DOCKETED

Docket Number:	09-AFC-07C
Project Title:	Palen Solar Power Project - Compliance
TN #:	202521
Document Title:	Exh. 3130 Smallwood - Suggested Standards for Science Applied to Conservation Issues
Description:	N/A
Filer:	Lisa Belenky
Organization:	Center for Biological Diversity
Submitter Role:	Intervenor
Submission Date:	6/23/2014 3:39:26 PM
Docketed Date:	6/23/2014

SUGGESTED STANDARDS FOR SCIENCE APPLIED TO CONSERVATION ISSUES

K. SHAWN SMALLWOOD, Department of Biological Science, California State University, Sacramento, CA 95819.

ARMAND GONZALES, Department of Fish and Game, 619 Second Street, Eureka, CA 95501

TARA SMITH, 8935 Salmon Falls Drive, Sacramento, CA 95826-1958

ED WEST, 2515 Bombadil Lane, Davis, CA 95616

COLE HAWKINS, 3612 Washoe Street, Davis, CA 95616

ERIC STITT, ECORP Consulting Inc., 2260 Douglas Blvd., Suite 160, Roseville, CA 95661

CHIRRE KECKLER, Mendocino National Forest, 825 N. Humboldt Ave., Willows, CA 95988

CRAIG BAILEY, 1313 Shadowglen Road, Sacramento, CA 95864

KAREN BROWN, California Department of Water Resources, San Joaquin District, 3374 East Shields Avenue, Room B-19, Fresno, California 93726

ABSTRACT: The Conservation Committee of The Wildlife Society (TWS)-Western Section (WS) commenced activities during the summer of 1999, and quickly encountered a profusion of conservation issues in the Western Section, reviewing environmental documents, determinations, decisions, and claims made by government agencies, political bodies, news media, and citizen groups. The Committee recognized that it could address only a fraction of these issues. In our experience, recognizing and debating each issue through both the Conservation Committee and the Executive Board will often require more time than allowed by government comment periods and the period during which the news media remain interested. We believe that it will be more effective to establish and re-affirm the standards of professional and scientific conduct that should generally found the issues. This way, TWS-WS members who are more familiar with the issues can use these standards as a collective benchmark to judge the adequacy of professional and scientific foundation underlying documents, determinations, decisions, and claims related to each issue.

We recommended to the Executive Board that we develop standards and present them at the Annual Meeting in January, 2000. On October 15th, 1999, the Executive Board moved to have our Committee act on its recommendation. This paper summarizes the preliminary standards developed by members of the Conservation Committee. These standards presented herein are preliminary, and have not been sanctioned by the Executive Board. We expect that this document is just the beginning of a debate on standards that are acceptable to TWS-WS for using scientific and other information when making conclusions that affect wildlife. We invite feedback on the standards presented herein.

Key Words: Conservation, environmental documents, science, standards, The Wildlife Society.

2000 TRANSACTIONS OF THE WESTERN SECTION OF THE WILDLIFE SOCIETY 36:40-49

Conservation issues have proliferated in the western U.S. as population and economic demands have increased the pressures and impacts on natural resources, including wildlife. Members of TWS-WS participate in these issues, oftentimes struggling against each other over a particular issue. Debates over decisions, conclusions and claims often have been contentious and fractious amongst wildlife professionals. Whether a conclusion or opinion is justified biologically is too often secondary to socio-economics and political expediency (Wilkinson 1998). These realities point not just to the diminished value given natural resources by decision-makers despite overwhelming public support to do otherwise, but also demonstrate our inability to convey our message consistently. Different backgrounds, disciplines, and philosophies can lead one to different interpretations of the data, and subsequently, to different conclusions. Disagreement amongst professionals is reasonable and not unexpected. Where we fail and consequently lose credibility as a profession is in our inconsistency to adequately support and justify our conclusions, and in the errant advocacy of wildlife biology from a non-biological inclination.

Environmental documents, decisions, determinations, and claims involving wildlife usually pertain to some *action* (or lack of action) and an *impact* to the wildlife due to that action. The action may encompass management, "take" of species, mitigation, or some combination of all these. The impact may be positive or negative, and it may be specific to one or more species of wildlife involving one of several demographic units such as individuals, family groups, populations, or metapopulations. The impact also can be specific to some other part of the environment (including humans) as a result of changed regulatory or real-world status of the particular species of wildlife. The impacts are direct, indirect, and cumulative. All of these actions, impacts, and the related conclusions drawn by different sectors of our society bear on the interests of wildlife biologists.

