SCIENTIFIC EVALUATION OF THE STATUS OF THE NORTHERN SPOTTED OWL

CHAPTER TEN

Questionnaire: assessment of data quality, uncertainty and risk

Drafting Author:
S. Courtney

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1 INTRODUCTION

This chapter reports the results and responses to a questionnaire submitted to the panel in June 2004. The goal of the questionnaire was to provide detailed information on the individual opinions of panelists, while at the same time determining the degree of concordance between panelists. We were particularly interested in evaluating issues such as 'data quality', 'uncertainty', and 'relative risk', which may defy easy quantification, but which are of fundamental importance to decision-makers.

1.1 UNCERTAINTY AND THE SCIENTIFIC METHOD

Science involves uncertainty. The core of scientific knowledge develops through the testing of hypotheses or unproven ideas. Some hypotheses gradually become strengthened, through processes of experimentation, analysis and critique. Such hypotheses eventually become the dominant explanations accepted by workers in a particular discipline. Knowledge therefore proceeds from greater to lower uncertainty – there always remains a possibility that new information will change our understanding. This review of Spotted Owls has provided numerous examples where initial hypotheses have been rejected or modified by new data or studies.

The study of wild organisms is inherently complex. An individual interacts with other members of its own species and other species, as well as the many components of its environment. This complexity means that there are often multiple uncertainties when considering a species' requirements and status. In the case of long-lived species such as the Spotted Owl, these uncertainties may persist over many years, as data accumulate slowly and the generation time is long. This poses problems for managers and policy makers who often must make decisions with only partial and inconclusive information. Development of more conclusive information may take many years and a large detailed research program that challenges an agency's commitment to ongoing investigation.

Biologists have long recognized the difficulties of working with complex natural systems. Ecology makes extensive use of advanced statistical techniques, in order to tease out the important factors affecting a species. Studies often rely on such statistical inference, and must often be largely observational with inference based on correlation. Only occasionally are biologists able to manipulate natural systems on a scale large enough to provide direct experimental testing of hypotheses. Therefore, ecological studies by their very nature are usually less definitive than some studies in other scientific fields.

1.2 PEER REVIEW

Science as a process involves many steps in the progress of an idea from untested hypothesis to widespread acceptance. Perhaps the most important aspect of the scientific method is the open presentation of studies that allow methods to be criticized, results to be evaluated and replicated if necessary, and conclusions to be challenged. Over the years, 'peer review' has developed as the major form of scientific quality control. Ideally, peer review is the unbiased assessment of scientific work, usually as presented in a scientific document. Using peer review, findings are

critically examined, and (we hope) mistakes are corrected, before they become accepted by the community.

A finding that has undergone peer review is more likely to be robust relative to a finding that has not undergone peer review. For those who must make decisions, whether or not a conclusion is based on peer-reviewed data and information may prove a useful indication of scientific quality. At the very least, the manager has confidence that someone with technical expertise has evaluated the findings.

Scientists make widespread use of peer review in many of their own decision-making processes. Hence peer review is used as the primary tool in determining whether a study was well carried out, and is sufficiently worthy of publication. Peer review is also a major tool that supports funding decisions, approving grants, awarding tenure, etc. Peer review is not just applied to materials for publication.

Published information has often (but not always) undergone peer review. Hence there is a tendency among many persons to assume that published work has been peer-reviewed, while unpublished reports, etc. have not, and are hence less reliable. This is an oversimplification and a mistake. For instance, some of the most heavily scrutinized science is undoubtedly to be found in graduate students' theses, which are unpublished and read by at most a few people. In studies of wildlife, many data are to be found in annual reports and other unpublished 'gray literature'; sometimes such reports have undergone (more or less) formal peer review, even though they are unpublished. An example from our review of the Northern Spotted Owl is the exhaustive meta-analysis of population trends, which is a massive and important scientific endeavor, reviewed by other scientists (Ecological Society of America), but is as yet unpublished. Conversely, all scientists are aware of publications that obviously received cursory or inadequate peer review, and are still replete with inappropriate statistical tests, mis-interpretations, etc. *Beier et al. (2003)* give an (un-peer reviewed) account of how peer review failed to prevent publication of incorrect inferences for one endangered species. Scientists also recognize that peer review does not automatically confer infallibility – it is simply one indication that a paper has been examined critically by experts in the field. The peer review that allows publication merely allows the paper to then be further evaluated on the international stage of scientific opinion.

