# MEMO

Date: 27 September 2014 (Note amendments to the August 25th version are highlighted)
To: U.S. Fish and Wildlife Service Officers: Daniel Ashe (Director), Robert Dreher (Associate Director), Tom Melius (Region 3 Director), Charles Wooley (Region 3 Deputy Director)
From: A. Treves, PhD, B. Bergstrom, PhD, D. Parsons, MS, P. Paquet, PhD, R.P. Thiel, Certified Wildlife Biologist (Retired), Jonathan Way, PhD,
Subject: State of Wisconsin report on gray wolf post-delisting monitoring year 1

**Purpose**
The purpose of this letter is to notify the U.S. Fish & Wildlife Service (USFWS) about scientific concerns that the best available science was not used in gray wolf, *Canis lupus*, management and monitoring in the Western Great Lakes region (WGL) during the period 28 January 2012 – 31 December 2013. This letter shares an independent scientific review of the State of Wisconsin's wolf management report (state report hereafter) for 5-year post-delisting monitoring (PDM) mandated by the ESA (*1*).

We describe three concerns:

a. The State of Wisconsin's wolf population status and monitoring report is incomplete, does not use the best available science, and perhaps unintentionally misleads the reader.
b. We are concerned that two new threats may be serious for the Wisconsin wolf population, yet no independent, scientific peer review has been conducted on the severity of the threats or the adequacy of regulating or monitoring those threats. The state report does not acknowledge these concerns.
c. The State of Wisconsin changed monitoring methods in the winter of 2013–2014 rendering inter-annual comparisons impossible, which clashes with the PDM.

We recommend three remedies:

1. We recommend the USFWS return Wisconsin's annual report for the first year of PDM for revisions that use the best available science. We recommend numerous detailed improvements for the state.
2. Given that concerns (b) and (c) cannot be remedied by revision of the report, we also recommend an independent, scientific, peer-review panel be convened to advise the USFWS on potential action.
3. We also recommend improvements to the data request submitted by the USFWS for the future PDM.

**Concerns**

*a. Monitoring data reported to the USFWS*

**We found significant omissions of information, unorthodox methods, and statements that could potentially be misleading in the state report to the USFWS.**

*Methods*
On 31 December 2013, the Wisconsin Department of Natural Resources (WDNR) posted online an official report to the USFWS as required by the WGL Post-Delisting Monitoring (PDM) plan (*1*). We refer to this as the state report (accessed 31 January

2014 at http://dnr.wi.gov/topic/Wildlifehabitat/wolf/documents/PostDelistMonitor.pdf). We based our evaluation on the state report (relevant passages are highlighted in yellow in the report, Appendix 2), three years of approved wolf-harvest proposals from the WDNR (*2-4*), and a subsequent account of wolf monitoring in 2013–2014 . These represent the public records we used to prepare this letter as well as the data request sent to WGL agencies by the USFWS (Appendix 2).

When calculating mortality rates, we used the minimum off-reservation population estimate of 774 in 204 packs for late-winter 2011–2012 and 779 in 205 packs for late-winter 2012-2013 as provided by the state report in Tables 1a and 1b respectively. We refer to off-reservation wolves only, because the state had no authority to manage wolves on-reservation. The state report does not make clear where wolves died. Also the Ojibwe tribes refused to harvest wolves (*6*). Discussing harvest, quotas, and management may be offensive to Ojibwe (*7*).

In the text that follows, we underline information from the state report. The report is not paginated so we cite tables or use direct quotes whenever possible. Our conclusions are in **boldface**.

The USFWS wrote to Mr. Thiede (WDNR) on August 16, 2012 the following: "…we will be requesting *any* data your state may compile on the following categories… *Mortality…Changes in regulatory mechanisms* affecting the protection or management of the species, its prey, or its habitat… If feasible, please categorize mortalities as follows: legal control actions (e.g., depredation control), road kill, illegal take, disease, intra-specific aggression, euthanasia (e.g., of diseases wolves), and unknown." ((reproduced in Appendix 2 below, emphasis added) among other requests we do not address.

*Findings*
We began by examining the mortality data presented in the state report.

