

How should scientific review and critique support policy?

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Abstract

Decisions that hope to advance broad public interests require a reliable foundation in facts. We provide a post-publication review of Laundré & Papouchis (2020) and compare it with a review included in the report, “[Human-Cougar Interactions: A Literature Review Related to Common Management Questions.](#)” undertaken by the Washington State Department of Fish and Wildlife to inform decisions and regulations made by that State’s Fish and Wildlife Commission. We focus on two aspects of objectivity in that report: (1) the constitution of the membership of the persons that performed the review; and (2) how they conducted their review. Our conclusions more broadly reveal how scientific review and critique should and should not be done to support policy decisions, regulations, and legislation, and how policy-makers can be enlightened or misled by scientific review. We conclude with recommendations for what the public and policy-makers should look for in a sound review of scientific evidence.

Introduction

Decisions that hope to advance broad public interests require a reliable foundation in facts. For policies that concern the biophysical environment, science is considered invaluable. Indeed, US environmental agencies have a legal duty to avoid arbitrary or capricious decisions [1]. Some agencies’ duties demand consideration of the best available science. Yet, identifying the best science, and considering it impartially for the sake of the greatest good, is not straightforward even if decision-makers can insulate themselves from political pressures or self-interest. Many environmental agencies rely on teams of qualified scientists to judge what evidence is available and which is best. This is especially important for government commissions that regulate uses of wild species and their environment or direct agency policy because commissioners typically are political appointees with little science training or experience.

Independent review of research findings is an ideal of good science. Moreover, the make-up of review teams and their working methods should fulfill at least two essential criteria as recommended by the US federal government and National Academies of Science for all pre- and post-publication reviews: (1) that reviewers are independent of competing interests (i.e., members can come to their own conclusions and are free to express these in open debate) and independent of each other (i.e., they represent diverse worldviews to prevent domination by one view and its presuppositions about evidence); and (2) that reviewers use accepted standards of evidence and judge data based on scientific criteria rather than anecdote, assumption, personal beliefs or organizational values [2, 3].

Post-publication review teams may be necessary for commissions and government agencies because peer review processes of scientific journals cannot guarantee that any given, single study is reliable or replicable (i.e., the finding can be reproduced by independent investigators). Likewise, a single post-publication review cannot settle an issue forever, as scientific progress in methods and new studies can

invalidate older findings. In the face of such paucity of scientific replication and certainty, policy-makers must place trust in their review teams.

Objectivity, defined as “to observe, measure, or infer with impartiality; detachment” (accessed 28 April 2022, <https://www.oed.com/>), is considered essential to science. Nevertheless, two common pitfalls occur in its practice: 1) people view scientists as either completely objective or completely unobjective, and 2) scientific judgments are sometimes based not on the methods used in observation, measurement, or inference, but on other unscientific criteria.

One extreme form of the binary view of objectivity is to claim no one can be objective. This claim commits the error of attributing impartiality and detachment to individuals rather than to observation, measurement, and inference (scientific actions). Instead, Naomi Oreskes [4] encourages us to think of objectivity as a continuum, and one that improves with practice. Improvements can occur personally and in a community of scientists. For example, relying on a diverse community of independent scientists to resolve uncertainties and disagreements without regard for any one scientist’s reputation or authority [4].

A clear example of the second pitfall comes from U.S. jurisprudence on agency science. In the U.S., courts routinely defer to the scientific claims of government agencies in their areas of expertise (e.g., the Chevron standard). Therefore, courts often award legal victories to the government establishment without examining the scientific methods they used. This is especially troublesome in the instances that agencies produce reports that summarize their reviews of scientific evidence, that are not externally reviewed. We must evaluate the scientific actions of observation, measurement, inference, not the actors or the communication styles.

A Case Study in Objectivity for Post-publication Review

Here, we conduct a post-publication review of Laundré & Papouchis [5] hereafter L&P and contrast our review with the post-publication review of this same paper conducted by the Washington Department of Fish and Wildlife (WDFW) and published in an agency report shared with the Commission and the public [6]. Our conclusions more broadly reveal how scientific review and critique should and should not be done to strengthen policy, how policy-makers can be enlightened or misled by scientific review, and what the public should look for when a scientific review is conducted.

Description of Our Team

Following journal policy, we disclose all potentially competing interests in the disclosures portion of this comment below but here we summarize our direct connections to the principal actors whom we address below.

AT co-authored a newspaper opinion with the late J. Laundré. His work is cited by L&P and by the WDFW Team (see disclosures of which articles below).

FK, has collaborated with WDFW on several endangered species recovery programs, volunteered on three WDFW advisory committees, and served on the Washington Fish & Wildlife Commission in 2021.

LME: Elbroch is a puma biologist and works for the wild cat science and conservation organization, Panthera. LME worked as a volunteer for J. Laundré studying pumas in 2000. My work is cited by L&P and by the WDFW Team (see disclosures of which articles below).

CMP was co-author with the late J. Laundré on the study in question (L&P 2020), contributing to its

conceptualization, methodology, validation, and review & editing of the original draft. He did not contribute to the review of L&P 2020 that follows.

