SCIENTIFIC EVALUATION OF THE STATUS OF THE NORTHERN SPOTTED OWL

CHAPTER NINE

Evolution and Effectiveness of Strategies for

Conservation of Northern Spotted Owl

Drafting Authors:
J. Franklin
S. Courtney

TABLE OF CONTENTS

1 THE NORTHWEST FOREST PLAN

1.1 EVOLUTION OF THE NORTHWEST FOREST PLAN

The Northern Spotted Owl conservation strategy adopted as a part of the Northwest Forest Plan (NWFP) evolved through a series of scientific assessments and planning efforts between 1982 and 1994, when the NWFP was adopted. This sequence of activities commenced in 1982 with initiation of the development of a regional guide for management of the Northern Spotted Owl. The Forest Service plan was based on designation of relatively small (e.g., 600 ha) habitat areas for single and small clusters of NSO pairs—called Spotted Owl Management Areas (SOMAs) and Spotted Owl Habitat Areas (SOHAs) (USDA Forest Service 1989). Knowledgeable scientists considered this strategy to be flawed at the time it was proposed and so advised Forest Service leadership (Thomas et al., 1990).

The Forest Service' proposal for dealing with the NSO was subsequently rejected by Seattle Federal District Court Judge Dwyer (Yaffee 1994) on the basis that it lacked scientific credibility and, therefore, did not fulfill legal obligations under the National Forest Management Act of 1976. Specifically, the Record of Decision was rejected because it provided only a 50% likelihood of NSO subspecies persistence over the 100 year time frame of the strategy.

A series of independent scientific assessments followed rejection of this proposal over the next four years, all of which contributed to the ultimate development of the NWFP. Several of these were initiatives of the executive branch of government and one was a congressional initiative; as will be noted, some of the assessments were under development and consideration simultaneously.

The Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl (hereafter the ISC) was the second independent scientific teams to address conservation of the Northern Spotted Owl (following Dawson et al 1987). An initiative of USDA Forest Service Chief Dale Robertson, this team was chartered in 1989 by four federal agencies to *"Develop a scientifically credible conservation strategy for the northern spotted owl"* under the chairmanship of Dr. Jack Ward Thomas. This committee made its report in 1990 (Thomas et al., 1990).

A landmark scientific assessment throughout, the ISC's plan made two groundbreaking recommendations that subsequently were incorporated - in some form - into all further planning efforts (Thomas et al., 1990):

1. ***Delineation and conservation of large blocks of suitable habitat*** with each block capable of supporting multiple pairs of Northern Spotted Owl; and
2. ***Provision for dispersal habitat*** for Northern Spotted Owl in areas between habitat blocks.

The large habitat blocks--called ***Habitat Conservation Areas (HCAs)***--were selected so as to provide for a minimum of 20 pairs of owls and spaced at a maximum distance of 12 miles, parameters based on than current knowledge of Northern Spotted Owl biology. The *"**50-11-40***

rule" was adopted as the strategy for enhancing successful Northern Spotted Owl dispersal through areas between HCAs, called ***the Forest Matrix***; this "rule" required maintenance of at least 50% of the forest landbase between HCAs in stands of timber with an average dbh. of 11 inches or greater and at least 40% canopy cover. A corridor-based strategy for facilitating dispersal of Northern Spotted Owl was rejected because Northern Spotted Owls were suspected to disperse in a random manner. This was the first documented use of a matrix-based strategy for facilitating dispersal in conservation biology.

The ISC's plan was not adopted by the administration of President George H. W. Bush largely because it called for withdrawing 5,827,000 acres from the federal timberland base. Nearly two years later the Forest Service was allowed to formally adopt the plan as the basis for its planned management of the Northern Spotted Owl, but Judge Dwyer rejected the plan, sending the agency back to answer a series of questions. One important influence on Judge Dwyer was that in the intervening two years the Scientific Panel on Late Successional Forest Ecosystems (described in next paragraph) had provided a report to congress focused on old-growth forest and aquatic ecosystems and their constituent organisms and Dwyer wished to see these larger issues addressed. The Scientific Analysis Team (SAT) was created by the Forest Service to respond to Dwyer's questions and reported in early 1993 (Scientific Analysis Team 1993). The SAT activity was eclipsed by the election of President William Clinton and his chartering of the Forest Ecosystem Management Assessment Team (FEMAT) process; however, the SAT analysis contributed concepts to FEMAT, particularly with regards to the aquatic conservation strategy.

Lacking resolution of the timber owl issues, Congress intervened in the process in May 1991 by chartering the Scientific Committee on Late Successional Forests, known as the Gang of Four (Gof4). The Gof4 was chartered by two committees of the House of Representatives to: (1) Assess the state of old-growth forests and related organisms in the Pacific Northwest (including the Northern Spotted Owl and Marbled Murrelet); (2) Develop a plan for congressional action to deal with these issues; and (3) Assess economic costs and ecological benefits associated with the plan. The Gof4 delivered its report to congress in July 1991 *(Johnson et al. 1991).*

The Gof4 made several important contributions to Northern Spotted Owl conservation strategies. First, Gof4, with the help of over 120 federal agency staff scientists, mapped the late-successional forest habitat (i.e., mature and old forest) on federal lands within the range of the Northern Spotted Owl and characterized its quality based on a variety of criteria, including age and level of fragmentation. This produced a spatially-explicit data base of polygons - an area delineated on a GIS map) identifying the localities of major areas of Late Successional/Old Growth (LS/OG) forest and their quality (ranging from 'low quality' LS/OG1 to 'high quality' LS/OG3). The rating from poorest (LS/OG3) to best (LS/OG) old-growth forest was based on multiple criteria including forest age, site elevation and productivity, and level of landscape fragmentation *(Johnson et al. 1991).* The LS/OG polygons were than used as the foundation for creating an incremental series of 34 management alternatives that provided for increasing levels of habitat protection and modified management in the intervening areas (the matrix) *(Johnson et al. 1991).* Reserves were increased systematically beginning with reservation of the LS/OG1 polygons and progressing to inclusion of all polygons from LS/OG1 through LS/OG3 as well as some additional forest polygons (Owl Additions) necessary to meet the spatial criteria used in designing the HCAs. Costs and benefits of these management alternatives were analyzed using:

(1) Impacts on allowable timber harvest to index economic cost; and (2) Probabilities over 100 years of maintaining (a) old-growth ecosystems, (b) Northern Spotted Owl, (c) Marbled Murrelet habitat, (d) anadromous fish habitat, and (e) other old-growth dependent organisms to index benefits (*Johnson et al. 1991*, see also Franklin 1995).

