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Mexican wolf management needs transparency in methods and data inclusion to support suggested policy decisions; a response to Breck et al. (2023)

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Summary

1. Mexican wolves (*Canis lupus baileyi)*, an endangered subspecies of gray wolves, were extirpated in the Southwest United States by the 1970s. Since 1998, reintroduced Mexican wolves have been listed as an endangered species under the U.S. Endangered Species Act. Policies that govern how wolves are managed have changed over time intending to reduce conflict, improve wolf survival, and better manage the recovery of the population.
2. In their analysis on the factors affecting Mexican wolf recovery, Breck et al. (2023) searched for correlates of population growth rate, mortality, and illegal killing and presented a result that led to the suggestion that releases of captive-bred adult wolves should be minimized. Here we identify four shortcomings in Breck et al. (2023) that we argue compromise and dilute their policy recommendations and conclusions: i) policy misalignment, ii) data mismatches, iii) deviations from Liberg et al. (2012) and iv) lack of consideration for genetic consequences.
3. In this forum we describe our concerns with Breck et al. (2023)'s analysis phases, which are based on institutional knowledge and not citable policy implementation and termination dates.

4. We explain how some of the data Breck et al. (2023) chose to include, or exclude, in their analyses do not align with publicly available agency data. We also describe how Breck et al. (2023) deviate from the methods employed by Liberg et al. (2012) without sufficient clarity and explanation despite citing Liberg et al. (2012) as the basis for their modeling.
5. Breck et al. (2023)'s conclusion to limit releases does not consider the genetic consequences their recommendations can have on long-term recovery. Here we describe this oversight.
6. *Synthesis and applications:* Breck et al. (2023) has several shortcomings, such as omissions in the interpretation of policy periods, lack of clarity on data inclusion and exclusion, unclear use of and changes to a referenced model and insufficient consideration of genetic diversity. While democratic, participatory, and transparent processes are needed for fostering coexistence between Mexican wolves and people, recommending reductions in approaches that enhance genetic diversity in this endangered population seems premature without stronger supporting evidence.

Introduction

Breck et al. (2023) analyzed the factors affecting Mexican wolf (*Canis lupus baileyi)* recovery in the US Southwest, by searching for correlates of population growth rate, mortality, and illegal killing. They did so by using the number of wolf removals, translocations and releases as predictors. Louchouarn et al. (2021) conducted a survival analysis on this same population of wolves and inferred that there existed a positive correlation between Mexican wolf unobserved, i.e. cryptic poaching, and policies that removed wolves. However, based on their analysis, Breck et al. (2023) assert that less than one wolf per year was cryptically poached and that illegal killing increased when wolf removals decreased. They also report a positive relationship between the illegal killing of Mexican wolves and the release of captive-reared adult wolves and/or translocation of wolves.

Here we identify four shortcomings in Breck et al. (2023) that we argue compromise their policy recommendations and conclusions. First, the detailed policy history is not adequately explained with sufficient transparency. Second, there are inconsistencies in the method description, and the use of particular data sets. Third, Breck et al. (2023)'s methods are confusing as they do not follow the models they refer to, and why certain data was included and others excluded. Finally, Breck et al (2023), do not fully consider the genetic consequences of their recommendations. These issues could have significant implications for the recovery of the endangered and genetically compromised Mexican wolf population. We find that in combination, these shortcomings result in Breck et al. (2023) making premature conclusions.

i) Policy Misalignment

Mexican wolves were extirpated in the Southwest United States by the 1970s (USFWS, 2019). In 1978, the first pups were born in captivity and in 1998, the first wolves were released into the recovery zone in New Mexico and Arizona. Since then, reintroduced Mexican wolves and their wild progeny have been listed as a non-essential, experimental population under section 10(j) of the U.S. Endangered Species Act (ESA). Two notable policies have impacted wolf management during the study period: Standard Operating Procedure 13.0 ("SOP 13"), in effect from 2005 to 2009, and a change in the 10(j) rule in 2015. SOP 13 was a binding commitment by the United States Fish and Wildlife Service (USFWS) to take lethal or permanent wolf removal actions in response to livestock predation (AMOC, 2005). Removals of wolves under SOP 13 resulted in the population growth rate flattening from 2003 to 2009 (Fitzgerald, 2018). The change in the 10(j) rule increased the recovery area for initial releases of captive-reared wolves and increased allowable forms of take of Mexican wolves among other policy changes. However, after finalization of the new 10(j) rule, state wildlife agencies no longer allowed captive adult wolves to be released into the recovery zone, only allowing the release of fostered pups into wild dens.

