UNITED STATES FISH & WILDLIFE SERVICE

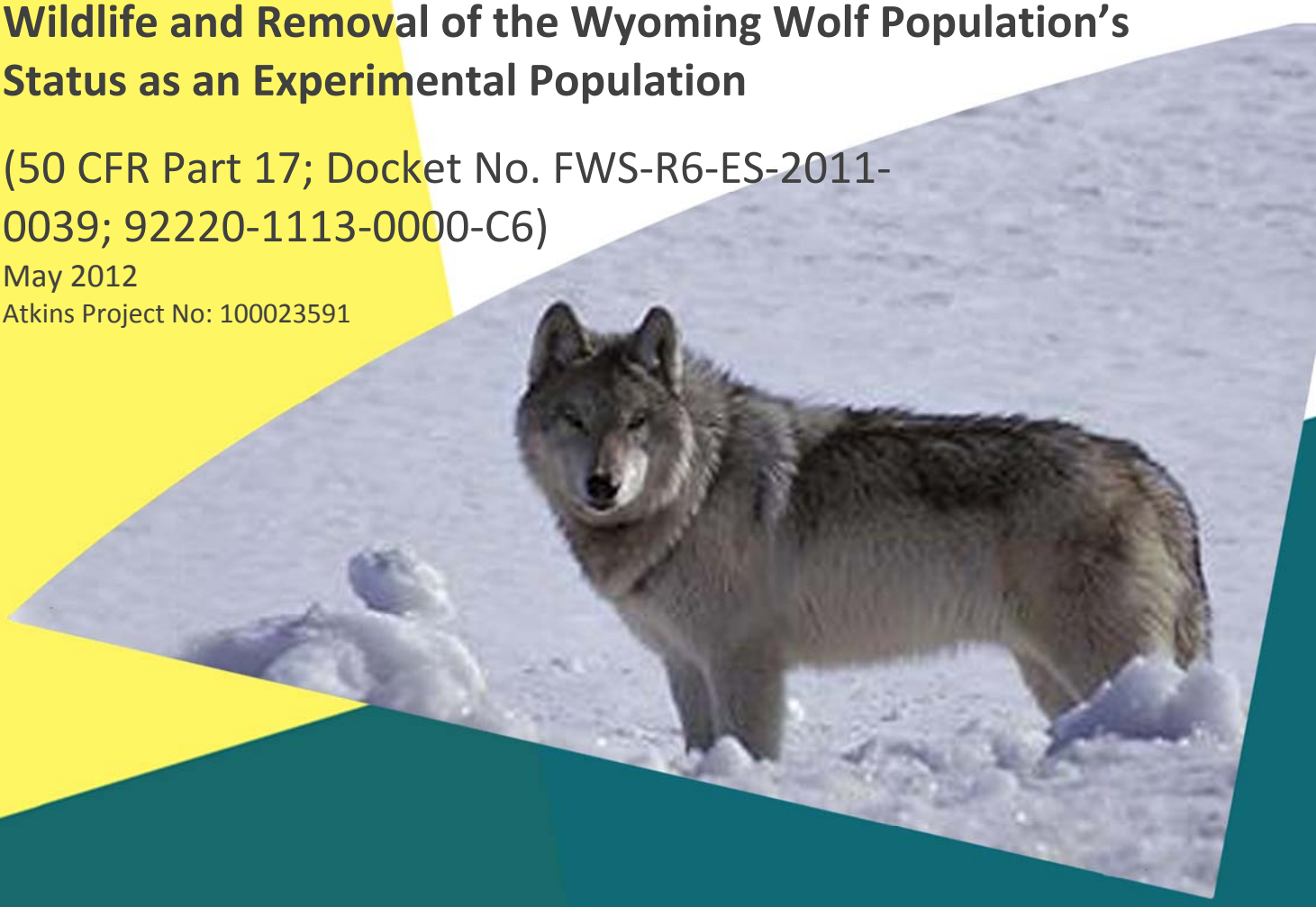
Final Peer Review of Four Documents Amending and Clarifying the Wyoming Gray Wolf Management Plan

Proposed Ruling: Removal of the Gray Wolf in Wyoming from the Federal List of Endangered and Threatened Wildlife and Removal of the Wyoming Wolf Population's Status as an Experimental Population

(50 CFR Part 17; Docket No. FWS-R6-ES-2011-0039; 92220-1113-0000-C6)

May 2012

Atkins Project No: 100023591



Plan Design Enable

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United States Fish & Wildlife Service Proposed Ruling: Removal of the Gray Wolf in Wyoming from the Federal List of Endangered and Threatened Wildlife and Removal of the Wyoming Wolf Population's Status as an Experimental Population (50 CFR Part 17; Docket No. FWS-R6-ES-2011-0039; 92220-1113-0000-C6)

Final Peer Review of Four Documents Amending and Clarifying the Wyoming Gray Wolf Management Plan

Panel Reviewers:

Dr. Layne Adams, *USGS Alaska Science Center*
Dr. David Mech, *USGS Northern Prairie Wildlife Research Center*
Dr. Scott Mills, *University of Montana*
Daniel Stark, *Minnesota Department of Natural Resources*
Dr. John Vucetich, *Michigan Technological University*

Third-party Contractor Staff:

Richard McEldowney (Atkins), Project Lead/Logistics
Dr. Tom St. Clair (Atkins), QA/QC
Dr. Steven Courtney (RESOLVE), Primary Author

Executive Summary

In 2011 the U.S. Fish and Wildlife Service (USFWS) requested Atkins to administer an impartial and independent peer review of the Wyoming Gray Wolf Management Plan, which they were considering for approval. During the initial scientific review, Atkins received a diverse set of opinions from five highly qualified experts. While most reviewers stated that the proposed management plan followed the scientific literature and appropriate standards, there was a minority opinion that the plan was not well grounded in science on several issues.

Following the initial peer review, Wyoming Game and Fish Department and co-operators (including USFWS) negotiated and wrote changes to the plan, and elaborated scientific responses to the points raised by all reviewers, but especially the concerns raised about 'buffering' the population against extinction risk. The enacting legislation also included language clarifying this issue. These new materials and amended plans were then sent to the same five reviewers who had reviewed the initial plan, to determine the reviewers' response to the changes made. Each reviewer was asked to address four questions regarding the agencies' responses to the initial review.

Three of the five reviewers are fully assured that the documents are well-prepared, based on the best available science (with a few minor suggested additions), and will support continued recovery of the population. Although some of the responses to the questions were brief, they appear to be well based in scientific opinion.

One reviewer (Dr. Mills) had substantive comments regarding monitoring and adaptive management. The technical issues raised by Dr. Mills regarding detectability and monitoring effort are pertinent and may be important going forward. Atkins recommends that agency staff consider these comments carefully in drafting any final adaptive management plan. Dr. Mills also comments that he finds no assurance that managers will be able to respond using adaptive management. This appears to be outside the strictly scientific scope of the review.

Dr. Vucetich was substantially more critical of the new documents than the other four reviewers. One of Dr. Vucetich's fundamental points is that he believes that his initial review was read as stating that the plan lacked detail and explanation – some of which is now provided. However, he believes that his critique was more focused on scientific substance than on lack of detail. Atkins notes that the substantive changes made to the plan are in direct response to reviewers' (mostly his) comments, and these changes are not simply cosmetic. We believe that the agencies have made efforts both to improve the science and to better explain it.

At the core of the discussion and disagreement voiced by Dr. Vucetich is human caused mortality. He argues that it is impossible to gauge the expected effect of human caused mortality on the population without a specified numerical buffer (in this he is joined by Dr. Mills). Dr. Vucetich also argues in detail that the expected resilience of the population is over-

estimated, based on a mis-reading of the literature by the agencies, and inappropriate use of outlying opinion (i.e., Gude et al. 2011).

Dr. Vucetich's review also contains several other points that have force, and should be considered by the agencies, notably:

1. The word 'buffer' can be, and is, used in several ways
2. The size of the buffer is left undefined
3. Without this information, the exact risk to recovery is not well understood or defined
4. Immigration, but not emigration, is discussed
5. His extensive analysis of alternative approaches to demographic analysis

At least the first four of these points are well made, and might be rectified to the extent practicable.

Dr. Vucetich (as did Dr. Mills) also makes numerous comments on the practice of adaptive management. We reiterate that these points, although they may be well thought through, are addressed to issues of management and policy, and not to matters of strictly scientific subject matter, and hence fall outside of the 'scientific peer review' scope of this work.

Ultimately, the level of risk to the wolf population that is acceptable must be determined by the USFWS; such a risk acceptance determination is a policy rather than a purely scientific issue. Whether or not the risk is 'too high' therefore falls outside the scope of this review. However it is within the scope of this review to determine whether the risk is well-characterized and whether the plan has fairly assessed the quality of all available science. On this basis, Atkins recommends that any final decision and analysis considers an explicit description and discussion of the full range of human caused mortality that has been observed, and also evaluates the effects on predicted extinction risk if assumptions about 'acceptable' human caused mortality are incorrect.

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1.0 Introduction

1.1 Initial Review

In 2011 the U.S. Fish and Wildlife Service (USFWS) requested Atkins to administer an impartial and independent peer review of the Wyoming Gray Wolf Management Plan, which they were considering for approval. During the initial scientific review, Atkins received a diverse set of opinions from five highly qualified experts. While most reviewers stated that the proposed management plan followed the scientific literature and appropriate standards, there was a minority opinion that the plan was not well grounded in science on several issues.

Atkins staff carefully considered the arguments made by the different reviewers, and the evidence they presented. Atkins also attempted to separate out issues of scientific opinion and fact from other issues which were essentially policy or management decisions, and hence fell outside of the scope of the review.

On one issue, Atkins decided that those reviewers opposed to human-mediated gene-flow were opposed to the practice on philosophical rather than scientific grounds. Because of this Atkins labelled such opinion as personal and management-oriented rather than scientific.

Most importantly, one reviewer of the five argued strongly that there was insufficient protection by (and indeed any documentation and commitment to) a buffer above the minimum number of wolves to be protected. On balance, Atkins staff agreed with the single reviewer, and recommended to the USFWS and Wyoming Game and Fish Department (WGFD) that this was a serious scientific issue meriting substantial additional attention.

1.2 Second review

Following the initial peer review, WGFD and co-operators (including USFWS) negotiated and wrote changes to the plan, and elaborated scientific responses to the points raised by all reviewers, but especially the concerns raised about 'buffering' the population against extinction risk. The enacting legislation also included language clarifying this issue.

These new materials and amended plans were then sent to the same five reviewers who had reviewed the initial plan, to determine the reviewers' response to the changes made (Appendix A). The procedure adopted was as follows:

1. The reviewers were sent the new materials, and asked to read them and consider any areas where they felt the need for clarification.
2. If any reviewer felt the need for clarification, Atkins and USFWS would convene a teleconference call, and USFWS staff would respond to any questions raised at that time. This call would have been recorded and notated.

This process was designed to ensure that all reviewers had equal access to the materials, and all information, and hence that each reviewer was operating under identical conditions.

In any event, no reviewer felt the need for clarifying questions, and therefore no additional information was discussed. Each reviewer completed his review based solely on the information provided to them by Atkins (Appendix A).

Each reviewer was asked to address four questions regarding the agencies' responses to the initial review:

1. Did the agencies understand your major scientific comments and provide scientifically based responses?
2. Do the proposed management documents have a solid basis and demonstrate an adequate understanding of the scientific literature, including that cited in your review?
3. Do the amended plans increase the probability of maintaining the populations' recovered status by providing for the desired population buffer?
4. Does the best available science provide for sufficient support for the position that the proposed approach is likely to maintain a recovered wolf population?

Each reviewer prepared a response to all of these questions. Note that for some of the reviews it is necessary to read them in their entirety to understand the response to the above four questions.

2.0 Review Results

Appendix B provides each of the five reviews verbatim. As before, there were differences of opinion among the reviewers on substantive scientific issues.

We will first summarize the reviewers' responses in Table 1 below, before discussing the major issues raised. We emphasize that this summary table is Atkins' own *précis* of the reviewers' responses.

Table 1. Summary of panelist responses to questions posed to them regarding the four documents.

Question	Peer Review Panelist				
	Adams	Mech	Mills	Stark	Vucetich
Did the agencies understand your major scientific comments and provide scientifically based responses?	Yes	Yes	Yes. More literature	Yes	No

Question	Peer Review Panelist				
	Adams	Mech	Mills	Stark	Vucetich
Do the proposed management documents have a solid basis and demonstrate an adequate understanding of the scientific literature, including that cited in your review?	Yes	Yes	Mostly	Yes	No
Do the amended plans increase the probability of maintaining the population's recovered status by providing for the desired population buffer?	Yes	Yes	Management documents do not provide this assurance	Yes	No
Does the best available science provide sufficient support for the position that the proposed approach is likely to maintain a recovered wolf population?	Yes	Yes	Yes	Yes	No

3.0 Review Details

Three of the five reviewers are fully assured that the documents are well-prepared, based on the best available science (with a few minor suggested additions), and will support continued recovery of the population. Although some of the responses to the questions were brief, they appear to be well based in scientific opinion.

One reviewer (Dr. Mills) had substantive comments regarding monitoring and adaptive management. The decision, whether or not to adopt adaptive management in the face of uncertainty, is not a scientific issue – it is a policy choice that falls to decision-makers who must balance science with other issues (e.g., conservation benefit, budget, etc.). However the *design* of adaptive management programs and especially monitoring components is a technical subject. The technical issues raised by Dr. Mills regarding detectability and monitoring effort are pertinent and may be important going forward. Atkins recommends that agency staff consider these comments carefully in drafting any final adaptive management plan. Dr. Mills also raises the issue that the size of the buffer is left undefined; this is an issue of scientific concern.

By contrast, Dr. Mills also comments that he finds no assurance in the language of the management documents that managers will be able to respond using adaptive management. While this is certainly a viable opinion to which Dr. Mills is entitled, it appears to be outside the strictly scientific scope of the review.

The final reviewer, Dr. Vucetich, was substantially more critical of the new documents than the other four reviewers. Essentially his position is an extension of many of the points raised in his earlier review of the first set of documents and plans. Dr. Vucetich has provided a full and well-

elaborated explanation of his opinions, including a new mathematical analysis of demography (not seen by the other reviewers).

A fundamental point of Dr. Vucetich's is that he believes that his initial review was read as stating that the plan lacked detail and explanation – some of which is now provided. However, he believes that his critique was more focused on scientific substance than on lack of detail. Atkins believes that Dr. Vucetich's position is itself not entirely accurate. The substantive changes made to the plan are in direct response to reviewers' (mostly his) comments, and these changes are not simply cosmetic. We believe that the agencies have made efforts both to improve the science and to explain it better.

At the core of the discussion and disagreement voiced by Dr. Vucetich is human caused mortality. He argues that it is impossible to gauge the expected effect of human caused mortality on the population without a specified numerical buffer (in this he is joined by Dr. Mills). Dr. Vucetich also argues in detail that the expected resilience of the population is over-estimated, based on a mis-reading of the literature by the agencies, and inappropriate use of outlying opinion (i.e., Gude et al. 2011). If he is correct in this assessment, then it follows that the wolf population will be at a higher risk than currently perceived, precisely to the extent that the adaptive management plan is unresponsive to maintaining an adequately sized population buffer.

Dr. Vucetich's review also contains several other points that have force, and should be considered by the agencies, notably:

1. The word 'buffer' can be, and is, used in several ways
2. The extent of the buffer size is left undefined
3. Without this information, the exact risk to recovery is not well understood or defined
4. Immigration, but not emigration, is discussed
5. His extensive analysis of alternative approaches to demographic analysis

At least the first four of these points are well made, and might be rectified to the extent practicable.

Dr. Vucetich (as did Dr. Mills) also makes numerous comments on the practice of adaptive management. We reiterate that these points, although they may be well thought through, are addressed to issues of management and policy, and not to matters of strictly scientific subject matter, and hence fall outside of the 'scientific peer review' scope of this work. For instance the statement "the plan seems more like a plan for how to develop a plan rather than a plan in and of itself" is a strongly made point, but it addresses a perceived management insufficiency rather than a scientific inadequacy.

We note that Dr. Vucetich (page 7 of his comments) argues forcefully that peer-reviewed publications are not the totality of best available science, an issue particularly important in management contexts. This is a correct statement. Scientific information, published or not, must be evaluated on its merits. While publications that have survived peer review are often regarded

with more credibility by many scientists, unpublished manuscripts and simple observations are also important parts of the record.

Ultimately, the level of risk to the wolf population that is acceptable must be determined by the USFWS; such a risk acceptance determination is a policy rather than a purely scientific issue. Whether or not the risk is 'too high' therefore falls outside the scope of this review. However it is within the scope of this review to determine whether the risk is well-characterized and whether the plan has fairly assessed the quality of all available science. On this basis, Atkins recommends that any final decision and analysis considers an explicit description and discussion of the full range of human caused mortality that has been observed, and also evaluates the effects on predicted extinction risk if assumptions about 'acceptable' human caused mortality are incorrect. It may be useful, for instance, to more fully explain how a monitoring program would allow swift corrective action to halt harvest (through the adaptive management approach) in the absence of a specified numerical buffer.

Appendix A. Materials Sent to Reviewers

April 3, 2012

Dear Reviewer:

This is a quick heads-up about timelines and expectations for the final phase of the wolf review.

As you know, the Service has contracted with Atkins and the peer review panel to review the proposed rule and the conclusions reached in light of Wyoming's recently updated regulatory framework. Specifically, in consult with the peer review panel, the Service has asked Atkins to provide a written assessment of whether these revised documents adequately address the concerns raised by the panel in the original report.

You have already received a set of documents; you are free to read them for background. However on April 10th we will send you a letter from the USFWS that sets out all the key points of these documents, changes from what the proposed rule discussed, and a Service assessment. That letter and the subsequent final Federal Register document will be the main focus for the final part of the review, as they will describe changes including those in response to your earlier comments.

We would like to follow the following procedure:

a. On April 10th we will send you the letter
b. If you have any questions about the materials, or feel the need for any clarification, please email them to me.
b. I will relay these to Seth Willey of USFWS.
c. If the issues or questions are relatively minor, we will send a clarifying email to all of you, answering such queries.
d. If the issues appear to warrant discussion, we will set up a conference call, where Seth (and perhaps other Service leadership as deemed necessary or appropriate) will answer your queries, and you may discuss the issues as a group.
e. You would each then write a response to the questions above, sending these directly and only to me.
f. We will then collate the comments into a final report, with a summary.

We are on a fairly tight time-line: we must receive the final comments no later than May 3, so that we can deliver the final report during the open public comment period. However since our task this time is far less wide-reaching I do not think this will be onerous a task. Nevertheless we will have to hit the following deadlines

April 10th: This letter
April 16: Send me any queries or request for clarification
April 26/27: Conference call if needed
May 3. All comments to me

If you'd like to chat with me informally about the process, or discuss these expectations, please give me a call at 202-965-6382. Rich McEldowney is the project manager, taking over the role

initially performed by Stephanie Lauer. Rich will be taking care of all logistical issues, and should be your first point of contact for getting documents etc., or if you can't reach me.

Thank you for your continuing support of this important effort to integrate science into public processes.

Sincerely,

Steven

Steven Courtney, PhD
Director of Science
RESOLVE

April 10, 2012

Dear reviewer:

The initial phase of the peer review process appears to have gone very well. The staff of the USFWS and the State of Wyoming have thoroughly reviewed your useful comments and our overall report.

As you know, the Service's October 5, 2011, proposal to delist Wyoming gray wolves relied heavily on Wyoming's wolf management plan and noted that conforming changes to State law and regulation would be required to allow Wyoming's plan to be implemented as written. Wyoming recently completed four documents that clarify Wyoming's approach to wolf management after delisting including revised State statutes, revised gray wolf management regulations (chapter 21), revised gray wolf hunting season regulations (chapter 47), and an Addendum to the Wyoming Gray Wolf Management Plan. The revised State statute and the Addendum are final documents. The gray wolf management and hunting season regulations are currently in draft and will be finalized by April 26th (minor changes may occur between now and then, but major changes are not expected).

The Service now plans to reopen the comment period for the proposal to allow all interested parties an opportunity to comment on the proposed rule in light of these documents. At the same time, the Service has contracted with Atkins and the peer review panel to review the proposed rule and the conclusions reached in light of these materials. Specifically, in consult with the peer review panel, the Service requested that Atkins provide a written assessment of whether these revised documents adequately address the concerns raised by the panel in the original report. Your reviews are central to this assessment.

Attached are copies of the relevant documents (finals where available; drafts where the finals are not yet available). We do not expect you to critically evaluate all the materials; instead they are provided as background information. You are free to use these materials in constructing your latest comments, however this last phase of the review process is focused **solely** on whether the major issues previously raised by the panel have been sufficiently addressed (i.e. it is reasonable to conclude that Wyoming's approach to wolf management is likely to maintain the population's recovered status). This last phase of the review is to assess the response to your previous comments - **not** to open up new areas for discussion.

We include a letter to us from USFWS that is a brief summary of (1) the major highlights of recently released Wyoming management documents; (2) variations or clarifications from what was described in the proposed rule; and (3) a Service Assessment. This is in essence a summary of all the important changes that have been made in response to your reviews.

In crafting your final review comments, please address the following:

1. Did the agencies understand your major scientific comments and provide scientifically based responses?
2. Do the proposed management documents have a solid basis and demonstrate an adequate understanding of the scientific literature, including that cited in your review?
3. Do the amended plans increase the probability of maintaining the population's recovered status by providing for the desired population buffer?
4. Does the best available science provide sufficient support for the position that the proposed approach is likely to maintain a recovered wolf population?

We would like to follow the following procedure:

a. On April 10th we will send you this letter
b. If you have any questions about the materials, or feel the need for any clarification, please email them to me.
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c. If the issues or questions are relatively minor, we will send a clarifying email to all of you, answering such queries.
d. If the issues appear to warrant discussion, we will set up a conference call, where Seth (and perhaps other Service leadership as deemed necessary or appropriate) will answer your queries, and you may discuss the issues as a group.
e. You would each then write a response to the questions above, sending these directly and only to me.
f. We will then collate the comments into a final report, with a summary.

As before, I encourage you to focus solely on issues of science, and to avoid making policy recommendations. Also, remember that we are really only looking at the responsiveness of the agencies to your previous comments, not to initiate new issues.

We are on a fairly tight time-line: we must receive the final comments no later than May 3, so that we can deliver the final report during the open public comment period. However since our task this time is far less wide-reaching I do not think this will be onerous a task. Nevertheless we will have to hit the following deadlines

April 10th:	This letter
April 16th :	Send me any queries or request for clarification
April 26th/27th:	Conference call if needed
May 3rd:	All comments to me

If you'd like to chat with me informally about the process, or discuss these expectations, please give me a call at 202-965-6382. Rich McEldowney is the project manager, taking over the role initially performed by Stephanie Lauer. Rich will be taking care of all logistical issues, and should be your first point of contact for getting documents etc., or if you can't reach me.

Thank you for your continuing support of this important effort to integrate science into public processes.

Sincerely

Steven

Steven Courtney PhD
Director of Science
RESOLVE

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Mountain-Prairie Region

IN REPLY REFER TO:

MAILING ADDRESS:
Post Office Box 25486
Denver Federal Center
Denver, Colorado 80225-0486

STREET LOCATION:
134 Union Blvd.
Lakewood, Colorado 80228-1807

Memorandum

To: Richard McEldowney, Project Manager, Atkins Global
Dr. Steven Courtney, RESOLVE
Dr. Layne Adams, USGS Alaska Science Center
Dr. Scott Mills, University of Montana
Dr. David Mech, USGS Northern Prairie Wildlife Research Center
Daniel Stark, Minnesota Department of Natural Resources
Dr. John Vucetich, Michigan Technological University

From: Michael Thabault, Assistant Regional Director, Mountain Prairie Region

Subject: Peer Review of Wyoming Wolf Delisting

As you know, in the next few weeks, we intend to reopen the public comment period on our October 5, 2011, proposal to remove the gray wolf (*Canis lupus*) in Wyoming from the List of Endangered and Threatened Wildlife. This proposal relied heavily on Wyoming's wolf management plan and noted that conforming changes to State law and regulation would be required to allow Wyoming's plan to be implemented as written. Wyoming is working to finalize four documents that clarify Wyoming's approach to wolf management after delisting. These documents include revised State statutes, revised gray wolf management regulations (chapter 21), revised gray wolf hunting season regulations (chapter 47), and an Addendum to the Wyoming Gray Wolf Management Plan. The revised State statute and the Addendum are final documents. The gray wolf management and hunting season regulations are currently in draft and will be finalized by April 26th.