The House Committees responsible for the oversight of this assessment process found the Gof4 report credible, but shocking in terms of impacts on timber harvest associated with achieving species and ecosystem conservation objectives. It was clear that no plans could provide for both high levels of timber harvest and associated old-growth forest ecosystems and organisms, including viable populations of Northern Spotted Owl. The three relevant committees of the House of Representatives agreed upon draft legislation based upon the Gof4 report but ultimately did not bring it to the floor of the House at the request of Speaker Tom Foley. Despite this lack of congressional action, the Gof4 effort made a substantial contribution to the FEMAT process, as will be seen, particularly in the form of the LS/OG polygon database.

During all of these processes a recovery plan for the Northern Spotted Owl had been under development by the US Department of Interior, which retained responsibility in the Secretaries Office rather than delegating it to US Fish and Wildlife Service. The final draft plan, which was never adopted, incorporated the HCA and Forest Matrix prescriptions from the ISC report (USDI 1992). HCAs were renamed Designated Conservation Areas (DCAs) in the DOI plan.

Management policy on federal forestlands within the range of the Northern Spotted Owl remained unresolved through 1992. Candidate William Clinton had committed to resolving the stalemate if elected and President Clinton initiated that resolution in April 1993. A timber summit was held in Portland to air public opinions on the various issues. President Clinton also initiated a scientific review leading to a environmental impact assessment (EIS) decision-making process as elements in resolving the conflict between timber and conservation objectives.

The Forest Ecosystem Management Assessment Team (FEMAT) was created to provide a review of scientific issues and provide plan alternatives (options) for the EIS process that would follow FEMAT. FEMAT dealt with multiple objectives and not just the Northern Spotted Owl, following the pattern of the Gof4. The Northern Spotted Owl and Marbled Murrelet were certainly key considerations, but maintaining viable old-growth ecosystems and all old forest associated species and sensitive fish stocks and aquatic ecosystems were also key objectives. FEMAT completed its work in three months (FEMAT 1993).

FEMAT produced 10 management alternatives or options (FEMAT 1993). All options were projected to provide for viable populations of Northern Spotted Owl over the long term with a high level of probability. All of the options were based upon establishment of extensive reserve systems—i.e., lands reserved from commercial timber harvest. The FEMAT team was unanimous that the primary emphasis in owl conservation should be on maintaining existing suitable habitat rather than attempting to create suitable habitat by forest management.

The reserve system involved several categories of federal land allocation or designation. It began with areas that had already been withdrawn from timber harvest by congress, such as wilderness areas and national parks, and administratively by the agencies themselves, such as

Research Natural Areas. However, significant new reserves--called Late Successional Reserves (LSRs)—were created to conserve much additional existing late-successional forest habitat. Areas representing these various categories of withdrawn lands were often contiguous resulting in large conservation units, such as where LSRs were adjacent to designated Wilderness. An additional new category of land allocation dedicated to restoration and maintenance of natural forest conditions were the unmapped Riparian Reserves, which were primarily to for conservation of aquatic organisms and processes but also contributed to terrestrial conservation objectives.

The LSRs were the major new withdrawal of land from the timber base under the NWFP. However, the various alternatives differed in the amount and basis for selection of these lands. The two alternative bases of construction of the reserve system represented in the FEMAT options were: (1) Reserves built primarily on the HCAs/DCAs developed by owl biologists; and (2) Reserves built primarily on the LS/OG polygons. These strategies differed significantly since the former focused on creating reserves for Northern Spotted Owl following a specific geographic design while the latter focused on conserving high-quality old-growth forests. As a consequence, the HCA/DCA system did not incorporate much of the best remaining old-growth forest (Franklin 1994).

FEMAT Option 9 was adopted as the preferred alternative in the EIS process that followed FEMAT (USDA Forest Service and USDI 1993). In this option the LSR system was based on integrating LS/OG polygons, which identified the best of the remaining old-growth forest habitat, along with the Key Watersheds (FEMAT 1993). The consequences of this choice were significant. More and generally better quality old-growth forest habitat was reserved than would have been the case with a HCA/DCA-based reserve system. As noted by Noon and McKelvey (1996), the selection of Option 9 resulted in creation of ". . . large reserve areas capable of supporting local populations of 40 to >170 owl pairs."

A key point is that the LSR network was designed to conserve existing late-successional forest conditions and all associated organisms (including Northern Spotted Owl), not exclusively as a conservation strategy for Northern Spotted Owl. However, the final ROD included "owl additions" to some LSRs where there were differences between the DCAs of the owl recovery plan and the LSRs.

The legal decision-making process involving draft and final supplemental environmental impact statements and a record-of-decision resulted in adoption of the NWFP (USDA Forest Service and USDI Bureau of Land Management 1994a, 1994b). The final alternative did include numerous modifications from Option 9 of FEMAT, however, particularly in regard to the width of the Riparian Reserves and adoption of the Survey and Manage provision. The land allocations within the NWFP included:

Congressionally Reserved Areas	7.3 million acres (30% of total area)
Late Successional Reserves	7.5 million acres (31%)
Riparian Reserves	2.2 million acres (11%)
Administratively Withdrawn Areas	1.5 million acres (6 %)
Matrix	4.0 million acres (16%)

Adaptive Management Areas	1.5 million acres (6%)

Judge Dwyer ruled positively on the acceptability of the plan and allowed the agencies to implement it in 1994.

The NWFP includes several important provisions for management of the LSRs that are relevant to creation and maintenance of Northern Spotted Owl habitat:

First, the NWFP allows for silvicultural treatment of young forests (<80 years of age) within LSRs for the purpose of accelerating development of late-successional forest habitat. This provision was included because the LSRs are relatively large blocks that include significant areas that have been logged, especially in the last 50 years. Since the development of large contiguous (unfragmented) blocks of late-successional forest is a key element of the Northern Spotted Owl strategy (ISC 1990) activities to accelerate restoration of simplified young stands were viewed as appropriate. Young forests have been treated under this provision of the NWFP.