Our Review

Overall, L&P exhibited several hallmarks of good science: hypothesis testing, citation to evidence, and open data, given that the data were all pulled from public databases. The authors tested four primary predictions, and the fourth prediction included two related predictions, for a total of six:

"If sport hunting is achieving the management goals sought by state wildlife managers, then California, in the absence of a sport hunt of pumas, should have: 1) higher puma population densities; 2) higher per-capita number of problematic puma-human encounters; 3) higher rate of puma predation on domestic sheep and cattle; and 4) higher levels of puma predation on ungulate populations, resulting in lower hunting opportunities for sport hunting of ungulates... If these predictions are supported by the 40+ year data base available, then it would lend support to the hypothesis that sport hunting of pumas is a reasonable management strategy to obtain the desired results as stated above. If these predictions are not supported, then it would be reasonable to reject this hypothesis." p.4 [5]

L&P argue that the data they employed to test their various predictions are the same data used to justify puma sport hunting, and therefore the data were the best data with which to proceed. In general, however, we believe that the authors would have provided greater insights into the influence of sport hunting on the response variables of interest discussed herein had they utilized a stronger analytical framework and a more diverse set of covariates. The authors' decision to stick with only the data found in public databases, however, was a judgement difficult to assess with science alone. If indeed these are the data driving agency decision-making about sport hunting, then it appears a defensible approach to stimulating discussion and reflection about current assumptions.

Our second general criticism was with the scale of analysis. The authors argue that state agencies make decisions at the scale of states, but we are unclear whether agencies make these assumptions at the geographic scale of entire states, or for smaller game management units (GMUs). We know of examples of both (GMU-level decision-making (e.g., targeted puma hunting in Oregon in response to puma-livestock conflict, public safety issues or failure to meet deer or elk management objectives [7]) and state-wide decision-making, e.g., "PLAN GOAL: Maintain a healthy cougar population within their current distribution while considering human safety, economic concerns, other wildlife species, and maintaining hunting traditions through 2025...Objective 1 Maintain cougar populations within their current statewide distribution" p.3, 21, [8]. In sum, both L&P and the state agencies should conduct appropriate analyses at the appropriate scales.

Below we evaluate each of their predictions in turn:

Prediction 1: California will have higher puma population densities.

The authors standardized abundance data across states to pumas/100 km², and then plotted these data in a figure; there were no confidence levels, so we could not evaluate variation or its significance quantitatively. There were no statistics employed to test this hypothesis, and instead the authors directly compared each state's calculated pumas/100 km² visually and in narrative. Because 4 states with puma hunting had higher reported density than California, they rejected the hypothesis that sport hunting reduces puma density and called the results "equivocal at best" p.8, L&P. We found this weak evidence in support for or against the prediction. Puma hunting results in additive mortality [9] but the impact of hunting on puma abundance varies with many factors not considered by L&P [10], including

the intensity (i.e., proportion of the population killed, duration of heavy killing by humans) and the population dynamics of pumas in adjacent habitats unaffected by intentional human-caused mortality (e.g., immigration [11]). Certainly, hunting can reduce puma numbers in local areas for short periods, but over longer time frames, this is less certain (e.g., [12]). For L&P, state agencies, and future analysts, we recommend that the requisite data on correlates of puma abundance and puma mortality from all causes are collected at similar, smaller scales, even smaller than GMUs in some cases, if anyone seeks to understand the long-term effect of intentional killing of pumas.

It is also well established in the field of ecology that animal abundance is driven largely by resource availability—water, forage (prey for pumas), and refugia where animals are safe. The authors did not include any of these variables in their test of puma abundance across the West, which varies from temperate rainforests to dry deserts. The authors also did not appear to include other forms of human-caused mortality, such as road strikes and depredation removals, which in the case of California may be comparatively higher than other states, e.g., [10]. At the scale of state-wide puma densities, we would expect these ecological variables to play important roles in explaining puma abundance.

Prediction 2: California will have a higher number of per capita puma-human incidents.

We believe the prediction is fair, and the author's inferences are defensible, even though we would again criticize the scale of analysis. Rather than a statistical test, the authors used a similar narrative approach as for Prediction 1 in assessing support for this hypothesis. Puma-human encounters are rare, complex, and beyond our scope [13]. Given that California is among the states with the lowest frequency of terms of human-puma incidents, we found the authors' interpretation of the summary data compelling, but perhaps simplistic.

Prediction 3: California will have a higher percentage of puma predation on domestic livestock.

We believe the authors methods and inferences were sound. Including data from multiple years, the authors generated variation around summary statistics on puma-livestock incidents, and therefore were able to use significance testing to evaluate this prediction. Their within-state before-and-after comparison was a stronger approach than above. They analyzed if the number of pumas killed by human hunters in any given year had any correlation with incidents of predation on livestock the following year, across all 10 western states. This supports recent findings in peer-reviewed literature linking puma harvest or removal rates to puma-livestock incidents [14-16]) and in several other carnivore species also (for empirical results [17, 18]; for reviews of evidence see [19-21]). At the massive scale of this analysis, this is compelling evidence for the potential relationship between killing pumas and increasing conflict with people and livestock, even in the absence of other covariates tested.