The reopened comment period will allow all interested parties the opportunity to comment on the proposed rule in light of these documents. Similarly, we have contracted with Atkins to review the proposed rule and our conclusions reached in light of these materials. Specifically, in consult with the peer review panel, we request that Atkins provide a written assessment of whether these revised documents adequately address the concerns raised by the panel in the original report. The individual peer reviews are central to this assessment.

In order to assist in this review, this memorandum provides a brief summary of (1) the major highlights of recently released Wyoming management documents; (2) variations or clarifications from what was described in the proposed rule; and (3) a Service assessment. Although this summary relies upon the draft regulations (we expect few if any noteworthy changes before these regulations are finalized), in order to satisfy the Endangered Species Act's requirement that we rely upon the best scientific and commercial information available, we request that your reviews

consider the final regulations once approved. We will provide these as soon as they are approved.

Background

On October 5, 2011, we proposed to remove the gray wolf in Wyoming from the List of Endangered and Threatened Wildlife (76 FR 61782). This proposal relied heavily on Wyoming's 2011 wolf management plan (WGFC 2011) and noted that conforming changes to State law and regulation would be required to allow Wyoming's plan to be implemented as written. These changes have now been finalized or are in draft and will be finalized soon.

Following publication of this proposal, we began discussions with Wyoming on necessary or advisable revisions to their State statutes. On January 9, 2012, we notified the Governor of Wyoming that draft legislative language, developed by the State in consultation with the Service, was consistent with our agreement and would provide an acceptable legal basis for implementing the State's Gray Wolf Management Plan (Ashe 2012a, in litt.). This legislation was passed by the Wyoming legislature during the 2012 session and, on March 7, 2012, was signed by the Governor of Wyoming and become law.

Wyoming also developed an Addendum to the Wyoming Gray Wolf Management Plan to address concerns raised by the independent peer review panel which evaluated our proposed rule and the supporting information. The addendum, developed by the State in consultation with the Service, provides additional clarification and detail about the Wyoming Game and Fish Department's approach to managing wolves. On March 5, 2012, Wyoming released the addendum for public review and comment. The Wyoming Game and Fish Commission approved a final version of the addendum March 22, 2012.

In early 2012, we began discussions with Wyoming on necessary or advisable revisions to their State regulations including Wyoming's "Gray Wolf Management" regulations (chapter 21) and "Gray Wolf Hunting Seasons" regulations (chapter 47). On March 9, 2012, we notified the Governor of Wyoming that the draft revised regulations, developed by the State in consultation with the Service, were consistent State law and Wyoming's conditionally approval Wolf Management Plan (Ashe 2012b, in litt.). On March 9, 2012, the Wyoming Game and Fish Department made the proposed regulations available for public review and comment. The Wyoming Game and Fish Commission is expected to approve a final version of these revised regulations at their April 25-26, 2012 meeting.

Atkins has been provided copies of the above documents. The final regulations will be provided once approved. Other citations are available upon request. As always, we are available to discuss any issues related to this summary or the underlying documents.

Major Highlights of Recently Released Wyoming Management Documents

Population Management – The Addendum to the Wyoming Gray Wolf Management Plan reaffirms Wyoming's commitment to manage the wolf population with a buffer above the agreed

upon population minimums of at least 10 breeding pairs and at least 100 wolves in Wyoming outside of Yellowstone National Park and the Wind River Indian Reservation at the end of the calendar year (WGFC 2012, pp. 3-5). The addendum adopts this approach as it will provide the greatest assurance that minimum agreed upon population targets can be confidently exceeded on an annual basis and that Wyoming will not risk managing wolves near minimum recovery levels (WGFC 2012, p. 5). Furthermore, Wyoming clarified that the buffer will be applied solely within Wyoming's portion of the population in the WTGMA (i.e., wolves in Yellowstone National Park and the Wind River Indian Reservation would not constitute the buffer) (WGFC 2012, p. 5). Regarding the size of the buffer, no specific number or range was offered. Instead, Wyoming noted that the buffer would be determined through an adaptive management approach and may fluctuate based on natural population dynamics and the effects of specific management actions (WGFC 2012, p. 4).

The Addendum to the Wyoming Gray Wolf Management Plan also reaffirms and clarifies Wyoming's intention to use an adaptive management framework based on intensive monitoring efforts to ensure minimum population objectives are never compromised (WGFC 2012, pp. 5-7). The addendum explains that Wyoming will monitor the wolf population more intensively than the Service has in the past because of additional human-caused mortality and that this effort will become more intense the closer the population is to minimum population objectives (WGFC 2012, pp. 4, 5). Regarding management response, the addendum clarifies that if the minimum population objectives are approached the State will sequentially limit control actions for unacceptable impacts to ungulates, harvest levels, control for damage to private property, and lethal take permits (WGFC 2012, p. 7). The last item in this sequential list (lethal take permits) is discussed further below. Regarding hunting specifically, the addendum notes that Wyoming will employ an iterative, adaptive and public process whereby season structures, hunt areas, and quotas are evaluated and adjusted based on the response of the wolf population to prior management actions (WGFC 2012, pp. 4-7). Furthermore, the addendum notes Wyoming's authority to immediately revise, reduce, or close hunting seasons if necessary (WGFC 2012, pp. 5-6).

The Addendum to the Wyoming Gray Wolf Management Plan also confirms the State's intention to manage wolf numbers to gradually reduce the wolf population over a series of years to provide the opportunity for the State to understand how to best manage wolves in Wyoming while not risking relisting of wolves under the Endangered Species Act (WGFC 2012, p. 6). Within the WTGMA, at the end of 2011 there were at least 177 wolves in at least 29 packs (including 16 breeding pairs) as well as at least 4 lone wolves; within the seasonal WTGMA, at the end of 2011 there were at least 10 wolves in at least 2 packs (including 1 breeding pair) as well as at least 5 lone wolves. Wyoming intends to authorize a hunting quota of 52 wolves in 2012 and believes this would reduce the population by about 10 percent within the permanent and seasonal WTGMA (K. Mills, Wyoming Game and Fish Department, 2012, pers. comm.). Specifically, Wyoming estimates the population within the permanent and seasonal WTGMA will be around 170 wolves and 15 breeding pairs at the end of 2012 (K. Mills, 2012, pers. comm.). We note that this first year goal is comfortably above the minimum agreed upon population targets.

In the permanent predator area, we estimated there were at least 22 wolves in at least 5 packs (including 2 breeding pairs) and at least 6 lone wolves at the end of 2011 (Jimenez 2012, in litt.). Additionally, one pack with 3 wolves (the Owl Creek pack on the Wind River Indian Reservation) borders and likely spends a significant portion of its time in the predatory area (Jimenez 2012, in litt.). We believe few of the wolf packs in predatory portions of Wyoming will persist to the end of 2012, although some individuals from these packs may survive as lone animals. Similarly, some of the current lone wolves in the predator area will be killed. Because none of the packs resident to the WTGMA are known to spend a significant portion of their time in the predatory portions of Wyoming (Jimenez 2012, in litt.), the predatory designation is not expected to meaningfully impact WTGMA wolves (Jimenez 2012, pers. comm.).

Regarding genetics, Wyoming's wolf management regulations indicate the State is committed to managing gray wolves in Wyoming to ensure genetic diversity and connectivity issues do not threaten the population (Chapter 21, section 4(a)(ii)). This regulation goes on to say this commitment will be accomplished by encouraging effective migrants into the population in accordance with the Wyoming Gray Wolf Management Plan (Chapter 21, section 4(a)(ii)). The Addendum to the Wyoming Gray Wolf Management Plan indicates the Wyoming Game and Fish Department will strive for a minimum genetic target of ~1 effective migrant per generation (WGFC 2012, pp. 6-7). If this minimum target is not achieved, the Wyoming Game and Fish Department will first consider changes to the monitoring program if the increased monitoring is likely to overcome the failure to document the desired the level of gene flow (WGFC 2012, p. 6). If increased monitoring is unlikely to document enough interchange or the Department determines that sufficient interchange is not occurring regardless of monitoring efforts, the Wyoming Game and Fish Department will alter management including reducing mortality quotas in dispersal corridors or reducing total mortality quotas over a series of years to increase the probability that migrants into the population survive and reproduce (WGFC 2012, pp. 6-7). Translocation of wolves between subpopulations will only be used as a stop-gap measure if necessary to increase genetic interchange (WGFC 2012, p. 7). These efforts will be coordinated with Montana and Idaho (WGFC 2012, p. 7).

Variations or Clarifications from What was Described in the Proposed Rule

Lethal Take Permits - Consistent with the Wyoming Wolf Management Plan (WGFC 2011, pp. 22-23, 32), the proposed rule explained that the Wyoming Game and Fish Department "may" issue lethal take permits in chronic depredation areas. However, State law (W.S. 23–1–30(n)) "requires" the issuance of lethal take permits to land owners or livestock owners in cases where wolves are harassing, injuring, maiming or killing livestock or other domesticated animals and where wolves occupy geographic areas where chronic wolf predation occurs. This mandatory approach to issuance of lethal take permits is a significant change from both current management and our summary of anticipated State management provided in the proposed rule. Another meaningful change from current Federal management is Wyoming's allowance for lethal take permits for "harassment." While these factors indicates lethal take permits could become a significant source of mortality, numerous safeguards are in place that limit their potential to meaningfully and detrimentally impact the population.

For example, State statute requires that permits be issued, and renewed as necessary, in 45-day increments (W.S. 23–1–30(n)) and State regulations indicate that a maximum of one lethal take permit for not more than 2 gray wolves can be issued per specified limited geographic or legally described area (Chapter 21, section 6(b)(ii)). These requirements should ensure application is limited in time and geography. Similarly, State regulations indicate that purported cases of wolf harassment, injury, maiming or killing must be "verified" by the Wyoming Game and Fish Department (Chapter 21, section 6(b)). We believe this requirement for Wyoming Game and Fish Department verification will limit potential abuse for this source of mortality. Finally, and most importantly, State law (W.S. 23–1–30(n)) and the implementing regulation (Chapter 21, section 6(b)(iii)) clarify that existing permits will be cancelled and issuance of new permits will be suspended if the Wyoming Game and Fish Department determines further lethal control "could" compromise the State's ability to maintain a population of at least 10 breeding pairs and at least 100 wolves in Wyoming outside of Yellowstone National Park and the Wind River Indian Reservation at the end of the calendar year. Importantly, the word "could" (as opposed to would or will) provides authority for the Wyoming Game and Fish Department to manage for a buffer above the minimum target and limit control from lethal take permits if necessary to maintain an adequate minimum buffer. However, the Addendum to the Wyoming Gray Wolf Management Plan explains that the State law's mandatory approach to issuance of lethal take permits requires that Wyoming's adaptive management framework limit other discretionary sources of mortality before it limits this source of mortality (WGFC 2012, p. 7).

On the whole, the available information indicates Wyoming's approach to lethal take permits may impact population abundance (particularly at a localized level where wolf-livestock conflict is high), but that Wyoming has instituted sufficient safeguards to ensure that this source of mortality will not compromise the State's ability to maintain a population of at least 10 breeding pairs and at least 100 wolves in Wyoming outside of Yellowstone National Park and the Wind River Indian Reservation at the end of the calendar year.

Management on the Wind River Indian Reservation - Another issue incorrectly characterized in the proposed rule is wolf management within the Wind River Indian Reservation. Specifically, the proposed rule noted that wolves would be classified as game animals within the Wind River Indian Reservation's boundaries. This assumption was reflected in the proposal's discussion of the percentage of Wyoming where wolves would be protected or managed as a game animal as this calculation considered the entire reservation as game. However, the Addendum to the Wyoming Gray Wolf Management Plan clarifies that wolves will be classified as predators on non-Indian fee titled lands within the Wind River Indian Reservation's boundaries (WGFC 2012, p. 3). This altered interpretation will have minimal impact on wolf management and abundance as these inholdings tend to be concentrated on the eastern side of the reservation outside of reported areas of wolf activity (Shoshone and Arapaho Tribal Fish and Game Department 2007, Figure 1). Furthermore, this change in our understanding is likely of little biological consequence as the proposed rule noted an expectation that the reservation would likely support only a "very modest… number of wolves." Therefore, this change does not alter our perspective on the viability of the Wyoming wolf population should delisting move forward.

Management Authority and Hunting – Following publication of the proposed rule, many publics expressed confusion about what it means to be included in the Wyoming Wolf Trophy Game Management Area (WTGMA) and whether hunting would occur in National Park Service and National Wildlife Refuge System units. First, let us clarify that nothing in this rule alters or in any way affects the jurisdiction or authority of the State of Wyoming, the National Park Service, and the U.S. Fish and Wildlife Service with respect to the regulation of hunting in any unit of the National Park or National Wildlife Refuge System. Whatever jurisdiction or authority the State and the respective Services had to authorize, prohibit, or regulate hunting in such areas prior to this rule is unchanged by the promulgation of this rule (except, of course, that this rule removes the protection of the Endangered Species Act from wolves wherever they may occur in Wyoming).

Wyoming regulations (Chapter 21, section 2; Chapter 47, section 4) and the Addendum to the Wyoming Gray Wolf Management Plan (WGFC 2012, p. 3) clarified management authority over various portions of the WTGMA. Specifically, Wyoming clarified that the State of Wyoming has no management authority in Yellowstone National Park, on lands administered by the National Park Service within Grand Teton National Park, on National Wildlife Refuges, and on lands within the Wind River Indian Reservation except non-Indian owned fee titled lands (as discussed above) (WGFC 2012, p. 3). Wyoming further clarified wolves present within Grand Teton National Park and the National Elk Refuge are designated as trophy game animals solely for the purposes of counting wolves toward the State's agreed upon management objectives (WGFC 2012, p. 3) and that any planned allowance for hunting does not apply in these areas (Chapter 47, section 4(a)). Although Wyoming does not abrogate hunting authority in the John D. Rockefeller Jr. Memorial Parkway, Wyoming's hunting regulations are clear that gray wolf hunting will be closed in the Parkway for at least 2012 (Chapter 47, section 4(i)).

While such clarifications are important to have a complete understanding of management after delisting, these characterizations of authority and clarifications of intention have little to no biological impact on the ability of Wyoming's regulatory framework to satisfy their agreed upon management objectives.

Service Assessment

The Service has reviewed the recently finalized Wyoming wolf management documents (including revised State statutes, revised gray wolf management regulations (chapter 21), revised gray wolf hunting season regulations (chapter 47), and an Addendum to the Wyoming Gray Wolf Management Plan) and concludes that the revisions to these documents are consistent with the conditionally approved Wyoming Gray Wolf Management Plan. Based on our review, we believe Wyoming's regulatory framework is likely to maintain a population of at least 10 breeding pairs and at least 100 wolves in Wyoming outside of Yellowstone National Park and the Wind River Indian Reservation at the end of the calendar year and, when considered in the context of management across the entire state and the entire NRM region, that the regulatory framework is likely to maintain Wyoming's share of a recovered NRM gray wolf population and contribute to the continued maintenance of the larger NRM gray wolf population above minimum recovery levels.

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IN LITERATURE AND PERSONAL COMMUNICATIONS

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Mills, Kenneth. 2012. Wyoming Game and Fish Department. Subject: Wyoming wolf management including expected population numbers and breeding pair numbers by the end of 2012. Telephone conversation with Seth Willey, U.S. Fish and Wildlife Service.

Jimenez, Mike. 2012. U.S. Fish and Wildlife Service. Subject: Wolf Numbers in Wyoming. Dated March 14, 2012.

Jimenez, Mike. 2012. U.S. Fish and Wildlife Service. Subject: Interpreting estimated wolf numbers in Wyoming and likely impact of predator and other state management on the wolf population. Telephone conversation with Seth Willey, U.S. Fish and Wildlife Service.

ADDENDUM: WYOMING GRAY WOLF MANAGEMENT PLAN

CLARIFICATION OF THE WYOMING GAME AND FISH COMMISSION'S COMMITTMENT TO MANAGE FOR A RECOVERED AND SUSTAINABLE WOLF POPULATION IN WYOMING

WYOMING GAME AND FISH COMMISSION

FINAL – MARCH 22, 2012

ADDENDUM: WYOMING GRAY WOLF MANAGEMENT PLAN

CLARIFICATION OF THE WYOMING GAME AND FISH COMMISSION'S COMMITMENT TO MANAGE FOR A RECOVERED AND SUSTAINABLE WOLF POPULATION IN WYOMING

STATEMENT OF REASON

The Peer Review Summary Report of the September 14, 2011 Final Wyoming Gray Wolf Management Plan and USFWS Proposed Delisting Rule identified several issues in the Wyoming Gray Wolf Management Plan (Plan) that warrant additional detail and clarification (Atkins 2011). We believe the overall conclusion of the peer review panel upholds the scientific merit of the Plan and the conclusion that delisting wolves in Wyoming is warranted and reasonable (Atkins 2011). Four of the five reviewers deemed the plan acceptable. One peer reviewer asserted the Plan lacks detail regarding how the Wyoming Game and Fish Department (Department) intends to implement safeguards ensuring the wolf population will remain above the minimum recovery level (Atkins 2011; Appendix B). While the commitment by the Department in the Plan to maintain a recovered and sustainable wolf population is explicit, we want to provide a more thorough outline of the Department's proposed adaptive management framework for wolves in Wyoming. This addendum provides clarification to the Plan concerning the proposed adaptive management framework for wolves in Wyoming.

INTRODUCTION

The State of Wyoming, the Wyoming Game and Fish Commission (Commission) and Department are committed to manage for a recovered, stable, and sustainable wolf population following delisting (WGFC 2011, pg. 1, par. 1). This commitment is articulated in the Plan, which was revised in 2011 to ensure the delisting process will proceed as agreed upon by the Governor of Wyoming and the U.S. Department of Interior/U.S. Fish and Wildlife Service (Service) (see WGFC; Appendix I). The Service subsequently approved the Plan contingent on conforming revisions to Wyoming State statutes and Commission regulations. The Service also initiated a public comment period to gather public opinion on the proposed delisting rule and a peer review process to determine the scientific validity of the proposed federal delisting rule and the Plan (USFWS 2011).

Four of five members of the peer review panel agreed with the Service's conclusion that delisting wolves under the Plan was warranted and supported by the best available science (Atkins 2011). However, the Peer Review Summary Report identified several areas of the Plan that lacked detail regarding how the Department intends to implement safeguards ensuring the wolf population will remain above the minimum recovery level. The primary issues identified in the Peer Review Summary Report were: 1.) The Department's process to manage for a population buffer; 2.) The Department's adaptive management framework; 3.) The Department's methods for monitoring and managing wolf genetics; 4.) The Department's commitment to manage all wolf mortality to ensure the population would not drop below minimum recovery levels and; 5.) The Department's estimate of the sustainable human-caused mortality rate. Public

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comments received during the Service's public comment period identified the lack of clarity in the Plan regarding management authority for wolves in different jurisdictions in Wyoming.

MANAGEMENT AUTHORITY OF WOLVES IN WYOMING

The following section outlines which jurisdictions have management authority for wolves in Wyoming after delisting:

- The State of Wyoming has management authority over all wolves in Wyoming except for wolves in areas of the state where the state of Wyoming does not have jurisdiction for wildlife management. These areas are Yellowstone National Park (YNP), lands administered by the National Parks Service (NPS) within Grand Teton National Park (GTNP), National Wildlife Refuges (NWR), and lands within the Wind River Reservation (WRR) except non-indian owned fee titled lands.
- The Wyoming Game and Fish Commission has management authority for wolves within the areas of the state where wolves are designated by state statute as trophy game animals, excluding wolves on the National Elk Refuge (NER) and on lands administered by the NPS within GTNP. However, wolves present within GTNP and the NER are designated as trophy game animals by state statute for only the purpose of counting toward the state's minimum recovery level of at least 10 breeding pairs and at least 100 individual wolves present within the state outside YNP and the WRR at the end of the calendar year.
    - The NPS has management authority for wolves in YNP. Wyoming statutes do not designate wolves in YNP as either trophy game or predatory animals.
    - The NPS has management authority for wolves on lands administered by the NPS within GTNP. Wolves in GTNP will be counted toward the state's minimum recovery level of at least 10 breeding pairs and at least 100 individual wolves.
    - The Service has management authority for wolves on the NER, but wolves on the NER will be counted toward the state's minimum recovery level of at least 10 breeding pairs and at least 100 individual wolves.
- Wolves present outside areas of the state where they are designated as trophy game animals under state statute, but within areas of the state where the state of Wyoming has jurisdiction for wildlife management, including wolves on non-indian owned fee titled lands on the WRR, will be under the management authority of the Wyoming Department of Agriculture and are statutorily designated as predatory animals. Wolves present in these areas can be counted toward the state's total wolf population, but because of their predatory animal status will not be relied upon to meet to the minimum recovery level.

COMMITMENT TO MANAGE FOR A POPULATION BUFFER

First, it is important to recognize that estimates of wolf populations in the Northern Rocky Mountains (NRM) are conservative and based on numbers of wolves, packs, and breeding pairs known to exist. At this time, the Department does not intend to develop a predictive model to estimate the total wolf population or breeding pairs; rather we intend to make management decisions based on known minimums. Consequently, a positive buffer is inherently built into our management and decision making processes. Moreover, several characteristics of wolf biology and ecology buffer the possible impact of management decisions. Among large carnivores,

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wolves are especially resilient to harvest because they can sustain human-caused mortality rates between approximately 22% and >50% without a decline in numbers (Adams et al. 2008, Creel and Rotella 2010, Gude et al. 2011; see also Fuller et al. 2003). In addition, wolf populations reduced by high levels of human-caused mortality usually rebound to pre-reduction levels within 1 to 3 years after reduction efforts are ended (NRC 1997).

Minimum population estimates, high sustainable levels of human-caused mortality and population resiliency to over exploitation coupled with conservative population metrics create a relatively large buffer that lends well to the adaptive management approach. The Department does not intend to rely on these characteristics in its management approach and will not risk managing wolves near minimum recovery levels for the following reasons:

- Wyoming Statutes and the Wyoming Gray Wolf Management Plan direct the Department to manage the wolf population to reasonably ensure at least 10 breeding pairs of wolves and at least 100 individual wolves are located in Wyoming outside of YNP and the WRR at the end of the current calendar year.
- Management of the gray wolf population at the minimum recovery level would remove the buffer needed to ensure the wolf population under the Commission's jurisdiction does not decline below the minimum recovery level due to management actions or any unanticipated and/or undetected sources of mortality such as disease, natural catastrophes, reproductive failure, etc. Managing the population to these minimum levels could lead to a status review and potential relisting.
- Managing the wolf population at the minimum recovery level would constrain the Department's ability to address and resolve situations where wolves cause damage to livestock or domesticated animals.
- Managing the wolf population at the minimum recovery level would preclude the Department's ability to provide a public hunting season for wolves.
- Hunting seasons will be prescribed through an iterative, adaptive and public process whereby season structures, hunt areas, and quotas are evaluated and adjusted based on the response of the wolf population to prior management actions. This process inherently requires a buffer to ensure the population does not decline below the minimum recovery level due to any unanticipated effects of harvest, or other natural or human-caused affects.
- Managing wolves above the minimum recovery level will enhance the likelihood for genetic connectivity through natural dispersal and immigration.