Breck et al. (2023) examined how periods with different wolf removal rates and release and translocation policies correlated to population growth rate, mortality, and illegal killing by dividing their analysis into two phases, the first from 1998 - 2007 ("Phase 1") and the second from 2008 - 2019 ("Phase 2"). Their rationale for this choice of periods was based on institutional knowledge about the implementation dates of SOP 13 (Breck et al, 2023 Appendix S1). Although management removals did decrease in 2008, as Breck et al. (2023) suggest, SOP 13 did not officially end until 2009 (USFWS, 2022b). Past studies examining wolf survival or population dynamics in response to policy changes, including one in this same system, suggest that policy start and end dates have important impacts on illegal killing (Chapron & Treves 2016; Louchouarn et al. 2021). Given the evidence in the literature does not support their approach, we urge Breck et al. (2023) to justify their decision to use implementation dates and numbers of wolves removed by management rather than the start and end dates of SOP 13. Further, if Breck et al. (2023) were examining how policies affecting wolf releases relate to illegal killing and mortality, we question why they chose not to mention the change in the 10(j) rule, nor clarify how releasing only fostered pups after 2015 might impact their results.

ii) Data Mismatches

Some of the data Breck et al. (2023) chose to include, or exclude, in their analyses do not align with publicly available USFWS data (USFWS, 2022a,b,c) as we detail below. Moreover, we argue that the discrepancies in these datasets have consequences for Breck et al. (2023)'s conclusions.

Breck et al. (2023)'s Table S1 groups all Mexican wolf management removals from the wild for various reasons into one column as a parameter for their model. The USFWS data publicly available divides those removals into four categories: livestock, nuisance, boundary, and other (Table 1; USFWS, 2022b). The 'other' category may include the re-pairing of wolves, pup management or fostering, veterinary care, or genetic considerations (USFWS, 2022b). Management removals can therefore be split into conflict removals, for livestock and nuisance issues, and non-conflict removals, i.e., removals of wolves crossing the delineated 10(j) recovery area boundary. These removals occur for different reasons, but they were not treated separately in Breck et al. (2023)'s data and model (Table 1). Grouping the causes of management removals of wolves in conflict situations and non-conflict situations poses questions about Breck et al. (2023)'s conclusions that "the removal of wolves that cause conflict could equate to lower illegal killing rates" (Breck et al., 2023). Livestock and Nuisance removal data includes adult wolves with dependent wolf pups in 2005, 2006, & 2007, thereby inflating the number of removals with dependent pups, which are unlikely to cause conflicts (USFWS 2022b).

Breck et al. (2023) assert the most significant finding from their model was the positive relationship between the illegal killing of Mexican wolves and the release of captive-reared adult wolves and/or translocation of wolves. They conclude that this increase in illegal mortality is the result of naive wolves being placed into unfamiliar territories and thus recommend limiting releases and translocations when possible in order to lower the illegal mortality of Mexican wolves (Breck et al. 2023, p. 8). However, the data Breck et al. (2023) included on releases and translocations is inconsistent with the publicly available data from USFWS (see Breck et al., 2024, Table S1; Table 2). Of the 133 translocated wolves included in their data (Table 2), 53 were boundary-related management removals and translocations (Table 1), i.e., dispersers who crossed outside the 10(j) designated management boundary and were often translocated back to their natal pack territories, which are not unfamiliar areas on the landscape for wolves as the authors claim (USFWS, 2015b). Breck et al (2023)'s data also include at least two wolves (M1695 and M1394) captured in the U.S. wild population in 2019 and subsequently translocated to Mexico, which is outside the scope of their analysis (USFWS, 2022b). Breck et al. (2023) do not explain which wolves were included or excluded in their translocation data. It appears that in several years their data includes wolves that were lethally removed from the wild, or captured and retained in captivity under the column of "Translocation", i.e. see data for 2003 and 2011 (see Breck et al., 2024, Table S1; Table 2). Therefore, of the 133 'translocated' wolves on which they based their conclusions, at least 55 (41%) were either not true translocations of new wolves, or were wolves translocated out of the study area and not into it.

