E., and Fangué, N.A.). Calgary, AB
76. California Senate Joint Committee on Fisheries and Aquaculture; California Legislature (2018) - expert testimony. The Status and Future of California Salmonids (Authors: **R.A. Lusardi**). State Capitol Building, Sacramento, CA. Invited Talk.
77. North Coast Regional Water Quality Control Board (2018). State of the Salmonids (Authors: **R.A. Lusardi**, Peter Moyle, and Patrick Samuel). Special session board meeting, Santa Rosa, CA. Invited Talk.
78. Biennial Symposium of the International Society for River Science (2017). Developing Tiered Environmental Flow Targets using Functional Flows (Authors: **R.A. Lusardi**, Sarah Yarnell, Sam Sandoval, Belize Lane, Eric Stein, Julie Zimmerman, Ted Grantham, Jeanette Howard, and Jay Lund). Hamilton, New Zealand.
79. California Aquatic Bioassessment Workgroup (2017). Migratory Assistance? Two-way Trap and Haul for Anadromous Salmonids in California (Author: **R.A. Lusardi**). Davis, CA. Invited Talk.
80. Salmonid Restoration Conference (2017). Two-way Trap and Haul as a Conservation Strategy for Anadromous Salmonids (Author: **R.A. Lusardi**). Davis, CA. Invited Talk.
81. Salmonid Restoration Federation (2017). Reintroduction of Salmon to Historical Habitats (**R.A. Lusardi**). Session coordinator. Davis, CA.
82. International Trout Congress (2016) ^{PP}. The Climate Dilemma: Preparing for an Uncertain Future for Trout. Bozeman, MT.
83. Society for Freshwater Science Annual Meeting (2016). Invertebrate Community Composition and Drivers of Assemblage Dissimilarity between Spring-fed and Runoff rivers (Authors: **R.A. Lusardi**, M.T. Bogan, P.B. Moyle, and R.A. Dahlgren). Sacramento, CA.
84. American Fisheries Society Annual Meeting (2015). Juvenile Coho Salmon Exhibit Compensatory Mechanisms in a Large Volcanic Spring-fed River (Author: **R.A. Lusardi**). Portland, OR.
85. The Nature Conservancy (2015). Prey Availability and Water Temperature Interact to Influence Coho Salmon Growth on the Shasta River (Author: **R.A. Lusardi**). Sacramento, CA. Invited Talk.
86. Coho Coalition Semi-Annual Meeting (2015). Maximizing Reach Specific Growth Potential of Coho Using Interdisciplinary Methods (Author: **R.A. Lusardi** and P.B. Moyle). Sacramento, CA. Invited Talk.
87. California Trout Science Meeting (2015). Juvenile Coho Exhibit Compensatory Mechanisms in a Large Volcanic Spring-Fed River (Author: **R.A. Lusardi**). Yreka, CA.

88. Salmonid Restoration Federation (2015). Coho Growth and Compensatory Mechanisms. (Authors: **R.A. Lusardi** and J.D. Kiernan). Santa Rosa, CA.
89. Salmonid Restoration Federation (2015)^{PD}. Innovative Trans-Boundary Approaches to Coho Salmon Recovery. Santa Rosa, CA.
90. Bureau of Reclamation-Fish Passage Technical Group (2015). Volcanic Spring-Fed Rivers: Ecosystem Productivity and Importance for Pacific Salmonids. (Authors: **R.A. Lusardi** and R.A. Dahlgren). Sacramento, CA.
91. Shasta River Coho Safe Harbor (2014). Coho Growth and Compensatory Mechanisms. (Author: **R.A. Lusardi**). Yreka, CA. [Invited Talk](#).
92. The Nature Conservancy (2014). Volcanic Spring-fed Rivers: Novel Ecosystems Provide Hope for Pacific salmonids. (Author: **R.A. Lusardi**). San Francisco, CA.
93. California Trout Water Talk (2013). Why Spring-fed Systems Offer a Glimmer of Hope in the Face of a Changing Climate. (Authors: **R.A. Lusardi** and C.A. Jeffres). Mt. Shasta, California. [Invited Talk](#).
94. Center for Watershed Sciences (2013). Coho Growth and Compensatory Mechanisms (Author: **R.A. Lusardi**). University of California at Davis.
95. Geological Society of America (2009). Restoration Potential of the Groundwater-fed Big Springs Creek, Siskiyou County, California (Authors: A.L. Nichols, J.F. Mount, M.L. Deas, C.A. Jeffres, J.D. Kiernan, **R.A. Lusardi**, and A.D. Willis). Portland, Oregon.
96. Bureau of Reclamation, Klamath Basin Office (2009). Big Springs Creek Baseline Assessment Study (Authors: M.L. Deas, C.A. Jeffres, A.L. Nichols, **R.A. Lusardi**, and A.D. Willis). Klamath Falls, CA.
97. American Fisheries Society (2008). Investigating Trophic Relationships on the Shasta River, CA Using Stable Isotope Analysis (Authors: **R.A. Lusardi** and J.D. Kiernan). Portland, Oregon.
98. California Aquatic Bioassessment Workgroup (2006). Gradients in Channel Morphology Along the Upper Owens River in Relation to the New Zealand Mudsail and Native Benthic Community (Authors: D.B. Herbst and **R.A. Lusardi**). University of California. Davis, CA.
99. Eastern Sierra Environmental Roundtable Group (2006). Surface and Groundwater Production in Mammoth Lakes: Sustainable Abstraction? (Author: **R.A. Lusardi**). Crowley Lake, CA.
100. California Trout Southern California Presentation Series (2006). Water in the Mammoth Basin: Competition for Water Resources (Author: **R.A. Lusardi**). The Olympic, Los Angeles, CA.
101. Hamilton College Senior Thesis Presentation (1998). The Growth of the Gypsy Moth, with Relation to Nitrogen Allocation and Defensive Chemistries of Host Plants (Author: **R.A. Lusardi**). Clinton, NY.