As the gray wolf population approaches the minimum recovery level, monitoring intensity will increase to ensure a more precise population estimate. Managing above the minimum recovery level will allow for a more efficient and cost effective monitoring program. The fundamental approach the Commission will employ to sustainably manage Wyoming's wolf population above the minimum recovery level is to maintain an adequate population buffer above minimum recovery levels. The size of the buffer will be determined through an adaptive management approach and may fluctuate based on natural population dynamics and the effects of specific management actions. An adequate buffer will allow "the flexibility needed to resolve wolf conflicts through control actions" and "compensate for population fluctuations caused by unanticipated and/or undetected sources of mortality" (WGFC 2011, pg. 23, par. 3). The buffer

concept was added to the revised Plan in addition to the requirements outlined in the Terms of Agreement. The Department, with input and concurrence from the Service, determined the buffer approach will provide the greatest assurance that minimum recovery levels can be confidently exceeded on an annual basis and articulated this concept in the Plan.

Some peer reviewers noted the Plan appears ambiguous in regard to whether the "buffer" refers solely to wolves expected to be contributed to the Wyoming wolf population by YNP and the WRR (Atkins 2011). The buffer will be applied only to Wyoming's portion of the population in the WTGMA to ensure that the wolf population in Wyoming outside YNP and the WRR will exceed at least 10 breeding pairs and at least 100 wolves as described in the Plan (WGFC 2011, pg. 24, par. 3, ln. 1).

ADAPTIVE MANAGEMENT FRAMEWORK

The appropriate venue for setting and adjusting buffers and hunting seasons, hunt areas, and mortality quotas is the annual season setting process as outlined in the Plan (WGFC 2011, pg. 23, par. 4 to pg. 25, par. 4). Annual wolf hunting seasons will undergo a number of professional and public review steps. The season setting process begins with development of proposed hunting regulations by the Department's large carnivore experts. The draft regulations are based on our knowledge of the current composition of the wolf population, wolf survival and mortality data collected throughout the year, past harvest data, and published literature on wolf population biology. Data and comments from other expert agencies such as the Service will also be considered as part of the adaptive management process. Once drafted, the proposed regulations are reviewed internally by the Department's regional supervisors, wardens, and population biologists, and by the staff of the Department's Biological Services Section. Final draft regulations are further reviewed and then accepted by Wildlife Division administration, the Department's Director's office, and Wyoming Attorney General's office, after which they are reviewed by the Governor's office and then undergo a formal public review process. Ultimately, the Commission meets to consider, approve, and authorize the final hunting regulations, during which time additional public comments are considered. This comprehensive review process provides multiple checks of the biological relevancy of proposed seasons, quotas, and buffers and assurance that social considerations are appropriately addressed.

The Department will consider end of previous year population estimates, cause-specific mortality from the previous and current year, estimated population trend, and the status of the wolf population in relation to the recovery targets to determine hunting seasons, mortality quotas, and an appropriate buffer during the season setting process. In addition, the Department will consider "wolf breeding seasons, short and long range dispersal opportunity, survival, success in forming new or joining existing packs, conflicts with livestock, and the broader game management responsibilities related to ungulates and other wildlife" while setting wolf mortality quotas, and the buffer required to ensure the population remains above minimum recovery levels (WGFC 2011, pg. 25, par. 2). The Department intends to monitor the wolf population more intensively than the Service has in the past because of additional human-caused mortality in the form of hunter harvest of both collared and uncollared wolves will require a more thorough monitoring effort to ensure adequate population information is gathered.

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The Department also intends to set hunting season regulations and mortality quotas late enough in the year to accommodate changes in wolf mortality or reproduction during the current biological year (WGFC 2011, pg. 25, par. 3). The Commission has the ability to implement an emergency regulation altering any aspect of wolf hunting seasons if changes in the wolf population in the interim indicate an adjustment is necessary. For example, if wolf mortality from control actions were higher, or reproduction was lower than expected during any given year, the Department could compensate for this by immediately closing the season as per authority granted in Wyoming Game and Fish Commission regulations in Chapter 2, Section 8. In addition the Commission, with the approval of the Governor, can issue an emergency wolf hunting season regulation to reduce mortality quotas or limit or close hunting seasons.

As mentioned in the Plan, the Department intends to manage wolf numbers to gradually reduce the wolf population over a series of years to "provide the opportunity for the Department to understand how to best manage wolves in Wyoming while not risking relisting of wolves under the [Endangered Species Act]" (WGFC 2011, pg. 24, par. 3). To initiate this goal, the Department will develop conservative wolf hunting seasons and mortality quotas with the intent of reducing the wolf population in 2012. Depending on the wolf population response to the initial hunting season, the Department will revise estimates for sustainable human-caused mortality and may adjust mortality quotas, hunt area boundaries, or harvest techniques to maintain the population above the minimum recovery level.

WOLF GENETICS MONITORING AND MANAGEMENT

The genetic connectivity requirements for delisting wolves requires that the NRM recovery areas are functionally connected through emigration and immigration events, resulting in the exchange of genetic material between subpopulations (WGFC 2011, pg 26). The Commission committed to monitoring and managing the wolf population under its jurisdiction to ensure that genetic connectivity is occurring between wolf recovery areas in the NRM to meet this requirement (WGFC 2011). The Peer Review Summary Report recognized this commitment, but suggested the sequence of adaptive management actions in the event the population does not meet minimum requirements could be more specifically outlined (Atkins 2011).

The Department's management plan includes general adaptive management actions that allow the Department to analyze the ultimate cause of the population not meeting minimum genetics requirements and implement the most appropriate and effective management actions. The alternative would be to invoke a series of predetermined management actions that may or may not be effective in increasing genetic interchange.

Management responses to address the population not meeting the minimum genetics criteria (~1 effective migrant/generation) will be based on the proximity of measured genetic interchange to the minimum criteria. For example, the Department will first address monitoring methodology if measured connectivity is only slightly below the minimum criteria and increased short-term monitoring efforts are likely to document enough interchange to allow the population to meet the minimum criteria. If increased monitoring is unlikely to document enough interchange and/or the Department determines that sufficient interchange is not occurring regardless of monitoring efforts, the Department will alter management of the wolf population to encourage effective

migrants. This option may include reducing mortality quotas in dispersal corridors or reducing total mortality quotas over a series of years to increase the probability that any migrants into the population will survive and reproduce. Finally, if adaptation of monitoring and/or management does not increase effective migration into the population, the Department will then translocate wolves between subpopulations in the NRM as a stop-gap measure to increase genetic interchange. This approach will allow the Department to determine the most effective strategy to encourage effective migrants (an average of at least 1 affective migrant per generation as measured over multiple generations). The Department will enter into a memorandum of understanding with the states of Montana and Idaho to coordinate management actions that facilitate genetic connectivity.

WOLF MORTALITY MANAGEMENT

The Department will manage mortality causes and mortality rates for wolves present within the WTGMA and Seasonal WTGMA and will consider all forms of mortality when making all management decisions to ensure that excessive mortality does not cause the wolf population to fall below minimum recovery levels. The Department will achieve this objective by taking a holistic approach to wolf mortality management and will adjust all controllable mortality factors, such as mortality resulting from harvest and depredation control, in response to measured mortality of all causes. The mortality rate and status of the wolf population in relation to the minimum recovery level will determine the Department's management response.

If the population approaches the minimum recovery level, the Department will sequentially limit control actions for unacceptable impacts to ungulates, harvest levels, control for damage to private property, and Lethal Take Permits. Mortality will be limited in this order because the Department is authorized, but not required, by statute to control wolves for unacceptable impacts to ungulates, offer wolf harvest, or control wolves for damage to private property. Alternatively, the Department is required by statute to issue Lethal Take Permits as long as the removals authorized by such permits could not reduce the numbers of gray wolves below 10 breeding pairs or a total of 100 individual wolves in the state outside YNP and the WRR. In such instances, the Department has the statutory authority to suspend issuance of Lethal Take Permits or cancel existing Lethal Take Permits.

For example, if high wolf mortality results from control actions associated with livestock depredations occur in any given year, the harvestable surplus of wolves for that fall's hunting season could be reduced. Alternatively, if a natural mortality factor is unexpectedly high in a given year due to circumstances such as a disease outbreak it may be necessary for the Department to reduce mortality quotas or limit or close wolf hunting seasons and limit lethal control in livestock depredation situations to ensure the wolf population will not fall below the minimum recovery level.

HUMAN-CAUSED MORTALITY RATE ESTIMATION

There was concern about the 36% human-caused mortality rate estimate in the Plan and proposed federal delisting rule that we determined was needed to stabilize the wolf population in Wyoming outside YNP and the WRR (Atkins 2011, USFWS 2011, WGFC 2011, pg. 12, par. 1, last sentence). The Department recognizes this estimate is not peer reviewed science and, therefore, we do not

intend to use this rate for decision making purposes. Sufficient data do not exist to rigorously estimate an appropriate human-caused mortality level required to stabilize the subpopulation of wolves in Wyoming outside YNP and the WRR. Therefore, the Department intends to utilize peer-reviewed publications to determine an appropriate human-caused mortality rate during the 2012 wolf hunting season setting process and apply what we learn through adaptive management to future season setting processes.

There is a wide range of sustainable human-caused mortality rates presented in peer-reviewed publications largely due to variable biological and ecological conditions among and within wolf populations. In addition, differing methodologies to estimate sustainable human-caused mortality levels contributes to the wide range available in the scientific literature. Two recent publications estimate the human-caused mortality rate that would be required to stabilize the NRM wolf population and provide vastly different rates because of different methodologies. Creel and Rotella (2010) estimated the rate to be 22%, while Gude et al. (2011) estimated the rate to be 48%. Other estimates of sustainable human-caused mortality rates are available for other gray wolf populations in peer-reviewed publications, but these rates largely fall within the range of Creel and Rotella and Gude et al.'s estimates and offer little direction in resolving the discrepancy between the two studies. Therefore, the Department intends to allow human-caused mortality required to stabilize the wolf population in the Wolf Trophy Game Management Area (WTGMA) and Seasonal WTGMA within a range of 22% to 35% in the first year. The Department will use an adaptive management approach to annually reassess the adequacy of the estimated human-caused mortality rate that will result in achieving the desired management goal and will adjust the rate up or down depending on the wolf population response as needed. The Department will collect data on the wolf population's response to human-caused mortality to guide management decisions for the wolf subpopulations under the Commission's jurisdiction.

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ORIGINAL SENATE
FILE NO. 0041

ENROLLED ACT NO. 26, SENATE

SIXTY-FIRST LEGISLATURE OF THE STATE OF WYOMING
2012 BUDGET SESSION

AN ACT relating to game and fish; providing for designation of wolves in specified areas and within specified dates as trophy game animals; providing for management for a minimum number of breeding pairs and individual gray wolves; repealing commission authority to enlarge or diminish areas where wolves are managed as trophy game animals; repealing governor's authority to change areas where wolves are managed as trophy game animals; limiting commission authority to establish areas where wolves designated as trophy game animals may be taken as predatory animals; amending authorized management techniques for controlling wolf populations; providing for use of animal damage management boards funds; specifying legislative intent; and providing for an effective date.

Be It Enacted by the Legislature of the State of Wyoming:

Section 1. W.S. 11-6-302(a)(ix)(B)(intro), (I) and (x)(B)(I), 11-6-309, 23-1-101(a)(viii)(B)(intro), (I), (xii)(B)(I) and (II), 23-1-302(a)(ii) and (xxix), 23-1-304(a), (d), (g), (h), (j), (m) and (n), 23-1-901 by creating a new subsection (g) and 23-3-115(c) are amended to read:

11-6-302. Definitions.

(a) As used in this article:

(ix) "Predatory animal" means:

(B) Until the date gray wolves are removed from the list of experimental nonessential population, endangered species or threatened species in Wyoming as provided by W.S. 23-1-108, "predatory animal" includes wolves. After that date, "predatory animal" shall include

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ORIGINAL SENATE
FILE NO. 0041

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2012 BUDGET SESSION

any gray wolf within areas of the state where the state of Wyoming has jurisdiction for wildlife management, but not within an area of the state in which the gray wolf is:

(I) Designated as a trophy game animal under ~~subdivision (x)(B)(I) of this subsection; or~~ W.S 23-1-101(a)(xii)(B)(I) or (II).

(x) "Trophy game animal" means:

(B) From and after the date gray wolves are removed from the list of experimental nonessential population, endangered species or threatened species in Wyoming as provided by W.S. 23-1-108:

(I) "Trophy game animal" shall include any gray wolf within those ~~tracts of land within the following described area, subject to modification as authorized in this subdivision: northwest Wyoming beginning at the east boundary of the Shoshone National Forest and the Wyoming-Montana state line; southerly along said forest boundary to the common boundary between the Shoshone National Forest and the Wind River Indian Reservation; westerly and then southeasterly along the Shoshone National Forest boundary to the Union Pass Road (USFS Road 263); southerly along said road until it intersects the north boundary of the Upper Green River Cattle Association's grazing allotment on forest service lands; following the eastern boundary of said allotment southerly and westerly to the point it intersects the Bridger-Teton National Forest boundary; westerly along said forest boundary to U.S. Highway 189-191; northwesterly along said highway to U.S. Highway 26-89-191 at Hoback Junction; northerly along said highway to Wyoming Highway 22; westerly along said highway to the Wyoming-Idaho state line; north along said state line to the Wyoming-Montana state line; north and~~

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~~then east along said state line to the east boundary of the Shoshone National Forest. This described area may be diminished by rule of the game and fish commission if the game and fish commission determines the diminution does not impede the delisting of gray wolves and will facilitate Wyoming's management of wolves; and~~ areas where gray wolves are designated as trophy game animals as provided in W.S 23-1-101(a)(xii)(B)(I) or (II).

11-6-309. Predator management district participation with the ADMB.

(a) Except as provided in subsection (b) of this section, if the predator management district has elected to participate in providing funding or upon approval of the ADMB, other in-kind resources, to the animal damage management account, the district may solicit funds or receive services from the ADMB under separate negotiated agreement.

(b) Whether or not a predator management district has elected to participate in providing funding to the animal damage management account, the district may solicit funds or receive services from the ADMB for control of gray wolves designated as predatory animals.

(c) In any area of the state not under the jurisdiction of a county predatory animal board, eligible applicants for funds appropriated to the animal damage management board for the purpose of controlling wolves designated as predatory animals include state or county agencies.

23-1-101. Definitions of wildlife.

(a) As used in this act:

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(viii) "Predatory animal" means:

(B) Until the date gray wolves are removed from the list of experimental nonessential population, endangered species or threatened species in Wyoming as provided by W.S. 23-1-108, "predatory animal" includes wolves. After that date, "predatory animal" shall include any gray wolf within areas of the state where the state of Wyoming has jurisdiction for wildlife management, but not within an area of the state in which the gray wolf is:

(I) Designated as a trophy game animal under subdivision (xii)(B)(I) or (II) of this subsection.~~;~~

(xii) "Trophy game animal" means:

(B) From and after the date gray wolves are removed from the list of experimental nonessential population, endangered species or threatened species in Wyoming as provided by W.S. 23-1-108:

(I) "Trophy game animal" shall include any gray wolf within those tracts of land within the following described area:~~, subject to modification as authorized in this subdivision: northwest Wyoming beginning at the east boundary of the Shoshone National Forest and the Wyoming Montana state line; southerly along said forest boundary to the common boundary between the Shoshone National Forest and the Wind River Indian Reservation; westerly and then southeasterly along the Shoshone National Forest boundary to the Union Pass Road (USFS Road 263); southerly along said road until it intersects the north boundary of the Upper Green River Cattle Association's grazing allotment on forest service lands; following the eastern boundary of said allotment southerly and westerly~~

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~~to the point it intersects the Bridger-Teton National Forest boundary; westerly along said forest boundary to U.S. Highway 189-191; northwesterly along said highway to U.S. Highway 26-89-191 at Hoback Junction; northerly along said highway to Wyoming Highway 22; westerly along said highway to the Wyoming-Idaho state line; north along said state line to the Wyoming-Montana state line; north and then east along said state line to the east boundary of the Shoshone National Forest. This described area may be diminished by rule of the commission if the commission determines the diminution does not impede the delisting of gray wolves and will facilitate Wyoming's management of wolves~~ northwest Wyoming beginning at the junction of Wyoming Highway 120 and the Wyoming-Montana state line; southerly along Wyoming Highway 120 to the Greybull River; southwesterly up said river to the Wood River; southwesterly up said river to the Shoshone National Forest boundary; southerly along said boundary to the Wind River Indian Reservation boundary; westerly, then southerly along said boundary to the Continental Divide; southeasterly along said divide to the Middle Fork of Boulder Creek; westerly down said creek to Boulder Creek; westerly down said creek to the Bridger-Teton National Forest boundary; northwesterly along said boundary to its intersection with U.S. Highway 189-191; northwesterly along said highway to the intersection with U.S. Highway 26-89-191; northerly along said highway to Wyoming Highway 22 in the town of Jackson; westerly along said highway to the Wyoming-Idaho state line; north along said state line to the southern boundary of Yellowstone National Park; east and north along said boundary to the Wyoming-Montana state line; then east along said state line to Wyoming Highway 120; ~~and~~

(II) "Trophy game animal" shall include any gray wolf ~~within any area of the state where gray wolves are classified as trophy game animals by the~~

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~~commission pursuant to W.S. 23-1-304(a)~~ located, from October 15 through the last day of February in the subsequent year, within the following described area: beginning at the boundary described in subdivision (B)(I) of this paragraph, where the Bridger-Teton National Forest boundary intersects U.S. Highway 189-191 at Hoback Rim; westerly and then southerly along said forest boundary to its intersection with USFS Road 10125 (McDougal Gap Road); westerly along said road to USFS Road 10138 (Grey's River Road); southerly along said road to Sheep Creek; westerly down said creek to Grey's River; southwesterly up said river to Bear Creek; southwesterly up said creek to the hydrographic divide between Bear Creek and Willow Creek; west from said divide to USFS Road 10080 (Willow Creek Road); northwesterly along said road to Lincoln County Road 123; southerly along said road to USFS Road 10081 (Grover Park Road); southerly then westerly along said road to Lincoln County Road 172; westerly along said road to the junction with Wyoming Highway 237; westerly along said highway to Wyoming Highway 238; southerly along said highway to Lincoln County Road 134; westerly along said road to the Wyoming-Idaho state line; north along said state line to Wyoming Highway 22 where the boundary described in this subdivision will rejoin the boundary described in subdivision (B)(I) of this paragraph.

23-1-302. Powers and duties.

(a) The commission is directed and empowered:

(ii) To establish zones and areas in which trophy game animals may be taken as game animals with a license or, with the exception of gray wolves, in the same manner as predatory animals without a license, giving proper regard to the livestock and game industries in those particular areas;

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(xxix) After the date gray wolves are removed from the list of experimental nonessential population, endangered species or threatened species in Wyoming as provided by W.S. 23-1-108, to ~~classify~~ set seasons and bag limits for gray wolves ~~as predatory or~~ designated as trophy game animals ~~in accordance with~~ pursuant to W.S. ~~23-1-304~~ 23-1-101(a)(xii)(B)(I) and (II), and to regulate the number of gray wolves which may be taken under a license issued under this act or as necessary to carry out the commission's duties under this act;

23-1-304. Classification of gray wolves.

(a) The commission shall by rule and regulation ~~establish areas within the state where gray wolves are classified as trophy game animals and~~ set seasons and bag limits within those areas where gray wolves are designated as trophy game animals pursuant to W.S. 23-1-101(a)(xii)(B)(I) and (II). The ~~areas designated,~~ seasons and bag limits shall be set annually in a manner the commission determines, through rule and regulation, ~~only~~ as necessary to reasonably ensure at least ~~seven (7)~~ ten (10) breeding pairs of gray wolves and a total of at least one hundred (100) individual gray wolves are located in this state ~~and primarily~~ outside of Yellowstone National Park~~, Grand Teton National Park and John D. Rockefeller, Jr. Memorial Parkway~~ and the Wind River Indian Reservation at the end of the current calendar year.

(d) The department shall institute and maintain an active program of population monitoring statewide~~.~~ subject to the following:

(i) Population monitoring shall include ~~the use of global positioning systems and radio collaring of gray~~

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~~wolves, including use of aerial tracking, necessary to~~ techniques that accurately determine the population and movement of gray wolves in areas of the state~~.~~ where gray wolves are designated as trophy game animals;

(ii) The commission is authorized to enter into memoranda of understanding with the United States fish and wildlife service or other federal agencies to ~~fund the purchase of the necessary technology and to~~ ensure accurate and adequate monitoring of wolf population levels and movements; ~~through global positioning systems and radio collar tracking.~~

(iii) In all areas of the state, except where otherwise provided, any person who ~~harvests~~ takes a wolf shall notify the department where the ~~harvest~~ take occurred within ten (10) days; ~~.~~

(iv) In areas of the state where gray wolves are designated as trophy game animals, any person who takes a wolf shall notify the department of the take and where the take occurred within a time period set by rule and regulation, which shall not exceed seventy-two (72) hours;

(v) In areas of the state where gray wolves are designated as trophy game animals, any person who takes a wolf shall submit the wolf or parts thereof, as defined by rule and regulation, to the department for inspection within a time period established by rule and regulation which will not exceed ten (10) days;

(vi) Any information regarding the number or nature of wolves legally ~~harvested~~ taken within the state of Wyoming shall only be released in its aggregate form and no information of a private or confidential nature shall be released without the written consent of the person to whom

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the information may refer. Information identifying any person legally ~~harvesting~~ taking a wolf within this state is solely for the use of the department or appropriate law enforcement offices and is not a public record for purposes of W.S. 16-4-201 through 16-4-205.

(g) The commission is authorized, through rule and regulation, to use ~~aggressive~~ management techniques including the use of aerial hunting and hazing by the department and issuance of permits to private landowners to take wolves to protect private property including, but not limited to, livestock and other domesticated animals from wolf depredation.

(h) Within forty-eight (48) hours of receiving notification from a landowner or his designee that any gray wolf in those areas of the state where gray wolves are designated as trophy game animals has harassed, injured, maimed or killed livestock or any domesticated animal, the department shall respond and initiate appropriate management actions. The department may use the ~~aggressive~~ management techniques authorized under subsection (g) of this section or any other management methods necessary, to minimize the harassing, injuring, maiming or killing of livestock and other domesticated animals in those areas of the state where gray wolves are designated as trophy game animals.

(j) At any time that there exists the number of breeding pairs of gray wolves and the number of individual gray wolves specified in subsection (a) of this section, the department is authorized to take any action necessary to ~~protect big and trophy game populations in this state from predation by gray wolves. The department shall give priority to areas where the wild ungulate herd is~~ reduce the effects of gray wolf predation on wild ungulate herds

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in areas of the state experiencing unacceptable impacts from gray wolf predation.

(m) The commission shall promulgate rules and regulations ~~requiring~~ authorizing lethal control of wolves harassing, injuring, maiming or killing livestock or other domesticated animals and for wolves occupying geographic areas where chronic wolf predation occurs. The rules and regulations shall provide that nonlethal control actions will be used if lethal control could cause relisting of wolves under the endangered species act or if requested by the livestock or domesticated animal owner or agent.

(n) The commission shall promulgate rules and regulations providing for issuance of ~~annual~~ permits to landowners or livestock owners for removing wolves which are harassing, injuring, maiming or killing livestock or other domesticated animals and for wolves occupying geographic areas where chronic wolf predation occurs. Permits issued or renewed under this subsection shall be valid for not more than forty-five (45) days from issuance or renewal. The permits shall be issued as long as ~~there are seven (7)~~ the removals authorized by such permits could not reduce the numbers of gray wolves below ten (10) breeding pairs or a total of one hundred (100) individual gray wolves within the state and outside of Yellowstone National Park~~, Grand Teton National Park and John D. Rockefeller, Jr. Memorial Parkway~~ and the Wind River Indian Reservation. The rules shall provide for suspending the issuance of permits or cancelling existing permits if further lethal control could cause ~~relisting of wolves under the endangered species act~~ the numbers of gray wolves to be reduced below ten (10) breeding pairs or a total of one hundred (100) individuals in the state outside of Yellowstone National Park and the Wind River Indian Reservation.

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23-1-901. Owner of damaged property to report damage; claims for damages; time for filing; determination; appeal; arbitration.