The 'gray literature' and other forms of scientific communication (presentations, personal communications, etc.) may contain important information that has undergone challenge. Presentation at formal meetings before a panel of experts, as carried out in this status review, is another form of review. Indeed the level of scrutiny and argument in the SEI panel process may sometimes be uncomfortably incisive.

1.3 RISKS, UNCERTAINTY, ACCURACY AND DECISION-MAKING

An important issue for those considering the application of science to natural systems is the probability of error and the risks of being wrong. Managers and policy makers should recognize that science does not provide certainty, and that decision-making will always be carried out against that background of uncertainty. Peer–review may reduce these uncertainties, by de facto solicitation of scientific opinion. However, scientists and decision-makers both need to

recognize the limits of science. Often the role of science is simply to delimit the 'decision space' for a manager or policy-maker.

It is useful to distinguish between risk and uncertainty. Uncertainty refers to whether an inference or conclusion is correct. Risk refers to the consequences of taking action with uncertain knowledge. There is always some level of uncertainty in a scientific conclusion. In systems such as natural ecosystems, this usually stems from inaccuracy, due in part to random factors, difficulties of observation, etc. In this status review it is important to recognize the differences between these independent criteria. For instance, we may characterize a study as having limited accuracy but little uncertainty. An example may be the attempts to track changes in habitat acreage over the past ten years. The review panel has characterized such estimates as inaccurate, but still believe that these estimates are good approximations to reality. There is low accuracy, but still little uncertainty, and decisions based on these data are unlikely to carry much risk from being wrong. Conversely, the panel reviewed many excellent and presumably accurate local studies, but are still uncertain about the degree that these can be extrapolated to other sites – that is there is good accuracy, but little certainty, and hence decisions based on such conclusions carry risks from the potential of being wrong. A well-known example of such a conclusion is the initial emphasis of Spotted Owl studies (in Washington and Oregon at least) on old-growth conditions; it is now clear that other components of habitat are also important in different parts of the range. Lastly, it is also useful to recognize that there may be some uncertainty over an issue, but that it still entails little risk. For instance, introgression of genes from Barred Owls may be entering the Spotted Owl population through hybridization – the degree of such gene flow is essentially unknown, but the panel has evaluated this as of little risk.

The SEI panel process attempts to lay bare these different criteria. Our intent is to show the degree to which different conclusions are supported by the evidence. This then allows us to evaluate remaining uncertainty over an issue, and to discuss the relative importance of different threats. Ultimately, information on uncertainty and risk is critical to decision-makers who must determine the listing status of Northern Spotted Owls.

1.4 THE QUESTIONNAIRE

The questionnaire was designed to make clear how information was used in the preparation of this status review. The results show the individual panelists' scientific opinions on the full range of topics. In some cases, the panelists agreed with their evaluation of studies and the conclusions to be drawn from them. For such issues and data, unanimity among the panel may be a measure of a relatively high degree of certainty. On other topics there was less agreement – this may be taken as indicating more uncertainty.

Each panel member was asked to respond to a set of 52 detailed questions. Some questions were more extensive, and more detailed than others, and each panelist was given the opportunity to comment or provide additional information on their response. The following sections of this report summarize the results of the eight questionnaires that were filled in. Full details of each panelist's responses are shown in the Record. Note that sometimes panelists checked more than one answer to a question, so that for some questions, there are more than eight responses recorded.

Initial sections of the questionnaire were focused on overall issues of data quality and of the comprehensiveness of the review process. Subsequent sections considered the data and conclusions in different subject areas. After these detailed questions, the questionnaire contained sections for evaluations of uncertainty and of risk, which ultimately led each individual to rate the threats now faced by Northern Spotted Owls. Finally, panelists were asked to compare our understanding of different subject areas, as well as the importance of developing new information to improve evaluations in the next status review. Thus, the questionnaire encapsulates in miniature the entire status review, including the degree of consensus among us.

2 SUMMARIZED RESULTS OF THE QUESTIONNAIRE

2.1 OVERALL RESPONSES

The panelists easily completed most sections of the questionnaire, and most made extensive comments. However in a few subject areas, not all panelists felt able to answer all the questions, indicating that they did not have sufficient information, or that they were not sufficiently familiar with the issue. In particular, sections dealing with models of habitat development were left blank by several panelists. In some other cases, panelists did not wish to express their personal opinions on issues which were very well explained elsewhere.