The state report noted 267 wolf mortalities, including 117 harvested in the period 27 January 2012–30 June 2013 (see Table 2a-c in the state report). The state reported, "In the period April 15, 2012 – April 14, 2013 WDNR personnel recorded 230 wolf mortalities (Table 2b) representing 28.22% of the 2012 minimum population."

**The casual reader might assume 28.22% is a mortality rate. It is not. Furthermore it is potentially misleading because it is a serious under-estimate of the mortality rate as we explain below. The statement in quotations resembles a statement about a mortality rate because it is expressed as a percentage of the April 2012 population. However it is actually a 'detection of dead wolves' rate.**

**Reporting mortality in this way makes interannual comparisons extremely difficult because the state did not report the effort devoted to search detection, and reporting dead wolves. By making interannual comparisons extremely difficult, the state report does not comply with the PDM plan promulgated by the USFWS in 2008 (*1*).**

**Although it would seem that the WDNR complied with the data request, they actually withheld information as we describe below. In the past, the WDNR reported mortality rates based on radio-collared animals. That was not done properly or completely as we explain below.**

The standard in wildlife research is to examine causes of mortality among a sample of marked individuals that lived for known intervals. Known "fates" allow researchers to estimate life-history traits such as mortality rates with greater precision and accuracy than possible using unmarked animals that have to be opportunistically detected (*8, 9*). For >45 years, such analyses have been standard for radio-collared wolf mortalities (*8, 10-15*).

**The state report omitted information on how many radio-collars disappeared during the monitoring period yet they have these data (D. Macfarland pers. comm. August 13, 2014) because it is collected inevitably during monitoring (i.e., pilots report a missing signal).**

When marked animals disappear, omitting them from analyses is a known biasing factor in wildlife research (*9, 16*). That omission leads to under-estimation of mortality rate, if even a single mortality followed a disappearance.

We were unable to remedy the inappropriate censoring of radio-collared animals retrospectively without an Open Record request. However it was the responsibility of the state report to present such information.

**The state did not report the number of radio-collared wolves that disappeared. The state did not report the date of death of the radio-collared animals it recovered. Omission of these data and the analyses these data allow was not explained. Independent scientific review such as ours was hindered by the omission of information from the state report.**

The state report did present some information on radio-collared wolves as follows:

<u>The 267 dead wolves included 23 with radio-collars. There were 63–88 radio-collared wolves alive at some point during the monitoring period. At some point in the complete wolf-year, 25 additional wolves were live-trapped and radio-collared.</u>

**The state report did not handle the data mentioned above in the standard manner.**

A common first step in analyzing radio-collared animals' mortality data is often to examine if they died in proportion to their numerical representation in the population (i.e., were marked animals representative?).

**The easy, common step of evaluating quantitatively if marked animals died in proportion to their numerical representation was not done and no explanation for why not was provided.**

We calculated that the radio-collared mortalities represented 8.6% of the total mortalities or 23 of 267. Overall 63 wolves were monitored at the start of the wolf-year and followed until death or disappearance that wolf-year [1]. We estimated that the 63–88 radio-collared

[1] The 25 additional radio-collars introduced during that year were omitted from our analyses because the length of time they were monitored was not reported. The exact dates of collaring or radio-collared mortality were omitted from the state report. Few if any wolves were radio-collared January–July 2012 due to administrative changes in the wolf management team. Therefore our estimate that assumes a full-year

animals represented 8.1–11.3% of the off-reservation population in April 2012.

**Because that range of values encompassed the 8.6% radio-collared wolves among the mortalities, we concluded that radio-collared wolves died with a frequency as expected from their numerical representation in the population.**

The state report omitted the above calculation and instead dismissed the radio-collared sample as follows, "Mortality on radio collared wolves was higher than historic averages, 21 radio collared animals died during the monitoring period (Table 2b)".