(g) For purposes of this section, "trophy game animals" shall include gray wolves located in the area described in W.S. 23-1-101(a)(xii)(B)(II) regardless of the date on which the damage occurs.

23-3-115. Taking black bear, mountain lion, gray wolf, bobcat, weasel, badger, squirrels or muskrat for damaging property.

(c) The provisions of subsection (a) of this section relating to the taking of animals doing damage to private property shall apply to gray wolves from and after the date gray wolves are removed from the list of experimental nonessential population, endangered species or threatened species in Wyoming as provided by W.S. 23-1-108. For purposes of this section as it applies to gray wolves, "doing damage to private property" means actual biting, wounding, grasping or killing of livestock or a dog, or chasing, molesting or harassing of livestock or a dog by a wolf that would indicate to a reasonable person that actual biting, wounding, grasping or killing of the livestock or dog is likely to occur at any moment. The owner, employee or lessee acting under authority of this section shall notify the department of the killing of a gray wolf within an area of the state in which the gray wolf is ~~classified~~ designated as a trophy game animal. The notification shall be made within ~~ten (10) days of the kill unless the gray wolf was taken in an area where wolves have been classified as trophy game animals pursuant to W.S. 23-1-304(a) in which case the notification shall be made within~~ seventy-two (72) hours of the kill.

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Section 2. W.S. 11-6-302(a)(ix)(B)(II), (x)(B)(II) and (b), 23-1-101(a)(viii)(B)(II) and (b), 23-1-109, 2003 Wyoming Session Laws, Chapter 115, Section 4(c) and 2007 Wyoming Session Laws, Chapter 168, Section 1 are repealed.

Section 3.

(a) The legislature finds that the contingencies required by 2007 Wyoming Session Laws, Chapter 168, Section 1 occurred and the provisions of 2007 Wyoming Session Laws, Chapter 168 became effective, and shall be effective, subject to amendment or repeal as provided in this act.

(b) It is the intent of the legislature that the management of gray wolves to ensure populations as provided in W.S. 23-1-304(a) shall be in addition to the number of gray wolves within Yellowstone National Park and the Wind River Indian Reservation, and shall contribute toward the requirements for delisting of gray wolves of at least fifteen (15) breeding pairs and at least one hundred fifty (150) individual animals throughout the state.

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Section 4. This act is effective immediately upon completion of all acts necessary for a bill to become law as provided by Article 4, Section 8 of the Wyoming Constitution.

(END)

Speaker of the House

President of the Senate

Governor

TIME APPROVED: _____

DATE APPROVED: _____

I hereby certify that this act originated in the Senate.

Chief Clerk

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WYOMING GAME AND FISH COMMISSION

CHAPTER 21

GRAY WOLF MANAGEMENT

Section 1. Authority. This regulation is promulgated by authority of W.S. §23-1-101, §23-1-102, §23-1-108, §23-1-302, §23-1-304, §23-1-901 and §23-3-115.

Section 2. Regulation. The Wyoming Game and Fish Commission adopts the following regulation for the management of gray wolves in Wyoming. The Commission has management authority for gray wolves in those areas of the state where wolves are designated as trophy game animals as defined in Section 4(a) excluding gray wolves present on the National Elk Refuge and on lands administered by the National Park Service within Grand Teton National Park. The Commission does not have management authority nor do these regulations apply to Yellowstone National Park or Tribal lands within the Wind River Reservation. Wolves present within all lands outside of Yellowstone National Park and the Wind River Reservation will be counted towards the Commission management objectives listed in Section 4(a). This regulation shall go into effect from and after the date gray wolves are removed from the federal list of experimental nonessential populations, endangered species or threatened species in Wyoming. This regulation shall remain in effect until modified or repealed by the Commission.

Section 3. Definitions. For the purpose of this regulation, definitions shall be as set forth in Title 23, Wyoming Statutes and the Commission also adopts the following definitions:

(a) "Breeding pair" means an adult male and an adult female gray wolf raising at least two (2) pups of the year until December 31.

(b) "Chronic wolf predation area" means a limited geographic or legally described area within the Wolf Trophy Game Management Area, or Seasonal Wolf Trophy Game Management Area from October 15 through the last day of February in the subsequent year, where the Department or its authorized agent has verified that gray wolves have repeatedly (twice or more within a two (2) month period immediately preceding the date on which the owner applies for a lethal take permit) harassed, injured, maimed or killed livestock or domesticated animals.

(c) "Designee" means any person(s) listed on a Lethal Take Permit in addition to the Lethal Take Permit holder as defined in this subsection who is authorized to take gray wolves under terms and conditions designated on the Lethal Take Permit.

(d) "Domesticated animals" means those individual animals which have been made tractable (easily managed or controlled) or tame and are not defined as wildlife. For the purpose of this regulation, only the following animals are considered domesticated:

Domesticated alpaca (Lama pacos), domesticated camel (Camelus bactrianus and Camelus dromedarius), domesticated emu (Dromaius novaehollandiae), domesticated ostrich (Struthio camelus), domesticated peafowl (Pavo cristatus), domesticated rhea (Rhea americana and Rhea pennata), domesticated vicuna (Vicugna vicugna), domesticated yak (Bos grunniens) and domesticated dogs (Canis familiaris).

(e) "Immediate family" means the owner's spouse, parents, grandparents or lineal descendants and their spouses.

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(f) "Lethal Take Permit" means a permit issued by the Department to an owner to kill not more than two (2) gray wolves on limited geographic or legally described areas and under terms and conditions designated on the permit.

(g) "Lethal Take Permit holder" means the person to whom a Lethal Take Permit is issued.

(h) "Livestock" means horses, mules and asses, rabbits, llamas, cattle, swine, sheep, goats, poultry, or other animal generally used for food or in the production of food or fiber and guard animals actively engaged in the protection of livestock. Bison are considered livestock unless otherwise designated by the Wyoming Livestock Board and the Commission.

(i) "Owner" means the owner, lessee, immediate family, employee or other person who is charged by the owner with the care or management of livestock or domesticated animals.

(j) "Seasonal Wolf Trophy Game Management Area" (Seasonal WTGMA) means all lands where wolves will be considered trophy game animals from October 15 to the last day of February in the subsequent year, within the following described area: beginning at the Wolf Trophy Game Management Area boundary, as described in subsection (n) of this Section, where the Bridger-Teton National Forest boundary intersects U.S. Highway 189-191 at Hoback Rim; westerly and then southerly along said forest boundary to its intersection with McDougal Gap Road (U.S.F.S. Road 10125); westerly along said road to Grey's River Road (U.S.F.S. Road 10138); southerly along said road to Sheep Creek; westerly down said creek to Grey's River; southwesterly up said river to Bear Creek; southwesterly up said creek to the hydrographic divide between Bear Creek and Willow Creek; west from said divide to Willow Creek Road (U.S.F.S. Road 10080); northwesterly along said road to Lincoln County Road 123; southerly along said road to Grover Park Road (U.S.F.S. Road 10081); southerly then westerly along said road to Lincoln County Road 172; westerly along said road to the junction with Wyoming Highway 237; westerly along said highway to Wyoming Highway 238; southerly along said highway to Lincoln County Road 134; westerly along said road to the Wyoming-Idaho state line; north along said state line to Wyoming Highway 22 where the Seasonal Wolf Trophy Game Management Area boundary will rejoin the Wolf Trophy Game Management Area boundary.

(k) "Site of kill" means the location where the gray wolf died.

(l) "Unacceptable impact on a wild ungulate population or herd" means any decline in a wild ungulate population or herd that results in the population or herd not meeting the Commission population management goals, objectives or recruitment levels established for the population or herd. The Department shall determine whether a decline in a wild ungulate population or herd constitutes an "unacceptable impact" and whether wolf predation is a significant factor causing the "unacceptable impact" based upon the best scientific data and information available.

(m) "Wild ungulate population or herd" means an assemblage of wild ungulates of the same species living in a specific geographic area.

(n) "Wolf Trophy Game Management Area" (WTGMA) means lands where gray wolves shall be considered trophy game animals on a year-round basis described as northwest Wyoming beginning at the junction of Wyoming Highway 120 and the Wyoming-Montana state line; southerly along said highway to the Greybull River; southwesterly up said river to the Wood River; southwesterly up said river to the Shoshone National Forest boundary; southerly along said boundary to the Wind River Reservation boundary; westerly, then southerly along said boundary to the Continental Divide; southeasterly along said divide to the Middle Fork of Boulder Creek; westerly down said creek to Boulder Creek; westerly down said creek to the Bridger-Teton National Forest boundary; northwesterly along said boundary to its intersection with U.S. Highway 189-191; northwesterly along said highway to the intersection with U.S. Highway 26-89-191; northerly along said highway to Wyoming Highway 22 in the town of Jackson; westerly along said highway to the Wyoming-Idaho state line; north along said state line to the southern

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boundary of Yellowstone National Park; east and north along said boundary to the Wyoming-Montana state line; then east along said state line to Wyoming Highway 120.

Section 4. Gray Wolves Designated as Trophy Game Animals or Predatory Animals.

(a) Gray wolves in that portion of Wyoming described as the WTGMA during all portions of the year and Seasonal WTGMA from October 15 to the last day of February in the subsequent year are designated as trophy game animals and managed under the authority of the Wyoming Game and Fish Commission.

(i) The Commission shall manage for at least ten (10) breeding pairs of gray wolves and a total of at least one hundred (100) individual gray wolves in Wyoming outside of Yellowstone National Park and the Wind River Reservation at the end of the current calendar year. The Department shall make management decisions based on the most current available data and in an adaptive manner that will ensure the maintenance of at least ten (10) breeding pairs of gray wolves and a total of at least one hundred (100) individual gray wolves.

(ii) The Commission is committed to managing gray wolves in Wyoming to ensure genetic diversity and connectivity issues do not threaten the population. This commitment will be accomplished by encouraging effective migrants into the population in accordance with the Commission's Wolf Management Plan.

(b) Gray wolves in Wyoming are designated as predatory animals as defined in W.S. §23-1-101(a)(viii) except for:

(i) Those areas where gray wolves are designated as trophy game animals in subsection (a) of this Section; and,

(ii) Yellowstone National Park; and,

(iii) The Wind River Reservation, except on non-Indian owned fee titled lands.

Section 5. Monitoring Gray Wolves.

(a) The Commission is committed to managing gray wolves in Wyoming to ensure genetic diversity and connectivity issues do not threaten the population. This commitment will be accomplished by encouraging effective migrants into the population. The Department will request voluntary submission of genetic samples from gray wolves killed as predatory animals and will collect and analyze genetic samples from live gray wolves handled by the Department or killed through sport hunting as trophy game animals, during agency control actions, for protection of private property and gray wolves that die from any other form of mortality to monitor genetic connectivity. The Department will enter into a memorandum of understanding with the states of Montana and Idaho to coordinate management actions that facilitate genetic connectivity.

(b) The Department shall institute and maintain a gray wolf population-monitoring program. Tracking devices may be placed on gray wolves handled by the Department in areas of the state where gray wolves are designated as trophy game animals during population monitoring, conflict resolution or management activities or non-lethal control actions to accurately determine the population and movements of gray wolves. The Department may enter into memoranda of understanding with other state or federal agencies to monitor gray wolf population levels and movements.

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Section 6. Lethal Control of Gray Wolves Designated as Trophy Game Animals.

(a) Any gray wolf in the act of doing damage to private property may be immediately taken and killed by the owner as provided in W.S. §23-3-115(c). The carcass of a gray wolf shall not be removed from the site of kill and the area around the carcass shall not be disturbed until investigated by the Department. The owner shall notify a district game warden, district wildlife biologist or Department personnel at a Game and Fish Department Regional Office within seventy-two (72) hours of the kill. The owner shall provide the location of the site of kill (identified by the section, township and range, or UTM coordinates), the name and address of the person taking the gray wolf, and the date of kill.

(b) Upon discovery that a gray wolf or wolves have harassed, injured, maimed or killed livestock or domesticated animals, or are occupying a chronic wolf predation area, the owner may notify the Department. Upon verification by the Department or personnel from other agencies operating under the authority of a signed memorandum of understanding with the Commission and upon request of the owner, the Department:

(i) Shall issue a gray wolf Lethal Take Permit to the owner if the conditions in Section 7(a) are met; and,

(ii) May authorize Department personnel or its agent(s) to remove the offending gray wolf or wolves.

(c) Gray wolves may be lethally removed when the Department determines that gray wolf predation is causing an unacceptable impact on a wild ungulate population or herd or when gray wolf-wild ungulate conflict has occurred at any state operated elk feedground.

(i) A gray wolf-wild ungulate conflict has occurred at a state operated elk feedground when a gray wolf or wolves displace elk from a feedground and it results in one of the following conflicts:

(A) Damage to private stored crops by displaced elk; or,

(B) Elk co-mingling with domestic livestock; or,

(C) Displacement of elk from a feedground onto a highway right of way causing human safety concerns.

(d) The provisions of subsections (b) and (c) of this Section shall not apply if the lethal removal of gray wolves may prevent the Department from achieving the management objectives described in Section 4(a)(i).

Section 7. Issuance of a Lethal Take Permit for Gray Wolves Designated as Trophy Game Animals.

(a) A Lethal Take Permit shall only be issued by the Department if legal removal of gray wolves will not prevent the Department from achieving the management objective described in Section 4(a)(i).

(b) If the requirements of Section 6(b) and Section7(a) are met, the Department shall issue Lethal Take Permits when requested by an owner.

(i) Lethal Take Permits shall only allow for the take of gray wolves by the use of firearms. Lethal Take Permits shall not allow the take of gray wolves from aircraft.

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(ii) One (1) Lethal Take Permit shall be issued for not more than two (2) gray wolves per specified limited geographic or legally described area as designated on the permit, and shall state the name, address and phone number of the Lethal Take Permit holder, a list of designees, and be signed by the Lethal Take Permit holder and a Department representative. The Lethal Take Permit shall specify the limited geographic or legally described area where the permit is valid.

(iii) The issuance of Lethal Take Permits shall be immediately suspended if the Department determines that further lethal control may prevent the Department from achieving the management objectives described in Section 4(a)(i). Any existing Lethal Take Permits shall be immediately cancelled if the Department determines that further lethal control may prevent the Department from achieving the management objectives described in Section 4(a)(i).

(iv) Notification of suspension or cancellation of Lethal Take Permits shall be provided via personal notification, certified return receipt mail, telephone or facsimile to all current Lethal Take Permit holders.

(v) The Lethal Take Permit holder or designee listed on the permit shall notify a Department representative(s) named on the Lethal Take Permit within twenty-four (24) hours either by personal or phone contact of the take of a gray wolf under the authority of a Lethal Take Permit.

(vi) Failure by the Lethal Take Permit holder or designee listed on the permit to abide by all provisions and conditions stipulated in this Section shall be cause for the Department to cancel the permit.

(vii) Lethal Take Permits shall expire forty-five (45) days after the date they are issued, unless the permit is cancelled in accordance with other provisions of this Section. Lethal Take Permits may be renewable in forty-five (45) day intervals for as long as conditions as set forth in Section 6(b) and Section 7(a) continue.

(viii) Lethal Take Permits shall not be issued for gray wolves designated as predatory animals as set forth in Section 4(b). Gray wolves designated as predatory animals may be taken without a license in any legal manner and at any time as provided by W.S. §23-2-303(d), §23-3-103(a), §23-3-112, §23-3-304(b), §23-3-305 and §23-3-307.

(ix) To possess a gray wolf taken under a Lethal Take Permit the Lethal Take Permit holder or designee shall procure a Wyoming Interstate Game Tag.

Section 8. Non-lethal Control of Gray Wolves Designated as Trophy Game Animals.

(a) Non-lethal control of gray wolves shall be initiated when deemed appropriate by the Department or when requested by the owner, but may be discontinued at the discretion of, and upon determination by the Department that lethal control is necessary to mitigate continued harassment, injury, maiming or killing of livestock or domesticated animals.

(b) Non-lethal control actions shall be initiated if further lethal control may prevent the Department from achieving the management objectives described in Section 4(a)(i).

21-5

Section 9. Savings Clause. If any provision of this regulation shall be held to be illegal or unconstitutional, such a ruling shall not affect other provisions of this regulation which can be given effect without the illegal or unconstitutional provision; and, to this end, the provisions of this regulation shall be severable.

WYOMING GAME AND FISH COMMISSION

By: _____
Aaron Clark, President

Dated: April 25, 2012

21-6

WYOMING GAME AND FISH COMMISSION

CHAPTER 47

GRAY WOLF HUNTING SEASONS

Section 1. Authority. This regulation is promulgated by the authority of W.S. §23-1-101, §23-1-102, §23-1-108, §23-1-302, §23-1-304, §23-2-104, §23-2-303, §23-3-111, §23-3-115 and §23-3-304.

Section 2. Definitions. For the purpose of this regulation, definitions shall be as set forth in Title 23, Wyoming Statutes and the Commission also adopts the following definitions:

(a) "Mortality" means any legal or illegal human-caused gray wolf death, excluding gray wolves taken by the Department, gray wolves taken under the authority of W.S. §23-3-115(c), gray wolves taken under Lethal Take Permits and known natural and accidental gray wolf deaths.

Section 3. Hunting Seasons Established. There shall be open seasons during 2012 for the hunting of gray wolves as set forth in this regulation. This regulation shall go into effect from and after the date gray wolves are removed from the federal list of experimental nonessential populations, endangered species or threatened species in Wyoming. This regulation shall remain in effect until modified or repealed by the Commission.

Section 4. Hunting Regulations for Gray Wolves Designated as Trophy Game Animals.

(a) All gray wolves within the Wolf Trophy Game Management Area and Seasonal Wolf Trophy Game Management Area as described in W.S. §23-1-101(a)(xii)(B)(I) and (II) are designated as trophy game animals. These regulations, and any allowance for hunting, do not apply to lands administered by the National Park Service within Grand Teton National Park or the National Elk Refuge. Gray wolves in Wyoming are designated as predatory animals as defined in W.S. §23-1-101(a)(viii) except for:

(i) Those areas where gray wolves are designated as trophy game animals; and,

(ii) Yellowstone National Park; and,

(iii) The Wind River Reservation, except on non-Indian owned fee titled lands.

(b) Gray wolves shall only be taken during open seasons with legal firearms and archery equipment, except as otherwise provided by Wyoming statutes and Commission regulations.

(c) Open hours for the taking of gray wolves. Gray wolves may only be taken from one-half (1/2) hour before sunrise to one-half (1/2) hour after sunset.

(d) No person, except as authorized by the Department, shall take a gray wolf with the use of or by the aid of radio tracking equipment.

(e) Bag and possession limit. The bag and possession limits for any person with a proper license shall be one (1) gray wolf during any one (1) calendar year (January 1 – December 31). Licensed hunters may take any gray wolf.

(f) Reporting and registering kills. Hunters taking a gray wolf in the hunt areas described in Section 6 shall retain the pelt and skull from each gray wolf for registration purposes. Even if the skull is damaged, it shall accompany the pelt for registration purposes. Visible external evidence of sex shall

47-1

remain naturally attached to the pelt. The pelt and skull shall be presented in an unfrozen condition to allow collection of biological samples and to determine the age and sex of the gray wolf.

(i) Within twenty-four (24) hours after taking a gray wolf, the licensee shall report the taking of a gray wolf by calling toll free **1-800-264-1280**. The report shall include the name of the person making the report, hunter's name and license number, date of the kill and location of the site of kill to include hunt area.

(ii) Within five (5) days after taking a gray wolf, the licensee taking the gray wolf shall present the pelt and skull to a district game warden, district wildlife biologist or Department personnel at a Game and Fish Department Regional Office during business hours for registration. The licensee shall provide his license number, date of kill and location of the site of kill to include hunt area, section, township and range or UTM coordinates.

(iii) Any person who makes a false statement on the registration form regarding the date the gray wolf was taken or the hunt area in which it was taken shall be in violation of this regulation and, such violation shall be punishable as provided by Title 23, Wyoming Statutes for violation of Commission regulations.

(g) Surrender of electronic radio tracking devices. Any person taking a gray wolf wearing an electronic radio tracking device within the hunt areas described in Section 6 shall surrender the device to the Department in accordance with registration dates in Section 4(f)(ii).

(h) Hunt Areas, Season Dates, Mortality Quota and Limitations.

Hunt Area	Season Dates Opens	Season Dates Closes	Mortality Quota
1	Oct. 1	Dec. 31	4
2	Oct. 1	Dec. 31	8
3	Oct. 1	Dec. 31	8
4	Oct. 1	Dec. 31	3
5	Oct. 1	Dec. 31	5
6	Oct. 1	Dec. 31	3; SEE SECTION 4(i)
7	Oct. 1	Dec. 31	1
8	Oct. 1	Dec. 31	7
9	Oct. 1	Dec. 31	2
10	Oct. 1	Dec. 31	2
11	Oct. 1	Dec. 31	7
12	Oct. 15	Dec. 31	2; SEE SECTION 4(j)

(i) Gray wolf hunting shall be closed in that portion of Hunt Area 6 in the John D. Rockefeller Jr. Memorial Parkway.

(j) Gray wolves located in Hunt Area 12 are designated as trophy game animals from October 15 through the last day of February in the subsequent year, but the hunting season shall end on December 31 or when the mortality quota is filled, whichever occurs first, as set forth in Section 4(h). Gray wolves located in Hunt Area 12 are designated as predatory animals from March 1 through October 14 and during this time period may be taken without a license.

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(k) Hunt area mortality quota limitation. The gray wolf hunting season shall close in each wolf hunt area when the mortality quota for that area has been reached. If the mortality quota is not reached, the season shall close upon the date specified in Section 4(h). Prior to hunting, it is the hunter's responsibility to confirm the hunt area the person intends to hunt is open. The status of hunt area closures shall be available twenty-four (24) hours a day by calling toll free **1-800-264-1280**.

Section 5. Archery. Gray wolves may be taken with legal archery equipment in all hunt areas as set forth in Section 4 of this Chapter.

Section 6. Hunt Area Descriptions.

(a) Area and Number.

Area 1. Clarks Fork. All of the area north of the Clark's Fork River and west of Wyoming Highway 120; all of the drainage of Pat O'Hara Creek, Paint Creek, Newmeyer Creek and Dead Indian Gulch west of Wyoming Highway 120; all of the drainage of Jim Creek, Trout Creek and Rattlesnake Creek north of the North Fork of the Shoshone River; all of the drainage of Cottonwood Creek, Dry Creek and Trail Creek west of Wyoming Highway 120.

Area 2. Sunlight. All of the drainage of Soda Butte Creek outside of Yellowstone National Park; all of the south drainage of the Clark's Fork River down to and including the drainage of Dead Indian Creek.

Area 3. Absaroka. All of the north and west drainage of the North Fork of the Shoshone River down to but excluding the drainage of Jim Creek; all of the south drainage of the North Fork of the Shoshone River outside of Yellowstone National Park; all of the north and west drainage of the South Fork of the Shoshone River below and including the drainage of Ishawooa Creek; all of the drainage of the Yellowstone River upstream from Yellowstone Lake outside of Yellowstone National Park.

Area 4. Greybull. Beginning where Wyoming Highway 120 crosses the Shoshone River in the town of Cody; southerly along said highway to the Greybull River in the town of Meeteetse; southwesterly up said river to the Wood River; southwesterly up said river to the Shoshone National Forest boundary; southerly along said boundary to the Hot Springs County-Fremont County line; northwesterly along said county line to the Park County-Fremont County line; northwesterly then southwesterly along said county line to the Continental Divide at Crescent Mountain; northerly along said divide to the divide between the Yellowstone River drainage and the South Fork of the Shoshone River drainage; northerly along said divide to the divide between Ishawooa Creek and the South Fork of the Shoshone River; northeasterly along said divide to the South Fork of the Shoshone River; northeasterly down said river to the Shoshone River at Buffalo Bill Reservoir; easterly down said river to Wyoming Highway 120.

Area 5. Wind River. All of the drainage of the Wind River west of the west boundary of the Wind River Reservation.