Wildlife biologists have rendered conclusions (or opinions) in countless environmental documents that have justified projects and management actions affecting wildlife. Many of these projects have resulted in net losses of habitat areas, degradation of habitat, "takings," and ineffective mitigation. The majority of Habitat Conservation Plans (HCPs) result in incidental, and increasingly, direct take of listed species, net loss of habitat areas, and involve conclusions about project impacts and mitigation effectiveness that are often poorly founded in science (Kareiva et al. 1999, Smallwood et al. 1999, Smallwood 2000*a*). Natural Community Conservation Plans, (NCCPs), are California's version of HCPs, and also result in takings and net losses in habitat areas. California Environmental Quality Act (CEQA) documents often justify projects in the form of "negative declarations" or determinations of "no significant effect" due to project actions. These CEQA documents have preceded and made legal the destruction of many thousands of acres of wildlife habitat. Virtually all of the large-scale conversions of wildlife habitat require assessments and conclusions from wildlife biologists, including projects such as housing developments, construction of industrial sites, construction of hazardous waste storage and treatment sites, dredging of shipping channels in coastal bays, construction of new roads, and the clear-cutting of large tracts of late seral Redwood forests.

The conclusions of wildlife biologists affect policies, management decisions, and management prescriptions in federal and state agencies responsible for wildlife, native plants, water resources, forestry, and transportation. Decisions by these agencies affect many thousands of hectares of wildlife habitat, including livestock stocking rates, predator control and other types of animal damage management, timber harvest rates and practices, water conveyance and storage systems, pesticide usage, the locations and design of roads, and game harvest seasons and quotas. These agencies also affect wildlife habitat by listing species as threatened or endangered, designating critical habitat, and preparing and implementing recovery plans. Many additional examples could be used to support our argument that wildlife biologists profoundly influence wildlife conservation issues by contributing to, or rendering, conclusions. Not necessarily the fault of wildlife biologists (see Wilkinson 1998), many of their conclusions conflict with the objectives of TWS by leading to the degradation of wildlife and wildlife habitat and by being rendered without sound scientific foundation.

That these issues bear on the interests of TWS is clear enough in the Bylaws of TWS, as well as in the program for certification of professional wildlife biologists. The principal objectives of TWS "are:

(1) to develop and promote sound stewardship of wildlife resources and of the environments upon which wildlife and humans depend;

(2) to undertake an active role in preventing human-induced environmental degradation;

(3) to increase awareness and appreciation of wildlife values; and

(4) to seek the highest standards in all activities of the wildlife profession."

The other TWS objectives might follow if objective (4) is met, so long as we can agree about what are the highest standards. Additionally, the Bylaws describe a Code of Ethics, which asks that each member "pledges to:

(1) Subscribe to the *highest standards* of integrity and conduct;

(2) Recognize *research and scientific management* of wildlife and their environments as primary goals; ...

(5) *Promote competence* in the field of wildlife management by supporting high standards of education, employment and performance;

(6) Encourage the use of *sound biological information* in management decisions ..." (*emphasis* added).

The program for certification of professional wildlife biologists re-emphasizes these same objectives and code of ethics. Also, we point out that the TWS objectives do not pertain to only endangered species of wildlife, but to all species of wildlife. The objectives of TWS are likely shared by most professional wildlife biologists, including non-members of TWS.

Obviously, many conclusions of wildlife biologists or of their supervisors conflict with TWS objectives, as the actions that followed have resulted in many takings, widespread losses and fragmentation of habitat, habitat degradation, and declines of many species of birds, mammals, reptiles and amphibians. Given the numerous conclusions affecting wildlife deleteriously, and the many that seem to be poorly founded in science, there may be different opinions about what qualifies as sound stewardship, high standards, research and scientific management, and sound biological information. The purpose of this paper is to begin a dialogue amongst biologists as to what they should expect, at a minimum, of themselves and others in the wildlife profession. The TWS-WS Executive Board established this dialogue as an action item for the Conservation Affairs Committee in its meeting of 15 October, 1999, but we present these preliminary standards as individuals, rather than as a Committee action.

STANDARDS

Our goals for establishing standards were:

1) To identify the standards by which to gauge the reliability of our own and others' premises and conclusions;
2) To improve the consistency in the use of our key terms and reporting methods;
3) To identify which conclusions are scientific and which are not;
4) To decide whether the conclusions are consistent with the TWS objective of conserving wildlife; and,
5) To encourage more people to involve themselves with conservation issues.