SELECTED RESEARCH IN THE MEDIA AND RADIO INTERVIEWS^{RI}

1. NPR, Morning Edition Radio (national). [Once again California will not have a commercial salmon season](#). 2024.^{RI}
2. Dateline: Science and Climate, University of California. [The salmon diaries: life before and after Klamath dam removal-salmon 'tell' scientist their life story as decades-old dams come down](#). 2024.
3. NPR (national). [Once again California will not have a commercial salmon season](#). 2024.
4. KQED. [California's commercial salmon season is close again this year](#). 2024.
5. CalMatters. [The Klamath River salmon die-off was tragic. Was it predictable?](#) 2024.
6. California Water Blog. [Can large dams help feed downstream ecosystems?](#) (Authors: Bellido-Leiva, Corline, N., and Lusardi, R.A.). 2024
7. CalMatters. [The world's largest dam removal has begun. Can the dammed Klamath River finally find salvation?](#) 2023.
8. Water Education Foundation. [If you unbuild it, they will come](#). 2023.

9. The Conversation. [Removing dam from the Klamath River is a step toward justice for Native Americans in northern California](#) (Authors: Middleton, B.R. and Lusardi, R.A.). 2023.
10. Oregon Public Broadcasting. [How will Klamath salmon adapt after Klamath Dam are removed? Scientists are trying to find out.](#) 2023.
11. Oregon Public Broadcasting. [‘Killing salmon to lose money’: A costly, questionable plan on the Willamette.](#) 2023
12. Humboldt, The Magazine of Cal Poly Humboldt. [Come down: Cal Poly Humboldt researchers are studying the Klamath River as one of history’s largest dam removal begins.](#) 2023
13. Salon.com, [Klamath countdown: researchers hustle before largest dam removal project begins.](#) 2023.
14. Earth Island Journal. [Rewilding baby salmon using indigenous knowledge.](#) 2023.
15. The Revelator, [Klamath countdown: researchers hustle before largest dam removal project begins.](#) 2023.
16. UC Davis Science and Climate Newsletter. [The science of saving salmon as Klamath dams come down.](#) 2023.
17. Resources Legacy Fund/Open River Fund. [Restoring the Klamath River: science informs where future salmon runs may go.](#) 2023.
18. San Francisco Chronicle. [California is about to begin the nation’s largest dam removal project. Here’s what it means for wildlife.](#) 2022.
19. Resource Legacy Fund/Open River Fund. [Acoustic tagging to prepare for the return of Klamath spring-run Chinook salmon.](#) 2022.
20. Maven’s Notebook: [California Water, Verbatim. Feature: The State of the Salmonids in California.](#) 2020.
21. Jefferson Public Radio (NPR). *Can more food offset climate effects on salmon?* 2020.^{RI}
22. Capital Public Radio (NPR). *Young salmon defend themselves against climate change by eating more – but there’s a catch.* 2019.^{RI}
23. Whale Scout Podcast interview with Dr. Robert Lusardi: [Dams and the State of Klamath River Salmon.](#) 2019.^{RI}
24. The Revelator, [Drones, algae, and fish ears: what we’re learning before the world’s largest dam-removal project—and what we could miss.](#) 2019.
25. The New York Times, [How Protecting Water Helps Industry and Nature.](#) 2017.
26. San Francisco Chronicle (Front Page with cover photo and inset photos), [Nearly Half of California Salmon Species on Track for Extinction.](#) 2017.
27. Earth Island Journal, [The Long Run Home: a Vanishing Tribe, a Critically Endangered Fish, and the Race to Pull Them Back from the Brink.](#) 2018.
28. Jefferson Public Radio (NPR), [Report Urges Caution in Fish Trap and Haul Programs.](#) 2017.^{RI}
29. Yes Magazine, [The Shasta Dam Killed off This Tribe’s Salmon — Or So They Thought.](#) 2017.
30. The Siskiyou Daily News, [Guest Opinion: Removing dams is key to fish recovery.](#) 2019
31. Field and Stream, [The Seven American Trout Species at Greatest Risk.](#) 2017.
32. Jefferson Public Radio (NPR), [California Fish in Serious Hot Water.](#) 2017.^{RI}
33. Scientific American, [Popular Sport Fish May Be Headed for Broad Extinction in California.](#) 2017.
34. San Francisco Chronicle, [Volcanic Springs Offer Hope for Threatened Fish.](#) August 2016.
35. Davis Enterprise, [Troubled Waters: Report Spotlights Fish in Peril.](#) May 2017.
36. California Water Blog, [Considerations for developing an environmental water right in California,](#) 2022.
37. California Water Blog, [Assessing portfolios of actions for winter-run salmon in the Sacramento Valley,](#) 2021.
38. California Water Blog, [Functional Flows Can Improve Environmental Water Management in California,](#) 2020.
39. California Water Blog, [From buckets to umbrellas: fish conservation before the storm,](#) 2022