Area 6. Pacific Creek. Beginning where the Continental Divide crosses the south boundary of Yellowstone National Park; southeasterly then southwesterly along said divide to U.S. Highway 26-287 at Togwotee Pass; westerly along said highway to the east boundary of Grand Teton National Park; northwesterly along said boundary to the Targhee National Forest boundary; northerly along said boundary to the southern boundary of Yellowstone National Park; easterly along said boundary to the Continental Divide.

Area 7. Targhee. Beginning where Wyoming Highway 22 crosses the Wyoming-Idaho state line; northerly along said line to the southern boundary of Yellowstone National Park; easterly along said boundary to the Caribou-Targhee National Forest boundary with the John D. Rockefeller Jr. Memorial Parkway boundary; southerly along said boundary to the Grand Teton National Park boundary; southerly

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along said boundary to the Bridger-Teton National Forest boundary; southerly along said boundary to Teton Pass and Wyoming Highway 22; westerly along said highway to the Wyoming-Idaho state line.

Area 8. Fish Creek. Beginning where U.S. Highway 26-287 crosses the east boundary of Grand Teton National Park; easterly along said highway to the Continental Divide at Togwotee Pass; southerly along said divide to the Union Pass Road (U.S.F.S. Road 600); westerly then southerly along said road to the Darwin Ranch Road (U.S.F.S. Road 620); westerly along said road to Kinky Creek; northwesterly down said creek to the Gros Ventre River; northwesterly down said river to the east boundary of Grand Teton National Park east of the town of Kelly; northerly along said boundary to U.S. Highway 26-287. In addition, a noncontiguous area shall be included in the hunt area described as beginning where the Caribou-Targhee National Forest boundary crosses Wyoming Highway 22 at Teton Pass; northerly along said boundary to the Grand Teton National Park boundary; northeasterly then southerly along said boundary to U.S. Highway 26-89-191; southerly along said highway to its junction with Wyoming Highway 22; westerly along said highway to Teton Pass.

Area 9. Crystal Creek. Beginning where the Gros Ventre River crosses the National Elk Refuge boundary near the town of Kelly; southeasterly up said river to Kinky Creek; southeasterly up said creek to the Darwin Ranch Road (U.S.F.S. Road 620); southerly along said road to the divide between the Green River and Gros Ventre River; southwesterly along said divide to the divide between the Gros Ventre River and Hoback River north of Hodges Peak; northwesterly along said divide to the divide between Granite Creek and Flat Creek northwest of Pyramid Peak; southwesterly along said divide to the divide between Flat Creek and Cache Creek at Cache Peak; northwesterly along said divide to the divide between Twin Creeks and Cache Creek; northwesterly along said divide to the National Elk Refuge boundary; northeasterly along said boundary to the Gros Ventre River.

Area 10. Rim. Beginning where U.S. Highway 26-89-191 crosses Flat Creek at the north edge of the town of Jackson; due east to the National Elk Refuge boundary; easterly along said boundary to the Bridger-Teton National Forest boundary and the ridge between Twin Creeks and Cache Creek; southeasterly along said ridge and the divide between Flat Creek and Cache Creek to Cache Peak; easterly along the divide between Flat Creek and Granite Creek to Pyramid Peak; southeasterly along the divide between the Gros Ventre River and the Hoback River to Steamboat Peak; southeasterly along said divide to the divide between the Green River and the Hoback River at Hodges Peak; southerly along said divide to U.S. Highway 189-191 at Hoback Rim; northwesterly along said highway to the intersection with U.S. Highway 26-89-191; northerly along said highway to where it crosses Flat Creek at the north edge of the town of Jackson.

Area 11. Green River. Beginning where the Union Pass Road (U.S.F.S. Road 600) intersects the Continental Divide; southerly along said divide to the Middle Fork of Boulder Creek; westerly down said creek to Boulder Creek; westerly down said creek to the Bridger-Teton National Forest boundary; northwesterly along said boundary to its intersection with U.S. Highway 189-191 at the divide between the Hoback River and the Green River (Hoback Rim); northerly along said divide to the divide between the Green River and the Gros Ventre River at Hodges Peak; northeasterly along said divide to the Darwin Ranch Road (U.S.F.S. Road 620); easterly along said road to the Union Pass Road (U.S.F.S. Road 600); northerly then easterly along said road to the Continental Divide.

Area 12. Alpine. Beginning where the Bridger-Teton National Forest boundary intersects U.S. Highway 189-191 at the divide between the Hoback River and the Green River (Hoback Rim); westerly and then southerly along said forest boundary to its intersection with McDougal Gap Road (U.S.F.S. Road 10125); westerly along said road to Grey's River Road (U.S.F.S. Road 10138); southerly along said road to Sheep Creek; westerly down said creek to Grey's River; southwesterly up said river to Bear Creek; southwesterly up said creek to the hydrographic divide between Bear Creek and Willow Creek; west from said divide to Willow Creek Road (U.S.F.S. Road 10080); northwesterly along said road to Lincoln County Road 123; southerly along said road to Grover Park Road (U.S.F.S. Road 10081); southerly then westerly along said road to Lincoln County Road 172; westerly along said road to the

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junction with Wyoming Highway 237; westerly along said highway to Wyoming Highway 238; southerly along said highway to Lincoln County Road 134; westerly along said road to the Wyoming-Idaho state line; north along said state line to Wyoming Highway 22; easterly along said highway to the intersection with U.S. Highway 26-89-191 in the town of Jackson; southerly along said highway to the intersection with U.S. Highway 189-191; southeasterly along said highway to the Bridger-Teton National Forest boundary at the divide between the Hoback River and the Green River (Hoback Rim).

Section 7. Area Closures. Areas administered by the U.S. Forest Service, Bureau of Land Management or the Wyoming Game and Fish Commission in which human presence is prohibited to protect wintering wildlife shall be closed to gray wolf hunting during the time period for which the areas have been closed to human presence.

Section 8. Take of Wolves Designated as Predatory Animals.

(a) Any person who takes a wolf designated as a predatory animal as set forth in Section 4(a) shall be required to report the kill to a district game warden, district wildlife biologist or Department personnel at a Game and Fish Department Regional Office within ten (10) days after the date the wolf was killed. The person shall be required to provide his or her name and address, the date the wolf was killed, the sex of the wolf and the location of the site of kill (identified by the section, range and township, or UTM coordinates). In addition, the Department may request the person to voluntarily provide a genetics sample from the wolf for testing to assess genetic connectivity.

(b) Surrender of electronic radio tracking devices. Any person taking a gray wolf designated as a predatory animal as set forth in Section 4(a) wearing an electronic radio tracking device shall surrender the device to the Department when registering a wolf in accordance with registration dates in Section 8(a).

Section 9. Violation of Commission Regulations. Failure to abide by the provisions of this regulation shall be punishable as provided by Wyoming statutes for violation of Commission regulations.

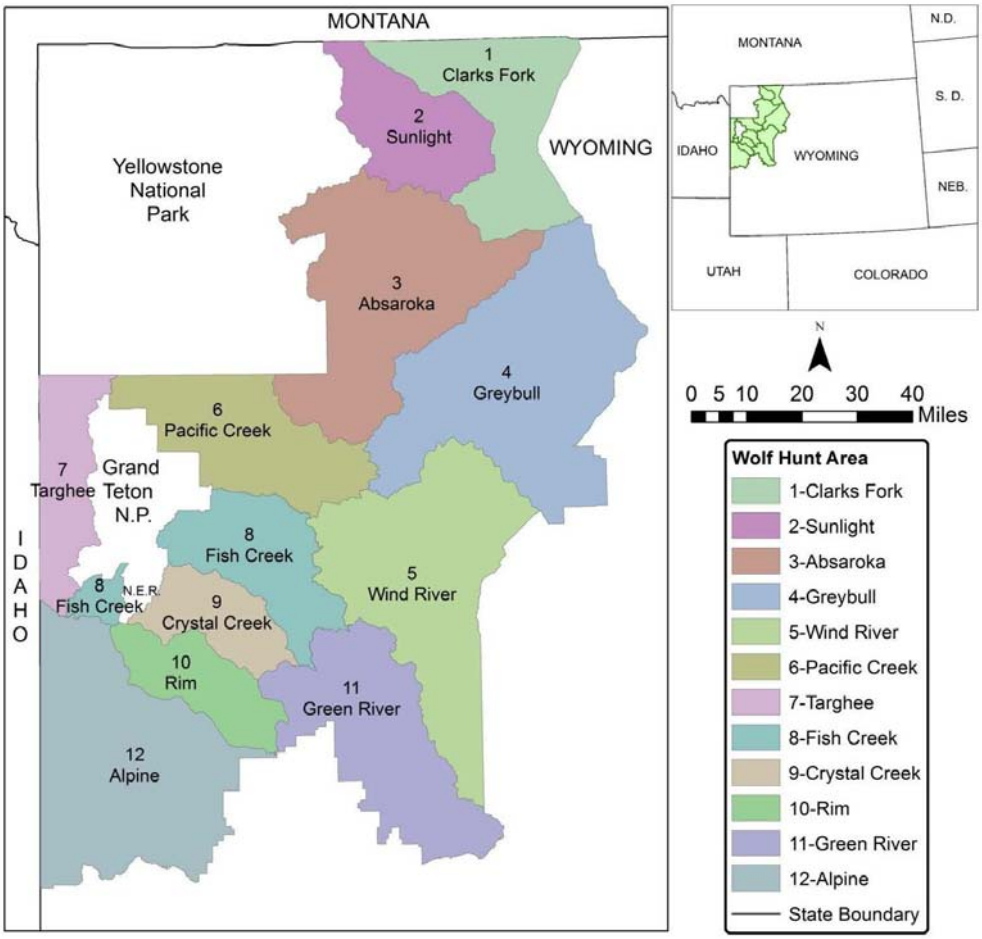
Section 10. Savings Clause. If any provision of this regulation shall be held to be illegal or unconstitutional, such a ruling shall not affect other provisions of this regulation which can be given effect without the illegal or unconstitutional provision; and, to this end, the provisions of this regulation shall be severable.

WYOMING GAME AND FISH COMMISSION

By: _____
Aaron Clark, President

Dated: April 25, 2012

47-5


MONTANA
WYOMING
IDAHO
Yellowstone National Park
Grand Teton N.P.
N.E.R.
1 Clarks Fork
2 Sunlight
3 Absaroka
4 Greybull
5 Wind River
6 Pacific Creek
7 Targhee
8 Fish Creek
8 Fish Creek
9 Crystal Creek
10 Rim
11 Green River
12 Alpine
N.D.
S. D.
NEB.
UTAH
COLORADO
N
0 5 10 20 30 40 Miles
Wolf Hunt Area
1-Clarks Fork
2-Sunlight
3-Absaroka
4-Greybull
5-Wind River
6-Pacific Creek
7-Targhee
8-Fish Creek
9-Crystal Creek
10-Rim
11-Green River
12-Alpine
State Boundary

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

JAN - 9 2012

The Honorable Matthew Mead
Governor of Wyoming
State Capitol
200 West 24th Street
Cheyenne, Wyoming 82002

Dear Governor Mead:

Thank you for your letter of December 27, 2011, concerning draft legislative amendments to the Wyoming Revised Statutes necessary to carry out the State of Wyoming's (State) revised gray wolf management plan. I appreciate your continued leadership on this issue and the close coordination between the U.S. Fish and Wildlife Service (Service) and your staff.

The Service has reviewed the draft legislative amendments and agrees that they are consistent with our agreement and will provide an acceptable legal basis for implementing the State's gray wolf management plan.

The Service looks forward to continued close coordination between our staffs in the development or revision of regulations to implement these legislative amendments or in addressing any other issues that may arise during the course of our rulemaking process.

Sincerely,

DIRECTOR

cc: Special Assistant Ferrell, Cheyenne, WY
WGFD Director Talbott, Cheyenne, WY

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Washington, D.C. 20240

Honorable Mathew Mead
Governor of Wyoming
State Capitol, 200 West 24th Street
Cheyenne, Wyoming 82002

MAR - 9 2012

Dear Governor Mead:

First, let me congratulate you on the recent passage of the legislative revisions to bring Wyoming statutes into alignment with the wolf management plan adopted last summer. Thank you for your leadership in accomplishing this important milestone.

We also appreciated the opportunity you provided to review and contribute to the associated draft revised Wyoming Game and Fish Commission regulations and the proposed addendum to your wolf management plan.

With the recent legislative revisions, and if the revised regulations are adopted as proposed, we believe that the State will have accomplished the conforming changes to Wyoming State law and regulations upon which our approval of the Wyoming Wolf Management Plan was conditioned.

Following approval by the Wyoming Game and Fish Commission, we will reopen the comment period on our delisting rule in order to provide the public and the scientific peer review panel the opportunity to review and comment on the final legislation, regulations and management plan amendment in the context of our delisting proposal.

Thank you again for your continued leadership on this complex issue.

Sincerely,

DIRECTOR

From: Mike Jimenez/R6/FWS/DOI
To: Seth Willey/R6/FWS/DOI@FWS

Date: Wednesday, March 14, 2012 12:29PM
Subject: Re: wolf numbers in WY

Attachments:
count.pdf

Total Counts Statewide (outside YNP) (based on 2011 Annual Report)
230 wolves
38 packs
19 BP

Counts in TGMA, Predator Area, WRIR, and Lone/Misc Wolves

TGMA	Predator Area	WRIR	Lone/Misc Wolves
177 wolves	32 wolves	6 wolves	Predator Area-6
29 packs	7 packs	2 packs	Seasonal Predator Area-5
16 BP	3 BP	0 BP	TGMA-4

TGMA (29 packs; 177 wolves)
Beartooth-11
Hoodoo-4
Clark-4
Absaroka-3
Sunligt-2
South Fork-4
Pahaska-11
Elk Fork-2
Ishawooa-7
Carter Mtn-3
Greybull-11
Snake River-7
Pacific Cr.-12
Phantom Springs-13
Huckleberry-6
Lower Gros Ventre-3
Pinnacle-13
Chagrin-7
Upper Gros Ventre-6
Rim-5
Black Butte-4
Green River-7
Lava Mtn-3
Washakie-8
Wiggins Fork-4
East Fork-6
Whiskey Basin-3
New Fork-4
Soda Lake-4
Total: 177

Predator Area (7 packs; 32 wolves)
Popo Agie-2
Scab Cr-2
Prospect-6
Daniel-4
Dog Cr-6
Big Piney-4
Gooseberry-8
Total: 32

WRIR (2 packs; 6 wolves)
Owl Cr-3
Bold Mtn-3
Total: 6

Note: Predator Area includes the seasonal TGMA area along the Idaho-Wyoming border. Only 2 packs [Daniel Pack (4) and Dog Creek Pack (6)] inhabit this area.

Appendix B. Individual Panelists' Reviews of Plan Addendum and State Regulations

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
ALASKA SCIENCE CENTER
4210 University Drive
Anchorage, Alaska 99508

IN REPLY REFER TO:

3 May 2012

MEMORANDUM

TO: Steve Courtney, RESOLVE
FROM: Layne G. Adams, USGS-Alaska Science Center, Anchorage, Alaska

SUBJECT: Review of recent legislation, regulatory actions, and addendum to the Wyoming gray wolf management plan.

As requested, I have reviewed legislation recently passed by the Wyoming legislature re: wolf management in Wyoming, regulatory chapters 21 and 47 agreed to by the Wyoming Game and Fish Commission, and the addendum to the Wyoming Gray Wolf Management Plan. These documents provide the legal and regulatory framework for managing wolves that is consistent with that described in the proposed rule for delisting wolves in Wyoming (76 FR 61782, 5 October 2011).

Responses to specific questions for this review:

1. Did the agencies understand your major scientific comments and provide scientifically based responses? In general, my scientific comments referred directly to the Proposed Rule and therefore I suspect will be addressed by the U.S. Fish and Wildlife Service in the Final Rule. As stated in my review, my specific scientific comments were generally minor and served to lend additional support to the biological analysis. My main concern was that the commitment to maintain 10 breeding pairs and 100 wolves on lands managed by the State of Wyoming should be limited to the WTGMA because it does not make sense to include in the recovery threshold animals outside the WTGMA that have little likelihood of persisting. This issue was addressed in the wolf plan addendum (pg. 3) stating that wolves from the predatory animal area "…will not be relied upon to meet the minimum recovery level." This adequately addresses my concern.

2. Do the proposed management documents have a solid basis and demonstrate an adequate understanding of the scientific literature, including that cited in your review? While the legislative and regulatory documents I reviewed are not scientific in nature, the management framework they describe is consistent with the scientific review provided in the Proposed Rule and the Wyoming Gray Wolf Management Plan, as amended.

3. Do the amended plans increase the probability of maintaining the population's recovered status by providing for the desired population buffer? In my initial review, I was satisfied that Wyoming would manage wolves with an adequate buffer above the minimum recovery threshold.

4. Does the best available science provide sufficient support for the position that the proposed approach is likely to maintain a recovered wolf population? In my previous review I stated that delisting gray wolves is Wyoming is well supported by our current scientific understanding and reasonable assumptions of expected wolf management by the State of Wyoming. These documents provide the legislative and regulatory framework to proceed with wolf management as described in the Proposed Rule. Therefore, I conclude that proposed wolf management in Wyoming as spelled out in these documents is likely to maintain a wolf population in Wyoming well above the specified recovery threshold.

3 MAY 2012

McEldowney, Rich R

From: Steven Courtney [spcourtney@gmail.com]
Sent: Friday, May 04, 2012 9:12 AM
To: McEldowney, Rich R
Subject: Fwd: WY Wolf Management Peer Review - Round 2 comments due this Thursday, 5/3

---------- Forwarded message ----------
From: **L. David Mech** <mechx002@umn.edu>
Date: Wed, May 2, 2012 at 3:42 PM
Subject: RE: WY Wolf Management Peer Review - Round 2 comments due this Thursday, 5/3
To: Steven Courtney <spcourtney@gmail.com>

Dear Steven,

Following are my replies to the 4 questions you asked us to reply to in your April 10 email:

1. Yes.

2. Yes.

3. Yes. There are several buffering aspects to the amended plan that should ensure an adequate buffering.

4. Yes.

I do wish to point out one discrepancy in the material we have reviewed, although it does not in any way affect my conclusions. The undated USFWS memo from Michael Thabault regarding "Peer Review of Wyoming Wolf Delisting" states on p. 4 (top line) that Jimenez (2012) "estimated there were at least 22 wolves in 5 packs" in the permanent predator area.

However, Jimenez (2012) states that there are 32 wolves in 7 packs in that area.

Sincerely,

L. David Mech, Senior Research Scientist
U.S. Geological Survey

From: McEldowney, Rich R [mailto:Rich.McEldowney@atkinsglobal.com]
Sent: Tuesday, May 01, 2012 10:34 AM
To: 'Layne G Adams'; L. David Mech; Scott Mills; 'Stark, Dan (DNR)'; John Vucetich
Cc: Steven Courtney

1

Subject: WY Wolf Management Peer Review - Round 2 comments due this Thursday, 5/3

Howdy,
I hope all of you are well and enjoying Spring!

This is a friendly reminder that your comments are due to Steven Courtney this Thursday, May 3rd.

As always, Steven and I and the USFWS truly appreciate your time and input into this project.
Thank you!
Rich

Rich cell: 406-599-2138
Steven cell: 503-278-9161

Richard McEldowney, PWS
Group Manager
Riparian/Wetland Ecologist

ATKINS

3810 Valley Commons Drive, Suite 4, Bozeman, MT 59718 | Tel: +1 (406) 624 3091 | Fax: +1 (406) 587 7278 |
Mobile: +1 (406) 599 2138| Email: rich.mceldowney@atkinsglobal.com|
www.atkinsglobal.com

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2

The University of Montana

Wildlife Biology Program
College of Forestry and Conservation
The University of Montana
Missoula, MT 59812-0596

Phone: (406) 243-5292
FAX: (406) 243-4557

May 2, 2012

TO: Atkins (Rich McEldowney) and Dr. Steven Courtney
FROM: Dr. L. Scott Mills, University of Montana
RE: Final review comments on delisting of wolves in Wyoming

I have reviewed the four documents that clarify Wyoming's approach to wolf management after delisting, including revised State statutes (Senate File #0041), revised gray wolf management regulations (chapter 21), revised gray wolf hunting season regulations (chapter 47) and the Addendum to the Wyoming Gray Wolf Management Plan (3/22/2012 final version). I also read the letter from USFWS on the subject of "Peer Review of Wyoming Wolf Delisting". I will refer to these five documents in my comments below.

As per the request in the April 10, 2012 request from Steven Courtney, I will answer his four specific questions (Section I). To keep those answers brief and direct, I will also include separate text (Section II) elaborating my responses to the key issues inherent to both the regulatory changes and the agency basis for Wyoming wolf management as described in the Addendum to the Wyoming Gray Wolf Management Plan.

I. Brief answers to the 4 questions:

1) Did the agencies understand your major scientific comments and provide scientifically based responses?

I believe the agencies did understand and provide scientifically based responses to my primary comments related to harvest mortality and management, and genetic connectivity and gene flow. Two issues where scientific responses by the agencies were insufficient include (see my section II for details): a) a framework for monitoring and management that would provide a buffer of wolf numbers above the relisting threshold; and b) a scientific framework to guide determination of whether "unacceptable impacts" to ungulate numbers are due to wolf predation. Both of these deficiencies are described more in my second section.

2) Do the proposed management documents have a solid basis and demonstrate an adequate understanding of the scientific literature, including that cited in your review?

For the most part, yes. A prominent exception with cross-cutting implications, however, comes from the text regarding the use of minimum wolf counts repeated over time with increased sampling intensity if wolf numbers decline towards relisting thresholds. As I explain in IIA below, such a strategy would predispose the monitoring and adaptive management plan to conclude increasing numbers and to implement higher harvest mortality when the population trend is actually decreasing.

3) Do the amended plans increase the probability of maintaining the populations's recovered status by providing for the desired population buffer?

As elaborated below (IIA), I am convinced by the desire of both the USFWS and WGFD to implement a buffer, but I am far from convinced that the management documents provide allowances to do so. Therefore, I must conclude that the amended plans do not provide for a population buffer in wolf management, so the buffer concept does not meaningfully increase the probability of maintaining the population's recovered status.

4) Does the best available science provide sufficient support for the position that the proposed approach is likely to maintain a recovered wolf population?

Despite the scientific deficiencies I have identified, I must answer this integrative question with a "yes", with the qualifying presumption that the WFGD will be able to play a meaningful scientific role in future wolf management despite the pressures that could divert the management process with politics and emotions. The threat of relisting, coupled with the wolf's innate high reproductive capacity, movement abilities, and general adaptability, implies that wolves are likely to persist long term under the proposed approach, provided that best wildlife population ecology practices can be implemented by the professional state wildlife management department.

II. Elaboration on key scientific issues addressed in the revised documents

A. Commitment to manage for a population buffer:

As I noted in both my original comments and in response to follow-up queries (Atkins 2011), a meaningful buffer above the "10:100" threshold should be in place. As I also noted, I understand the practical limitations of detailing at this point either quantitative thresholds for the buffer or the specific, operational protocol that will be used to determine the buffer. However, the commitment to a buffer should be stated in the revised documents in terms that are both compelling and scientifically credible. Unfortunately, they are not. The revised documents do not provide a scientifically based response that articulates a commitment to a meaningful population buffer.

Nothing in the Final Revised State Statute supports managing any sort of buffer for wolves in Wyoming. Section 23-1-304 specifically states that the seasons and bag limits will be set as necessary to reasonably ensure "at least ten (10) breeding pairs of gray wolves and a total of at least one hundred (100) individual gray wolves…" In section (n), The issuing of permits and the suspension or cancelling of permits is specifically tied to preventing reduction of the numbers of wolves below the 10:100 threshold; no mention at all is made of any buffer above that threshold.

Likewise, the revised gray wolf management regulations (Ch. 21, Section 4) directs the Commission to manage to the 10:100 rule: "The Department shall make management decisions … that will ensure the maintenance of at least ten (10) breeding pairs of gray wolves and a total of at least one hundred (100) individual gray wolves." Nothing here can be construed as supporting, or even allowing, management at a buffer. (The words "at least" in the quoted text would be fulfilled by 11 breeding pairs or 101 individual gray wolves, and so do not fulfill any biologically meaningful assertion of a buffer).