To meet these goals, we prepared a draft worksheet (Table 1) to assist preparation or review of environmental documents. Table 1 is divided into several sections, each of which follows from one of the key phrases in the objectives of the TWS Bylaws, and is discussed below. Table 1 is proposed to stimulate discussion on how best to achieve our goals. Perhaps the final analysis, including the stated goals and objectives, will take a much different form than what we have proposed here. We will, however, continue to refine our thinking through thoughtful input from wildlife biologists, in hopes of furthering the credibility and effectiveness of our profession.

Consequences of action based on conclusion(s)

The TWS Bylaws require members to steward wildlife and to prevent their degradation, meaning that wildlife biologists are expected to protect or conserve wildlife. We are expected to promote the persistence of healthy wildlife populations and their habitats for the long term. Given this stewardship role, our standards should first assist the reviewer in putting the conclusion(s) at issue into perspective. In judging the importance of a conclusion, wildlife biologists first need to clearly identify what is at stake in terms of our stewardship role. The magnitude of the likely consequences to wildlife should determine how closely wildlife biologists follow our proposed standards when rendering conclusions.

For example, one could use Table 1 to check off whether the proposed action would restore habitat for a net gain, or whether it would degrade or remove habitat. The former consequence would lessen the reviewer's level of concern over standards not being met. However, the degradation or removal of habitat for a net loss to wildlife ought to heighten the vigilance of those preparing or reviewing the environmental document(s). Similarly, one could use Table 1 to check off whether the project is likely to have no consequence for the survival or behavior of individuals, or whether the project would displace or kill all the individuals composing a population or metapopulation. The former consequence probably warrants little concern over the soundness of the supporting documents, but the latter demands the use of the highest standards of our profession.

The consequences of an action based on a conclusion has two aspects related to health and integrity: one involving habitat and the other involving demographic units. To restore habitat for a net gain or to have no impact on the health of individual animals would qualify proposed actions as achieving the highest standards relative to the conservation goals of TWS, whereas the net loss of habitat or the loss of one or more metapopulations would qualify proposed actions as achieving the lowest standards. Lower standards for these aspects of a conclusion warrant a closer examination of the scientific foundation and the soundness of the biological information leading to the conclusion.

Scientific foundation of conclusion

By expecting wildlife biologists to recognize research and scientific management as primary goals, the TWS Bylaws attach great importance to using the scientific method to understand more about wildlife and habitat, founding management decisions, and integrating them into management prescriptions. Management decisions can be founded in the scientific method by basing them on data collected as part of a scientific research program. Such data might come from a monitoring program that scientists designed or used for testing hypotheses, or they might be from scientific reports, and collected using methods that are widely accepted by scientists. Habitat determinations can be an example of scientifically derived data pulled from published reports. So long as the hypotheses in the report are consistent with the management context, the use of data from published reports can contribute to scientific management.

Adaptive management is an example of integrating science into management prescriptions (Holling 1978, Lancia et al. 1996). Hypotheses are described prior to the management implementation, and are the bases for the monitoring program. Hypotheses that are tested while management is implemented determine future management prescriptions. Whether basing management decisions on scientific data or integrating scientific methods into them, TWS prefers conclusions that are scientifically founded. Environmental documents should be clear

Table 1. Worksheet for identifying the standards applied to conclusions that have consequences for wildlife conservation. Each conclusion can be composed of 19 aspects organized under 3 key phrases in the TWS Bylaws. Each aspect of a conclusion can then be assigned a standard, which is represented by a phrase. When only *one* phrase can characterize an aspect of a conclusion, the highest standard is that phrase at the top of the list, and the lowest standard is at the bottom of the list. When *all* phrases can characterize an aspect of a conclusion, the highest standard applies when all the phrases can be checked off. The highest standards are denoted by brackets encompassing the check space: [____].

Consequences of action based on conclusion(s)

1. Conclusion can lead to action that would (check *one* applicable phrase):

Restore habitat for a net gain	[____]
Enhance habitat for a net gain	[____]
Protect all existing habitat at issue	[____]
Protect a portion of the habitat at issue to mitigate for take	
Replace habitat to mitigate for take	
Pay into a conservation bank as mitigation for take	
Degrade habitat	
Remove habitat, or compensate financially for habitat loss	

2. Conclusion can lead to action that, through habitat loss or otherwise (including a sanctioned game harvest), would likely or certainly kill or remove (check *one* applicable phrase):