Prediction 4: California will have higher puma predation on ungulate populations, specifically deer.

We believe this initial prediction is based on a misunderstanding of puma ecology, but the misunderstanding may be that of state agencies and not the authors. Puma kill rates are remarkably consistent across ecosystems [22] and therefore the only way to increase puma predation on deer would be to increase puma abundance, which is the same prediction as #1 above. The authors went on to test two additional predictions linked to this one, which are more biologically relevant: First, "After 10 years of intensive puma control, states with sport hunting of pumas should experience higher deer densities and densities of deer taken by hunters [a standardized metric reflecting deer killed by permitted hunters) than California," and second, "There should be a positive correlation between deer hunter success and the sport killing of pumas the previous year." We believe the methods and

inferences of the authors were sound for these tests. For these predictions the authors included significance tests to evaluate if there is a correlation between puma hunting and deer abundance or hunter take of deer. Two recent meta-analyses support the findings of L&P and show the limited benefits to ungulate population dynamics gained from killing carnivores [23, 24], and more specifically, the unlikely influence of carnivore mortality on overall ungulate abundance.

Finally, we note that L&P has similar shortcomings as do many studies that attempt before-and-after comparison of the effects of predator control, reviewed in [19-21, 25, 26]. All such studies and subsequent ones suffer from the similar weakness of selection bias and treatment bias. Namely, the subjects that underwent treatment and control (if any) were not randomly selected or treatment was applied in a biased fashion to subjects selected by researchers or managers. These are the most prevalent forms of bias in many scientific fields and especially in predator management and ecology because of the difficulty (but not impossibility) of randomized assignment. L&P took the precaution of within-subject analysis which provides superior inference to correlations that do not control for subjects and their experiences over time. We call on scientists to aim higher and respect the studies that reduce confounding variables more highly than those that do not.

State Agency Post-publication Review of Laundré & Papouchis

In 2022, the Washington Department of Fish and Wildlife (WDFW) published the report, [“Human-Cougar Interactions: A Literature Review Related to Common Management Questions,”](#) (hereafter WDFW Team). The WDFW chose the Team explicitly for expertise and objectivity: “The Human-Cougar Interaction Science Review team was created...[for] review of the science on the topic of human-cougar conflict objectively.” pp. 2-3, [6] [emphasis added]. First, we assessed the diversity in experience and worldview among WDFW team members. From the report: “The [Team] was created under the guidance of [WDFW’s] Chief Wildlife Scientist, Game Division Manager, and Wildlife Program Director. WDFW members were selected whose roles included cougar research and management or who brought unique skills related to the assessment of scientific methods and literature. WDFW sought external (non-WDFW) team members to bring additional perspectives to the work of the team. The primary criterion for external team members was that they had experience with cougar research and management or had strong research design skills or had exceptional quantitative skills.” pp. 2-3, [6].

The WDFW convened 11 authors, of which six were employees of WDFW: two authors held the office of the above-referenced Chief Wildlife Scientist and Game Division Manager, one author was the Deputy Director of the Wildlife Program, and 3 others were subordinate employees of these WDFW managers pp. 71-73, [6]. Therefore, a majority of the 11-member expert team and authors were employees of the state agency summarizing policy-relevant guidance to the agency and overseeing Commission. To imagine why this might pose a problem for impartiality, consider the difficulty of being impartial when your boss is observing you.

“Additionally, WDFW staff interviewed external members to see if they could approach the task of doing a critical review of the science on the topic of human-cougar conflict objectively (i.e., did not already have a fixed view of the literature on the topic).” pp. 2-3 [6]. Interviews are fertile ground for confirmation bias in which one gets the answer one prefers. The costs to impartiality are particularly likely when leaders of an agency that distributes funds are conducting the interviews. Even for those

who might never earn a dollar from engaging with the WDFW, there are non-financial competing interests associated with government. Concerns about government capture by special interests have a long history in environmental regulation [4, 27, 28]; carnivore conservation and management is no exception [29-32], including for cougars [33, 34].

Finally, we don't know what is meant by a "fixed view of the literature" in the quotation above. If the interviewers knew the literature well enough to evaluate if an interviewee had a fixed view, it suggests some presuppositions about the literature may have already existed.

The diversity of the WDFW Team was low by other criteria: 100% current or former employees of government agencies, among other homogeneous traits pp. 71-73, [6]. Prior research on carnivore management shows agency scientists' worldviews differ significantly from their constituents [35, 36], or differ from majorities of scientists [37]. The latter landmark study surveyed 593 grizzly bear scientists to ask about protections for bears. "Overall, a majority (74%) of scientists recommended continued Endangered Species Act protections for Greater Yellowstone Ecosystem grizzly bears." However, "agency experts were 7.3 times more likely to recommend delisting grizzlies" over maintaining protections [37].