**The WDNR did not present historic averages or a reference to a scientific study demonstrating unrepresentative mortality in the radio-collared sample of 2012. That would be an important finding with ramifications for population estimates and many other policy-relevant parameters (*17*). We examined the public record and found no support for the assertion that radio-collared animals died at higher rates in wolf-year 2012 or before (*2-4*). We reject the state report's assertion quoted above as misleading.**

Although the state report omitted essential information on disappearances of radio-collared wolves, dates of mortality for radio-collared wolves, and the starting date for newly radio-collared wolves, we could still estimate a minimum mortality rate based on the 63 radio-collared wolves monitored since the start of the wolf-year. Our estimate (33%) is a minimum estimate for four reasons:

1. Any disappearances of radio-collared wolves might have been mortalities, which would increase the calculated mortality rate.
2. Any of the newly radio-collared wolves or starting 63 wolves that died during the wolf-year under consideration should be considered to have had a 'lifespan' briefer than one wolf-year yet we calculate the rate per wolf-year from those alive at the start of the monitoring period.
3. The date of death of the 63 radio-collared wolves would allow us to calculate days alive rather than assuming a full wolf-year elapsed before death.
4. The WDNR has long focused its radio-collaring efforts on non-pup wolves in pack areas, which are likely to be resident adults who tend to have lower mortality rates than dispersers or pups (*17*).

**Despite our estimate being a minimum and clearly an under-estimate of mortality rate it is still higher than the 28.22% recorded mortality for all wolves presented prominently in the state report, which a casual reader might misinterpret as a mortality rate. Because the state report did not present our calculations this appears deliberately misleading.**

Why did the state report mortality of 28.22%? The state report presented 28.22% based on the detection of mortality in both radio-collared and non-radioed wolves.

**Inclusion of non-radioed wolves must be done with great care because of several likely biases. Non-radioed wolves provide imprecise and inaccurate estimates of mortality rate, because people must encounter their carcasses by chance and then report them, or alternately be the perpetrators themselves and choose to**

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would tend to under-estimate mortality similar to excluding disappearances. Because wolf pups are almost never radio-collared in Wisconsin, our analyses are largely unaffected by the emergence of pups.

**report the mortality. Therefore, mortality estimates that include non-radioed wolves inevitably underestimate *total mortality* by the number of undiscovered carcasses. The state report neither explained the above under-estimation bias nor did it take the necessary precautions in analysis when reporting 28.22% of the April 2012 population.**

The state report made only one mention of unreported mortalities: "We speculate the reporting rate for wolf mortalities has declined since federal delisting, this may partially explain the low number of *natural mortalities* detected" (emphasis added).

**That statement acknowledges under-reporting bias and notes a problem with changes in reporting frequency. By the data request we quoted above and the PDM (*1*), a change in monitoring or regulatory effectiveness should be reported as such. It was not. However, the state report goes further. It attributes the under-estimate to *natural mortalities* going unreported rather than the probable larger number of *undetected poaching* events going unreported.**

Poaching is known to be very difficult to detect by law enforcement, rarely reported by the perpetrators, and a significant source of mortality in large carnivore populations (*13, 18-23*). The best study of missing wolf mortalities found that poaching was systematically and substantially under-estimated because poachers destroyed evidence and telemetry collars (*12*). Those authors found 67% of poaching events—51% of all wolf mortality—were concealed and no carcass recovered (*12*). The WDNR was aware of the above-referenced Swedish study.

**The state report included data on law enforcement as requested, but no transparency about under-reported poaching. Attributing under-reporting to undetected natural mortalities rather than to undetected poaching could mislead the USFWS and other readers.**

We examined poaching in the state report. Again radio-collared data were instructive.

Among 21 radio-collared wolves reported dead, 4 died from harvest, 4 from lethal control permits, 4 from vehicle collision, 2 from nonhuman causes, and 7 from poaching (these data were included in the state report Table 2b).

Thus, poaching accounted for 11% of radio-collared wolves monitored at the start of the complete wolf-year and one-third (33%) of reported radio-collared wolf mortalities (7/21), whereas nonhuman mortality accounted for 3% and 10% respectively.

Furthermore, if we apply the Swedish study to Wisconsin's data, another 42 poaching mortalities (or 22% of radio-collared mortalities if that many disappeared) might be included in total mortality.

Therefore the observed mortality rate of radio-collared wolves = 33% (21/63) which is a known under-estimate for 4 reasons we explained above. If even one radio-collared wolf disappeared and died (which is likely) the mortality rate would be at least 35%. If the Swedish study is applicable, the mortality rate could be as high as 55%.