No individuals, and it would not affect their behaviors or physical health	[____]
No individuals, but it would affect behaviors or sicken one or more individuals	____
No individuals, but it would affect behaviors or sicken all of a population	____
No individuals, but it would affect behaviors or sicken individuals across a region	____
Individuals	____
One or more reproductive groups (i.e., mated pair)	____
A population	____
One or more metapopulations	____

Scientific foundation of conclusion

1. Uncertainty in the conclusion was (check *one* applicable phrase):

Specified using a quantitative method	[____]
Specified using a qualitative method	
Specified as a list of alternative outcomes	
Not specified	

2. Presence and condition of the species were based on (check *one* applicable phrase):

Scientific study involving an area that is larger than the project area	[____]
Scientific study involving the entire jurisdiction or project area	
Scientific study involving a small portion of the jurisdiction or project area	
Presence of habitat, which was described elsewhere using scientific methods	
Non-scientific data, such as NDDB or cursory walk-over site visits	
No study or data indicated	

3. Conclusion was based on (check *one* applicable phrase):

Quantitative data collected from the site and species at issue	[____]
Quantitative data collected from offsite or for another species	
Qualitative data collected from the site and species at issue	
Qualitative data collected from offsite or for another species	
No data collected	

Table 1 (continued)

4. Conclusion was based on methods, in which (check all phrases that apply):	
Temporal scale of data collection was specified	[ ]
Spatial scale of data collection was specified	[ ]
The hypotheses being tested or the assessment's objectives were clearly described	[ ]
Experimental or research design was specified and described	[ ]
Assumptions were identified and discussed	[ ]
The conditions of the study site were described relative to the full range of conditions experienced or likely to occur at the site	[ ]
5. Conclusion was reported in a document that described (check all phrases that apply):	
All methods used to collect data	[ ]
All methods used to aggregate data	[ ]
All methods used to analyze the data	[ ]
The time periods during which observations were made or data collected	[ ]
6. Conclusion was based on statistical tests upon which (check all phrases that apply):	
The test was appropriate for the data and the hypothesis	[ ]
The assumptions of the test were met	[ ]
Type II error was established, if warranted	[ ]
7. Conclusion was based on research design that included (check all phrases that apply):	
A control treatment, if manipulation of the study units was involved	[ ]
Replicates	[ ]
Interspersion of treatments, whether they be mensurative or manipulative	[ ]
Soundness of biological information leading to conclusion	
1. Referenced source information consisted of (check *one* applicable phrase):	
Published reports subjected to independent scientific review	[ ]
Published reports that were not peer-reviewed	
Personal communications, opinions, and anecdotes	
No referencing of source	
2. Personal communications and opinions were (check *all* phrases that apply):	
Supported by contact information of the individual(s) cited	[ ]
Accompanied by a statement of uncertainty	[ ]
3. Referencing of source information was (check *all* phrases that apply):	
Comprehensive	[ ]
Balanced according to the competing arguments	[ ]
4. For each reference, check off whether it was (check *all* phrases that apply):	
Accurate	[ ]
Relevant	[ ]
Fully described	[ ]
Readily accessible in a library or other location	[ ]
5. Document quality (check *all* phrases that apply):	
All species names are spelled correctly and scientific names are current	[ ]
All important terms, such as ecosystem, habitat, population, community, corridor, and net benefits were either defined or a definition referenced	[ ]
All important terms were accurately used	[ ]
The qualifications of the analyst or assessor were described (if not peer-reviewed)	[ ]

Table 1 (continued)

6. Conclusion invoked population study including (check *all* phrases that apply):	
Numbers (density)	[ ]
Demography	[ ]
Gender ratio	[ ]
Genetics	[ ]
Condition of food resources	[ ]
Condition of habitat	[ ]
7. Conclusion invoked habitat study (check *all* phrases that apply):	
At the scale of the population or larger	[ ]
Spanning at least one generation of the species	[ ]
Based on use and availability analysis	[ ]
At a scale smaller than the population	
Spanning <1 generation of the species	
Based on presence of only "optimal" or "preferred" habitat	
8. Conclusion of impacts due to management was based on (check *one* applicable phrase)	
Quantitative, empirical evidence from multiple examples	[ ]
Quantitative, empirical evidence from one example	
Qualitative, empirical evidence from multiple examples	
Qualitative, empirical evidence from one example	
No empirical evidence	
9. Management impacts in conclusion were specific to (check *one* applicable phrase):	
Each species or species' habitat	[ ]
Taxonomically or functionally related species or their habitats	___
Umbrella species, umbrella habitat, or some other indicator of the species	
Not specified	
10. Management impacts in a conclusion followed consideration of (check *all* phrases that apply):	
A full range of project and mitigation alternatives, including 'no project' alternative	[ ]
The benefits and disadvantages of each project and mitigation alternative	[ ]
Spatial requirements of the species	[ ]
PVA	[ ]
Appropriately designed monitoring program	[ ]
Impacts on ecosystem processes that affect the species (indirect effects)	[ ]
Cumulative impacts on the species	[ ]

about the extent to which science was part of the conclusion or management decision. Table 1 is intended to promote this clarity.