Second, the NWFP allows for silvicultural treatments, including mechanical and prescribed fire methods, of old-growth forests on sites characterized by frequent, light to moderate intensity fire, such as pine and mixed-conifer dominated forests on the eastern slopes of the Cascade Range and in the Siskiyou-Klamath region. This provision was included because of the potential for uncharacteristically intense wildfire on sites where uncharacteristic fuel levels have accumulated. Such fires pose a high potential for temporary (and often long-term loss) of old-growth conditions, including habitat of Northern Spotted Owls. As noted elsewhere, such fires have occurred since the NWFP as adopted. This NWFP recommendation has not been widely implemented because such treatments often involve areas currently or potentially occupied by Northern Spotted Owls. Land management agencies appear not to have aggressively implemented such treatments even though the USDI FWS ultimately has approved any projects for which formal review was requested, even where “take” was involved, and sometimes has encouraged the development of such fuel treatment proposals.

1.2 EXPECTATIONS OF THE NWFP WITH REGARDS TO NORTHERN SPOTTED OWL CONSERVATION

1.2.1 HABITAT CONSERVATION

The NWFP has achieved several important goals for Northern Spotted Owl conservation. Foremost has been protecting the majority of existing suitable habitat of the Northern Spotted Owl from timber harvest on federal lands. Timber harvest levels on federal timberlands within the range of the Northern Spotted Owl during the last decade have been less than 5% of the area harvested on an annual basis during the 1980s. In fact, harvest in mature and old forests has been much less than the levels expected under the NWFP, for a variety of reasons, including law suits brought to challenge actions and provisions of the NWFP, particularly the Survey and Manage provision.

These provisions have made significant contributions to the maintenance of existing habitat, and accelerating the development of structurally simple forest into suitable habitat in the foreseeable future, hence contributing to owl recovery

By contrast, active management of late-successional forests on characteristically fire-frequent sites in the eastern and southern areas of the Northern Spotted Owl range has not been accomplished as envisaged under the NWFP. It was expected that significant areas of LSRs, which had uncharacteristic fuel accumulations, would be treated during the first decade of the plan; in fact, very few acres have been treated to reduce uncharacteristic fuels within LSRs and we are not aware of any that involved landscape-level plans for treatments within LSRs. Consequently, there has been limited progress in restoring characteristic structures and fuel conditions and reducing the potential for uncharacteristic stand-replacement fires on tens of thousands of LSR acres. The NWFP provides for such treatment but agencies have not implemented them despite the clear potential for significant loss of Northern Spotted Owl habitat. Factors probably include inadequate funding for this activity, other management priorities, potential public controversy, and risk aversion.

Thus far, the loss of Northern Spotted Owl habitat due to such uncharacteristic stand replacement fires has not been extensive range wide, although it has been locally extensive. However the failure to implement this provision of the NWFP is continuing to place high risk on existing owl habitat, and must be accounted as contributing to the risks of extinction of the species. This risk is sub-regional and not range wide; as we note elsewhere the issue of uncharacteristic fuel accumulation and potential stand-replacement fire is confined to the dry eastern and to a lesser extent the southern fringes of the NSO range (see chapters on habitat trends and questionnaire). Large fuel accumulations (i.e., stand structural complexity) and stand-replacement fires are characteristic within the bulk of the NSO range; any effort to modify these forests typified by the westside Douglas-fir/western hemlock type would, in fact, create totally unnatural habitat conditions for both NSO and their prey.

Failure to treat stands on characteristically fire-frequent sites also contributes to potential problems with insect pests, including loss of large veteran trees as a result of competition from densely growing young trees (see, e.g., McDowell, et al. 2003). For example, there has been significant loss of LSR forest and Northern Spotted Owl habitat due to spruce budworm epidemics on the Yakama Indian Reservation (WA) and Deschutes National Forest (OR). In the case of the Deschutes National Forest, dead trees created by the spruce budworm contributed significantly to the B&B Fire Complex that burned in 2003. As one example, the combination of Spruce Budworm and fire have impacted 18 out of 24 pairs of Northern Spotted Owls on the Sisters District of the Deschutes in 10 years; 15 of those pairs were affected by the B&B Fire Complex and habitat for 11 of those pairs is completely gone *(Helen Maffei, pers. comm.).*

The NWFP was always intended to have an adaptive component, so that new information could be incorporated into management. Some new information, such as that concerning the emergence of Sudden Oak Death (see Appendix), may constitute significant changes in our understanding of the threats to habitat (in the case of SOD, in a limited part of the subspecies' range). At the moment, SOD is an obvious threat but its ultimate impact on habitat is hard to assess at this stage. SOD does have the potential to have major impacts given the wide range of

host tree species that are affected and its demonstrated virulence on several keystone tree species, such as tanoak, and the possibility that it may ultimately spread throughout the entire range of the Northern Spotted Owl.

In summary the NWFP has had considerable benefits to Northern Spotted Owls, by halting the removal by logging of occupied and future potential recovery habitat on federal lands, which would not have otherwise occurred. However failure to fully implement some of the provisions of NWFP has increased the risk that such habitat, occupied or future, will be lost in some portions of its range, moderately reducing the potential for Spotted Owl persistence and recovery. Note that in their individual responses to questions in the questionnaire, five of six panelists replied in response to Q.31 that habitat was at risk to fire in the Eastern Cascades, the Klamath region, and on federal lands generally. In response to Q.48, eight respondents all regarded fire as a risk to Northern Spotted Owls (2 high, 5 moderate and 1 low), ranking fire as the third greatest risk for owls (behind Barred Owls and timber harvest); in responses to Q.50, six panelists saw this risk as increasing.

1.2.2 CONSERVATION OF OWL POPULATIONS

The Reserve and Matrix strategy of the NWFP has been successful in that Northern Spotted Owl populations are persisting, and (largely) performing as predicted. Chapter 8 and Anthony et al (2004) discuss in detail the current and recent demographic performance of Northern Spotted Owls. Some owl populations have been stable over the past 14 years, some are declining, while on others the data do not allow us to determine whether the population is declining or not. As noted elsewhere in this chapter, declines over the past 14 years are expected under NWFP, and not immediate cause for concern. However lack of a firm predicted population trajectory makes such comparisons difficult.

However, in some regions, Northern Spotted Owl populations have declined faster than anticipated, including areas with little or no ongoing timber harvest (*AFRC 2004*). Given the *accelerating* downward trends in survival and reproduction on some federally managed study areas that have essentially no additional timber harvest since implementation of the NWFP, this suggest that something other than timber harvest is responsible for the decline and apparently has not been dealt with by implementation of the NWFP, at least not during its first 10 years of implementation.