In addition, the Breck et al. (2023) data includes four years (2016 - 2019) of fostered pups (n = 30) into the wild as initial releases. We find their inclusion confusing in light of their policy recommendations. The USFWS defines pup fostering as "the transfer of offspring from their biological parent(s) and placement with surrogate parents" (USFWS, 2022d). In a captive-to-wild fostering event, the pups reside with their birth parents in captivity for 14 days or less, until being transferred to the wild and placed in a den with surrogate parents (USFWS, 2022d). Without separating the adult wolf releases from the fostered pup releases in their data, we question how the authors can conclude that adult captive-reared wolves have naïve and nonadaptive behaviors in the wild that lead to more illegal killings (Breck et al., 2023, p. 8, citing Harding et al., 2016). Breck et al. (2023) assert that translocated and released wolves are not familiar with the landscape, may be more likely to cause conflicts and therefore be killed illegally. However, as we explain above, the data the authors use to support this claim is made up of an unknown, and likely significant proportion of wolves who are familiar with the landscape either because they were translocated back to their pack territories. Nearly 24% of the wolf releases in their data consist of fostered pups <14 days of age who were raised by a pack in the wild, which seems to contradict the conclusion that captive-reared releases lead to increased illegal mortality (USFWS, 2022a,d).

Further, although Breck et al. (2023)'s data stopped in 2019 (see Breck et al., 2024, Table S1), they assert in the discussion that the slower population growth rate from 2020 to 2021 was due to lower pup survival, disease outbreaks, drought or other undetected factors. They specifically state that it was *"not a result of increased removal rates or other mortality"* (Breck et al. 2023, p. 8). However, the USFWS public data show a high level of mortality, including illegal mortality and legal mortality for each of these years, as well as high management removals in 2020 and 2021 – potentially contradicting the authors' conclusions (USFWS, 2022c). There were five lethal removals of Mexican wolves in 2020, tied as the highest year for lethal removals since the reintroduction program began, when five wolves were lethally removed in 2006 (USFWS, 2022b). The above quotation by Breck et al. (2023) highlights the lack of clarity around which data were included or omitted in Table S1, when compared to the publically available USFWS Mexican wolf Population data (see Table 1 & 2) (USFWS, 2015a,b,c,d).

iii) Deviations from Liberg et al. (2012)

Breck et al. (2023) test two hypotheses regarding illegal mortality, i.e., poaching: 1) that reintroduction and translocation of wolves would cause increased poaching, and 2) that increased management removals would reduce poaching. Breck et al. (2023) claim to use *" the technique developed by Liberg et al. (2012) to estimate illegal killing rates more accurately,"* (Breck et al., 2023 p. 2202), but then deviated from Liberg et al. (2012) in three important ways that Breck et al. (2023) do not justify.

First, Breck et al. (2023)'s process model updates an overall non-removal mortality rate and subsequently allocates a portion of that model-estimated mortality rate as the poaching rate. In doing so, Breck et al. (2023) assume that unobserved mortality mirrors the patterns of observed mortality, in contrast with Liberg et al. (2012), who assumed that unaccounted-for mortality was overwhelmingly likely to be poaching. In short, given the same dataset, Breck et al. (2023)'s approach will estimate lower cryptic (unobserved) poaching than Liberg et al. (2012)'s approach (Treves et al., 2017). This deviation is material to Breck et al. (2023)'s hypotheses regarding poaching.

Second, Breck et al. (2023)'s modeling approach assumes that cryptic poaching and observed poaching are not fundamentally different processes that may respond differently to policy signals, but rather a single poaching process that is imperfectly observed. This assumption contrasts with Liberg et al. (2012), who treated these as separate mortality variables. Moreover, a previous study of the same Mexican wolf population (Louchouarn et al., 2021) alongside other studies of gray wolf populations

(Chapron & Treves, 2016; Santiago-Ávila et al., 2020; Santiago-Ávila & Treves, 2022) and a red wolf population (Agan et al., 2021; Santiago-Ávila et al. 2022) have repeatedly observed different patterns of cryptic and observed poaching. Sometimes rates of the two types of poaching change in opposite directions as policies changed, hinting at how Breck et al. conflating the two might obscure important patterns.

Third, Breck et al. (2023) do not compare their population-model estimate of cryptic poaching to the number of wolves “lost to follow up,” (i.e. disappeared from monitoring because of a failed or destroyed radio collar) as Liberg et al. (2012) did. In particular, 67 collared wolves were considered “lost to follow up” from 1998 to 2016; 29% of the population dropped out of the monitoring data for this reason (Louchouarn et al., 2021). While individuals lost to follow up are often censored in survival analyses, the decision to do so should be justified and done with care to avoid under-estimation bias for certain causes of death that are associated with transmitter failure such as poaching. We argue that Breck et al. (2023) did not adequately consider or discuss one of Liberg et al. (2012)’s main insights: that disappearances of known individuals from the isolated, closed population of wolves in Scandinavia most likely reflected cryptic poaching.