Scientific methods are designed to reduce human uncertainty in natural phenomena (Popper 1969, Kuhn 1970). Statements of uncertainty are therefore critical to scientists, because they help maintain an honest account of scientific progress. Scientists prefer uncertainty statements that are quantitative, consisting of confidence intervals or error terms (National Research Council 1986), but often qualitative statements are the best that can be expected under the circumstances (Morgan and Henrion 1990, Cooke 1991). When the magnitude of negative impact to wildlife is high, risk assessment is warranted, along with uncertainty statements. Population Viability Analysis (PVA) is one form of risk assessment that is appropriate for application to wildlife.

Scientific generalizations depend largely on the scope of the investigation, with more confidence in generalizations stemming from studies encompassing larger areas and longer time periods. Larger-scale studies can include wider ranges of variation in measured variables, thereby expanding the portion of the environment that may be experienced by the study units and considered in the conclusion. Scientific conclusions are considered more accurate and reliable when they are derived from methods and data that are specific to the study units at that particular place and most recently. The more grossly an indicator represents the study units, or the less the indicator has been functionally related to the study units, the less reliable are hypothesis tests or assessments stemming from the use of indicators (Simberloff 1998). Therefore, the scientific merits of a conclusion should be examined more closely when the assessment or hypothesis test involved a keystone species, umbrella species, sensitive species, or indicator species. They should also be examined more closely when species' numerical trends are determined from the trends in anecdotal, indicator data such as the frequency of road-kills, sightings, issuance of depredation permits, or hunter harvests.

Scientific conclusions are considered more reliable when the methods used to derive them are fully and clearly described so that the reader has the opportunity to repeat the study. When a project proponent or their consultants claim that the species in question has not been observed on the project site, the project proponent should explain the types of observations employed, when and how often the observations occurred, and how long of a time period was involved. Scientists also attach greater reliability to conclusions from experiments that suffer less from pseudoreplication (Hurlbert 1974). Many population studies are autonomous and involve no replication or interspersion of treatments. Relating the results of these studies to environmental conditions at the study site is a form of pseudoreplication, and should be interpreted conservatively. Also, some scientists expect more conservative conclusions from hypothesis-testing by considering Type II error or by conducting power analysis of trend data (Shrader-Frechette and McCoy 1992, Gerrodette 1987). A Type II error — not rejecting the null hypothesis when in fact it was false — can lead to no management actions being taken to halt the decline of a species or its habitat (Shrader-Frechette and McCoy 1992).

The accepted scientific methods for wildlife biologists are described in numerous publications, including Dasmann (1981), Verner et al. (1986), and Morrison et al. (1998), as examples. Some methods for reducing uncertainty are described by the National Research Council (1986), for example.

The scientific foundation of a conclusion has seven aspects that we identified. The highest standards would be, for example, to report the uncertainty of the conclusion quantitatively (aspect 1), assess the presence of the species across a larger area than the project area (aspect 2), and to use a research design that incorporates replication, control, and interspersion of treatments (aspect 7). The lowest standards correspond with no uncertainty specified for the conclusion (aspect 1), no study or data apparently used to assess presence or absence of the species (aspect 2), and no experimental or research design principles used to make the conclusion (aspect 7).

Soundness of biological information leading to conclusion

Not all conclusions or actions are scientific. The TWS Bylaws expect wildlife biologists to use sound biological information and the highest standards in all aspects of our profession. These standards pertain to many aspects of conclusions that are both scientific and nonscientific. The credibility of a conclusion can be judged based on the quality of the document reporting it, including the writing, the relevance and accuracy of premises, and the rigor in referencing source information. The following standards are intended to foster document preparation based on sound biological information.

Source material in environmental documents and decisions needs to be identified and referenced. So long as the reference is relevant to the conclusion, scientists usually prefer source material to consist of independently reviewed scientific documents (Smallwood et al. 1999), followed by scientific documents that were not reviewed, and personal communications or anecdotes. We recommend that personal communications be backed up by contact information of the individual(s) cited. Opinions should be accompanied by a statement of uncertainty (see above). All references of source information should be accurately represented. Referencing should also be comprehensive and balanced according to the arguments or anticipated counter arguments.