**These steps might put the range of possible mortality rates as high as 35–55% or 7–27% higher than the 28.22% reported prominently by the state. When one**

**considers the radio-collared mortality sample is an under-estimate of actual mortality rates, the state report's failure to acknowledge poaching or address it scientifically raises additional concerns. The public record provides no evidence to dismiss our estimates. Indeed past reports to the Wisconsin Natural Resource Board provided mortality rates based on radio-collared animals, which allow interannual comparisons. The state report appears to withhold such data and analyses.**

A relaed set of concerns surfaced when we evaluated the WDNR population model and its predictions. Appendix 1 at the end of this document presents the state report of the WDNR wolf population model, predictions, and assumptions in tabular format. We found no other mention in the public record, or a published model. Therefore, we restricted our examination to the state report.

That model is important because it was used to make decisions about harvest quotas among other decisions. We assume that the best available science demands a scientific presentation of their population model given its importance. To be scientific, the state report should illuminate the population model's assumptions, structure (parameterization and internal operations), and the monitoring methods and results used to parameterize the model. Risky or cautious assumptions should be understood to reflect on the predicted impacts of harvest on wolf population status. We classified each assumption as CAUTIOUS if it over-estimated the impact of harvest on the wolf population and RISKY if it under-estimated the impact of harvest. When the scientific literature was absent or unsettled, we classified an assumption as UNCERTAIN. We also noted cases where the wording of assumptions was UNCLEAR. This step allowed us to evaluate the clarity of the public record. A single assumption in the state report could earn two classifications (e.g., UNCERTAIN and UNCLEAR).

**Appendix 1 presents our point-by-point evaluation of transparency (UNCLEAR or CLEAR), classification of impact of harvest (RISKY, CAUTIOUS, or UNCERTAIN), and the use of peer-reviewed science in the state report. In summary, seven assumptions were made in the model. We classified five as RISKY, four as UNCLEAR, three as CLEAR, two as UNCERTAIN, and zero as CAUTIOUS. The five RISKY assumptions led one to underestimate the effects of harvest on the wolf population. The four unclear assumptions could not be evaluated fully because of unclear wording or incomplete information. In addition, our review of the public record found the WDNR model was not published or independently peer-reviewed before implementing harvests (*2-4*).**

The state report went on to make a prediction for 2014 based on the model: "one-year population reduction of 3.4–22.6% (median 12.72%) if the total 2013 quota of 275 is achieved, other mortality rates remain at historic levels and depredation control results in removal of 10% of the wolf population (unpublished data)".

**The condition that "other mortality rates remain at historic levels" seems unfalsifiable because the state report did not specify the historic mortality rates. That omission does not comply with the data request.**

However the WDNR had previously reported a historic mortality rate estimate of 32–48%

(2), without providing methods or conclusions [2]. Nevertheless we used that estimate because it was in the public record. Likewise we adhered to the WDNR assumption of a completely additive harvest of 275 wolves—even though that assumption is not cautious (Appendix 1). Accordingly, the 2013 harvest represented a 35% mortality rate (275 out of a population estimated at 779 off-reservation). We added the above-mentioned historic mortality rate range to the harvest mortality rate for an expected, total mortality rate of 67–83%.

According to the WDNR's public record (NRB greensheet 2012), historic mortality levels were 32-48% without harvest. Add that to the 2012 harvest of 15% (117/774) = 47-63% after harvest. They tell us int he state report that there was a 0.74% population decline by April 2013.

**If we accept these data, then in 2013 that mortality rate of 47-63% after harvest would have increased by 20% because of the higher quota in 2013 (35% of the off-reservation population 275/779 instead of 15% as in 2012).**

**Therefore – if no hidden assumptions were introduced – the wolf population should have declined 20.74% by April 2014.**

Yet the state predicted a 3.4–22.6% (median 12.72%) decline by April 2014.

**So we concluded the model had hidden assumptions or an unpublished historic mrotality rate.**

**The prediction appears to require additional assumptions about compensatory mortality or reproduction. There is no explanation for the discrepancy in the state report, the data used have not been provided as requested by the USFWS, and the model is not published or publicly available. Therefore we conclude it does not use the best available science.**

The state report also predicted, "the wolf population will be 595 (95% CI: 512-677) in 20 years".