The WDFW Team evaluated L&P in a paragraph, quoted in full below:

"Laundré and Papouchis (2020) made questionable assumptions (#1) in their design, and their methodology had substantive shortcomings in data assimilation and analysis (#2). The authors misapplied a treatment-control-design (i.e., claimed a treatment-control design was used when it was not) (#3), used poorly justified and questionable variables for deer and livestock abundance (#4), modeled phenomena at a statewide scale that no published work has ever suggested operated at that scale (#5) (e.g., predation effects on deer), and dismissed general outcomes (e.g., that higher levels of human harvest can reduce cougar numbers) that have been well documented to have occurred in numerous field studies across several states (#6). It appears likely that data dredging was a prominent feature in the analyses (#7) of Laundré and Papouchis (2020). An a priori advocacy goal dominates the authors' Introduction and Conclusion sections (#8)." pp.18-19, [6], emphasis and bracketed numbers added; we confirm the above paragraph is the only written critique of [5].

Initially, we note that 6 of the eight bracketed statements above are unsubstantiated assertions of fact because there is not a single citation included to support them. We did, however, find some supportive definitions and literature for (#3) and (#7) in the methods section of [6]. Below we address each callout in turn.

(#1) "questionable assumptions":

We did not find support for this criticism because the WDFW Team did not define or identify the assumptions that were questionable. Nor did they present evidence to support this accusation. For example, in our own review we specifically questioned the assumptions of scale and cited evidence from puma kill rates and from state agency management plans to do so (above). Therefore, (#1) has no validity in its current form as a sweeping dismissal.

(#2) "substantive shortcomings in data assimilation and analysis":

We found some support for this statement. We are unclear as what was meant by "data assimilation," but we believe L&P used the available public data in innovative methods. The WDFW did not

explicitly explain what shortcomings they identified in the analyses, but as you will see above, we too criticized some methods, and argued for changes in scale or for broadening the list of potential covariates that could have been explored in evaluating predictions. We also felt that the authors made defensible assumptions, analyses and inferences in other instances. Therefore, we find criticism (#2) too sweeping and non-specific.

(#3) “claimed a treatment-control design was used when it was not”:

We concluded that this criticism [3] was misleading and erroneous as a point of scientific design. The WDFW Team defined “treatment-control” as “...exploring dynamics of cougars or their prey typically necessitates a control/treatment design using population manipulation achieved through intentional removals or increases or decreases in cougar or ungulate harvest (e.g., Logan and Runge 2021).” p. 6, [6]. Note that the example they cite does not cite L&P. Therefore, we examined whether L&P’s methods conformed to the definition in the quote above to evaluate if their criticism in [6] is accurate. In L&P, the first paragraph of methods stated, “State and Federal data sets used in our analysis include: 1) estimates of puma abundance, 2) numbers of pumas killed yearly by sport hunters and other causes, 3) estimates of deer populations, 4) estimates of the number of deer killed yearly by hunters, 5) estimates of the inventory of livestock, cattle and sheep, and 6) estimates of the number of livestock, cattle and sheep killed by pumas.” p.4 [5]. Therefore, it appears L&P studied “Intentional removals or increases or decreases in cougar or ungulate harvest” p. 6 [6] just as required by the WDFW Team’s definition. While the intent of the cougar removals or decreases or increases of cougar and deer populations was not to provide L&P with data, such natural experiments are often exploited in science to draw inference about large, wild-populations [23, 38-41].

If the WDFW Team’s criticism (#3) of L&P was instead that the data were not intentionally divided into treatment and control but rather haphazardly divided by events on the ground, then the Team should have considered the possibility of selection bias (e.g., [19, 20]). However, that seems unlikely because the WDFW Team cited [42] for their definition of treatment/control, and those authors wrote about their own work, “Our research was an un-replicated case study on 1 geographic area having a before and after treatment effect design without a separate control area where pumas were not hunted.” p.5, [42]. That design is very similar to the design in L&P, and furthermore, neither the replicated treatment/controls nor the harvest of pumas in [42] was designed by the researchers. Probably, L&P produced stronger inference because they compared several different sites at the same time over years. Therefore, we find criticism (#3) misleading and invalid.

(#4) “poorly justified and questionable variables for deer and livestock abundance”:

We conclude that this criticism is unwarranted. The data analyzed by Laundré and Papouchis (2020) were pulled from public databases maintained by state and federal agencies, and in our opinion, very relevant to the predictions being tested. We were not alone, as integral to the peer-review process of a journal such as PLoS One is the assumption that independent peer reviewers evaluated the suitability of the variables and took into account their shortcomings, before they supported the publication of the paper. We would argue that additional covariates and data would have been useful in testing the predictions more thoroughly and building a more defensible scientific method, but the variables included seemed pertinent to the questions being asked. The WDFW Team did not substantiate its criticism and made it in a cursory fashion in its report, therefore we are inclined to trust the PLoS One reviewers on this issue.

(#5) “modeled phenomena at a statewide scale that no published work has ever suggested operated at that scale”:

We conclude that this criticism is both inaccurate and accurate, depending upon the prediction in question. First, such statement necessitates a systematic review of the literature ([43], which the WDFW Team did not undertake, so they seem to be making this accusation based only on the literature they are familiar with. Peebles et al. (2013), for example, analyzed human-puma conflict data at the GMU scale but made inferences at the state-level. Mattson et al. (2011) analyzed puma attacks on people and made inferences about scales larger than states. Further, even if this accusation were accurate, it would not invalidate the approach. Novel approaches are essential to scientific progress. We share the WDFW Teams apparent concerns about analyzing data at the statewide scale, but we specified how the state may sometimes be appropriate above. Therefore, we find criticism (#5) inaccurate, sweeping, and inflammatory.