Evidence of sound biological information may be the qualifications of the analyst or assessor who prepared the conclusion, although qualifications are no guarantee that the conclusion was sound. Using correct spelling and accurate names of species also improves the soundness of the conclusion, as does clear and accurate use of key terms in the wildlife profession.

A conclusion involving wildlife can be considered more sound if greater thoroughness was applied to the issue. Thoroughness is increased by including data of more population or demographic parameters routinely studied by wildlife biologists, as well as more aspects of habitat or resources needed by the species. Thoroughness is also increased when inter-generation dynamics in demographic parameters are considered, when the entire region is included in the assessment or analysis, and when the species' use of habitat elements or food resources is compared to the available habitat elements or food resources.

Thoroughness bears on the soundness of biological information leading to conclusions of management impacts. Such conclusions can be considered more sound when the analysts have considered a full range of project and mitigation alternatives, including a 'no project' alternative and all the benefits and disadvantages of each alternative (O'Brien 2000). Conclusions can be considered more sound when analysts rely upon risk analysis (PVA) of the proposed actions and alternatives, as well as the spatial requirements of specific demographic units. Conclusions of management impact are more sound when the analysts consider the indirect effects on ecosystem processes that affect the species (Ricklefs et al. 1984) and when they consider cumulative impacts (McCold and Holman 1995).

The soundness of biological information leading to a conclusion has 10 aspects that we identified. The highest standards include, for example, referencing of peer-reviewed scientific reports as sources of a conclusion (aspect 1), referencing of source information that is both comprehensive and balanced to the arguments (aspect 3), and estimated management impacts that consider the full range of project alternatives, spatial requirements of the species, PVA, an appropriately designed monitoring program, impacts on ecosystem processes that affect the species (indirect effects), and cumulative impacts (aspect 10). The lowest standards correspond with no referencing of source information (aspect 1) or biased, selective referencing (aspect 3), and the management impacts make no consideration of project alternatives or spatial or numerical requirements of the species, monitoring, ecosystem processes, nor cumulative impacts.

DO WE REALLY NEED THESE STANDARDS?

We have witnessed poorly prepared environmental documents, containing loosely founded, questionable conclusions and extraordinary claims regarding wildlife and their habitats. Examples illustrating this point are unfortunately all too commonplace, often relying on "gray literature", "white papers", "draft" documents, and personal communications when peer-reviewed research reports are available. Specific examples have the potential to perhaps embarrass rather than instruct, and will therefore be avoided here. Suffice it to say, the reliance on non-scientific opinion, anecdotal information, speculation, and the misuse of published literature, unpublished literature, and personal communications have an embarrassing effect on the profession.

Wildlife biologists often lack the funding and time needed to make *sound* or *scientific* biological conclusions. Project proponents will not wait, and neither will the news media or concerned citizens. The interests of wildlife biologists are also often at odds with the agendas of others who have substantial influence over the conclusions, such as politicians, attorneys, and non-biologist administrators or bosses. Wildlife biologists are often asked to provide hastily prepared conclusions or opinions, and they usually do the best they can under less than ideal circumstances. Nevertheless, the conclusions of wildlife biologists, made under these kinds of circumstances, have consequences for wildlife and for the wildlife profession.

Hastily prepared documents do not reflect well on the wildlife profession when species names are out-dated or misspelled, when citations do not appear in the list of references, when references listed in the back of the document were not cited in the main body of the document, or when scientific sources are misrepresented. Conclusions of species' absence reflect poorly on the profession when they are based on lack of records in California's Natural Diversity Data Base (NDDB), or when they are based on only GIS habitat maps (no ground searches) or cursory walkover searches of the project sites. Conclusions of species' absence reflect poorly on the profession when species are pigeon-holed into "preferred" or "optimum" habitat associations and then deemed absent for lack of these habitats on a project site (Lidicker 1995). Such mistakes evoke a sense of carelessness and inappropriate haste in coming to conclusions, and they suggest bias.

Unsupported conclusions of project impacts and mitigation effectiveness reflect poorly on the wildlife profession. Substantial support is warranted for conclusions that the project and its mitigation will provide protection or net benefits to the species, or that they will be conserved under the rubric of adaptive management or ecosystem management, or that they will produce no significant impact, no cumulative impact, and no indirect or synergistic effects. The quality of the supporting documents not only bears on the wildlife profession, but also bears on the credibility of the conclusions and ultimately the consequences to the species.