Moreover, the lack of mention of the disappearances of collared Mexican wolves does not adequately reflect on prior work in the Mexican Wolf recovery zone. Louchouarn et al. (2021) recently demonstrated that the hazard and incidence of Mexican wolf disappearances from 1998 to 2016 correlated with two policies that authorized the removal of wolves, a finding particularly relevant to Breck et al. (2023). Wolves may disappear from a monitored population for three reasons: 1. The wolf migrated out of monitoring range. This is not likely in this case or would affect few collared wolves, given "*the intensive monitoring efforts accompanying the Mexican wolf recovery program*" (Breck et al. 2023, pg.8). 2. The radio collar may fail. While we are well aware single collars fail (Habib et al. 2014 estimate this rate at 13-14% for VHF collars), a series of collar failures would be unusual and would denote a faulty batch of collars. Further, due to the intensive monitoring of the population, a live wolf with a failed collar is more likely to be recovered quickly, and this is generally shown in the data, unless the data are incomplete or not transparently shared. And finally, 3. Wolves die and the carcass disappears with concurrent transmitter failure, which results show (Louchouarn et al. 2021) correlates to the SOP 13 and 10(j) rule change policy periods because these disappearances are most often cryptic poaching (Treves et al. 2017; Liberg et al. 2012) unless the collar failed first (see point 2).

While Breck et al. (2023) refer to Liberg et al. (2012)'s work as the basis for their model, they do not make clear their reasons for substantial analytical deviations from Liberg et al.'s work. In the discussion, they attribute differences between their findings and those of Liberg et al. (2012) to socio-ecological system differences without mention of important methodological differences. We suggest Breck et al. (2023) were free to adapt the model but they should state and justify their modifications of Liberg et al.'s model that are pertinent to their hypotheses, as we have detailed here.

iv) Consideration of Genetic Consequences

Breck et al. (2023)'s conclusion to limit releases considers only the change in the population over time, which they defined in their methods to mean the population size with demographic losses and gains (section 2.2, p. 4). However, the authors did not mention the genetic consequences their recommendations can have on the long-term recovery and persistence of a small, reintroduced endangered population.

All Mexican wolves alive today descended from just seven individual founders from the 1980s. This means the Mexican wolf population descends from one of the smallest effective founder populations of any endangered species ever reintroduced from near extinction (Hedrick, 2017). Mexican wolves have the lowest levels of genetic heterozygosity of any gray wolf population due to human-caused population declines (Taron et al., 2021). Releases and translocations of Mexican wolves serve two important purposes: to increase population numbers and to increase the population's genetic diversity and evolutionary adaptive potential. These important management objectives should be carefully considered before adopting policies that limit wolf releases.

The release of captive-reared adult wolves is a method by which managers attempt to increase genetic diversity as part of a recovery program and was the established technique used to increase genetic diversity in the wild for Mexican wolves since 1998. (USFWS, 2015). However, in 2015, in response to the new 10(j) rule, the game and fish commission of Arizona unanimously opposed the release of any captive-reared adult wolves, and, later that same year, New Mexico denied permits to the USFWS to conduct releases of captive-reared adults (AZGFD, 2015; NMDGF, 2015). Although the USFWS had the federal authority to continue releases in accordance with the 10(j) final rule, they adopted the states' policies to cease adult wolf releases since 2016 (USFWS, 2015; USFWS, 2022a).

Further, the policy decisions by the Arizona and New Mexico state game and fish commissions to oppose captive-reared adult wolf releases were made prior to the first attempted fostering of captive Mexican wolf pups in 2016 (AZGFD, 2015; NMDGF, 2015). Captive-to-wild pup fostering of Mexican wolves had never been done before, and there was no evidence that fostering would be a successful technique for increasing genetic diversity in the wild population (USFWS, 2022a). Breck et al. (2023)'s conclusion to limit captive-reared adult wolf releases aligns with the states' policy decisions, but as we have argued above it is premature due to uncertainties and lack of clarity in Breck et al (2023)'s data and analysis.