Two panelists (A. Franklin and Gutiérrez) declined to fill in sections of the questionnaire dealing with demography of Northern Spotted Owls. Their reasoning was that the meta-analysis report (Anthony et al 2004) is a much more complete analysis of demography than that the summary prepared for this review. They felt that the empirical data in the meta-analysis were available and more relevant than panel opinions on the summary provided. Also, as co-authors on the meta-analysis, it was difficult for them to comment on it. The rest of the panelists, while agreeing that the meta-analysis should be used directly by those interested in population trends, nevertheless felt able to summarize the data. It is necessary nevertheless to point out that A. Franklin and Gutiérrez are the two panelists with greatest experience with Spotted Owls, and hence that the answers on demography were provided only by non-Spotted Owl biologists.

Although all panelists provided additional comments throughout the questionnaire, there was (unsurprisingly) a tendency for panelists to comment most extensively on those subjects in their own area of particular expertise or where they had had primary authorship of a chapter within the status review. Therefore, in these sections below, we distinguish the comments of such ‘specialists’ from those of the other panelists.

The following sections summarize the responses of the panelists, including clarifying comments. An example of the actual questionnaire follows, with all scores and comments. Individual panelists’ responses are provided in the Appendix.

2.2 QUESTIONS ADDRESSING DATA QUALITY AND THE REVIEW PROCESS

Panelists were asked to rate the overall quality of information available to them during the review process (Q.1). There was considerable variation among panelists' responses, with some indicating general satisfaction, while others argued that there were major information gaps. However detailed examination of comments showed that most respondents recognized that, compared to other endangered species, the available data on Northern Spotted Owls are excellent, and represent the combined work of many biologists over an extensive period. The Northern Spotted Owl is "one of the best studied birds in the world" with "one of the largest information bases for any endangered species". Nevertheless all panelists thought that there was a need for more information on critical topics.

In general panelists expressed satisfaction with many of the individual studies and the data examined through the review process (Q.2,3). As noted, there was recognition that some subject areas were better treated than others. However for the most part, panelists were satisfied with the high quality of published papers, but more critical of unpublished reports or of presentations where data were not easily examined. There was no obvious tendency for panelists to be more or less critical of information in their particular specialty area.

The panelists reported using peer-reviewed data in nearly all or at least a majority of instances (Q.4). Bigley and Fleischer reported that in their particular subject areas (habitat trends and genetics) some of the information was relatively new, and had not yet been subjected to extensive peer review. When non peer-reviewed data were included, most panelists felt that appropriate care was used (Q.5), with some recognition that discussion by the panel constituted a form of peer review. However Gutiérrez felt that non-peer reviewed data had been used excessively, particularly with regard to Barred Owls and habitat trends, while A. Franklin was concerned that sometimes too much credence was placed on information from oral presentations at panel meetings because too many details were omitted for the panel to adequately review the information.

There was unanimity among the panelists that the status review had comprehensively considered all issues of importance (Q.6).

2.3 GENETICS AND TAXONOMY

There was no disagreement among the panel about the status of the Northern Spotted Owl relative to other subspecies (Q.7,8). All felt that the California and Northern Spotted Owls had separate evolutionary histories, warranting distinct subspecies status. When differences were noted among published papers, the panelists felt these were minor (Q.9), with some earlier studies being superceded by later studies.

The panel showed a diversity of opinion on the issue of boundaries between subspecies, half the responses indicating that the boundaries are well characterized, the other half disagreeing (Q.10), with some interest being expressed in additional studies. Introgression into the Northern subspecies was not currently thought to be a major threat, although most thought this was

insufficiently known to assess (Q.11). Similarly, loss of genetic variation in small populations was not identified as a currently significant threat, but most thought that the data on this subject were insufficient to assess (Q.12). The geneticist on the panel (Fleischer) argued that there must eventually be some losses of genetic diversity, "but that how much and how significant a threat this will be is unpredictable".

2.4 PREY

Although the general patterns of prey use appear to be known (Q.13), some panelists were critical of gaps in knowledge. No panelist felt that the effects of variation in prey abundance, habitat use, and availability on Spotted Owl populations are well understood (Q.14) or that the population dynamics of prey themselves are well understood (Q.15). The fact that such studies had not been pursued or funded was singled out for comment by several panelists. Similarly, the panel unanimously felt that there was insufficient or inconclusive evidence as to whether Spotted Owls deplete their prey (Q.16). Biologists on the panel who study owls were as critical of the insufficiencies of prey studies as the other panelists. Generally, throughout the review process, panelists frequently commented on the irony of studying a predator without studying its prey.