**This prediction is unclear. It is unclear because one might interpret the prediction to mean the wolf population will reach the stated level by the end of 20 years. Alternately one might interpret it to predict stability for the duration of 20 years. The prediction cannot be falsified for this reason and the problems noted above so the prediction is unscientific.**

**In sum, we found the data presented in the state report were incomplete, the analyses were inadequate in places, and some of the underlying data were improperly handled. The population model on which harvest and other decisions were based was not presented scientifically in the state report or public record, and may have had hidden assumptions or a miscalculation. Our independent, scientific evaluation also addresses potentially misleading items in the state report. Prominent among these is the report of 28.22% mortality in wolf-year 2012.**

[2] From the NRB greensheet 2012, the paragraph beginning "The combination of…" presents the WDNR's estimate of total mortality hazard without a hunt as 22–33% (human-caused) and 82% of the latter rate or 18–27% would be additional (nonhuman risk) as described in the preceding paragraph.

**This is potentially misleading because it used an unorthodox calculation and concealed the major source of unreported mortality (poaching). The report does not use the best available science and in so doing it precludes interannual comparisons as required by the 5-year post-delisting monitoring plan under the Endangered Species Act of 1973 as amended.**

*b. New threats*

Ten months after delisting, the Wisconsin wolf population experienced the first-ever public, hunting-and-trapping season from 15 October – 23 December 2012 and those same dates again in 2013; the latter season added a new method of chase, using up to 6 hounds per licensed hunter to 'track and trail' wolves (Wisconsin Act 169). On July 10, 2014, the Wisconsin Court of Appeals allowed training hounds on wolves year-round, night and day, without strict regulation anywhere free-running hounds are allowed, and without safeguards for wolves or hounds. The preceding historical facts suggest two new threats have emerged.

The first threat is hound-hunting wolves in 2013, which has never been studied scientifically (A. Treves, affidavit provided for Wisconsin Federated Humane Societies, Inc. et al. v. Stepp, Court of Appeals District IV, AP000902, 2013). Given that wolves and the large hounds used to track mammalian game are extremely similar and wolf attacks on hounds are well-documented in Wisconsin (*24, 25*), the most reasonable assumption is that hounds pose a threat to wolves, especially pups and lone wolves.

The second threat is the unregulated use of this novel training method that cannot guarantee the safety of wolf pups or older wolves confronted by a pack of ≥6 hounds. This activity is currently unmonitored because the timing, location, and method of hound training are not currently regulated and there are no provisions for informing law enforcement when training is underway.

**Both of these potential threats could be severe and could require additional regulation to avoid unlawful or unsustainable take of wolves ('take' being defined by the ESA as '"to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct', ESA Sec. 3(19)). Without more scientific information on both of the above potential threats, assurances by authorities or interest groups should not be definitive. The state report should have described the change in regulatory and monitoring systems if any, which allowed them to monitor these new threats.**

*c. Changes in monitoring that reduce comparability between years*

In April 2014, the WDNR released a preliminary report on the minimum, late-winter 2013–2014 population estimate (Appendix 2).

**The monitoring methods changed in the winter 2013–2014 if not earlier, therefore independent scientists cannot evaluate interannual changes in population or the WDNR's interpretation of the data. This appears to violate the PDM plan requiring states to monitor in a way that allows for interannual comparisons.**

One change in monitoring and reporting has been documented. The Great Lakes Indian Fish & Wildlife Commission was refused access to the meeting, in which data

aggregation and interpretation occurred (*5*) accessed 22 May 2014 at http://thepoliticalenvironment.blogspot.com/search?q=wolf). This step prevented one independent assessment. In addition, four changes in monitoring appear to have occurred relative to prior years (*26*): (i) novice trackers' data appear to have been included contrary to the prior 15 years of practice; (ii) it is unclear if those trackers underwent the training required since 2000; (iii) expert trackers appear not to have verified data and performance of all novice trackers; (iv) methods for data analysis changed for the first time in at least 14 years (AT, personal observation). Specific to the latter change, civilian trackers and the public were barred from observing the meeting, whereas, in the past, an opportunity for public dialogue had preceded interpretation of each volunteer trackers' data and discrepancies between WDNR staff and volunteer data were reconciled in open dialogue.