(#6) “dismissed general outcomes (e.g., that higher levels of human harvest can reduce cougar numbers) that have been well documented to have occurred in numerous field studies across several states”.

We agree with the WDFW Team about their specific example, even though the WDFW team provided no evidence to support this general criticism. We discussed the importance of time and geographic scale when assessing the impact of hunting on puma abundance in our own review. We cannot assess criticism (#5) further because we would be forced to interpret their vague claim that L&P dismissed general outcomes. If the WDFW Team meant to conclude that human-caused mortality always results in a long-term decline in cougar abundance, we suggest instead that intensity and diversity of human-caused mortality need to be considered. Therefore, we find criticism (#6) cursory and vague.

(#7) “data dredging was a prominent feature in the analyses”:

We concluded that this accusation was unjustified. The WDFW defined data dredging as “...(analysis unguided by specific questions in the hopes of finding something of interest; Nuzzo 2014, Parker et al. 2016).” p.14 [6]. L&P however, made a concise statement of one hypothesis with 6 predictions, which we outlined above in our own review. The Results were relevant to the six predictions also. The data used by L&P were justified and collected from public sources. We find no validity to criticism (#7). Indeed, the word ‘dredged’ has an unscientific tone to it.

(#8) “An a priori advocacy goal dominates the authors’ Introduction and Conclusion sections”:

We concluded this criticism [8] is a vague ad hominem attack. It contains a common erroneous assumption that scientists should not advocate for anything [44]. In the current context, this criticism seems ironic because the WDFW Team is itself drawing inference with the goal to advocate. Furthermore, the journal PLoS One that published L&P instructs referees to judge submissions on their scientific merit, not the importance, urgency, or other unscientific criteria. Therefore, the WDFW Team replaced its own partial judgment with that of the ostensibly impartial, anonymous, independent peer reviewers recruited by a third-party (the editors of PLoS One).

Recommendations For Policy-makers Using Scientific Reviews

We disagreed with much of the review of L&P conducted by the WDFW Team. We are concerned that the WDFW team eliminated the possibility that this paper be included in the education of policy-makers on human-carnivore interactions. Every study has strengths and weaknesses that should be

identified following accepted scientific standards that are openly cited and considered thoughtfully by any post-publication review teams. Peer-reviewed science, such as that included in PLoS One have been vetted by reviewers selected after declaration of potentially competing interests. Post-publication reviews conducted by homogeneous groups lacking an external review process may not hold the same standards of objectivity. We disclosed all of our potentially competing interests in this Comment and subjected or writing to editorial review by PLoS One as a way to avoid this potential pitfall. This case study illustrates the importance of policy-makers understanding the standards for objective, independent reviews of scientific evidence as an aid in their decisions.

There are remedies for failures of impartiality and a loss of objectivity. First and foremost, is diverse representation and inclusion. “The greater the diversity and openness of a community and the stronger its protocols for supporting free and open debate, the greater the degree of objectivity it may be able to achieve as individual biases and background assumptions are ‘outed’ ...” p.63 [4]. The recent movement to Open Science with its incentives for transparency, self-correction, and replication of scientific findings is also an excellent start for scientific actions as we have defined them here. Among the many tools for improving our own objectivity as scientists, Open Science provides a coordinated toolkit. Its encouragement for transparency in all actions all involved actors, its requirements for data sharing, its provision of registered reports, and its focus on the reproducibility of results offer hope for a brighter future with more objective science.

For agencies and organizations seeking an authentic independent review of science before decisions are made, we summarize our general recommendations as follows:

- A. Relinquish ideas and actions to control the constitution or methods of the review team because undue political influence readily interferes with the scientific process of open debate and criticism.
- B. Diversify the pool of candidates for review teams and enlarge that pool to avoid ‘echo chambers’ that promote or even reify one worldview;
- C. Articulate the goals of the review in impartial scientific language as used in systematic reviews (e.g., <https://www.conservatione...>);
- D. Never gag the review team members or edit the language or modes of communication by the review team members lest you lose the trust of scientists and the public at large;
- E. Allow minority reports and comments, as consensus tends to make dissenting voices inaudible; and
- F. Apply consistent scientific standards to avoid the appearance or reality of post hoc or hypocritical review. Stipulate the standards of scientific evidence beforehand using third-party, impartial sources.

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Relevant Disclosures

We declare no financial competing interests.