Conclusions

We argue that there are shortcomings in Breck et al (2023)'s policy evaluation due to i) omissions in the interpretation of the policy periods, ii) lack of clarity on the inclusion and exclusion of essential available data, iii) unclear modification of the published model they claimed to use, and iv) insufficient consideration of genetic diversity in management recommendations. Therefore, it remains unclear whether the policies limiting adult wolf releases or translocation correlate to illegal mortality, though Louchouarn et al. (2021) suggest they do.

Democratic, participatory, and transparent processes that are informed by scientific evidence and consensus are essential for fostering the coexistence of Mexican wolves and people. However, in the meantime, it seems premature to recommend reductions in approaches that enhance the genetic diversity in an endangered population of wolves without stronger evidence to support the conclusions for doing so.

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Figure Legends

Table 1: A comparison between the data used in Breck et al. (2023) collectively presented as "Management removal" and publicly available data from the USFWS (orange) that detail the causes of Mexican wolf management removals from 1998-2022 (USFWS 2022b). Unexplained discrepancies in the data are highlighted in yellow.

Table 2: Mexican wolf removals from Breck et al. (2024) versus USFWS, 2022b. Data highlighted in yellow represent discrepancies.

Table 1:

	Breck et al. (2024) data (see Table S1)	Causes of Mexican wolf management removals 1998-2022 (from USFWS, 2022b)				
Year	*Management removal*	Livestock	Nuisance	Boundary	Other	Total
1998	6	0	2	1	3	6
1999	12	9	0	0	3	12
2000	23	6	6	5	6	23
2001	10	2	2	6	0	10
2002	7	2	1	4	0	7
2003	15	2	1	12	0	15
2004	7	4	1	2	0	7
2005	21	10*	5	5	1	21
2006	18	16*	1	1	0	18
2007	23	19*	1	3	0	23
2008	2	0	0	2	0	2
2009	7	0	0	4	3	7
2010	0	0	0	0	0	0
2011	2	1	1	2	0	4
2012	1	1	0	0	0	1
2013	6	2	1	2	1	6
2014	13	2	0	2	9	13
2015	4	1	1	0	2	4
2016	2	2	0	0	0	2
2017	10	4	0	1	4	9
2018	4	1	0	1	3	5
2019	9	7	0	0	6	13
	202	**91**	**23**	**53**	**41**	**208**

*Includes adult wolves and dependent pups; see USFWS Annual Reports for additional details.

Other = e.g., re-pairings, cross-foster of wolf pups, wolf pup removal due to adult abandonment, veterinary care, genetic management of population.

Table 2:

	From Breck et al. (2024) data (see Table S1)	Outcomes of Mexican wolf management removals 1998-2022 (from USFWS, 2022b)				
Year	*Translocation*	Lethal Control	Translocated in U.S. population	Translocated in Mexico population	Retained in Captivity	Total
1998	3	0	4	0	2	6
1999	2	0	9	0	3	12
2000	18	0	16	0	7	23
2001	6	0	7	0	3[b]	10
2002	7	0	4	0	3	7
2003	15	1	13	0	1	15
2004	9	1	6	0	0	7
2005	16	1	15[d]	0	5[d,e]	21
2006	6	5	3	0	10[d,b]	18
2007	5	3	11[d]	3[d]	6[d]	23
2008	6	0	2	0	0	2
2009	6	0	5[e]	0	2[e]	7
2010	1	0	0	0	0	0
2011	4	1	2	0	1	4
2012	0	0	0	0	1	1
2013	3	0	2	0	4[e]	6
2014	12	0	11[e]	0	2	13
2015	1	1	1[e]	1[e]	1	4
2016	0	0	0	0	2	2
2017	2	1	2[e]	0	6[e]	9
2018	5	0	4[e]	0	1	5
2019	6	1	5[e]	2	5[e]	13
	133	**15**	**122**	**6**	**65**	**208**

[a] Translocations indicated above may not have occurred in the year of removal
[b] One wolf died during non-lethal removal activities
[c] Standard Operating Procedure 13.0 (Control of Mexican Wolves) was finalized on 10 October 2005, however, management-related wolf removals throughout the remainder of 2005 were conducted under the auspices of an earlier draft version. SOP 13.0 guidelines were authorized through 2 December 2009.
[d] includes adult wolves and dependent pups; see USFWS Annual Reports for additional details.
[e] e.g., re-pairings, cross-foster of wolf pups, wolf pup removal due to adult abandonment, veterinary care, genetic management of population.
(from USFWS, 2022b)