**We were unable to confirm if monitoring data were handled properly as we have done for years. Lack of transparency is not consistent with the use of best available science or the PDM plan.**

*Agency responsibility*

We acknowledge that scientists within and outside the decision-making agencies attempt to balance diverse interests as well as regulatory requirements in the face of scientific uncertainty. Failure to strike that balance is not a reflection on their integrity or abilities. Agency scientists may find themselves pressured by their superiors and unable to communicate freely. **The solution seems to us to engage independent scientists with academic freedom who have no direct conflicts of interest.**

We also acknowledge that a clear public record, and the use of the best available science are subjective ideals that cannot be evaluated scientifically. Nevertheless Wisconsin's state report on its wolf population and harvest impacts contains statements and methods of analysis that can be evaluated scientifically. These fell short of standards for accepted methods, conventional analyses, clarity, and scientific consensus on the use of best available science as mandated by the ESA and PDM.

*Summary and recommendations*

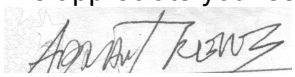
1. **The State of Wisconsin report to the USFWS contains unorthodox methods for analyzing wolf mortality data, which run counter to decades of scientific practice and do so without sound reasoning or clear explanations. This conflicts with the use of best available science.**
    a. **The state report did not transparently describe the rate of wolf mortality among radio-collared wolves. Moreover it would have been a clear under-estimate yet was substantially higher than an unorthodox and misleading figure reported prominently (28.22%). We recommend against presenting the lower figure and instead describing under-reporting and appropriate rate calculations clearly and transparently. We recommend revision of the handling of mortality data and full presentation of required data as requested by the USFWS and as detailed in this Letter.**
    b. **The state report made unscientific assumptions about future wolf population status based on an unfalsifiable model that has never been presented fully or with proper scientific peer review. We recommend deletion of this model and its predictions until scientific consensus is**

established on how to make such population projections in Wisconsin.

c. **We recommend suspension of the Wisconsin wolf harvest until the scientific public record is clear that the wolf population will stay above the state's threatened level (250) with a 99% probability. The latter estimate must take into account uncertainty and variance in the input data.**

2. **Facing unmonitored new threats (hound-hunting and hound-training), potential increases in an old threat (poaching), and changes in monitoring methods, we express strong scientific concerns about Wisconsin's wolf management.**
   a. **We recommend an independent scientific review by scientists from multiples disciplines who have peer-reviewed, scientific publications on wolf mortality, hound-hunting, or human dimensions of poaching.**
   b. **The independent scientists should be chosen to avoid those with conflicts of interest or otherwise beholden to the USFWS or the WDNR. That panel should be authorized by the USFWS to inspect all data collected by the State of Wisconsin.**
   c. **We recommend the Secretary of the Interior consider the option of emergency relisting, as provided in Section 4(b)(7) of the Endangered Species Act of 1973 as amended, because completion of the independent review using the best available science will require time but the Wisconsin wolf harvest is set to resume 15 October 2014. We recommend emergency relisting be considered because the monitoring data provided through April 2014 did not allow independent scientists to evaluate the current status of the Wisconsin wolf population.**
3. **Finally, we recommend the USFWS modify its data request for future years. Specifically we recommend that the request emphasize *all data* be presented in a standard format and that data from marked animals be presented separately from those for unmarked animals along with the start and end dates for monitoring all marked animals including those that disappeared. We also recommend that USFWS instruct reporting agencies to omit unpublished models and methods from such reports and that deviations from conventional, accepted methods be scientifically justified or avoided.**

We appreciate your serious consideration of the above concerns,



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Appendix 1: The state report presented a population model described in the first cell of the table below.