Adrian Treves

Treves' work was cited by the WDFW Team and by L&P as follow:

- Ohrens, O., C. Bonacic, and A. Treves. 2019. Non-lethal defense of livestock against predators: flashing lights deter puma attacks in Chile. *Frontiers in Ecology and the Environment* 17: 32-38.
- Ohrens, O., A. Treves, and C. Bonacic. 2016. Relationship between rural depopulation and puma-human conflict in the high Andes of Chile. *Environmental Conservation* 43: 24-33.
- Treves, A. and K. U. Karanth. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. *Conservation Biology* 17: 1491-1499.
- Treves, A., 2009. Hunting for large carnivore conservation. *Journal of Applied Ecology* 46: 1350-1356.
- Treves A. Hunting for large carnivore conservation. *J Appl Ecol.* 2009; 46: 1350–1356.
- Artelle KA, Reynolds JD, Treves A, Walsh JC, Paquet PC, Darimont CT. Hallmarks of science missing from North American wildlife management. *Sci Adv.* 2018. 4: eaao0167.
<https://doi.org/10.1126/sciadv.aao0167> PMID: 29532032

Treves' list of funding sources since 2007 and CV for all potential non-financial competing interests related to work outside of his institution: [All funding awarded to Adrian Treves as of 13 April 2022](#) and a CV [for disclosure of potential competing interests](#).

Mark L. Elbroch

Citations in this work: Elbroch's work was cited by the WDFW Team and by L&P as follow:

- Elbroch LM, Quigley H. Social interactions in a solitary carnivore. *Curr Zool*, 2017; 63: 357–362
<https://doi.org/10.1093/cz/zow080> PMID: 29491995
- Elbroch, M. L. and H. Quigley. 2019. Age-specific foraging strategies among pumas, and its implications for aiding ungulate populations through carnivore control. *Conservation Science and Practice* 1: e23.

Research and Employment

Elbroch maintains current research on pumas in Washington, California, Chile and Argentina, defined as active data collection via capture and GPS technology or camera traps. He has worked for Panthera, the global wildcat science and conservation organization, since 2012 when he graduated from the University of California, Davis with a doctorate in Ecology.

Literature: Elbroch has contributed to mainstream books and peer-reviewed literature, most of which is focused on puma ecology and conservation. Books are available [here](#), and scientific resources are accessible via [Google Scholar](#) and [ResearchGate](#).

Outreach: Elbroch actively engages with the media and in various outreach capacities, mostly with regards to puma ecology and conservation. Most video content can be found [here](#) and other media [here](#).

Funding: Elbroch’s direct support for the last 5 years, all of which is dedicated to puma conservation, has come from the Ayers Wildcat Conservation Trust (\$1.6 million), Fat-Cat Fish Company (\$500,000), Regina Bauer Frankenberg Foundation (\$220,000), Carroll Petrie Foundation (\$550,000), Summerlee Foundation (\$270,000), National Geographic Society (\$30,000), and other private individuals (\$98,000).

Memberships and Professional service (unpaid)

IUCN Cat Specialist Group (member)

American Society of Mammalogists (member)

International standards committee, CyberTracker International

Director, CyberTracker International

Wild Felid Association (previous Chair for Grants Committee and General Council)

Peer reviewer for numerous scientific publications.

Elbroch is also a member (unpaid) of 1) WDFW Cougar Focus Group, with a focus on providing guidance with regards to stakeholder outreach materials, 2) Texans for Mountain Lions, which is advocating for changes in state policy and regulation with regards to the species, 3) Cougar Research Collaborative, which explores puma dispersal and the potential biological and social carrying capacities for pumas to return to historic range, and 4) other groups composed of academics analyzing shared data sets.

Fred W. Koontz

Koontz and Washington Department of Fish & Wildlife (WDFW) and Washington Fish & Wildlife Commission

From 2011 – 2017, Koontz collaborated with WDFW on endangered species recovery programs for western pond turtle, Oregon silverspot butterfly fly, and Oregon spotted frog. He served on WDFW’s Wildlife Diversity Advisory Council, 2012-2018; Budget and Policy Advisory Group, 2018; and the Snoqualmie Wildlife Area Advisory Committee, 2020. He also served in 2021 as a Commissioner on the Washington Fish & Wildlife Commission.

Professional Service (Koontz retired from full-time employment in 2017)

Current activities (unpaid): Board Member (Vice-president), [Wildlands Network](#); Advisory Board, [Wildlife for All](#); Fellow, [PAN Works](#).

Current professional society memberships (unpaid): [The Wildlife Society](#); [Society for Conservation Biology](#); and [Wild Felid Research and Management Association](#). Recent professional society presentations include those at the North American Congress for Conservation Biology (July 2022) and The Wildlife Society Annual Meeting (November 2022).

Publications on Washington state wildlife: (1) Wainstein, M., Harding, L.B., O’Neill, S.M. *et al.* 2022. Highly contaminated river otters (*Lontra canadensis*) are effective biomonitors of environmental pollutant exposure. [Environmental Monitoring and Assessment, 194, 670 \(2022\)](#). And (2) Pramuk, J. F. Koontz, M. Tirhi, S. Zeigler, K. Schwartz, and P. Miller (eds.) 2013. [The Western Pond Turtle in Washington: A Population and Habitat Viability Assessment](#). IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, MN.

Past employment (2011 -2017): Vice President of Field Conservation, [Woodland Park Zoo \(WPZ\)](#), Seattle, Washington. WPZ collaborates with WDFW on several wildlife projects.