40. California Water Blog, *Drought and the Sacramento-San Joaquin Delta, 2012-2016: Environmental Reviews and Lessons*, 2020.
41. California Water Blog, *Functional Flows for Developing Ecological Flow Recommendations*, 2018.
42. California Water Blog, *The Little Shasta River, A Model for Sustaining Our National Heritage*. 2017
43. California Water Blog, *Conservation of Inland Trout Populations in California*. 2016.
44. California Water Blog, *Aquatic Macrophytes: Unsung but Prime Salmon Habitat*. 2015.

RESEARCH METHODS

- **Field:** Surface water, groundwater and soil sampling, river transect surveys and quantification of physical habitat parameters, discharge measurements, substrate characterization, riparian cover characterization, water quality sampling, algae and particulate organic matter sampling and processing, aquatic invertebrate sampling and identification, stable isotope data collection and processing, electro-fishing surveys, snorkel surveys, pit tagging, seining and otter trawling sampling methods, fish taxonomy and identification.
- **Laboratory Analysis:** Macroinvertebrate taxonomy, macrophyte/particulate matter/algae biomass processing, otolith dissection and preparation, stable isotope preparation and analysis, otolith methods, and spectrophotometric analytical methods.
- **Software:** R, SAS, SigmaPlot, JMP, ArcGis 9.0, AutoCAD, Microsoft Office.

PROFESSIONAL AND PUBLIC SERVICE

- Putah Creek Salmon Passage Project Technical Committee. Technical committee convened to study fish passage at Los Rios check-dam on Putah Creek and to advise on future volitional passage of adults and juvenile Chinook salmon.
- Healthy Watersheds and High-Quality Waters Assessment Technical Advisory Committee. Committee tis convened by the California State Water Board to provide guidance on a conservation strategy of streams and rivers of high intrinsic value throughout California.
- UC Davis Boating Safety Committee. One of two faculty members to serve and advise on boat safety and research at UC Davis.
- SAGE (Science, Advice, and Guidance for Emergencies). Committee member to provide guidance and on drought and water in the west. Department of Homeland Security, United States of America
- University of California, Davis, Graduate Group in Ecology. Conservation Ecology Area of Emphasis (AOE), Chair. University of California, Davis (2023-present)
- Associate Director of the Center for Watershed Sciences, University of California, Davis (2024).
- Avian Ecologist Search Committee, member. Department of Wildlife, Fish, and Conservation Biology (2023).
- WFCB Curriculum Committee, member. Department of Wildlife, Fish, and Conservation Biology (2023-present).
- WFCB Museum Committee, member. Department of Wildlife, Fish, and Conservation Biology (2023-present).
- WFCB Picnic Day Committee, Chair. Department of Wildlife, Fish, and Conservation Biology (2023-present).
- Faculty co-chair of the Justice, Equity, Diversity, and Inclusion (JEDI) committee. Department of Fish, Wildlife, and Conservation Biology (2021-present).
- WFCB Tribal Outreach, coordinator. Worked with the Yurok, Karuk, and Hoopa Tribes to bring high school students to University of California, Davis, for tours of the Department and the Native American Student Success Center (2022-present).