The strongest assertion that a buffer will in fact be implemented can be found in the USFWS memorandum (p. 5). However, I believe what the USFWS memorandum describes as expected state regulations differs from what is actually in the final version of Ch. 21. Notably, the USFWS memorandum expects that existing permits will be cancelled "if the Wyoming Game and Fish Department determines further lethal control 'could' compromise the States's ability to maintain a population of at least [the 10-100 minimum].." The USFWS memo notes that "Importantly, the word 'could' (as opposed to would or will) provides authority for the Wyoming Game and Fish Department to manage for a buffer above the minimum target…" However, I do not see this language in the final versions of either the State Statute or the implementing regulations (CH. 21). Instead, the word "could" in the State Statute (section 21-1-304(n)) is used as follows: "The rules shall provide for suspending the issuance of permits or cancelling existing permits if further lethal control could cause the numbers of gray wolves to be reduced below ten (10) breeding pairs or a total of one hundred (100) individuals…" I see nothing here that asserts authority for the Wyoming Game and Fish Department to manage for a buffer or to limit control from lethal take permits if necessary to maintain an adequate minimum buffer. Likewise, in Ch. 21 the cancellation of lethal take permits is stated to occur if it will compromise achieving the management objectives described in Section 4(a)(i). But I see no implicit or explicit reference to a buffer in 4(a)(i). In short, I do not see evidence that the revised statutes or regulations do in fact provide authority for Wyoming Game and Fish Department to manage for a buffer above the 10:100 threshold.

Finally, the Addendum to the Wyoming Wolf Management Plan also does not contain scientifically credible language concerning management for a buffer. First, the proposed approach of monitoring and making management decisions based on raw counts, or 'known minimums', instead of a statistically sound estimate of total wolf population or breeding pairs (p. 3), is counter to basic principles of wildlife population monitoring. Further, it will not lead to a buffer for managing above the minimum threshold. It is true that raw counts are conservative in the sense that the count will be less than true abundance when all animals are not detected. The fundamental premise of abundance estimation, captured in the 'canonical equation' that underlies virtually all statistically reliable estimates of abundance, is that:

$$\text{abundance} = \frac{\text{raw count}}{\text{detection probability}}.$$

The key problem is that raw counts will only reliably track true abundance if the percent of the population detected (detection probability) is exactly constant from year to year. Otherwise, raw counts will always have an unknown relationship to true numbers. Similarly, attempts to use changes in raw counts from year to year will be unlikely to reflect the actual changes in the wolf population. The problem exists even if detection rates of wolves in the population is quite high, as it is likely to be. As a hypothetical example, suppose in 2016 the raw count reveals 105 wolves and in 2017 the raw count reveals 115 wolves. This would be widely perceived as a 10% increase in the wolf population. However, if the 2016 survey detected only 80% of the wolves (so the actual number of wolves was 131) while in 2017 a more intensive count detected 95% of the wolves (so actual wolf number was 121), then the wolf population would actually have declined by 8% from 2016 to 2017 even though the uncorrected raw count index indicated a 10% increase! **In short, it is easy to see how reliance on "known minimums" or raw counts as an abundance index could falsely assert an increasing population, perhaps leading to more aggressive management, when in reality the population could be declining.**

Although the reliance on minimum counts would provide some unknown 'buffer' in raw counts relative to actual numbers of wolves at that time (eg 105 wolves counted versus 131 actually on the ground in my example above), the example shows that this unknown and surely changing relationship between the minimum and true count will *not* necessarily provide any buffer in decision making processes based on changes over time. In fact, the proposed strategy (P. 4) will make the problem worse because it is stated that "As the gray wolf population approaches the minimum recovery level, monitoring intensity will increase to ensure a more precise population estimate". **This approach, if followed, will virtually guarantee that the hypothetical scenario I gave above could play out, because as the true population declines, more intense monitoring will increase the proportion of the true population that gets counted from year to year making it appear that the population is increasing even as it actually declines!**

The comment on pp. 3 and 4 of the Addendum, that wolves can sustain relatively high mortality rates, is not relevant to the buffer question. Compensation of mortality does influence the expected response of the wolf population to harvest, but does not affect the question of adequate buffer.

I very much agree with all the bulleted points on page 4 of the addendum that articulate the need for a buffer. However, I simply do not see that any of the relevant enacting documents support the concept of a buffer. Likewise, beyond the assertion on pages 4 and 5 of the Addendum that an "adequate" buffer will be implemented, I do not see how such a buffer would exist, given the very explicit language in state statutes and regulations which directs management directly to the 10:100 threshold.

Thus, I find myself convinced that the USFWS and the WY Department of Game and Fish would like to manage with a buffer above 10:100, but unconvinced that the state regulations will allow them to do so. As I stated in my original peer review comments of 10/31/11 (Atkins 2011), I remain concerned by the regulatory framework "…that could inexorably pressure the WGFD to allow harvest to push wolf numbers closer and closer to the razor edge of the 10:100 minimum."

B. Adaptive Management Framework

I understand the complexity of setting mortality quotas, and the need for the professionals in the Department to have latitude for assessing and regulating hunting and take limits. An adaptive management framework is certainly an appropriate scientific basis for setting harvests from wildlife populations. Also, I find reasonable the proposed reduction of the wolf population over a series of years to minimize the risk of relisting while increasing understanding of how wolf population dynamics respond to harvest. In addition, the clarifications of management authority for hunting in various regions and land ownerships in the reviewed documents seem fine.

I note, however, that a rigorous monitoring component is critical to adaptive management. While much of what is described on pages 4 and 5 of the Addendum is appropriate, I noted above the severe problem with monitoring wolf numbers via raw minimum counts with increasing effort as the population approaches the minimum recovery level. From a scientific perspective, such an approach runs the strong risk of declaring a decreasing population to be increasing (see example above). **Therefore, consistent with previous comments, I strongly encourage the WGFD to develop a scientifically rigorous monitoring program.**

C. Wolf genetics monitoring and management

I am pleased to see a commitment to analyze specific causes and mechanisms that underlie potential genetic impoverishment if it occurs in the future (Addendum, p. 6). As before, I continue to be optimistic that if wolves are not overharvested, gene flow throughout the NRM recovery area should be sufficient. Regarding the use of a 1 effective migrant per generation threshold, I again note that this is a useful "rule of thumb" when other information is not available; however as I noted previously this rule of thumb should be replaced with a more tailored population modeling framework as time passes and Wyoming wolf genetic and demographic data accumulate. This should include assessments of the statistical power to detect and quantify gene flow with reasonable accuracy, a deep challenge.

I agree with the management responses (Addendum pp. 6-7) that rank the use of human assisted migration as a stop-gap, last resort method of facilitating connectivity among populations of the NRM. As I noted in previous comments (Atkins 2011), multiple biological factors argue against human assisted migration in all but the most extreme cases.

D. Wolf Mortality Management and Mortality Rate Estimation.

In general, I found both of these sections in the Addendum to be satisfactory from a scientific perspective. In particular, I appreciated the clarifications that all mortality sources will be considered when making management decisions. I also appreciated the sequential steps that will be taken to limit wolf mortality levels if the population approaches the minimum recovery level. Finally, I appreciate that the Amendment downplayed the problematic 36% human-caused mortality rate, and proposed a reasonable process for implementing and modifying human-caused harvest following delisting. The discussion of the range of sustainable mortality rates is reasonable, as is the proposal for initial wolf harvest following delisting.

One scientific issue that I raised in my previous comments (Atkins 2011) that is not satisfactorily addressed in the Addendum or other supporting documents is the statutory statements to control wolves for "unacceptable impacts to ungulates." As I noted at length previously, the determination of wolf predation effects on ungulate numbers is a complex scientific question that cannot be made accurately when based on emotion or speculation. This issue is a concern in the Regulation language (e.g. Chapter 21: Section 3(l) and Section 6(c)) where it appears that any decline in a wild ungulate population could be declared to be attributable to wolf predation. It is not clear how the role of wolf predation would be separated from effects of other predators, weather, disease or changing habitat conditions.

I hope these comments are useful.

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Minnesota Department of Natural Resources
500 Lafayette Road • St. Paul, MN • 55155

5/4/2012

Steven Courtney, PhD
Director of Science
Resolve

Dear Dr. Courtney,

The following information concludes my final review of the supporting documents and amended Wyoming Game and Fish Plan (Plan). My comments are organized based on the specific questions to be addressed by the peer review panel.

1. **Did the agencies understand your major scientific comments and provide scientifically based responses?**

Yes. The Service and the WGFD have clarified the information in the Proposed Rule and Plan previously submitted for the peer review.

2. **Do the proposed management documents have a solid basis and demonstrate an adequate understanding of the scientific literature, including that cited in your review?**

Yes. The proposed management documents have been amended with information that was provided in the initial review of the Final Rule and the Plan. Issues raised related to the population and genetics management and monitoring have been clarified in the addendum to the Plan. Specifically the revision addresses concerns of the 36% human caused mortality rate estimate in the Plan and Proposed Rule.

3. **Do the amended plans increase the probability of maintaining the population's recovered status by providing for the desired population buffer?**

Yes, the amended plan describes how WGFD will manage wolves for the desired population buffer. Although it does not describe a specific population buffer it demonstrates the states commitment to manage for a buffer that exceeds the population objective and allows flexibility for the state to make management changes to current population trends.

4. **Does the best available science provide for sufficient support for the position that the proposed approach is likely to maintain a recovered wolf population?**

Yes. The current and previously reviewed information have supported that the proposed approach is likely to maintain a recovered wolf population and is well supported by the best available

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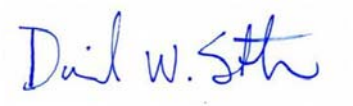
science. The wolf population in Wyoming has exceeded recovery criteria for about a decade. The population continues to thrive and will likely continue to do so following the implementation of state wolf management provisions in Wyoming. The changes in wolf management from federal to state management, including regulated hunting, will allow wolves to persist as long as these levels aren't excessive and as described in the proposed approach allow the State to react to current information and population changes. Although hunting is a new management paradigm for Wyoming wolves, as described by the Addendum to WGWMP and the Service memorandum will not have immediate wolf population impacts. It is my conclusion that the wolves in the Yellowstone recovery area, including the commitment of Wyoming to manage for a buffer above 10 breeding pairs and 100 wolves are likely to exceed the number of wolves needed to maintain a recovered wolf population.

Overall I found the Addendum to the Plan and supporting information and the Service assessment has addressed the comments from the initial peer review and that there is strong reason to support wolf recovery in Wyoming and proceed with delisting.

Sincerely,



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Review of Wyoming's Amended Management Plan for Wolves

submitted by John A. Vucetich on 23 April 2012

The review makes reference to several documents: *Wyoming's 2011 Management Plan for Wolves* (Sept 14, 2011) is hereafter referred to as the WY Plan. *Addendum: Wyoming gray wolf management plan* (March 22, 2012) is referred to, hereafter, as WY Addendum. Together, these documents will be referred to as the Amended Plan. On 24 October 2011, I submitted a review of proposed wolf management in Wyoming. That review was included as an appendix in Atkins (2011). Hereafter, that review is referred to as Vucetich (2011).

The opening paragraph of the WY Addendum summarizes the motivation and scope of the addendum: *"We believe the overall conclusion of the peer review panel upholds the scientific merit of the Plan… Four of the five reviewers deemed the plan acceptable. One peer reviewer asserted the Plan lacks detail regarding how the Wyoming Game and Fish Department (Department) intends to implement safeguards ensuring the wolf population will remain above the minimum recovery level (Atkins 2011; Appendix B)… we want to provide a more thorough outline of the Department's proposed adaptive management framework… [and] clarification to the Plan concerning the proposed adaptive management framework for wolves in Wyoming."*

I am the "one peer reviewer" who did not "deem the plan acceptable." The WY Addendum summarized my review as merely "assert[ing] the Plan lacks detail." The WY Addendum is a gross understatement of any reasonable interpretation for the concerns expressed about wolf management in Wyoming in Vucetich (2011). If the concerns raised in Vucetich (2011) had been limited to merely "lacking detail," then the addendum would likely have met those concerns by *"provid[ing] a more thorough outline"* and *"clarification of the Plan."* However, the concerns expressed there are more substantive and their accommodation would require much more than *"a more thorough outline"* and *"clarification of the Plan."* As such the WY addendum does not, by its own assessment, represent any substantive revision in plans for wolf management in Wyoming[1].

This is the essential basis that leads me to conclude that the amended plans do not allay the substantive concerns expressed in Vucetich (2011). Meeting the concerns raised in Vucetich (2011) would almost certainly require non-trivial revision to the Plan, rather than mere elaboration of the Plan. This is the essential basis that leads me to conclude that the amended plans do not significantly increase the probability of maintaining the population's recovered status. This statement answers Question #3 that had been asked of the peer reviewers.

The remainder of this review is organized in two parts. Part 1 substantiates how summarizing Vucetich (2011) as merely "assert[ing] the Plan lacks detail" is a misrepresentation of the concerns raised in Vucetich (2011). Part 2 substantiates how the *"more thorough outline"* and *"clarification of the Plan"* provided in the Addendum does not meet the concerns raised in Vucetich (2011).

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[1] If I recall properly, from the face-to-face meeting held on 17 October 2011 between government officials and the peer-viewers, the government officials expressed the great difficulty that would accompany substantive changes to the management plan. Similarly, one government official expressed interest that the peer reviewers' assessments would not lead so much to a revised plan, but would instead be useful for providing legal defense against "enviros" who might like to litigate. I mention these recollections because they further suggest lack of interest in the developing a revised plan.

PART 1

Vucetich (2011) is organized as answers to six questions that had been asked of the peer reviewers. Below, is a table repeating those questions and a verbatim summary of the responses given in Vucetich (2011).

QUESTION	CONCLUSION OF RESPONSES OFFERED IN VUCETICH (2011), VERBATIM
1. Is the Service's description and analysis of the biology, population, and distribution accurate?	"The Service's description of the population ecology associated with how human-caused (anthropogenic) mortality affects wolf population dynamics is inappropriate."
2. Does the proposed rule provide accurate and adequate review and analysis of the factors relating to the threats?	"The Service's description of population ecology associated with how human-caused (anthropogenic) mortality affects wolf population dynamics is inappropriate."
3. Are the conclusions the Service reaches, including their projection of maintenance of a viable population, logical and supported by the evidence they provide?	"The Service's position on human-assisted dispersal is not logical for the reasons outlined below... The service's account for the relationship between hunting and human tolerance of wolves is weak."
4. Did the Service include all the necessary and pertinent literature to support their assumptions/arguments/conclusions?	"[T]he Proposed rule uses Isle Royale wolves as an example of a population that does not suffer from inbreeding depression. Two papers explain how the fitness and demography of Isle Royale wolves has been affected by inbreeding depression. These papers are..."
5. Is it reasonable for the Service to conclude that Wyoming's approach to wolf management, as described in the Plan and the proposed rule...is likely to maintain Wyoming's wolf population above recovery levels...?	"Hunting and lethal control is not necessarily incompatible with recovery, but it can be. Anthropogenic mortality is a threat factor for NRM wolves. For this reason, a regulated public harvest is not an obvious tool for maintaining recovery. As such, it is reasonable expect adequate answers to these questions, *What is the purpose of the regulated public harvest?*, and *What are the details for how each year's quota will be determined?* The WY plan does not offer adequate answers to these questions. The ideas in [earlier in Vucetich (2011)] suggest that the objectives and (or) implementation of the harvest may well be inconsistent with the objectives of recovery."
6. Is it reasonable for the Service to conclude that Wyoming's approach to wolf management, as described in the Plan and the proposed rule... is likely to provide for sufficient levels of gene flow?	"It may not be reasonable for the Service to conclude that Wyoming's approach to wolf management (and the approach of other states) is likely to maintain sufficient levels of gene flow..."

Questions (1) through (4) focus on the Service's assessment of wolf management in Wyoming. Consequently, answers to those questions are focused on the Service, rather than the state of Wyoming. This distinction is effectively moot in these cases (especially questions [1] through [3]) because the State and the Service appear to hold the same views on anthropogenic mortality, assisted migration, and the relationship between hunting and human tolerance of wolves.

The salient point is that the answers provided in Vucetich (2011) entail much more than merely "assert[ing] the Plan lacks detail." It appears that the agencies do not even acknowledge the major scientific concerns raised in Vucetich (2011). Yes, the WY Addendum contains sections entitled, for example, *Wolf Mortality Management* and *Human-caused Mortality Rate Estimation*. However, these sections represent, as the WY Addendum states at the outset, a *"more thorough*

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outline" and "*clarification of the Plan*." This statement answers, in large part, Question #1 that had been asked of the peer reviewers.

PART 2

I. Adaptive Management for a population buffer

[A] The WY addendum uses 'buffer' to refer to several different ideas. Sometimes 'buffer' refers to the life history and ecology of wolves. For example (p. 3): "Moreover, several characteristics of wolf biology and ecology buffer the possible impact of management decisions." Elsewhere, 'buffer' refers to a geographic buffer (e.g., p. 5). In other places, 'buffer' refers to some level of abundance greater than the "minimum recovery level." Important references to this last kind of buffer include most of the bulleted points on page 4. Each kind of buffer is important and relevant.

[B] Changes to the document entitled, *Wyoming Game and Fish Commission, Chapter 21, Gray Wolf Management* give rise to an unmet need for a geographic buffer around National Park lands. The changes to that document are:

(1) Section 5(b) and what had been section 3(f), which gave Wyoming a stake and interest in the status of wolves on National Park lands (i.e., Yellowstone and Grand Teton), have now been struck. That section stated: "*If the Commission determines that there are less than eight (8) breeding pairs located inside of the National Parks for two (2) consecutive years, then the Department shall manage for a sufficient number of breeding pairs and wolves in the area of the WTGMA located outside of the National Parks to achieve the management objectives described in Section 4(a).*"

(2) What had been §4(a) is now relabeled and revised as §4(a)(i). These revisions make Wyoming's obligations for minimum wolf abundance completely independent of the condition of wolves on National Park lands.

The limitation created by these revisions is that Wyoming would simultaneously: (i) have no interest in the conservation of wolves in those protected areas, and (ii) the ability to kill wolves that generally reside within these protected areas, but sometimes travel outside the park. This influence will be potentially very important for Grand Teton, because most of the wolves that would be consider resident to that protected area also spend non-trivial amounts of time outside the protected area, where they risk being kill by Wyoming's management plan. This problem could be resolved by placing a geographic buffer around protected areas – a buffer zone that would protect wolves that are essentially residents of the protected areas.

[C] Hereafter, I use 'buffer' to refer to some level of abundance greater than the "minimum recovery level." Knowing what the size of this buffer will be is critical for understanding whether Wyoming's approach to wolf management is likely to maintain Wyoming's wolf population above recovery levels.

[D] The section of the WY addendum entitled, *Commitment to Manage for a Population Buffer*, provides a compelling explanation for why an adequate buffer is in the interest of Wyoming. But that section does not even attempt to explain what the size of the buffer would be.

[E] The section of the WY addendum entitled, *Adaptive Management Framework*, outlines how the "*venue for setting and adjusting buffers and hunting seasons, hunt areas, and mortality quotas is the annual season setting process as outlined in the Plan... [which] will undergo a number of professional and public review steps.*" Again, that section does not even attempt to explain what the size of the buffer would be.

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[F] The WY addendum does: (1) identify the ecological factors that would be important in setting and adjusting the size of the buffer, (2) describe provisions for management flexibility (e.g., adjustment of quotas on short notice should the state become aware of some unexpected circumstance), (3) offer Wyoming's intention on page 6 to *"gradually reduce the wolf population over a series of years"* (apparently in contrast to doing it all in one year?), and (4) explains on page 4 how *"the size of the buffer will be determined through an adaptive management approach and may fluctuate based on natural population dynamics and the effects of specific management actions."* All of this is valuable, but insufficient.

[G] It is insufficient because, what the amended plan essentially tells us is that <u>when</u> Wyoming determines the size of the buffer, it will use AM to do so. The unmet responsibility is to also describe the size of the buffer and to justify why that size is appropriate. The details of that description and justification will also reveal, quite appropriately, how AM would be used to adjust the size of the buffer in the future, should that become necessary.

[H] The responsibilities outlined in [G] are appropriate because:
1) Knowing the size of this buffer and the justification for it are critical for understanding whether Wyoming's approach to wolf management is likely to maintain Wyoming's wolf population above recovery levels.
2) The stated purpose of Wyoming's regulated public harvest appears incompatible with the requirements for recovery[2]. Achieving both goals would be a remarkable accomplishment. Being a remarkable accomplishment, there is a burden to explain how it will be met. That explanation would include knowing the size of the buffer and its justification.
3) Wyoming's interest is to begin managing wolf abundance immediately, not at some undetermined point in the future. Given that immediacy, the amended plan relies too often only on general principles, where more specific determinations would be appropriate (e.g., the size of the buffer). The amended plan seems more like a plan for how to develop a plan, rather than a plan in and of itself.

Ultimately, Wyoming's apparent resistance to specifying the size of the buffer raises concern that the buffer will be inadequate.

II. Adaptive management for genetic connectivity

[A] The WY addendum outlines an adaptive management plan for genetic connectivity that essentially entails two steps: (1) If monitoring suggests insufficient connectivity, then Wyoming will increase its monitoring effort, and (2) *"If increased monitoring is unlikely to document enough interchange* ***and/or*** *the Department determines that sufficient interchange is not occurring regardless of monitoring efforts, the Department will alter management of the wolf population to encourage effective migrants. This option* ***may include reducing mortality quotas…****"* (page 6-7 of WY Addendum, emphasis added).

[B] The wording "and/or" is remarkable for allowing the Department to conclude, by fiat, that connectivity is adequate, and to do so in spite of evidence provided by empirical monitoring. The phrase "may include reducing mortality quotas" is equally remarkable, given the circumstances which include:

i) good reason to believe that appreciable reductions in wolf abundance would lead to

[2] The purpose of the WY harvest and concern that it conflicts with the requirements for recovery are described in sections [3], [4a], [4b], [4c] all under question 4, which appear on pages 6-8 of Vucetich (2011).

inadequate connectivity[3].

ii) Wyoming's motivation for managing mortality appears inconsistent with the requirements for recovery[4], and

iii) Wyoming's resistance to disclosing the level of abundance at which it hopes to maintain wolves.

[C] These shortcomings suggest, necessary (though not necessarily sufficient) features of an appropriate adaptive management plan: (i) relatively precise specification of what empirical evidence would count as insufficient connectivity[5], (ii) a requirement to immediately cease human-caused mortality that is under the control of management, if evidence suggests connectivity is inadequate, (iii) a requirement to maintain cessation of that mortality until connectivity becomes adequate or until it is shown that human-caused mortality is not, directly or indirectly, limiting connectivity, and (iv) conditions for changing such a plan should it become apparent that it is not achieving the desired goals.

[D] The idea behind adaptive management is to develop as precise a plan as current knowledge and circumstances permit, and then modify that plan when circumstance indicate the need to do so. By contrast, the proposed AM plan for connectivity more closely resembles: if a problem presents itself, then we'll look closer to be sure that a problem really exists; if it does, then we'll develop a plan for solving it. That kind of management is not adaptive, and may not even qualify as responsible.

[E] The Service's proposed rule (75 FR 61782 [2011-10-5]) outlines the potential role of human-assisted migration for wolf management in the Northern Rockies. That perspective was adopted by the WY plan. Section 3.A (pages 4 and 5) of Vucetich (2011) explain why those perspectives are inadequate and why human-assisted migration should be relied upon only as a matter of last resort.

The WY Addendum states (p. 7) that human-assisted migration will be relied upon as a "stop-gap measure". This sentiment seems disingenuous because the WY Addendum also states that the response to inadequate connectivity "*may* include reducing mortality" [italics added]. If human-assisted migration was a truly "stop-gap" management response to inadequate connectivity would be like that described in paragraph [C], on the previous page of this document.