Protection of suitable habitat for Northern Spotted Owl under the NWFP has not prevented invasion by the Barred Owl, a potential competitor (see chapter 7); i.e., the NWFP resulted in protection of the habitat but the Barred Owl may have rendered a significant amount of this habitat currently unavailable to Northern Spotted Owl (see chapter 6 and extensive debate therein). Continued cutting of suitable habitat of the Northern Spotted Owl (i.e., with no NWFP) might have accelerated the decline of he species and, possibly, facilitated more rapid displacement or occupation of vacated habitat by Barred Owl. Provision of suitable habitat for Northern Spotted Owl was an essential contribution of the NWFP but has not protected it from competition from Barred Owl.

In the same way, the imminent arrival of West Nile Virus constitutes a potential threat to Northern Spotted Owl populations that cannot be addressed simply by habitat protection under

NWFP (note that the extent and degree of threat posed by WNV is largely speculative at this point).

We emphasize that provision of habitat for owls remains an important contribution of NWFP but that, while provision of habitat is a necessary condition, it is not in itself a sufficient one to ensure conservation of Northern Spotted Owls or any other species. We also do not want to suggest that development of additional habitat and protection of existing habitat are not important conservation objectives.

1.2.3 ADAPTIVE MANAGEMENT PROVISIONS

Adaptive management activities have not been aggressively implemented under the NWFP, although adaptive management was supposed to be one of the major themes of the plan. Adaptive management was a strong element in FEMAT (1993) but has not been as strongly emphasized in the application of the final NWFP. There are many reasons for this lack of implementation, including the tendency of stakeholders of all stripes, managers, and courts to favor certainty rather than to emphasize uncertainty, which adaptive management does. The NWFP provided for 1.6 million acres in 10 Adaptive Management Areas but activities on AMA lands were actually more constrained than on the Matrix allocation, a circumstance that was definitely not intended by the FEMAT (1993) team. Lack of financing is also an important factor limiting learning-based adaptive approaches.

Adaptive management as envisaged under the Draft Recovery Plan, FEMAT and NWFP was expected to contribute to Northern Spotted Owl conservation, through the development of new management techniques, which would promote habitat development. The failure to take full advantage of the adaptive management provisions of the NWFP during its first 10 years is unfortunate for Northern Spotted Owl conservation.

1.2.4 RESEARCH AND MONITORING

There is a large scientific component to NWFP, including an extensive effectiveness monitoring program. Much has been achieved through science conducted under the framework of the NWFP (e.g. Lint et al 1999). For instance, the federal contribution to the coordinated demographic studies has been key, and has provided the majority of data currently available on owl population trends. Elsewhere (section 10 below, chapter on information needs), we have critiqued the lack of information on some important issues. A few of these information gaps pertain directly to NWFP (notably the lack of information on the amount and distribution of habitat); others (such as Barred Owl effects) are likely to be important across the range, including on NWFP lands. While some of these issues are pressing, we recognize that a constraint on research and monitoring under NWFP is that it must be relevant to plan implementation and success. We acknowledge that it is not a function of NWFP to answer all questions regarding Spotted Owl conservation.

1.3 THE SCIENTIFIC BASIS OF NWFP

As we have shown, the NWFP has been a major contributor to Northern Spotted Owl conservation. The huge efforts of scientists and managers in designing and implementing the

plan to benefit owls have not been in vain. However we have also suggested that some expectations have not been met. In this section we address the successes and failures of the NWFP, regarding the scientific principles on which the Plan is based. We are particularly interested in determining whether the Plan's scientific premises regarding the NWFP are still defensible, or whether new information or hypotheses call into question either the overall strategy of the plan, or implementation of key features.

In the questionnaire section, the panel members were asked:

The federal conservation plan for NSO and other species (Northwest Forest Plan) depends upon the maintenance of populations, primarily in Late Successional Reserves, in a metapopulation structure, where each population has a high probability of survival. There have been changes in the implementation of the NWFP (lower harvest rates) and also in the impact of different threats. Based on the evidence available to the panel, and your evaluation of current threats, is this strategy based on premises that are currently well-founded, and supported by current information?

Of eight responses, none thought the NWFP was well supported on all issues, but none regarded the plan as 'not well supported'. Comments from panelists made clear that some felt that issues not fully considered under NWFP were emerging threats from Barred Owls and disease.

In the sections that follow, we address each of several main premises of NWFP in more detail.

1.3.1 A RESERVE NETWORK

All species require adequate habitat if they are to maintain themselves. This basic premise was at the core of the Northern Spotted Owl listing decision, and formed the heart of the NWFP (see above). Nothing has changed to alter this fundamental principle of conservation. Similarly, nothing has altered the general premise that the reserves for Northern Spotted Owl should be well-distributed throughout the range of the species, if reserves are to form the basis for range-wide recovery.

Similarly, it is a common principle of conservation biology that reserves should be large enough to allow persistence of local populations through demographic fluctuations, with an overall low expectation of local extirpation. While this principle is intact, the application of it to Northern Spotted Owl populations under the NWFP may be overly optimistic, in that new and emerging threats may reduce local populations of owls below levels anticipated, including in LSRs and despite the fact that the collective reserved areas under the NWFP are very large.

1.3.2 METAPOPULATION DYNAMICS, DISPERSAL AND MATRIX HABITAT

Allied to the concept of reserves, is the theory of metapopulation structure. When there are possibilities of local extirpation, or persistent 'sink' areas, core breeding reserves may allow the overall population to persist, and local habitat 'patches' to be recolonized if they lose owls. Again, this is a fundamental concept in conservation biology, which remains unchallenged.

The implications for Northern Spotted Owls of a metapopulation strategy are the need to have conditions in the matrix to allow for movement of dispersers from reserve to reserve, and perhaps to have some contribution of breeders in the matrix. Management of matrix habitat has been, if anything, of lower impact on Northern Spotted Owls than predicted. Owls are known to breed in substantial numbers in some matrix areas, and there is no evidence to suggest that dispersal habitat is currently limiting to the species in general (there remain local areas, e.g. Oregon Coast Ranges, where dispersal habitat has been identified as needed (see FDRP 1992)). Note however that dispersal remains a difficult topic to study (see chapter 6).

The general strategy under the NWFP was to replace earlier conservation strategies for dispersal habitat (the 50-11-40 rule of the ISC) with one based primarily on retention harvest requirements in the matrix and riparian reserves. Although the 50-11-40 rule was based on known information on habitat conditions for dispersal of juvenile owls *(Miller 1989)*, the riparian reserve strategy is thought to preserve more, better, and better-distributed dispersal habitat. More recent data on dispersal (Forsman et al. 2002) does not change this conclusion.