2.5 HABITAT

Panelists commented on our current understanding of habitat associations of Northern Spotted Owls in different parts of the subspecies' range. With few exceptions, panelists felt that initial findings on habitat associations, as known at the time of listing, were confirmed and supported by more recent work (Q.17). An association with old-growth forest is still accepted, with demographic performance being linked to availability of such habitat (Q.18), and at least some evidence that late successional habitat may sometimes be limiting (although there is a diversity of opinion on the strength of such evidence) (Q.19).

Nevertheless, panelists acknowledged changes in our understanding of habitat since 1990. No panelist thought that there was significant support that, throughout the range, 'optimal' home ranges consists entirely of pristine old-growth (Q.20). As noted by those scientists studying owls, A. Franklin and Gutiérrez, this may be locally true, where flying squirrels are the primary prey. Similarly, panelists largely rejected the notion that forest fragmentation was synonymous with habitat fragmentation (Q.21) (with the same caveat from A. Franklin and Gutiérrez).

Local differences in habitat associations were acknowledged by all panelists. Most panelists accepted that in the Redwood zone, owls may use young, but still structurally complex forests (Q.22), and that hardwoods were sometimes an important component of habitat (Q.24). However there was a diversity of opinion on habitat associations in the Eastern Cascades (Q.23).

Similarly, all panelists believe that there is evidence that heterogeneous landscapes favor higher demographic performance in some circumstances, such as in the Klamath region (Q.25) although opinion is divided for other regions in California and southern Oregon (Q.26) and most panelists think that there is little or no supportive evidence in other regions such as the Cascades (Q.27). There were substantial differences of opinion on whether local variation in habitat associations was generally explicable in terms of differences in prey (Q.28). All panel members felt that

there was some evidence for this proposition, but opinion divided sharply on the strength of such evidence.

The distribution and availability of habitat was addressed in a separate chapter of this review (6) and in the latter part of the questionnaire section on habitat. There was a wide diversity of opinion on the quality of the data made available to the panel. Three of eight respondents thought such data were generally good, but three others disagreed, and characterized the data as generally limited (Q.29). Two others registered an intermediate position. It is worth noting however that no panelist regarded the data on habitat distribution as excellent.

Local and ownership specific trends in habitat were addressed in the sections of Q.30. The wide diversity of responses to some of these specific questions suggests an overall low level of confidence and understanding. While most respondents thought that habitat trends in British Columbia or on state or tribal lands were probably or definitely declining, for other areas, such as areas in the western Cascades, and on federal land, there was a great diversity in responses, with several panelists feeling that habitat trends are positive, several suggesting the opposite, and others unsure. Given the acknowledged importance of habitat to Spotted Owls, the low level of agreement among panelists for this question suggests that there is a significant need for better and less ambiguous data (as indeed was suggested by respondents A. Franklin and Gutiérrez).

The causes of habitat loss were addressed by Q.31, again on a regional basis. For this question, there was more concordance. Although both biologists who study owls (A. Franklin and Gutiérrez) and Fleischer felt unable to answer this question, the other panelists clearly identified regional causes of habitat loss. In British Columbia, and western Washington and Oregon, timber harvest continues as a major cause of habitat loss, although fire also is regarded as important by some. By contrast, on the eastern slope of the Cascades and in the Klamath region, fire is regarded as the major cause of habitat loss, together with insect damage (eastern Cascades only). In the Redwood region, no clear pattern was apparent, although three respondents regarded timber harvest as important. Considered by ownership basis, panelists clearly distinguished federal lands from others. Only one respondent considered timber harvest to be a significant contributor to habitat loss on federal lands, as opposed to five who saw fire as important. On tribal and private lands, timber harvest is still regarded as the major cause of habitat loss, while state lands occupy an intermediate position in the opinion of panelists.

Habitat trends were modeled by the federal agencies, who presented results on habitat development (presentation of Cadwell). Questions regarding this model drew a poor response from panelists - four of eight felt able to comment at all, even to state that the performance of the model was uncertain (Q.32). Given this low rate of response, it is probably unwise to draw many conclusions on this model, or on the highly variable panel responses (Q.33-36). Note however that the panel specialist in this area, R. Bigley, gave a long and detailed response to these questions, including a critique of methods.