The wildlife profession does not benefit from careless or inconsistent use of its central terms, such as *habitat* (Hall et al. 1997), *corridor* (Beier and Loe 1992), *ecosystem* (Fauth 1997), and *population* (Smallwood 2000*b*). These terms endured rigorous scientific debate, which attributed specific definitions to them. Inconsistent use of definitions for such important terms creates confusion among wildlife biologists and others, and this confusion can have dire consequences for wildlife. If wildlife biologists present confusing arguments, then their case is weakened and the TWS objectives are vulnerable.

Conclusions can be embarrassing to the wildlife profession when they are said to be scientific or scientifically founded, but do not involve hypothesis testing, nor data or well accepted methods for reducing scientific uncertainty. The application of critical thinking is not necessarily the same as scientific thinking, although science relies largely on critical thinking. Scientific conclusions, in the form of estimates or assessments, should be accompanied by some statement of uncertainty, which can be quantitative, qualitative, or consist of a list of alternative outcomes based on a likely range of conditions or different assumptions. Data that were considered, but then excluded from the analysis, need to be identified and an explanation provided for their exclusion. *Scientific conclusions must be accompanied by a description of the data, the data collection methods, the analytical methods, and the assumptions leading to the conclusion. A conclusion can qualify as scientific when the reader has sufficient information in the document to repeat the methods and possibly come to the same conclusion.*

We do not suggest that standards can be broadly agreed upon and implemented for every nuance of our profession. We suggest that there are core aspects of our profession that possibly could be ascribed standards upon which most of us could agree are appropriate (Table 1). We expect that a set of standards will improve our profession by being available as reminders to wildlife biologists of the factors they need to consider, and by being available for anybody to judge the credibility of environmental documents, decisions, determinations, and claims made by wildlife biologists or others. With such a set of standards, a reviewer of documents or conclusions could readily describe what TWS would expect as foundation for a particular conclusion. Standards established by wildlife biologists could empower many people in forming opinions about conclusions regarding actions and impacts involving wildlife. It could also promote better adherence to relevant environmental laws, such as the Endangered Species Act, National Environmental Policy Act, California Environmental Quality Act, and California Endangered Species Act, and be used to assess the conclusions of EIRs, EISs, EAs, HCPs, court or other public declarations or testimonies (depositions), press releases, commissioned reports, progress reports, and even scientific reports.

By publicly establishing standards we, as professional wildlife biologists, can ensure our work products meet or exceed these standards. Knowing that a more clearly and generally agreed-upon set of standards exists, the analyst is more likely to be vigilant in applying these standards. We believe wildlife biologists will provide conclusions that are more sound and scientific by having the ability to systematically check whether they or their colleagues employed a widely agreed-upon set of standards when establishing the foundation or support documentation for their conclusions. Others within and outside our profession can readily identify if and when deviations from the standards occur. We believe our standards will foster sound stewardship, sound biological information, and scientific management. These standards are broadly applicable to conclusions that bear on the welfare of wildlife. However, those who use Table 1 to criticize the foundation of others' conclusions should themselves be qualified to do so, and their credentials should accompany the critique.

IMPLEMENTING THE STANDARDS

When conclusions are made that grossly fall short of the standards of the wildlife biology profession, then professional colleagues, and even the Western Section itself, should use Table 1 to bring the shortfall to the attention of the interested parties. TWS-WS members could challenge an EIR in court by relying largely on the standards in Table 1. A judge could be convinced that the EIR is, in fact, not an informative document, which is a requirement for EIRs under CEQA. (Under CEQA law, "the court does not pass upon the correctness of the EIR's environmental conclusions, but only upon its sufficiency as an informative document" (County of Inyo v. City of Los Angeles (3rd Dist. 1977) 71 Cal. App. 3d 185, 189 [139 Cal. Reptr. 396, 399]), meaning that any conclusion in the EIR can be considered valid by the courts so long as foundation for the conclusion is summarized in the EIR.) Conversely, those who prepared an EIR could attach Table 1, along with all the items checked-off, thereby demonstrating the extra step they took to prepare the EIR. In either case, an explanation of the items checked should be provided so that careless use of Table 1 can be avoided.

These standards, or some later version of them, also could be codified into standard practice by case law, or by revisions to environmental laws or to the operations manuals of government agencies. However these standards might be used, they are a statement of what we currently believe is appropriate. Indeed, we expect the standards to change as our knowledge, methods, and technologies improve.