1.3.3 HABITAT DESCRIPTIONS

The NWFP focused on a strategy of conservation of late-successional forests, as these were regarded as prime habitat for Northern Spotted Owls throughout the subspecies' range (recognizing that in some areas, e.g. the coastal redwood region, structure could lead to owls using substantially younger habitat types). Notwithstanding the associations of owls with younger forests with complex structure in some areas (see chapter 5), there is still a strong association of owls with late-successional forests. Hence there is no reason to call into question this basic tenet of the plan.

As noted, some data from different parts of the range suggest that individual stand attributes and landscape configurations of habitat may hold more subtleties than at first recognized, which may complicate management effects.

1.3.4 PROTECTION OF HABITAT

A fundamental assumption of the NWFP was that habitat was adequately protected by reserve status or by management of reserves and matrix areas. This assumption would still appear to be warranted throughout most the Northern Spotted Owl's range along the crest and west of the Cascade Range, where large disturbance events are characteristic and to which the owl is presumably adapted. The FEMAT scientists knew that large disturbance event are to be expected in this region and designed the reserve system to accommodate such losses and appropriate recovery periods. However, in the driest portions of the Northern Spotted Owl's range—primarily east of the Cascade Range—proactive fuel measures have not been undertaken at the scale that was expected and there have been significant losses of habitat to uncharacteristic stand-replacement wildfire. The original intent of the NWFP was to treat these forests to reduce the potential for such fire. Such treatments need to be accelerated to assure continued existence of Northern Spotted Owl habitat in these areas.

1.3.5 POPULATION DECLINES

The NWFP predicted that Northern Spotted Owls would continue to decline for some time after plan implementation, as the consequence of lag effects at both individual and population levels, and the continued harvest of habitat (see Record of Decision). The most explicit treatment of expected population trends is given by *Raphael et al. (1994a,b)* who carried out simulation analysis of likely population trends in relation to alternatives being considered under FEMAT, based on earlier models developed by Lande (1987,1988), Thomas et al (1990), and Lamberson et al (1992). However these models were not intended to be benchmarks for considering plan success. Instead they were tools developed in order to qualitatively evaluate the alternatives under consideration. The models were extremely sensitive to both starting conditions, and to rule sets applied, so that they cannot in any way be held to represent predicted population trends:

> "Actual prediction of population levels during a transitional period is extremely unlikely to be reliable – even if the model were perfect- because these levels are very dependent on the start-up population and estimates of current population are still fairly crude."
>
> "Results of this analysis do not purport to represent actual population trends; rather its major purpose is to shed light on the sensitivity of owl population dynamics to varying degrees of habitat change over time and to compare the qualitative similarity of trends among alternatives. There are simply too many unknowns to be confident that any model will predict the actual population of a species many decades into the future."
>
> "Therefore, our results do not directly address the issue of whether owls will eventually achieve a stable equilibrium" *(Raphael et al. (1994a) pp 7-8).*

Note also that, while *Raphael et al.* are very wary about predicting 'decades into the future', they also state that initial model conditions swamp predictions of population trend early in the simulations. "Thus, the model results for the first decade or two are not as useful as those from later years"(p.5). *Raphael* go on to compare population trends only for years 20-30 of the simulations (corresponding to years 2014 to 2024) (see calculations of λ in Figure 6 of *Raphael et al. 1994a*). That is, *Raphael et al.* make essentially no predictions on owl trends over the period 1994 to 2004.

Hence no strong prediction of the magnitude of population decline was possible; indeed the results of *Raphael et al. (1994a,b,)* are largely qualitative and rank alternatives, but do not provide predicted owl numbers. There was however a clear expectation that populations would eventually rebound as more habitat developed *(Raphael et al. 1994b).* Models of habitat growth do indeed suggest that there is significant ingrowth and development of habitat throughout the federal landscape (see chapter 6 on habitat trends).

The observed pattern of demographic change of owl populations suggests a continuing range-wide decline (Anthony et al 2004). As mentioned above, the fact of such a decline is not in and of itself unexpected, or reason to doubt the effectiveness of the core NWFP strategy. Note also that for some areas studied in the demographic analyses there is significant ongoing timber harvest (such as on the Simpson Timber Company study area which is higher than on federal lands. The overall rate of loss over the whole population should not necessarily be the metric for

examining NWFP success. Nevertheless, considering just populations on federal lands, there is a decline. The problem in assessing this decline is that we lack a strong benchmark to know whether this decline is greater or less than that predicted under NWFP.

Comparing geographic regions, there seems little doubt that populations in Washington are declining faster than elsewhere in the US (Anthony et al, 2004). This regionally greater decline is certainly not as predicted under NWFP. The reasons for these regional patterns are discussed in chapter 8. It is clear that there is no simple correlation with timber harvest patterns for instance (*AFRC 2004*), and Barred Owl invasion is certainly a viable hypothesis for this regional pattern (chapter 7).

Similarly, there is some evidence, that in some populations at least, there is a downward trend in patterns of survival and reproduction (Anthony et al, 2004) (i.e. the population is not simply declining in response to low values for survival and reproduction – these low parameter values are themselves declining). This is not predicted by the science underlying the NWFP. Again, Barred Owls are one factor that has been notably strengthening over the past few years, and may explain the observed pattern in demographic parameters. Climatic patterns (cyclic or directional) probably also need to be considered as a contributing factor.

One further concern about the continuing validity of NWFP science is that the Plan predicts a decline in owl populations until habitat begins to re-grow over a long time period. The current reserve system is designed to be large enough and close enough to maintain large populations in reserves, thus minimizing the risk of local extinction. This strategy of recovery from 'population lows' is predicted from theory, and there is no new information to suggest that the base principles are incorrect. However pressure from new threats (Barred Owls, WNV, SOD) may be such that the populations in reserves fall to lower levels (and at a faster rate) than anticipated under NWFP, thus increasing local extinction risks, and reducing the overall probability of owl recovery.

1.3.6 RECOVERY STRATEGIES

NWFP predicts that recovery of the Northern Spotted Owl will require provision of new habitat, through succession. There are no new data to suggest that this habitat strategy is incorrect or that it will be insufficient in the long term. Indeed, much of the habitat that is currently coming "on line" is the result of unsalvaged wildfires in the 19th and early 20th century that typically has significant biological legacies from the original old-growth stands and should, therefore, have attributes of suitable habitat. It is also assumed by the NWFP that recovery of owl populations in low population areas will require immigration of owls, from LSR and other reserve 'source' populations. There are no new data on, for instance, dispersal that suggest that this strategy is conceptually incorrect.