2.6 BARRED OWLS

No area of the review was more strongly debated among the panel than the quality of the data and studies on the effects of Barred Owls on Spotted Owls. This debate was reflected in

responses to the questionnaire. Two panelists (A. Franklin and Gutiérrez) declined to fill out the tables in three Barred Owl questions that required detailed geographic knowledge, given what they saw as insufficient information to make such specific comments. However, they did provide comments concerning their general opinions on effects. By contrast the other panelists were unambiguous in their opinions: all six respondents felt that Barred Owls were currently having strong effects on Spotted Owls in British Columbia and Washington, with nearly as strong as effect in Oregon or on the whole subspecies (Q.37). These six respondents included panelists (Cody, Marzluff, Courtney) with extensive experience with inter-specific interactions. Similarly, all six respondents saw lower or no effects in the Klamath and Redwood zones, and no effects in the California Cascades and the Sierra Nevada.

A very similar response was shown to considerations of the long-term (>50 year) effects of Barred Owls on a regional basis (Q.38). A. Franklin and Gutiérrez again declined to fill out the table in this question, while other panelists saw the Barred Owl as having a negative effect in > 50 years everywhere except in the California Cascades and the Sierra Nevada where the future was unpredictable. Once more, predictions of the future trends of Barred Owl numbers followed the same pattern. The six respondents suggested lower rates of increase in the northern-most areas (British Columbia and Washington) where the population of Barred owls is already large, with greater predicted rates of increase in Oregon, and uncertainty regarding California (Q.39).

Detailed considerations of the spread and effects of Barred Owls drew somewhat mixed responses. Regarding Barred Owl use of more mesic habitats, five panelists predicted that this pattern would change (Q.40), but three were uncertain. However we note that no panelist predicted that a continued association of Barred Owls with mesic habitats was likely. A very similar pattern of responses was elicited to a question on whether Barred Owls would maintain a current association with late-successional habitat (Q.41). A majority of panelists predicted this pattern would change, but many were uncertain. There was however no clear response on whether forest harvest and fragmentation promoted spread of Barred Owls (Q.42). Finally, no panelist saw hybridization between Barred Owls and Spotted Owls as frequent (Q.43).

Despite the diversity of opinions and predictions about the effects of Barred Owls on Spotted Owls, there was agreement among the panel about the quality of the data on this issue: no panelist thought that the data were of high quality (Q.44). At best, panelists saw the data as of mixed quality, with several regarding the data as poor.

2.7 DEMOGRAPHY

The panelists were asked to consider the effects of West Nile Virus (Q.45). None thought that there was a compelling basis for extrapolation to predict effects on Spotted Owls, although the majority thought such an effect would be logically consistent.

Regional population status and trends were addressed in Q.46. As discussed above, the two most qualified panelists (A. Franklin and Gutiérrez) declined to fill in the table, in deference to results from the meta-analysis report. By contrast the other panelists, including those with a background in population approaches (Cody, Marzluff, Courtney) unanimously stated their opinions that Spotted Owl populations were in decline in British Columbia and most of western Washington.

The situation was regarded as probably negative elsewhere in Washington, but was regarded as less certain progressing further south, with mixed opinions for the Klamath, Redwoods, and California Cascades areas.

2.8 RISK AND UNCERTAINTY

One of the most important sections of the questionnaire asked panelists to assess the state of knowledge on different issues of Spotted Owl biology (Q.47). There was a great deal of unanimity among the panelists, especially considering the diversity of backgrounds of the panelists, and the healthy debate during the review process.

Panelists thought that the following topics were either well or adequately understood: taxonomy of spotted owls; population trends overall, and in different regions.

Panelists thought there was more uncertainty on the following topics, with some debate about whether the knowledge base was adequate: genetics, effects of Barred Owls, current harvest, fire, windthrow, insect damage, fragmentation, weather and demographic isolation.

Panelists agreed that the following subjects were inadequately understood: West Nile Virus and other diseases, synergism between and among factors.

On only two subjects were there significant differences among panelists. There was little agreement about the state of knowledge on the effects of past harvest, and of predation.

Many of these same factors were then evaluated in terms of the risk to Spotted Owls, if they were to occur (Q.48). Again there was a heartening unanimity among panelists.