[F] The WY plan acknowledged the need for immigration, but not emigration. Both processes are critical for adequate connectivity. The WY addendum now acknowledges the need for both immigration and emigration. The conditions required to satisfy both immigration and emigration suggest even more the need for an AM plan like that outlined above.

III. Human-caused mortality

[A] The WY Addendum states (p. 8): *"The Department* ***intends to allow human-caused mortality required to stabilize*** *the wolf population in the Wolf Trophy Game Management Area (WTGMA) and Seasonal WTGMA within a range of 22% to 35% in the first year [emphasis added]."* The emphasized text seems to make that sentence mean the Department intends (by the force of its will-power?) to make a rate of HCM between 22% to 35% be the rate that stabilizes the population. Obviously, that doesn't make any sense, but that is what

[3] These reasons are outlines in Vucetich (2011), under point [2] of question 6.
[4] See footnote 2 on page 3.
[5] This expectation is reasonable because of what is currently known about the strengths, weaknesses, and limitations of current methods for monitoring connectivity are known.

the sentence seems to say.

Perhaps Wyoming officials meant to write: *"The Department* ***will limit the total rate of human-caused mortality for*** *the wolf population in the Wolf Trophy Game Management Area (WTGMA) and Seasonal WTGMA within a range of 22% to 35% in the first year."* If that is what the statement means, then that is what the statement should say. Perhaps the sentence is intended to mean something else.

Critical inadequacies of the amended plan have been revealed by applying similar levels of scrutiny to precise wording of statements (e.g., point II.A on page 4 of this document). For that reason, it seems unfair to expect a reviewer to pass judgment on what may be such a critical statement.

[B] In its treatment of human-caused mortality (HCM), the WY Addendum also states (p. 8): *"There is a wide range of sustainable human-caused mortality rates presented in peer-reviewed publications largely due to variable biological and ecological conditions among and within wolf populations. In addition, differing methodologies to estimate sustainable human-caused mortality levels contributes to the wide range available in the scientific literature,"* and *"Sufficient data do not exist to rigorously estimate an appropriate human-caused mortality level required to stabilize the subpopulation of wolves in Wyoming outside YNP and the WRR."*

Compared to other vertebrate species, the effect of HCM on wolves is very well studied. The wide range of variation observed in response to HCM is not an artifact of limited scientific observation; it is the result of having observed the response to HCM in so many locations. The effects of HCM are varied and difficult to predict in advance. These circumstances call for more caution than the Amended Plan demonstrates – caution that would be reflected, for example, by an adequate description and justification for the size of the buffer (Section I of this document) and an adequate plan for adaptively managing genetic connectivity (Section II of this document).

[C] Instead of expressing appropriate caution, the Amended Plan seems to allay concern for the absence of caution though an unreflective interpretation of the peer-reviewed literature. For example, the WY Addendum states (p. 4): *"In addition, wolf populations reduced by high levels of human-caused mortality usually rebound to pre-reduction levels within 1 to 3 years after reduction efforts are ended (NRC 1997)."* The resiliency of the wolf populations being referred to in NRC (1997) was almost certainly attributable to, in significant part, high rates of immigration from neighboring wolf populations. The Wyoming wolf population is not surrounded by neighboring wolf populations – it is at the edge of it geographic range. Moreover, wolf populations that do adjoin Wyoming have not been supplying immigrants at a rate capable of mitigating high rates of HCM. And, in the future, they will likely be less able to do so as the abundances of those adjoining populations are reduced through high rates of HCM.

Second, the WY Addendum also states (p. 4): *"Wolves can maintain population levels despite very high sustained human-caused mortality rates of 22 to greater than 50 percent (Keith 1983; Ballard et al. 1987; Fuller 1989; Fuller et al. 2003, pp. 182–184; Creel and Rotella 2010)."* This statement reiterates, nearly verbatim, a core premise of the WY plan.

Vucetich (2011) uses peer-reviewed literature to explain why this statement in particular represents an overall inappropriate understanding of HCM and why that inappropriate view raises doubts about the WY plan's ability to maintain recovery[6]. The WY Addendum does not revise its view on HCM, nor does it defend itself against those criticisms. Instead, it essentially reiterates its position on HCM.

[6] These reasons are outlined on pages 1-4 of Vucetich (2011), under points [1], [2], and [3] of question 1.

[D] The WY addendum concedes the inappropriateness of a particular estimate (36%) for the rate of human caused mortality expected to result in population stability[7]. That concession is appropriate, but trivial and inconsequential to Wyoming's overall inappropriate view on HCM.

[E] The WY Addendum draws special attention to the results of two papers on HCM for wolves in the Northern Rocky Mountains. Gude et al. (2011) conclude that the rate of human caused mortality expected to result in population stability (m_a) is 48%, but Creel and Rotella (2010) estimate m_a to be 22%. The WY Addendum also explains that the papers "*provide vastly different rates because of different methodologies*" and "*Other estimates* [of m_a] *are available for other gray wolf populations in peer-reviewed publications, but these rates largely fall within the range of Creel and Rotella and Gude et al.'s estimates and offer little direction in resolving the discrepancy between the two studies.*"

These interpretations are incredulous. First, no paper, aside from Gude et al. (2011) in the existing peer-reviewed literature concludes that m_a is anywhere near 48%. That point is clearly demonstrated on pages 1 and 2 of Vucetich (2011).

Second, differences between Gude et al. (2011) and Creel and Rotella (2010) are not attributable merely to "different methodologies." Vucetich (2011) writes: "Gude et al.'s calculations [which] overestimate m_a, ... led them to overestimate the value of m_a at which wolf populations in the Northern Rocky Mountains should be expected to decline." Vucetich (2011) states that the details associated with those claims are provided in a manuscript, Vucetich and Carroll (*unpubl. manusc.*). Vucetich (2011) states: "Vucetich and Carroll (*unpubl. manusc.*) is included as an appendix to this document." That appendix appears not to have been included as part of the final report by Atkins (2011). I do not know why it was not included. Its exclusion is no fault of Wyoming.

[F] Nevertheless, it is noteworthy that Wyoming officials, as they prepared the WY Addendum, did not contact me to receive a copy of this Appendix which details the shortcomings of Gude et al. (2011). The apparent failure to follow-up is noteworthy because the WY addendum states (p. 8): "*... the Department intends to utilize peer-reviewed publications to determine an appropriate human-caused mortality rate during the 2012 wolf hunting season setting process and apply what we learn through adaptive management to future season setting processes.*"

First, good management depends on the best-available science. Peer-reviewed publications are not the totality of best-available science, and not everything that appears in peer-reviewed literature represents the best-available science. Second, the apparent failure to follow-up on that appendix may suggest the limits to Wyoming's interest to learn new information that might lead to adapting its management.

Of course, it is possible that Wyoming officials obtained that appendix in some other way. If so, it is noteworthy that the Addendum does not address the criticisms in that Appendix. In any event, this document includes an appendix that details how Gude et al. (2011) overestimated m_a.

[G] A concluding remark of the WY Addendum (p. 8): "*The Department will use an adaptive management approach to annually reassess the adequacy of the estimated human-caused mortality rate that will result* ***in achieving the desired management goal*** *and will adjust the rate up or down depending on the wolf population response as needed [emphasis added].*"

The desired management goals expressed by the amended plan include, (i) requirements for abundance and connectivity that represent recovery and (ii) using human-

[7] See the first two sentences of the section entitled, *Human-Caused Mortality Rate Estimation*, on page 7 of the WY addendum.

caused mortality to "manage the wolf population and alleviate conflicts with livestock, domesticated animals, and unacceptable impacts to big game.[8]" The compatibility of these desired management goals is far from obvious[9]. The likelihood for incompatibility, especially in conjunction with Wyoming's view on the impact of human-caused mortality on wolf populations and its reluctance to explain and justify the size of the buffer, is a problem.

CONCLUSION

Vucetich (2011) indicated that the best available science does not provide sufficient reason to think that WY's plans for wolf management is consistent with recovery. The amended plan is not substantively different from the original WY plan. These statements answer questions #2 and #4 that had been asked of the peer reviewers.

The appendix begins on the next page.

[8] See page 23 of WY plan.
[9] See sections [3], [4a], [4b], [4c] all under question 4, which appear on pages 6-8 of Vucetich (2011).

APPENDIX:
The influence of anthropogenic mortality on wolf population dynamics, with special reference to Creel & Rotella (2010) and Gude et al. (2011)

Introduction

An important interest in basic and applied ecology is to understand how various sources of mortality (e.g., predation or anthropogenic mortality) affect the overall population dynamics of animal populations (Boyce, Sinclair, & White 1999). This interest is generally associated with assessing hypotheses about whether a particular source of mortality is compensatory, partially compensatory, additive, or superadditive (e.g., Cooley *et al.* 2009; Rolland *et al.* 2010; Sedinger *et al.* 2010; Sandercock *et al.* 2011). These hypotheses are commonly evaluated by assessing the slope of the relationship between a cause-specific rate of mortality (m_x) and total mortality (m). Occasionally, investigators have enough information to assess the slope of the relationship between m_x and population growth rate. In either case, the approach is especially valuable for understanding the ecology of these processes. However, managers of exploited populations also need to know the maximum cause-specific rate of mortality that a population can endure and still avoid population decline. This rate cannot be inferred simply from knowing whether a source of mortality is additive, compensatory, or otherwise.

In the past decade, five studies have inferred the maximum rate of anthropogenic mortality that wolf populations can endure and still avoid population decline (Fuller, Mech, & Cochrane 2003; Adams *et al.* 2008; Creel & Rotella 2010; Gude *et al.* 2011; Sparkman *et al.* 2011). Reviewing these studies reveals some interesting issues that are important for understanding how the dynamics of any animal population are affected by any cause-specific mortality. One review of the topic, including the analysis of 19 populations from throughout North America, concluded (Fuller *et al.* 2003: 184): "On average, wolf population size should stabilize with a mortality rate of 0.34+/-0.06 SE, or a human-caused rate of 0.22 +/-0.08 SE." Another review, relying on a expanded set of observations from across North America, similarly concluded that wolf populations are not likely to decline unless m_a is greater than ~0.29 (Adams *et al.* 2008). Another study focusing on anthropogenic mortality in red wolves concluded that decline in those populations should be expected for rates of anthropogenic mortality that exceed ~0.25 (Sparkman *et al.* 2011).

A pair of papers recently investigated the relationship between the rate of human-caused (or anthropogenic) mortality (m_a) and population growth rate (λ) for the three populations of wolves living in the Northern Rocky Mountain (NRM) region of the United States between 1999 and 2009 (Creel & Rotella 2010; Gude *et al.* 2011). Both analyses were based on data collected by the USFWS and reported in a series of annual reports (i.e., USFWS *et al.* 2009). That data included annual estimates of population abundance and number of wolves killed by humans. From these data the authors of both papers calculated estimates of λ and m_a. Despite being based on the same data collected from the same populations, the papers differ substantially in their conclusions about the relationship between m_a & λ. One analysis suggests that, in the absence of information about recruitment, the expected growth of a wolf population would be unlikely to decline for m_a<~0.22 (Creel & Rotella 2010). The other analysis suggests, again in the absence of

information about recruitment, that the expected growth of a wolf population would be non-negative if $m_a < 0.48$ (Gude *et al.* 2011). Gude *et al.* (2011) attributes differences in these results to: (i) having omitted three data points that they considered unreliable, and (ii) constructing population models that also account for the mediating influence recruitment would have on the relationship between m_a & λ. Creel & Rotella (*in review*) provide a reasonable explanation for why an analysis of the relationship between m_a and λ should not be biased by not accounting for the influence of recruitment. Upon request, the authors of these papers shared with us the data files they used to assess the relationship between m_a & λ. Remarkably, the values of m_a & λ used in each analysis differed greatly (Fig. 1). Plotting linear regression lines estimated by least squares estimation (LSE) through these different data sets suggests the differing conclusions are largely attributable to differences in values of m_a & λ used.

In this paper, we conduct analyses to explain how the authors arrived at different sets of values. We also calculate a new set of values for m_a & λ which compensate for shortcomings of these previous two analyses. Then we explain how both analyses violated an important assumption of linear regression, and demonstrate use of a modified regression technique more appropriate to this type of data. The latter technique has wide relevance to analyses of such monitoring data in other species. We use this modified regression technique to assess the relationship between m_a & λ for the NRM data and similar data collected from populations of wolves from across North America (i.e., the Adams *et al.* [2008] data set).

Analysis & Results

Calculating values of m_a & λ

By notational convention, the growth rate of a population at time t is expressed as $\lambda_t = N_{t+1}/N_t$. Let the mortality rate during time t (i.e., proportion of prey that died during time t) be the number of individuals that died from human causes between t and t+1 ($D_{t \rightarrow t+1}$) divided by N_t (i.e., $m_{(a)t} = D_{t \rightarrow t+1}/N_t$). Adopting these notational conventions, an appropriate way to assess the effect of mortality rate on population growth rate is to assess the statistical relationship between $m_{(a)t}$ with λ_t. However, this approach assumes N_t is estimated very shortly after the time of year when young individuals are recruited into the population.

This assumption does not hold for wolves in the Northern Rockies. For these populations, N_t is estimated about 7 months after pups are born. Consequently, the denominator of $m_{(a)t}$ is smaller than it should be, because it does not include newly recruited wolves, who are also vulnerable to being killed. Calculating $m_{(a)t}$ as $D_{t \rightarrow t+1}/N_t$ will tend to overestimate the true value of $m_{(a)t}$. The consequence of overestimating $m_{(a)t}$ is to overestimate the value of $m_{(a)t}$ that corresponds to population decline (i.e., λ<1). An adequate understanding of the relationship between m_a and λ requires minimizing (or at least accounting for) bias in estimates m_a.

By inspecting the data provided by Gude *et al.* (2011) and presented in Table 1, they appear to have analyzed the relationship between $m_{(a)t}$ (= $D_{t \rightarrow t+1}/N_t$) with λ_t (=N_{t+1}/N_t). To see how, consider data from GYA for the year (they describe as) 2002, where Gude *et al.* compare λ=1.24 and m=0.119 (Table 1). This value of

lambda is $\lambda_{2001} = N_{2002}/N_{2001} = 271/218=1.24$. This value of mortality rate is $m_{2001}=D_{2001\rightarrow 2002}/N_{2001} = 26/218$. The notation of Gude et al. is slightly unconventional insomuch as they attribute $m_{(a)t}$ and λ_t with the year t – 1, rather than the year t (e.g., the value of $\lambda_{2001} = 1.24$ is associated with the year 2002). While this notation is unconventional, it is not fundamentally problematic. Most importantly, Gude *et al.* (2011) calculated $m_{(a)t}$ in a way that tends to overestimate the value of $m_{(a)t}$ that corresponds to population decline (i.e., $\lambda<1$).

By inspecting the data provided by Creel & Rotella (2010) and presented in Table 1, they appear to have analyzed something different. For example, Creel & Rotella (2010) compare λ=1.25 and m=0.06 for the year 2001 (which corresponds to what Gude *et al.* [2011] label as the year 2002). Creel and Rotella's value of λ=1.25 differs from Gude et al.'s (λ=1.24) in a trivial way that can be explained by Creel & Rotella thinking that $N_{2002} = 272$, rather than $N_{2002}=271$ (which is what Gude et al. assumed). Creel & Rotella's value for m_a seems to be $D_{2000\rightarrow 2001}/N_{2002} = 14/218$. This is not a conventional way to calculate m_a. Creel & Rotella (2010) may have had a justified reason for calculating m_a in this way, but we are unaware of what that reasoning may be. Ultimately, the different conclusions reached by Gude *et al.* (2011) and Creel & Rotella (2010) seem to be explained differences in how they calculated $m_{(a)t}$ and λ_t (Fig. 1).

In our re-analysis of this data, we considered three alternative methods for calculating $m_{(a)t}$ (Table 1). First, we estimated the rate of human-caused mortality as $m_{(a1)t} = D_{t\rightarrow t+1}/(N_t+ D_{t\rightarrow t+1})$. Because this denominator does not include recruits that were not killed by humans, this expression overestimates the rate of human-caused mortality. Second, we also estimated the rate of human-caused mortality as $m_{(a2)t} = D_{t\rightarrow t+1}/(N_t+R_{t+1})$. Recall that because of how wolves are monitored in the NRM, R_{t+1} represents the number of new recruits added to the population between times t and t+1 (see Table 1). Because this denominator does not include recruits that died, it may overestimate for the rate of human-caused mortality. However, this calculation may underestimate the rate of human-caused mortality because the denominator includes recruits even though recruits are not vulnerable to being killed throughout the entire year. Third, we estimated rate of human-caused mortality as $m_{(a3)t} = D_{t\rightarrow t+1}/(N_t+R_{t+1}+D_{t\rightarrow t+1})$. This calculation would underestimate mortality rate only to the extent that a wolf counted as newly recruited would also be counted as a wolf that was killed by humans. In any event, assessing $m_{(a3)}$ will provide useful context for interpreting analyses based on $m_{(a1)}$ and $m_{(a2)}$. Given the data available in Table 1, these are the best ways that we know for estimating the rate of human-caused mortality. In the Discussion, we explain how the potential biases of these estimators affect the conclusions drawn from our analysis.

Assessing the relationship between m_a & r_t

Hereafter, we use m_a* to denote the rate of human-caused mortality associated with an expected population growth rate of zero. For reasons explained below, we assess the relationship between $m_{(a)t}$ and r_t (=ln[λ_t]).

Northern Rocky Mountain Populations

Linear regression by least squares estimation (LSE) suggests that the relationship between $m_{(a)t}$ and r_t for NRM wolves is well described by a linear relationship.

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However, simple linear regression depends on an assumption these data violate in a critical way. Specifically, an assumption of regression based on LSE is that values on the *x*-axis are measured without sampling error (Draper & Smith 1998). All sampling (measurement) error is assumed to lie in measurements of *y*. This assumption corresponds to the method of LSE, which is based on minimizing the sum of squared errors. In other words, the regression line is obtained by minimizing the vertical error in a plot between *x* and *y* (Fig. 2). The simplest way to begin appreciating the importance of this principle is to recall that regressing *x* onto *y* results, in general, in a different regression line than results from regressing *y* onto *x* (Draper & Smith 1998). The consequence of ignoring measurement error in the *x* variable is that estimates of the slope tend to be biased toward zero (Fuller 1987). This bias is critical for our purposes because the data from NRM wolves largely falls in quadrant I of the *x*-*y* plane (i.e., positive values of $m_{(a)t}$ and r_t). Consequently, concluding that the slope is shallower than it really will result in overestimating m_a*.

The most general methods to account for sampling error in the *x* variable require estimates of the variance in that sampling error. Such estimates are not available or easily calculable for NRM wolf data. However, total least squares (TLS) regression is a technique that accommodates the case where *x* and *y* are measured in the same units and where *x* and *y* are measured with similar levels of precision (i.e., variance in the error term which describes sampling error) (Fuller 1987). These circumstances better describe the relationship between $m_{(a)t}$ and r_t than does the assumption that all sampling error lies in the y-axis. Under these conditions, TLS estimation results in an unbiased estimate of the slope. The method for obtaining the best-fitting total least squares regression line is to minimize (Fuller 1987):

$$\left(1-\beta_1\right)^{-1}\sum_{i=1}^{n}(y_i-\hat{y}_i)^2 \quad ,$$

where β_1 is the slope, *y* is the observed response (population growth rate), *y*-hat is the predicted response, and *n* is the sample size.

Using the solver function in Excel, the TLS regression algorithm, and values of $m_{(a1)t}$, the predicted value of m_a* is 0.194 when mortality is estimated as $m_{(a1)}$ (Fig. 3a), 0.173 when mortality is estimated as $m_{(a2)}$ (Fig. 3b), and 0.144 when mortality is estimated as $m_{(a3)}$ (Fig. S1 in Supporting Information). For context, the values of m_a* obtained from LSE are 0.316 when mortality is estimated as $m_{(a1)}$, 0.269 when mortality is estimated as $m_{(a2)}$ (Fig. 3b), and 0.215 when mortality is estimated as $m_{(a3)}$ (Fig. S1 in Supporting Materials).

North American populations

Creel & Rotella (2010) presented an analysis of data representing 19 wolf populations living at different sites from across North America. That analysis suggested the relationship between m_a and population growth among North American populations was similar to the relationship for NRM wolf populations (see Fig. 2 in Creel & Rotella [2010]). In particular both relationships appeared to be linear.

However, Adams *et al.* (2008) performed a similar analysis on a data set of North American wolf populations that included almost twice as many observations (n=41; see Table 7 and Fig. 19 of Adams *et al.* [2008]). That analysis suggests that the relationship between m_a and r is nonlinear and that the predicted value of m_a* may be greater than what was predicted for NRM wolves. Specifically, Adams *et al.* (2008) fit $y=\beta_0+\beta_1 x^2$ to the data they had collected. However, they did not use any model selection procedure to evaluate the performance of this model in relationship to the performance of a linear model.

Of the 41 observations used by Adams *et al.* (2008), five were from the wolf population on Isle Royale (1959-2006). One of these Isle Royale observations was judged to be an outlier and omitted from their analysis. Because the entire data set includes 41 observations, the appropriateness of treating one case (Isle Royale) as five separate observations is arbitrary. In the analysis presented here, we represent the Isle Royale wolf population as a single observation (m_a = 0; r = 0.03), representing their population dynamics between 1959 and 2010. As such Isle Royale represents one case in North America where the population is not harvested and over the long-term its growth is nearly zero. Adams *et al.* (2008) considered two other observations to be outliers ([m_a = 0.02, r = 0.62] and [m_a = 0.23, r = –0.50]; see Fig. 4). The residuals for these observations, in relationship to the best-fitting, non-linear model (see below), are 2.6 and 3.1 times the standard deviation of the residuals for the entire data set. The magnitude of these residuals suggests it may or may not be reasonable to consider these observations as outliers. We conducted a set of analyses omitting these observations, and another including them. Results for both analyses did not differ appreciably. Below, we report the results for the analysis excluding these observations. On occasions where the results may differ importantly, we report both sets of results.

We fit two models to the North American data, a simple linear model and $y=\beta_0+\beta_1 x^{\alpha}$, where the superscript α represent a flexible way to allow for the possibility that the influence of m_a on r_t increases with increasing m_a. The non-linear model was unequivocally more parsimonious than the linear model. Specifically, the linear model was characterized by R^2=0.60, an Akaike Information Criterion value (corrected for small sample size; AIC_C) of –124.5, and an AIC weight of 0.01; and the nonlinear model was characterized by R^2=0.71, an AIC_C value of –133.5, and an AIC weight of 0.99. The AIC weights indicate the non-linear model is 89 times more likely than the linear model. For the nonlinear model, $m_{(a)}$* = 0.324 when the potential outliers are excluded (Fig. 4), and m_a* = 0.289 when the potential outliers are included.

The relatively poor performance of the linear model is inconvenient because the TLS algorithm is not, in general, applicable to nonlinear relationships. This inapplicability raises concern about being unable to assess the potential influence of sampling error in the x-axis. However, this concern may be largely allayed through data transformation. Specifically, exponentiating both the x- and y- axis results in a linear relationship and both axes of the transformed data are measured on the same scale. Recall that exp[r] is the definition of λ. We can compare LSE and TLS for this transformed data set. The predicted value of m_a* (when the outliers are excluded) is the same (to 3 significant figures) regardless of whether it is estimated by LSE or TLS (m_a* = 0.278) (see Fig. S2 in *Supporting Materials*).

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Isle Royale wolves and mortality

The NRM data and the North American data seem to differ in important ways with respect to m_a* and the overall relationship between m_a and r (cf., Figs 3 and 4). The relationship between total annual mortality rate (m_{total}) and r for the Isle Royale wolf population, where m_a is zero, may help understand why the NRM and North American observations seem to differ. For the Isle Royale data, the linear and non-linear models performed similarly well (Fig. 5). Specifically, the linear model was characterized by R^2=0.48, an AIC_C of –130.77, and an AIC weight of 0.38; and the nonlinear model was characterized by R^2=0.52, an AIC_C value of –131.75, and an AIC weight of 0.61.