Grants received while employed with WPZ: (1) WPZ Project Lead, \$20,000 awarded in 2015-2016 from [Wilburforce Foundation](#) to conduct the “Washington Wildlife Leaders Forum,” a conference of 50 leaders who strategized on methods for wildlife agency reform in Washington state, especially aimed at improving non-game wildlife conservation. (2) Various individual donor and [Wilburforce Foundation](#) grants awarded to WPZ, 2013-2017, totaling about \$100,000 to establish and fund WPZ’s “Living Northwest,” a field research and conservation program focused on Washington state wildlife.

Community service: Since moving to Washington state in 2011, community participation relevant to wildlife and WDFW included leading the Biodiversity Task Force of the Central Puget Sound [Regional Open Space Strategy \(ROSS\)](#) in 2015, and serving on [Forterra’s](#) Central Puget Sound Leadership Council, 2015-2017.

Chris M. Papouchis

Papouchis’ work was cited by the WDFW Team and reviewed in this document as follow:

Laundre, J. & C. Papouchis. 2020. The Elephant in the room: What can we learn from California regarding the use of sport hunting of pumas (*Puma concolor*) as a management tool? PloS One 15(2): e0224638.

Employment (since 2001): Lecturer, Environmental Studies department, California State University, Sacramento, 2011-2022; Adjunct Professor, Natural Resources department, American River College, Sacramento, California, 2008-2022; Managing Editor, Wild Felid Monitor, Wild Felid Research and Management Association, 2007-2013. Conservation biologist, The Mountain Lion Foundation, Sacramento, California, 2001-2007

Paid Service as Consultant (nominal fee <\$5000 or expenses only):The Cougar Fund (2008) – drafted comments on WDFW *Draft Supplemental Environmental Impact Statement, 2009 – 2013 Game Management Plan*; Humane Society of the United States (2013)

Unpaid Service as an Advisor/Consultant: The Cougar Fund (2012-2014); California Department of Fish and Wildlife (2014).

Memberships and Professional Service (unpaid): Governing Council, Wild Felid Research and Management Association, 2006-2018; Member, Wild Felid Research and Management Association, 2007-present; Member, Implementation Science Team for the recovery of Sierra Nevada bighorn sheep, USFWS, 2011-present Peer reviewer for the Journal of Wildlife Management; International Journal of Biodiversity and Conservation

Relevant Publications and Reports

Papouchis, C.M. 2007. Pumas and people. Pages 1150-1153 in M. Bekoff, ed. *Encyclopedia of Human-Animal Relationships: A Global Exploration of Our Connections with Animals*. Greenwood Press, London.

Papouchis, C.M. 2007. Human-caused mortality of mountain lions in the American West. Mountain Lion Foundation, Sacramento, California.

Papouchis, C.M. 2006. Living with lions: does sport hunting reduce conflicts with humans? Mountain Lion Foundation, Sacramento, California.

Papouchis, C.M. 2005. Non-lethal approaches for reducing conflicts between mountain lions and people. Mountain Lion Foundation, Sacramento, California.

Papouchis, C.M. 2004. Conserving mountain lions in a changing landscape. Chapter 11 in N. Fascione, A. Delach, and M. Smith, eds. *Predators and People: From Conflict to Conservation*. Island Press, Washington, D.C.

RELEVANT PAPERS PRESENTED AT PROFESSIONAL CONFERENCES

Sweanor, L., J. Beecham, C. Belden, D. Dawn, R. DeSimone, G. Koehler, S. Negri, **C.M. Papouchis**, H. Robinson, and R. Thompson. 2008. Formation of a professional organization: the Wild Felid Research and Management Association. *Ninth Mountain Lion Workshop*, Idaho Fish and Game, Sun Valley, ID (May).

Papouchis, C.M. 2006. Conflict, controversy and conservation: humans and mountain lions in the western U.S. *Carnivores 2006*, Defenders of Wildlife, St. Petersburg, FL (Nov).

Papouchis, C.M. and E.M Cunnison. 2006. People and mountain lions: strategies for coexistence. *Carnivores 2006*. Defenders of Wildlife, St. Petersburg, FL (Nov).

Papouchis, C.M., R.A. Hopkins, and D.D. Dawn. 2005. A new paradigm for managing mountain lions in the 21st Century. *Eighth Mountain Lion Workshop*, Leavenworth, WA (May).

Papouchis, C.M. and T. Dunbar. 2004. Human-caused mountain lion mortality in the western U.S., 1997-2004. *Carnivores 2004*, Defenders of Wildlife, Santa Fe, NM (Nov).

Hopkins, R.A. and C.M. Papouchis. 2004. A new paradigm for cougar conservation in the 21st Century: Distinguishing myth from science. *Carnivores 2004*. Defenders of Wildlife, Santa Fe, NM (Nov).

Papouchis, C.M. and J.D. Wehausen. 2004. Desert bighorn sheep and mountain lions: confronting the challenges. *Desert Bighorn Council Meeting*. St. George, UT.

Papouchis, C.M. 2004. Mountain lion conservation in a changing landscape. *Western Section of the Wildlife Society Conference*. Rohnert Park, CA (Feb).