Biologists could also use Table 1 to support their arguments for additional time and funding to arrive at scientifically sound conclusions. The public could better assess what we are able and unable to do, given our funding and time constraints. These standards can also benefit our profession by inspiring debate over particular standards or their descriptions, ultimately leading to an improved set of standards.

ACKNOWLEDGEMENTS

We thank Dale McCullough and an anonymous reviewer for helpful comments on an earlier draft of this paper.

REFERENCES

Beier, P., and S. Loe. 1992. A checklist for evaluating impacts to wildlife movement corridors. Wildlife Society Bulletin 20:434-440.

Cooke, R.M. 1991. Experts in uncertainty: opinion and subjective probability in science. Oxford, New York.

Dasmann, R. F. 1981. Wildlife biology, 2nd ed. John Wiley & Sons, New York, NY, USA.

Fauth, J. E. 1997. Working toward operational definitions in ecology: putting the system back into ecosystem. Bulletin Ecological Society of America 78:295-297.

Gerrodette, T. 1987. A power analysis for detecting trends. Ecology 68:1364-1372.

Hall, L. S., P. R. Krausman, and M. L. Morrison. 1997. The habitat concept and a plea for standard terminology. Wildlife Society Bulletin 25:173-182.

Holling, C. S. (ed.). 1978. Adaptive environmental assessment and management. John Wiley & Sons, New York.

Hurlbert, S. H. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monographs 54:187-211.

Kareiva, P., S. Andelman, D. Doak, et al. (14 additional authors). 1999. Using science in Habitat Conservation Plans. American Institute of Biological Sciences, Washington, D.C.

Kuhn, T. S. 1970. The structure of scientific revolutions, 2nd Ed. The University of Chicago Press, Chicago. 210 pp.

Lancia, R. A., C. E. Braun, M. W. Collopy, R. D. Dueser, J. G. Kie, C. J. Martinka, J. D. Nichols, T. D. Nudds, W. R. Porath, and N. G. Tilghman. 1996. ARM! For the future: adaptive resource management in the wildlife profession. Wildlife Society Bulletin 24:436-442.

Lidicker, W. Z. Jr. 1995. The landscape concept: something old, something new. Pp. 3-19 *in* W. Z. Lidicker, ed., Landscape approaches in mammalian ecology and conservation. University of Minnesota Press, Minneapolis, MN.

McCold, L., and J. Holman. 1995. Cumulative impacts in environmental assessments: how well are they considered? The Environmental Professional 17:2-8.

Morgan, M. G., and M. Henrion. 1990. Uncertainty: A guide to dealing with uncertainty in quantitative risk and policy analysis. Cambridge University Press, Cambridge, U.K.

Morrison, M. L., B. G. Marcot, and R. W. Mannan. 1998. Wildlife- habitat relationships: concepts and applications, Second ed. University of Wisconsin Press, Madison, Wisconsin. 435 pp.

National Research Council, 1986, Ecological knowledge and environmental problem-solving: concepts and case studies, National Academy Press, Washington, D.C.

O'Brien, M. 2000. Making better environmental decisions: an alternative to risk management. The MIT Press, Cambridge, Massachusetts. 283 pp.

Popper, K.R. 1969. Conjecture and refutation. Routledge and Kegan Paul, London, U.K. 431 pp.

Ricklefs, R. E., Z. Naveh, and R. E. Turner. 1984. Conservation of ecological processes. The Environmentalist 4, Supplement 8:1-16.

Shrader-Frechette, K. S., and E. D. McCoy. 1992. Statistics, costs and rationality in ecological inference. Tree 7: 96-99.

Simberloff, D. 1998. Flagships, umbrellas, and keystones: Is single-species management pass3/4 in the landscape era? Biological Conservation 83:247-257.

Smallwood, K. S. 2000*a*. A crosswalk from the Endangered Species Act to the HCP Handbook and real HCPs. Environmental Management 26 (Supplement 1): S23-S35.

Smallwood, K. S. 2000*b*. Ecological restoration in the context of animal demographic units and their habitat areas. Restoration Ecology : In press.

Smallwood, K.S., J. Beyea and M. Morrison. 1999. Using the best scientific data for endangered species conservation. Environmental Management 24:421-435.

Verner, J., M. L. Morrison, and C. J. Ralph. 1986. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. The University of Wisconsin Press, Madison, Wisconsin. 470 pp.

Wilkinson, T. 1998. Science under siege. Johnson Books, Boulder, Colorado. 364 pp.