Because the linear model performed reasonably well, we can make reasonable inferences about the possible effect of sampling error in the x variable by comparing LSE and the TLS algorithm. Conveniently, this comparison suggests that sampling error in the x variable has little influence on understanding m_{total}* (i.e., the value of m_{total} that is associated with an expected growth rate of zero). Specifically, LSE results in m_{total}*=0.281 and the TLS algorithm results in m_{total}*=0.268 (Fig. 5).

The non-linear model predicts m_{total}*=0.334. Because the linear and non-linear models performed similarly well, there is value in calculating a weighted average of m_{total}*, where the weights correspond to the AIC weights for the linear and non-linear model. This weighted average is m_{total}*=0.314. In the discussion, we explain how these observations help us interpret the difference between the NRM data and the North American data. For now the salient observation is that population growth is expected to be negative if m_{total} is less than approximately 0.31.

Uncertainty

Previous analyses of the relationship between m_a and r have focused on m_a*, the *expected* value of m_a that would result in a growth rate of zero. While the TLS algorithm accounts for statistical bias in estimates of m_a* that arises from sampling error in the x variable, these estimates are still characterized by statistical uncertainty. Consequently a population with an anthropogenic mortality rate of m_a* will experience a substantial risk of population decline, even if m_a* is based on TLS. Good decision-making in conservation and management requires accounting for these kinds of risk (Regan, Colyvan, & Burgman 2002).

A statistic that can account for this risk is m_a', which is the value of m_a that corresponds to an appropriately small risk that the populations growth rate will fall below some acceptable lower value. It is beyond the scope of this manuscript to judge what counts as an "appropriately small risk" or an "acceptable lower value." We aim only to show that determining the maximum allowable rate of anthropogenic mortality depends greatly on the level of risk that is deemed appropriate.

When regression is assessed by LSE, the value of m_a' is given by (Eqn 17.31 in Zar 1984):

$$\bar{x} + \frac{b(y^* - \bar{y})}{K} - \frac{t_{(2p),df}}{K}\sqrt{s_{yx}^2\left[\frac{\left(y^* - \bar{y}\right)^2}{\sum x^2}\right] + K\left(1 + \frac{1}{n}\right)} \qquad \text{(Eq 1)}$$

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where the x's refer to observed values for the rate of anthropogenic mortality; the y's refer to observed values of population growth rate; b is the slope of the relationship between x and y; n is the sample size; s_{yx}^2 is mean squared residual; $t_{(2p),df}$ refers to the t-distribution evaluated at $n - 2$ degrees of freedom (df), and p is probability that the population's growth rate would fall below y^*; and K is equal to $b^2 - (t_{(2p),df})^2 s_b^2$, where s_b^2 is equal to $s_{yx}^2/\Sigma x^2$. Selecting a value of p represents an explicit and quantified account of the precautionary principle, which suggests that management decisions account for the risk of causing harm when there is uncertainty about the outcome of management is uncertain (Raffensperger & Tickner 1999).

We applied this equation to the LSE regression model for the NRM wolf population where mortality was calculated as $m_{(a2)}$ (i.e., dashed line in Fig. 3B). For example, suppose it had been judged that a 25% chance of population decline ($y^*=r<0$) represents an appropriate level of risk, then the maximum allowable rate of anthropogenic mortality is ~0.20 (See the solid blue line in Fig. 6.). By comparison, ignoring risk and focusing only on the expected value of m_a would lead one to think the maximum allowable rate of anthropogenic mortality would be 0.27 (i.e., the value of m_a where the dashed line in Fig 3B. crosses the y-axis).

Because LSE overestimates m_a^* for the NRM wolf populations, there is value in assessing the influence of uncertainty on TLS estimates of m_a^*. The concern is that equation (1) was developed for LSE not TLS estimation. However, judicious use of equation (1) can provide at least an approximate understanding of how uncertainty affects estimates of m_a'. To develop this approximate understanding we first used equation (1) and LSE to calculate the difference between the $m_{(a2)}^*$ and $m_{(a2)}'$ for a specified value of y^* and p. Then we subtracted half of this difference from $m_{(a2)}^*$ as calculated from the TLS algorithm (i.e., the value of m_a where the solid line in Fig 3B crosses the y-axis). By subtracting only half the difference, these estimates of m_a' are unlikely to underestimate the maximum allowable harvest. The dashed lines in Figure 6 illustrates how acceptable levels of risk and population growth rate affect maximum allowable rates of anthropogenic mortality.

One of the most important reasons to consider values of $y^*>0$ is that the long-run growth rate of a population is reduced by temporal variability in r. Specifically, $\bar{r} = r - (\sigma^2/2)$, where σ^2 is the interannual variance in growth rate (reference). The observed values of growth in Figures 1, 3, and 4 are short-term growth rates (based on just one or a few years). That is, the observation in these figures corresponds to r, not $\bar{r}$. To account for this influence, one would set y^* equal to $\sigma^2/2$. The value of $\sigma^2/2$ varies quite a bit among wolf populations. For example, $\sigma^2/2$ was between 0.08 and 0.67 for some Alaskan populations (Foley 1994), 0.03 for Isle Royale wolves (Vucetich & Peterson 2004), and between 0.01 and 0.02 for populations in the Northern Rockies (Table 1).

Equation (1) was derived in the context of linear regression. Applying this equation to the North American data set, which was described by the relationship, $y=\beta_0+\beta_1 x^*$. This relationship can be treated as a linear relationship by regressing y onto x^*. We obtained estimates of m_a' by backtransforming the results of equation (1). Again, suppose that a 33% chance of population decline is considered an

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acceptable risk, and suppose that $\sigma^2/2 = 0.025$ (i.e., $y^*=0.025$). In this case, the maximum allowable rate of anthropogenic mortality is ~0.20 (Fig. 6B).

Many values of m_a' are lower for the North American populations than for the NRM populations, especially for levels of risk lower than 25% (*cf.*, Figs. 6A and 6B). Superficially, this may seem unexpected because m_a^* is greater for the North American populations than the NRM populations (cf., Figs. 3 and 4). In other words, being certain that anthropogenic mortality will not cause population decline among North American populations requires lower values of m_a than for the NRM wolf populations, even though the expected value of m_a for which populations are expected to decline is greater for North American populations. Nevertheless, the relatively low values of m_a' for the North American data are explained by s_{yx}^2 and s_b^2 (see Eqn 1) greater for the North American populations than for the NRM populations. In other words, the relationship between m_a and r for the North American populations is characterized by greater variability and uncertainty.

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Figure 1. The relationship between the rate of anthropogenic mortality (m_a) and population growth rate (λ) for wolf populations living in the Northern Rocky Mountains between 1999 and 2009. Filled circles are data analyzed by Gude et al. (2011) and open circle are data analyzed by Creel and Rotella (2010). The lines are simple linear regression models. The regression lines crosses λ=1 when m_a = 0.47 for data used by Gude et al. (2011), and λ=1 when m_a = 0.23 for the data used by Creel & Rotella (2010).

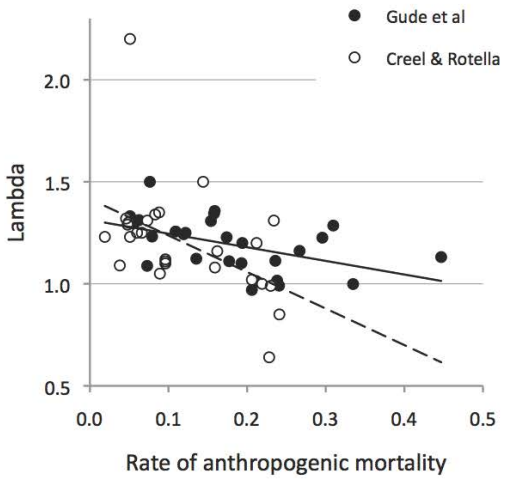

Fig. 2. Simple linear regression (dotted line) minimizes the "vertical error" between the data and the best fitting model (e.g., arrow A). This approach underestimates the magnitude (absolute value) of the slope of a line when there is measurement error in the *x*-variable. If the scale (or units for which) the *x*- and *y*- axes are measured the same, and if and magnitude of the measurement error associated with the *x*- and *y*- axes are similar; then, then total least squares regression, which minimizes the "perpendicular error" (e.g., Arrow B), provides an unbiased estimate of the slope.

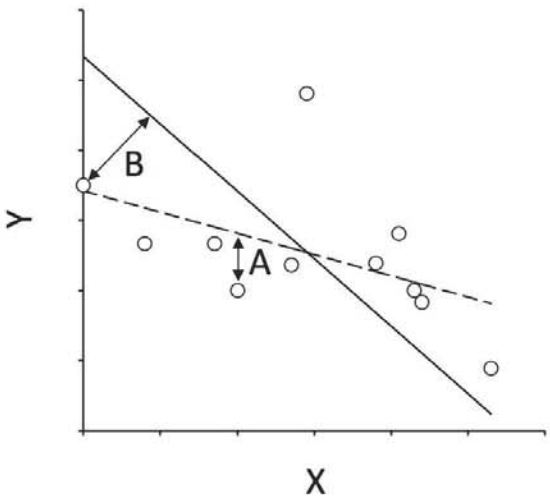

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Figure 3. Relationship between rate of anthropogenic mortality and annual population growth rate for wolf populations living in the Northern Rocky Mountains. Panel (A) is based on mortality rate calculated as $m_{(a1)t} = D_{t\rightarrow t+1}/(N_t+D_{t\rightarrow t+1})$, and panel (B) is based on mortality rate calculated as $m_{(a2)t} = D_{t\rightarrow t+1}/(N_t+R_{t+1})$ (see Table 1). The dotted lines represent simple linear regression which results in a slope that is biased toward zero because they assume the *x* variable is measured with perfect precision. The solid lines are the result of the Total Least Squares algorithm which accounts for the influence of sampling error in the *x* variable. Each relationship is statistically significant (i.e., $p<0.02$).

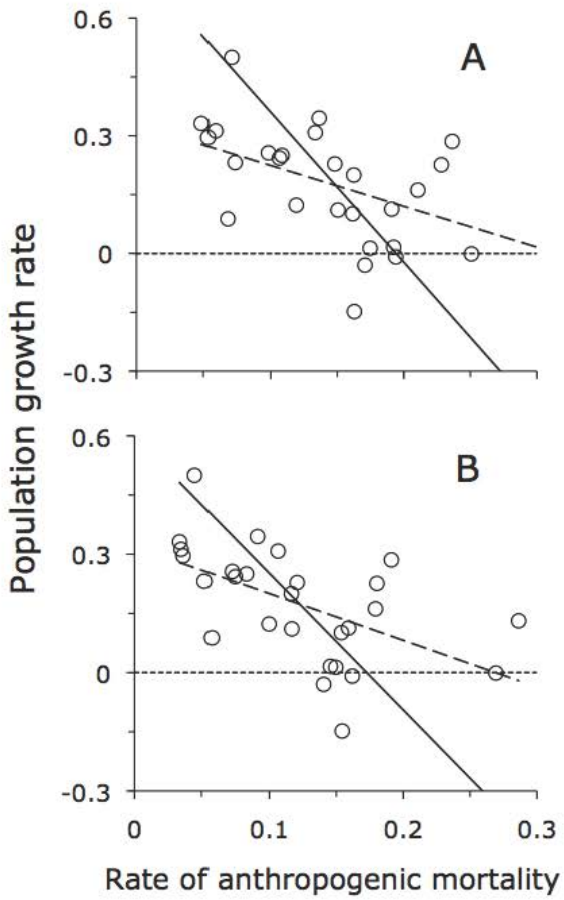

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Fig. 4. Relationship between rate of anthropogenic mortality and population growth rate for populations of wolves living at various sites throughout North America. The filled circles are likely outliers. The curved line is the best fitting non-linear model (y=0.114 – 2.284$x^{2.658}$; R^2=0.71; p<0.01). Data are from Adams et al. (2008).

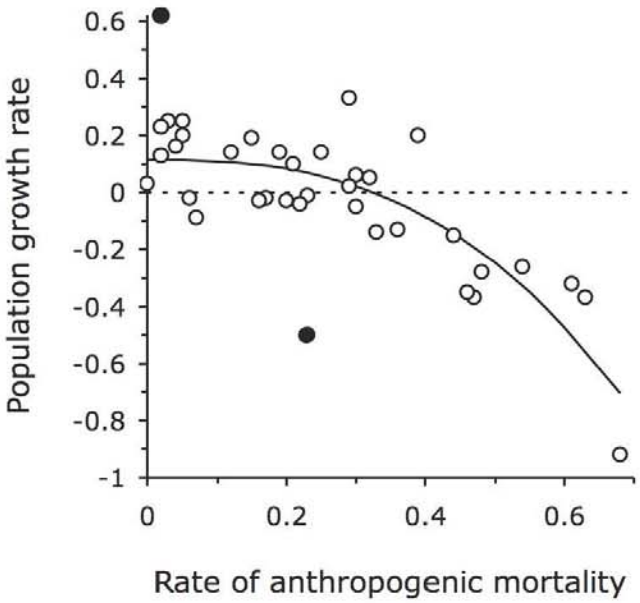

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Fig 5. Relationship between total annual mortality rate and population growth rate for the Isle Royale wolf population (1959-2011). The solid curve, y=0.215 – 2.557$x^{2.256}$ (R^2=0.52; p<0.01), is based on least squares regression. The dashed line is linear regression based on total least squares estimation, and the dotted-dashed line is the linear regression model based on least squares estimation. The two linear models show how m_{total}* (i.e., mortality rate at which growth rate is zero) is essentially unaffected by measurement error in the x-axis. The linear model and non-linear models performed similarly well (see Results). Together these models suggest that m_{total}*≈0.31, which offers insight for why m_a* (i.e., rate of anthropogenic mortality at which growth rate is zero) differs between NRM and N America (see Discussion).

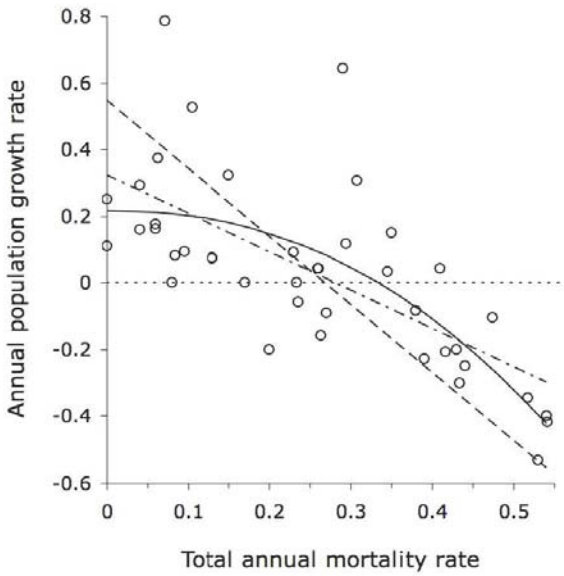

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Fig. 6. The level of risk (x-axis) of falling below various specified rates of population growth (different colored lines) associated with various rates of anthropogenic mortality (y-axis) for wolf populations in the Northern Rocky Mountains (A) and from throughout North America (B). For example, the black circle at [0.25, 0.18] in (A) indicates that a population harvested at a rate of 0.18 has a 25% chance of exhibiting a population growth rate less than 0.02. In (A), the lines are the result of applying data in Figure 3B to Equation (1), solid lines is based on the least squares regression model, and the dashed lines are based on the total least squares regression model. In (B), solid lines are based on applying data in Figure 4 to Equation (1), and dashed lines are the same except they assume that variance left unexplained by the regression line is only half of that which was actually observed. That is, the dotted lines in (B) represent values of m_a' if s_{yx}^2 had been half as great as what had been observed. These curves are shown only for the purpose of showing how sensitive values of m_a' are to variability and uncertainty.

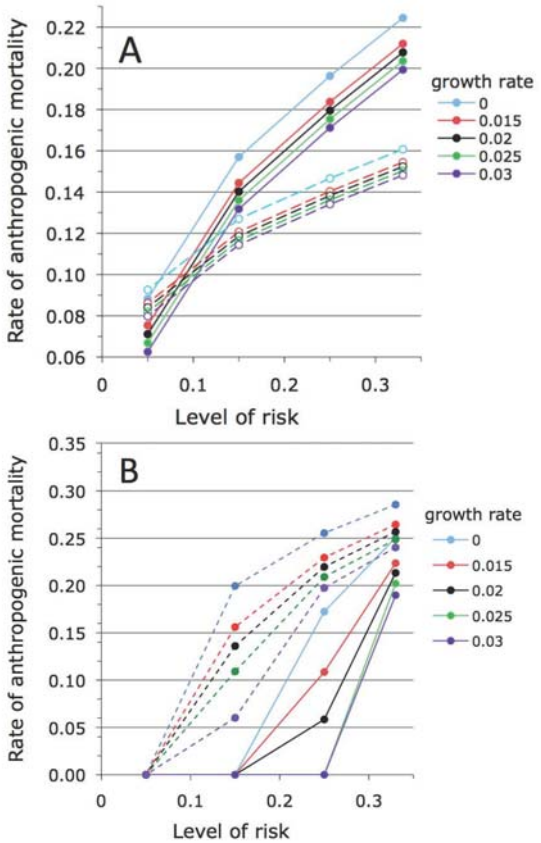

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Table 1. Population data from wolf populations in the Northern Rocky Mountain region of the United States. The areas are northwest Montana (NWMT), Greater Yellowstone Area (GYA), and Central Idaho (CID). *N* is abundance, *R* is the number of wolves recruited into the populations be time *t* and *t*–1, *M* is the number of wolves killed between time *t* and *t*–1, λ is the population growth rate, *r* is equal to $\ln(\lambda)$, m_a are estimates for the rate of anthropogenic mortality as calculated by either Gude et al. (2011) or Creel and Rotella (2010), and $m_{(a1)}$, $m_{(a2)}$, and $m_{(a3)}$ are estimates of anthropogenic mortality used this analysis (See *Analysis & Results*). Dashes indicate values for which estimates are not available or cannot be calculated. Asterisks indicate values that were omitted (or not calculated) because they depend on unreliable field observations (i.e., unreliable estimates of *N* and *R*, see *Analysis & Results*).

		Gude et al. (2011)					Creel and Rotella (2010)			Figure 3 and S1			
Year	Area	N	R	M	λ	m_a	N	λ	m_a	r	$m_{(a1)}$	$m_{(a2)}$	$m_{(a3)}$
1999	NWMT	63	–	16	–	–	63	1.02	0.206	0.016	0.192	0.146	0.127
2000	NWMT	64	40	15	1.02	0.238	64	1.31	0.234	0.313	0.059	0.035	0.034
2001	NWMT	84	51	4	1.31	0.063	84	1.29	0.048	0.286	0.236	0.191	0.160
2002	NWMT	108	52	26	1.29	0.310	108	0.85	0.241	-0.148	0.163	0.154	0.134
2003	NWMT	92	28	21	0.85*	0.194*	92	0.64	0.228	*	*	*	*
2004	NWMT	59	21	4	0.64*	0.043*	59	2.2	0.051	*	*	*	*
2005	NWMT	126	70	8	2.14*	0.136*	130	1.32	0.046	*	*	*	*
2006	NWMT	171	102	20	1.36	0.159	171	1.35	0.088	0.345	0.136	0.091	0.084
2007	NWMT	230	125	27	1.35	0.158	230	1.34	0.083	0.226	0.228	0.180	0.153
2008	NWMT	282	147	68	1.23	0.296	308	–	0.166	0.131	0.309	0.286	0.223
2009	NWMT	319	158	126	1.13	0.447	–	–	–	–	–	–	–
1999	GYA	118	–	10	–	–	112	1.05	0.089	0.500	0.071	0.045	0.043
2000	GYA	177	83	9	1.50	0.076	118	1.5	0.144	0.232	0.073	0.052	0.050
2001	GYA	218	93	14	1.23	0.079	177	1.23	0.051	0.243	0.107	0.074	0.069
2002	GYA	271	131	26	1.24	0.119	218	1.25	0.06	0.111	0.150	0.117	0.105
2003	GYA	301	140	48	1.11	0.177	272	1.11	0.096	0.113	0.191	0.159	0.137
2004	GYA	335	145	71	1.11	0.236	301	1.08	0.159	-0.030	0.171	0.141	0.123
2005	GYA	325	156	69	0.97	0.206	324	1	0.219	0.200	0.162	0.179	0.104
2006	GYA	390	216	63	1.20	0.194	325	1.2	0.212	0.162	0.211	0.116	0.152
2007	GYA	453	190	104	1.16	0.267	390	1.16	0.162	-0.009	0.194	0.162	0.140
2008	GYA	449	220	109	0.99	0.241	453	0.99	0.23	0.013	0.175	0.150	0.130
2009	GYA	455	186	95	1.01	0.212	449	–	0.243	–	–	–	–
1999	CID	156	–	11	–	–	–	–	–	0.256	0.098	0.072	0.067
2000	CID	196	79	17	1.26	0.109	–	–	–	0.332	0.049	0.034	0.033
2001	CID	261	101	10	1.33	0.051	261	1.09	0.038	0.088	0.068	0.057	0.054
2002	CID	284	70	19	1.09	0.073	284	1.3	0.049	0.296	0.053	0.036	0.035
2003	CID	368	157	16	1.30	0.056	368	1.23	0.019	0.228	0.148	0.121	0.108
2004	CID	452	162	64	1.23	0.174	452	1.25	0.066	0.250	0.108	0.083	0.077
2005	CID	565	211	55	1.25	0.122	565	1.31	0.073	0.308	0.133	0.106	0.096
2006	CID	739	252	87	1.31	0.154	739	1.12	0.096	0.123	0.119	0.100	0.091
2007	CID	830	263	100	1.12	0.135	830	1.1	0.096	0.101	0.162	0.154	0.133
2008	CID	914	210	160	1.10	0.193	914	–	0.143	-0.001	0.251	0.269	0.212
2009	CID	913	222	306	1.00	0.335	–	–	–	–	–	–	–

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Supporting Materials for the Appendix

Fig. S1. Relationship between rate of anthropogenic mortality and annual population growth rate for wolf populations living in the Northern Rocky Mountains, where mortality rate calculated as $m_{(a3)t} = D_{t\rightarrow t+1}/(N_t+R_{t+1}+D_{t\rightarrow t+1})$ (see Table 1). The dashed line represent simple linear regression, and the solid line is the result of the Total Least Squares algorithm. Each relationship is statistically significant (i.e., p<0.01).

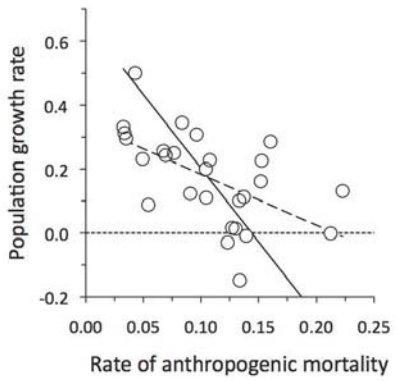
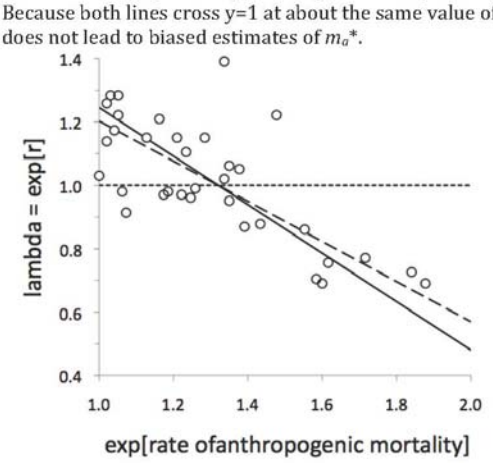


Fig. S2. The relationship between anthropogenic mortality and population growth rate for populations of wolves living at various sites throughout North America. Data are same as in Figure 4, except here they are linearized by exponentiating both axes. We linearized the data to compare the results of least squares regression (dashed line) and total least squares regression (solid line). Because both lines cross y=1 at about the same value of x, failure to account for measurement error does not lead to biased estimates of m_a*.



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