Papouchis, C.M. 2003. Conserving mountain lions in a changing sociopolitical landscape *7th Biennial Conference on Research on the Colorado Plateau*. USGS - Biological Resources Division. Flagstaff, AZ (Nov).

Papouchis, C.M. and M. Cullens. 2003. Community-based conservation of mountain lions. *10th Annual Conference of the Wildlife Society*. Burlington, VT (Sept).

Papouchis, C.M. 2003. Mountain lions and bighorn sheep. *10th Annual Conference of the Wildlife Society*. Burlington, VT (Sept).

Papouchis, C.M. and L.M Cullens. 2003. Improving our understanding of mountain lion management trends: the value of consistent multi-state recordkeeping. *Seventh Mountain Lion Workshop*. Jackson, WY. (May).

Papouchis, C.M. and J.D. Wehausen. 2002. Conserving mountain lions and bighorn sheep: challenges to resolving an apparent disequilibrium. *Carnivores 2002*, Defenders of Wildlife, Monterrey, CA. (Nov).

Cullens, L.M. and C.M. Papouchis. 2002. Conserving mountain lions in California - a collaborative approach (poster). *9th Annual Conference of the Wildlife Society*, Bismarck, ND (Sept).

Papouchis, C.M. and L.M. Cullens. 2002. After the hunt: challenges facing California's Mountain Lion Population. (poster). *82nd Annual Meeting of the American Society of Mammalogists*, St. George, LA (June).

INVITED PRESENTATIONS, LECTURES AND WORKSHOPS

Marin Humane Society. Novato, CA. September 21, 2010. *Mountain Lions - Saving California's last great predator*

Golden Gate Audubon's monthly Speaker Series. San Francisco Botanical Garden, San Francisco, CA, November 17, 2006. *Saving the mountain lion*.

Pacific Grove Museum of Natural History, Pacific Grove, CA, July 7, 2004. *Co-existing with mountain lions*.

Living with Carnivores forums. Sponsored by the Northcoast Environmental Center and Defenders of Wildlife, Garberville Civic Center and Eureka Community Center, CA, November 17 and 18, 2003. *Co-existing with mountain lions*.

Point Reyes National Seashore Association Field Seminars, Pt. Reyes National Seashore, CA, February 2003. *Mountain lion ecology, management and conservation*.

U.C. Davis, Department of Veterinary Medicine, Graduate seminar in Conservation Biology and Veterinary Medicine Lecture, Davis, CA, January 30, 2003. *Puma conservation in California*.

San Bernardino Community Forum, University of California, San Bernardino, October 23, 2002. *Living with mountain lions*.

U.C. Davis, Graduate Group in Ecology, graduate seminar in Conservation Biology, Davis, CA, October 2002, *Mountain lion conservation and management*.

Point Reyes National Seashore Association Field Seminars, Pt. Reyes National Seashore, CA, February 2002. *Mountain lion ecology and conservation*.

Co-existing with Native Predators Forum, Marin Humane Society, Novato, CA, September 30, 2001. *Co-existing with native carnivores: Living with our wild neighbors*

San Ramon-Dublin community forum on coyotes. Dublin Community Center, Dublin, CA, July 10, 2000. *Living with coyotes*

Motherlode Chapter of the Sierra Club, Lodi, CA, February 2, 2000. *Coyote ecology and the nonlethal resolution of conflicts with livestock*.

San Mateo Coyote Management Forum, Junipero Serra County Park, San Bruno, CA, July 20, 1999. *Preventative non-lethal methods to stem potential conflicts between coyotes and humans on the San Francisco Peninsula*

ORGANIZATION/MODERATING OF SESSIONS AND WORKSHOPS AT PROFESSIONAL CONFERENCES

Organized and moderated panel discussion, *Mountain lions, People and Policy: Improving our prospects for effective conservation of a keystone predator*, Carnivores 2009 Conference. Defenders of Wildlife, Denver, CO. (November 2009).

Organized and chaired session, *Mountain lions: Attitudes and Management*, Carnivores 2009 Conference. Defenders of Wildlife. Denver, CO. (November 2009).

Organized and chaired sessions, *Mountain Lion Ecology*, *Mountain Lion Conservation*, and *Living with Lions*, Carnivores 2006 Conference, Defenders of Wildlife. St. Petersburg, FL (November 2006).

Chaired session, *Political Influences of Mountain Lion Management*, Eighth Mountain Lion Workshop, Washington Department of Fish & Wildlife, Leavenworth, WA. (May 2005).

Organized three sessions on mountain lion conservation, Carnivores 2004 Conference, Defenders of Wildlife, Santa Fe, NM. (November 2004).

Organized and chaired session, *Mountain Lion Conservation*, The Seventh Mountain Lion Workshop, Wyoming Game & Fish, Jackson, WY. (May 2003).

Organized and chaired sessions, *Mountain Lion Conservation and Management*, *Mountain lion Conservation: Managing Change*, and *Cougars, Cores and Corridors*. Carnivores 2002 Conference, Defenders of Wildlife, Monterey, CA. (November 2002).