1.3.7 OVERALL ASSESSMENT OF SCIENTIFIC PRINCIPLES OF THE NWFP

The NWFP was extraordinarily ambitious in addressing conservation of a complex series of ecosystems over a large area. Many, but not all of the scientific building-blocks of this plan have been confirmed or validated in the decade since adoption. Largely the successes of NWFP are ascribable to good design and implementation. The inadequacies seem more to do with

implementation – important provisions, such as fuels treatment and adaptive approaches have not been adequately applied.

One major limitation of the NWFP appears to be the inability of a reserve strategy to deal with invasive species. Not much will. Reserves are no protection against viruses, fungi or invasive owls. The reserve system was predicated upon redundancy of individual reserves in order to spread risk across the entire reserve system. The redundancy of the reserve strategy may yet prove a strong suite. However, nationally, there have been no 'magic bullets' for dealing with invasive species. Sometimes drastic measures and perpetual vigilance can prevent spread of the organism, as with the eradication of Medfly in Southern California, or the quarantine on Hawaii against spread of brown tree snakes. In other cases, nothing has proven successful (e.g. the spread of starlings). The NWFP cannot be held uniquely responsible for a general impossibility. Instead, we recognize that the NWFP has made important conservation contributions, and without the plan the situation of Northern Spotted Owls would be far bleaker. Indeed, one strength of the NWFP, its intended flexibility and adaptability, may yet prove key in responding to unexpected challenges.

Climate change is an additional threat to Northern Spotted Owls that was not explicitly addressed in the NWFP and, more generally, is not readily addressed by a reserve-based conservation strategy. Climate change is an additional uncertainty that could have both direct and indirect impacts on Northern Spotted Owls and their prey. However, the emphasis on maintenance of structural complexity and organismal diversity in the Matrix under the NWFP should contribute to the resilience of the federal forest landscapes to the impacts of climate change.

1.4 FUTURE DIRECTIONS FOR CONSERVATION OF NORTHERN SPOTTED OWLS ON FEDERAL FOREST LANDS

What inferences for Northern Spotted Owl conservation can we draw from the last 10 years of experience under the NWFP?

First, based on existing knowledge, ***large contiguous blocks of suitable habitat are still viewed as necessary for Northern Spotted Owl***, even if the habitat is not sufficient, by itself, to sustain Northern Spotted Owls in the face of a threat such as Barred Owl invasion. This science has not changed in the last 10 years. The details of the meta-population model on which it is based should probably be reexamined, however, since this model assumed that areas located between the large habitat blocks (the matrix) would be only partially suitable for dispersal (50-11-40 rule) and generally unsuitable for nesting and foraging. In actuality the NWFP provided for some protection of Northern Spotted Owl nesting and foraging habitat within the matrix (e.g., reserves around nest sites, although these reserves are very small and currently often unoccupied) as well as maintenance of general conditions within the matrix that would facilitate dispersal of Northern Spotted Owl and recovery of Northern Spotted Owl habitat following logging—e.g., variable retention harvesting. For these reasons, Northern Spotted Owl are using matrix habitat more than would be predicted with the meta-population model. Note however, that this is also a consequence of lack of management and harvest activity in the matrix. Owls currently live in a 'matrix' that has more habitat value than is designed for under the NWFP. The long-term suitability of matrix areas under a fully-implemented NWFP is impossible to assess at this point.

Second, **there are significant new uncertainties (i.e. new threats) for the Northern Spotted Owl that were not present at the time that the NWFP was adopted**. The level of competitive pressure on the Northern Spotted Owl from the Barred Owl is one of the most important of these uncertainties. However, Barred Owl intrusions do not negate the need for structurally complex forest to sustain Northern Spotted Owl. There is no clear indication at this point whether Barred Owls will render the reserve system less functional. Cutting habitat occupied by Barred Owl might simply result in further displacement of Northern Spotted Owl; furthermore, there is the possibility that Northern Spotted Owl may ultimately reoccupy some of the habitat currently occupied by Barred Owl. Major additional uncertainties for the Northern Spotted Owl arise from the potential impacts of West Nile Virus on Northern Spotted Owl and of Sudden Oak Death on Northern Spotted Owl habitat in the southern part of its range.

The NWFP was not designed to deal with invasive species and, given the new threats and uncertainties, realized population levels for the Northern Spotted Owl may be substantially lower than those predicted under the NWFP. At this point, it is possible that existing suitable habitat for Northern Spotted Owl eventually will prove important to the persistence of the subspecies. Very little late successional forest has been logged during the first 10 years of the NWFP on federal lands, so that additional options do exist for policy makers, such as protection of owl habitat outside of existing LSRs.

Third, **the hypothesis that Matrix is more effective as Northern Spotted Owl habitat than LSRs is neither proven nor necessarily relevant**. There is only limited evidence for such a phenomenon—e.g., a study on the upper Cispus River drainage near Mount Rainier. We are unsure whether this phenomenon is real and, if so, how widespread. In any case, within the Matrix allocation the Northern Spotted Owl is mainly using the patches of late-successional forest as nesting and roosting habitat (except within the Coast Redwood zone, and some young stands with LSOG components, in the Willamette Valley margin, and the Klamath region). There is also the possibility that Northern Spotted Owl and Barred Owl may partition some landscapes with Barred Owl favoring LS/OG forests found on highly productive sites along stream and river courses.

Fourth, ***we think that there is high potential for loss of significant Northern Spotted Owl habitat in the next few decades in the eastern and southern portions of its range.*** Significant acreages of suitable Northern Spotted Owl habitat are at risk of uncharacteristic stand-replacement fire, primarily on the eastern side of the Cascade Range and on localized sites in the Klamath Province. This will result in very long-term loss of suitable Northern Spotted Owl habitat on affected sites, which may also be locales where Northern Spotted Owl may have its best chance of resisting Barred Owls. The current dry phase of the Pacific Decadal Oscillation may also be contributing significantly to the increased size and intensity of fires within the range of the Northern Spotted Owl.