| |
|---|
| "WDNR personnel consulted with the Van Deelen lab… to assess the likely impacts of harvest on the wolf population. Population modeling conducted by the Van Deelen lab estimates one-year population reduction of 3.4-22.6% (median 12.72%) if the total 2013 quota of 275 is achieved, other mortality rates remain at historic levels and depredation control results in removal of 10% of the wolf population (unpublished data). This model predicts the wolf population will be 595 (95% CI: 512-677) in 20 years if harvest [1] and mortality rates (percent of the population) [2] remain constant. Assumptions of this model include harvest occurs prior to the breeding season [3], background mortality risk remains constant [4], harvest in MN and MI remain at 2013 rates [5], all mortality sources are additive [6] and wolf behavior and dispersal do not change in response to harvest [7]." (state report, p. 5, superscripts added; see below for key to each) |
| 1. It is unclear if this refers to the absolute number of wolves harvested or percent of the population. Neither the absolute quotas nor the proportions were constant. Regardless the model predicts the wolf population will stabilize at a high mortality rate (see text). That makes the assumption UNCLEAR and RISKY. A cautious model would specify the quota and a probability of extinction or relisting. |
| 2. We interpreted "mortality rates (percent of the population) remain constant". Theory predicts a non-linear population response (depensatory) to increasing human-caused mortality so assuming constant mortality rates is RISKY (*10, 23*). A cautious model would add harvest rate to the maximum mortality rate in recent years under similar management. |
| 3. The wolf-hunt spans 15 October–28 February by law. Because the wolves' breeding season starts in mid-winter (http://dnr.wi.gov/topic/wildlifehabitat/wolf/facts.html#Breeding), it seems likely that mating could be prevented by harvest. Wolf-hunts in 2012 and 2013 ended December 23rd. Yet the removal of a breeder long before the mating season can disrupt breeding for an average of 2.7 years (*11*) The frequencies of disbanding or breeding failure more than doubled when both breeders died, hence the higher the quota the more disruption of breeding would be expected. Note that findings by Borg et al. (*27*) that Alaskan wolf population growth did not change as a result of breeder loss require analyses that take into account observation error and uncertainty not simple regressions. Therefore assumption 3 is UNCLEAR (why assume something that is apparently false?) and RISKY. A cautious model would assume harvest-related breeding failure. |
| 4. Mortality risk refers to the proportion of dead wolves attributable to any given cause (as opposed to assumption 2 about rate), whether poaching, lethal control, nonhuman causes, etc. Assumption 4 treats these risks as relatively similar to historical risk levels. At face value that is impossible because any change in one mortality cause (e.g., harvest) demands that the proportions of all others decrease, because they sum to 1. Moreover some hypothesize that harvest will reduce depredation and poaching rates while others predict it those rates will increase (*18, 28*). Therefore assumption 4 is UNCLEAR and UNCERTAIN. |
| 5. Wisconsin has no control over neighboring states' quotas. In 2013 Minnesota halved its quota (*29*). In 2013 and again in 2014, Michigan faced challenges to its wolf-hunt design and quota. This assumption seems to serve as a proxy for assuming that migration rates will not change. Therefore assumption 5 is UNCLEAR and its effect is UNCERTAIN. |
| 6. Additive mortality is generally assumed and considered cautious. However Vucetich (*23*) detected a non-linear (depensatory or super-additive mortality) population response to increased human-caused mortality, when using a statistical model built on data from 37 North American wolf populations. Also Creel and Rotella (*19*) reported an average super-additive mortality of 106% (92–120%) when analyzing similar data. Others have inferred compensatory reproduction (*30*) but the evidence remains equivocal as noted in 3 above. Therefore assumption 5 is RISKY. A cautious model would assume super-additive mortality averaging 106%. |
| 7. Wolf packs typically become unstable after removal of breeders (13, 27, 31). As pack size diminishes, the proportion of breeders per pack rises (30). Removal of breeders may affect pack stability and reproductive performance for years (13, 27). Given the small packs found in Wisconsin, harvest is equally (or more) likely to remove breeders as to remove auxiliary individuals. Also the behavior of survivors may change if packs disband. Therefore assumption 8 is RISKY. A cautious model would treat packs that lost a breeder as non-breeding for years. |

Appendix 2: Data request from the USFWS and documents from the WDNR, which comprise the public record we analyzed (attached).

- Population estimates, pack numbers, and distribution;
- Mortality;
- Disease and parasite occurrence;
- Verified or probable depredation incidents and follow-up actions;
- Changes in regulatory mechanisms affecting the protection or management of the species, its prey, or its habitat;
- Law enforcement investigations of wolf mortality; and,
- Other information on the status and distribution of wolves in the state.

If feasible, please categorize mortalities as follows: legal control actions (*e.g.*, depredation control), road kill, illegal take, disease, intra-specific aggression, euthanasia (*e.g.*, of diseased wolves), and unknown. If this information is already summarized or described in separate reposts, please provide copies or access to those reports.