Panelists agreed that the following issues, if they were to occur, would pose little risk to Spotted Owls: Genetics issues, including introgression and hybridization with other subspecies and species; windthrow; predation.

Significant risks were identified by panelists for the following issues: habitat loss to past and current harvest, fire, insect damage and Sudden Oak Death; the effects of fragmentation, weather, demographic isolation, and synergistic interactions.

The panelists were unanimous in stating that the risk posed by Barred Owls was high.

The last response was particularly interesting. Although there is disagreement among the panelists on the strength of evidence regarding the effects of Barred Owls (see section 2.f), there is no disagreement that such effects could pose high risks. This is a subtle but important point – the panelists clearly identify Barred Owls as a potential major threat.

Questions 49 and 50 directly address the issues of threats. The panelists were asked to evaluate the many different factors as current or future threats to Spotted Owl survival. All panelists regarded Barred Owls as a current and probably future threat. A majority of panelists also identified the lingering effects of past harvest, and synergistic interactions as current threats.

Current harvest and fire were regarded as current threats by 50% of the panelists. Genetic effects, Sudden Oak Death, West Nile Virus, and demographic isolation were largely regarded as future rather current threats. Introgression was regarded as a threat only by Fleischer, the panel geneticist. Insect damage and disease other than WNV were seen as threats only by a few panelists. Hybridization, windthrow, and predation were not regarded as significant current or future threats by any panelist (including those panelists with backgrounds in these study areas: Fleischer, J. Franklin, Bigley, Marzluff).

The panelists also compared these issues in terms of threat with the perceived threats from these same factors at the time of listing (Q.50). In general, panelists were in close agreement about the changes in threats over the past 14 years. All saw Barred Owls and West Nile Virus as increasing threats. Most also saw increased threats from fire, Sudden Oak Death, and synergistic interactions. Similarly there was general agreement that the threats posed by ongoing harvest had decreased significantly. On only two issues was there substantive disagreement: two panelists thought that the delayed effects of past harvest were decreasing - one panelist thought the opposite; five of seven respondents thought that the effects of fragmentation should be seen as a reduced threat now – two demurred.

In general, changes in perceived levels of threat came about due to a change in the factor itself rather than a change in our understanding of the issue. Barred Owls, West Nile Virus, and Sudden Oak Death are new, invasive threats, while the threat posed by fire is thought to be increasing due to the lack of pro-active management in fire-prone forests. Similarly the perceived threats from harvest and fragmentation have decreased greatly with the reduced harvest levels on federal lands following adoption of the Northwest Forest Plan. New information has contributed to these changed assessments of threats primarily for only two (related) issues: weather and synergistic effects. There is also some indication that new knowledge suggests that predation is less of a threat now than was thought at the time of listing.

2.9 CONSERVATION PLANS AND MANAGEMENT

The panelists were asked to re-evaluate the scientific premises of the Northwest Forest Plan, given the new information that has accumulated since Plan design (Q.51). No panelist thought that *all* the premises were currently well-supported (primarily because of the invasion of Barred Owls according to several responses). Two panelists thought that most important scientific premises were still supported, but five thought that only some such premises were still well-founded; this included the two panelists (J. Franklin and Bigley) with greatest experience with land management and the NWFP.

2.10 MONITORING AND RESEARCH

Given that the panelists had completed an analysis of scientific knowledge, and identified significant gaps in information, they were asked to evaluate whether further information would be useful to a future status review (Q.52). An important distinction was made between research (which would provide qualitatively new information, that could alter our understanding of Spotted Owl biology and status) and monitoring (which may not produce qualitatively new data, but will be essential to tracking , for example, population and habitat trends.

For only one subject area did the panelists generally feel that new information was unlikely to change understanding – the panel almost unanimously agreed that the taxonomy of Spotted Owls is robust, and unlikely to benefit from further investigation.
The panelists almost all favored a series of strong monitoring programs that would provide accurate information on owl population trends, habitat trends, and the incidence of Barred Owls, fire and West Nile Virus.

Many panelists also identified significant research needs: prey selection and dynamics, demographic performance in different habitats, genetic differentiation, regional differences in habitat selection and the extent and effects of ingrowth.

It is worth stressing that no panelist regarded the current knowledge base on Spotted Owls as adequate, or thought that monitoring programs should be curtailed.