More aggressive active management will be necessary in late-successional forests and landscapes, which are at risk of uncharacteristic stand-replacement fires, if there is an intent to reduce the current potential for large losses of suitable Northern Spotted Owl habitat. Silvicultural treatments that involve both mechanical treatment and prescribed fire may be

useful. Such treatments appear essential to avoid essentially permanent loss of Northern Spotted Owl habitat—as well as many other ecological values—on these sites, particularly on the eastern slopes of the Cascade Range. It is important to note that such fuel treatments are ***not*** appropriate on sites that are naturally characterized by heavy fuel accumulations and infrequent stand-replacement fire regimes, such as the moist Douglas-fir—western hemlock forests of western Oregon and Washington. Mechanical treatments if not properly applied can also reduce habitat quality or eliminate important habitat.

Developing guidelines for landscape-level treatments that are consistent with maintaining Spotted Owl habitat is an urgent research need on the eastern slopes of the Cascade Range. Immediate interim guidelines could be developed through expert panels. Maintenance of sufficient Northern Spotted Owl nesting and roosting habitat is a critical consideration as is maintenance of Northern Spotted Owl prey habitat. One hypothesis worthy of testing would be the value to Spotted Owls of maintaining islands of denser nesting and roosting habitat within a landscape matrix that has been treated to reduce the potential for stand-replacement fire. Some well-designed long-term research to test effectiveness of several alternative approaches is imperative; this research is going to have to address creation of heterogeneity at larger spatial scales. We believe that substantial progress in resolving questions could be accomplished in ten years. However, we also view it as imperative to avoid widespread application of untested ideas.

Finally, we note that that the LSRs were not created solely for nor justified exclusively by Northern Spotted Owl! The LSRs were designed to provide for the full array of organisms that utilize LS/OG habitat, including Marbled Murrelet and hundreds of other species. LSRs were located to provide for high-quality LS/OG terrestrial and aquatic habitat. The only aspect of the LSR design that was driven primarily by Northern Spotted Owl biology was the concept of creating large compact, contiguous blocks of habitat, which meant incorporating younger stands and recreating the late-successional integrity of the blocks over time. The LSR network was also designed to accommodate the large-scale disturbances that are characteristic of the region and to allow natural recovery processes when disturbances occur.

2 CONSERVATION MEASURES ON STATE AND PRIVATE LANDS (HABITAT CONSERVATION PLANS)

Conservation measures on non-federal lands are regulated under both the Endangered Species Act (ESA) and the Migratory Bird Treaty Act, as well as state laws (e.g. California ESA) and other regulations, including Forest Practices Rules. We do not intend to review all these regulatory mechanisms, which are appropriately dealt with by USFWS in their role of assessing regulatory sufficiency. In this section we will focus solely on Habitat Conservation Plans (HCPs), which are authorized under section 10 of ESA. Our goal is to examine whether the scientific principles used in development of such plans are well-founded, or invalidated by recent scientific results.

Essentially, HCPs allow management of non-federal lands where threatened or endangered species occur, including 'incidental take' – killing or otherwise harming of the species as a

consequence of management activities. Incidental Take Permits are issued by USFWS in response to a conservation plan, on the basis of several criteria, including (most importantly):

1. The level of 'take' cannot cause jeopardy (an appreciable increase in the risk of extinction).
2. 'Take' is mitigated to the maximum extent practicable.

Typically (but not always) HCPs have stated objectives, an implementation plan, and reporting and monitoring requirements.

Managers and owners of non-federal lands are not obligated to prepare an HCP, nor are they obligated to make particular conservation proposals, or to follow guidelines set by an overall coordinating plan (e.g. Final Draft Recovery Plan). Each HCP is proposed by the applicant, under unique circumstances, and is then negotiated with USFWS. This applicant driven process determines a great deal of the idiosyncratic nature of HCPs, which are typically prepared and negotiated independently, often by different USFWS staff and USFWS offices in each case.

Currently there are 17 approved Northern Spotted Owl HCPs, with plans in each of the three states. HCPs range in size from 1,632,000 acres (Washington DNR) to 40 acres (Scofield Corp). Plan duration and mitigation measures also vary: from 100 year plans (West Fork Timber) to five year plans (Boise Cascade) to one-time partial harvest with permanent deed restrictions (Scofield Corp).

In this document we will not critique individual HCPs, address the likelihood of their success, or second-guess the USFWS decision on the appropriateness of approving the HCP and ITP, or the adequacy of the conservation and other measures in place. Nor will we comment on the desirability of approving HCPs or on policies applying to HCPs (e.g. 'no surprises'). Our goal is simply to assess the scientific principles used in plan development and implementation. Where policies have both a scientific and a value driven component, we will pass comment on the science, but make no judgment on the appropriateness of the overall regulatory decision, which (appropriately) addresses other issues in addition to science.

A case in point is the 'no-surprises' policy that is in place, and provides assurance to land-owners that HCPs and ITPs will rarely be withdrawn or modified by USFWS at additional cost to the landowner. An important issue in such situations is what constitutes 'unforeseen circumstances' that may cause plan modification. Typically an HCP, or Implementation Agreement may define such circumstances from a legal perspective. Scientific results that may, under some HCPs, qualify as such 'unforeseen circumstances' would be major new threats to the listed species that might affect HCP success. Biologically there are several emerging threats to Northern Spotted Owls (Barred Owls, West Nile Virus, Sudden Oak Death) and perhaps other new information (e.g. on habitat definitions) that might be relevant to individual plans. We make no recommendations on action regarding individual HCPs or on whether these new threats or new information should result in modifications to the plans.

We note an important fact concerning HCPs – they are voluntary and remain in place only at the permit owner's pleasure. In the event that Northern Spotted Owls and their habitat are no longer

found on the lands in question, the permit-holder could withdraw from the HCP (but would be required to continue agreed mitigation for incidental take occurring to that point). While it is not our role to critique this aspect of HCPs, it is worth noting that threats that remove owls or their habitat (such as invasive species or large stand replacement fires) could eliminate the landowners need for a take permit.

2.1 CONSERVATION AND MANAGEMENT MEASURES UNDER HCPS

Because of the overall small number of HCPs, and their great variation, there is no one model or yardstick for plan design and implementation. Similarly the conservation objectives of individual plans vary greatly. In some HCPs, specified numbers of breeding owls, with specified levels of reproductive success are indicated. In other HCPs, habitat alone is the management objective. Habitat too can be of different types – nesting/roosting/foraging habitat or dispersal habitat only.

Monitoring and reporting requirements also vary greatly between HCPs, often in relation to the performance objectives. Some plans for instance require monitoring of owl reproductive success; others simply require reporting of habitat modifications (and even here there is variation in reporting – for some plans harvest levels are not reported separately for habitat and non-habitat). Some plans require annual reports on owl populations; others require only five year reporting of harvest levels. This lack of consistency across plans means that no meaningful critique on the overall scientific basis of monitoring is feasible.