- Quantitative Fisheries Ecologist Search Committee, member. Department of Wildlife, Fish, and Conservation Biology (2022).
- Cooperative Extension Specialist Position Development, co-chair. Department of Wildlife, Fish, and Conservation Biology (2022)
- Session coordinator, Salmonid Restoration Federation Annual Meeting. Beyond physical habitat: the importance of prey availability and productivity in recovering imperiled salmonid populations. Salmonid Restoration Federation Annual Meeting. Santa Cruz, CA. April 2022.
- Session coordinator, Salmonid Restoration Federation Annual Meeting. The influence of food webs on salmonid growth and performance: a forgotten link to species resilience. Virtual due to COVID-19. April 2020.
- Elwha River Dam Removal Symposium (2022). Examined the science and management of dam removal in the western United States with a particular focus on the Elwha and Klamath Rivers. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, University of California at Davis, United States Geological Society, Klamath River Renewal Cooperation, National Parks Service, Resources Legacy Foundation, Oregon State University, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife. September 2022.
- Salmonid Bioenergetics Symposium (2018). Examined the history and current use and application of bioenergetics modeling in salmonid conservation, gaps in knowledge, and opportunities. National Oceanic and Atmospheric Administration, Fresno State University, University of California (Davis and Santa Barbara), Oregon State University, Humboldt State University, National Marine Fisheries Service, University of Nevada (Reno), USGS, University of Alaska (Fairbanks)
- California Environmental Flows Framework (CEFF), Technical Workgroup. Establish environmental flow targets for all streams in California and make scientifically based recommendations on appropriate methods. University of California, Davis, University of California, Berkeley, USGS, The Nature Conservancy, and California Trout. January 2017-present.
- Climate change effects on environmental flows, Technical Advisory Committee. Review flow ecology models and relationships and comment as appropriate. Advise on the use of models to assess anticipated climate change effects on stream ecosystems in southern California. Southern California Coastal Watershed Research Project, National Park Service, California Department of Fish and Wildlife, California State Water Resources, Control Board, University of California. March 2018-present.
- Scientific adviser: California Trout (Shasta River Program, Limiting Factors Analysis). January 2015-present.
- Session coordinator, Salmonid Restoration Federation. Reintroduction of salmonids to historical habitat. Davis, California: April 1, 2017.
- Session coordinator, International Society for River Science. The environmental flow and water management nexus: implementation challenges, strategies, and outcomes of environmental flow program. Vienna, Austria: September 2019
- Session coordinator, Salmonid Restoration Federation. Davis, California: Spring, 2020. The influence of food webs on salmonid growth and performance: a forgotten link to species resilience (R.A. Lusardi). Session coordinator. Santa Cruz, CA. *Cancelled due to Covid-19*
- Center for Watershed Sciences Principal Investigator Partnership. Chair. University of California Davis. March 2020-June 2020.
- Department of Wildlife, Fish, and Conservation Biology (WFCB) Justice, Equity, Diversity, and Inclusion (JEDI) Committee Member. August 2020-present.
- Graduate Group in Ecology, Conservation Ecology Area of Emphasis (AOE) Advisor, University of California, Davis. 2020-present.

- Center for Watershed Sciences Principal Investigator Partnership. Chair. University of California Davis. January 2020-June 2021 and January-March 2022.
- Center for Watershed Sciences Executive Committee. Member. University of California, Davis. January 2021-2022.

SERVICE TO DISCIPLINE

Ad hoc manuscript reviewer for the following peer reviewed journals: *Global Change Biology*, *BioScience*, *Conservation Biology*, *Journal of Applied Ecology*, *Transactions of the American Fisheries Society*, *Fisheries*, *Reviews in Fish Biology and Fisheries*, *River Research and Applications*, *Ecosphere*, *Water*, *Northwest Naturalist*, *Environmental Biology of Fishes*, *Limnology*, and *Marine and Freshwater Research*.