2.2 CONSERVATION PRINCIPLES USED IN HCPS

2.2.1 RESERVES

A few HCPs establish no-take areas of different sizes, with reserve provisions for the length of the permit or other long-term periods (for instance on the Elliott State Forest, where long rotation periods on some river basins effectively function as reserves). As with our discussion under the NWFP above, we see no reason to question the utility or effectiveness of such reserve strategies (note that many HCPs are small, some even smaller than the home range of a single owl). Maintenance of breeding owls distributed across the landscape is consistent with the objectives of the FDRP, and remain supported as a conservation measure. However, we again recognize that reserves will not protect owls from invasive threats such as Barred Owls or WNV.

Note that in some HCPs there are reserves established for other species (e.g. Marbled Murrelet, salmonids) that may function as additional protection measures for Northern Spotted Owls, just as riparian reserves under NWFP may foster owl conservation.

2.2.2 SHIFTING MOSAIC PROVISIONS

Several plans protect either owls or owl habitat on a shifting basis, such that harvest is tied to the development of habitat and the movement of owls. Harvest then is allowed in some areas as owls move, or new habitat develops.

Such provisions are based on several aspects of Northern Spotted Owl biology. For instance, owls are known to shift nestsites (though rarely), and individual territories may be occupied only in some years. Moving harvest around such animals will minimize disturbance and take. Such strategies may be particularly useful in situations where owls are not strongly linked to foraging in late-successional habitats (i.e. southern 'woodrat' populations). Habitat will nevertheless be 'taken' under this approach, so that this sort of HCP may only delay 'take'.

Shifting-mosaic models for owl persistence on the landscape are less well developed than reserve based models. There have been no analyses evaluating the efficacy of the shifting mosaic model. However we have no reason at this point to feel that scientific evidence negates this as plausible conservation strategy.

2.2.3 DISPERSAL HABITAT

Several HCPs have as their sole or major objective the development or maintenance of dispersal habitat. Given that, in some plans at least, this meets identified global objectives as set out in the FDRP, or represents an improvement from current conditions, such dispersal habitat may have a useful conservation function. We see no reason to challenge the proposition that dispersal habitat is an important and necessary objective, given the metapopulation conservation strategy in place for much of the subspecies' range (see above section for NWFP). We also note that some HCPs are designed specifically to bolster dispersal opportunities for owls on adjacent federal landscapes; this should augment the federal NWFP strategy and should increase the probability of success of that plan. We note, however, that the standards for such dispersal habitat are not consistent across plans, nor are they consistent with the original federal provision (50-11-40) or current NWFP strategies (primarily riparian reserves).

2.2.4 DEVELOPMENT AND MAINTENANCE OF NESTING/ FORAGING/ ROOSTING HABITAT

Several plans aim to maintain or develop habitat for resident owls (although with no actual provision that such habitat must be occupied). As with the reserve strategy above, this appears to be a reasonable objective, and certainly would represent a contribution to conservation whenever Spotted Owls are maintained or recruited. As with the reserve strategy however, it is unclear whether this 'habitat only' strategy will be less likely to succeed than was originally planned in the face of new emergent threats.

Note that, as with dispersal habitat, there is no one definition of 'nrf' habitat used across HCPs. This may be justifiable and well supported on scientific grounds, to the extent that such variation may reflect regional differences in the habitat associations of Northern Spotted Owls (see chapter 5).

Some plans aim to develop habitat, often at some future point, following the harvest of existing habitat. This strategy may be appropriate given its generic resemblance to federal conservation strategies that envisage an owl population that declines initially, and then recovers as new habitat develops. However given additional challenges that threaten to further reduce owl populations (e.g. West Nile Virus), it may be that the survival of owls in such landscapes is now less assured.

2.2.5 MONITORING AND ADAPTIVE MANAGEMENT

As noted above, many HCPs have only limited monitoring requirements. While this may be appropriate and proportionate to the goals of the individual plan, it does mean that it is more difficult to make an overall assessment of the conservation success of HCPs. Some other HCPs have rigorous and statistically well-designed monitoring programs, with specified trigger points. These plans are easier to assess; currently no such plan is in serious default of its stated objectives.

The panel has discussed (section 6 above) the role of adaptive management in the NWFP. Few HCPs specifically state similar goals – adaptive management is unfortunately inimical to the regulatory certainty that is desired by most landowners. Nevertheless some HCPs have trigger points that can cause changes in management, and others have formal mechanisms for plan amendments and management changes. The panel is supportive of the proposition that relevant science be incorporated into HCPs on an ongoing basis.

2.3 CONCLUSIONS

The majority of scientific principles applied to HCPs remain valid, just as these same principles continue to underlie the NWFP. Application of these principles varies strongly across HCPs (as to be expected given the different management and conservation priorities for such lands). Similarly the standards imposed, e.g. for habitat definitions, vary greatly; there is less justification for this variation on a purely scientific basis.

Just as with the NWFP, there is reason for optimism in that most conservation measures appear well designed, from defensible scientific statements. However there is reason for the same global concern as for the federal plans – current conservation measures offer no protection against invasive species.

Finally it is worth noting that some, but not all, HCPs are nested within an overall conservation strategy that references local and regional contributions, and coordinates with the larger federal NWFP. Such landowners, who are contributing to an overall strategy, and may carry out significant monitoring and research, may provide a tangible conservation benefit.

3 CONSERVATION MEASURES IN CANADA

The Canadian population of the Northern Spotted Owl, although it falls under Canadian jurisdiction, is still listed under the US ESA. This small population is the subject of intense debate in Canada, and was the subject of a workshop held in early 2004 *(Zimmerman et al 2004).* The workshop proceedings summarized the particular circumstances faced by the owl in Canada, the conservation challenges that are posed, the problems with conservation and management, the uncertainties in information, and the role of science in the overall coordinated strategy. It is not our intent here to critique or report in detail the results of these efforts, which are appropriately understood from the primary source *(Zimmerman et al 2004).* Our goal here is simply to report on the main scientific principles in use, and to compare the two national strategies.

The Canadian population of the Northern Spotted Owl is very small, isolated and apparently in sharp decline *(Harestad et al 2004).* There are gaps in the Canadian distribution, and the species has not been found in large areas of apparently suitable habitat (however, some areas have not been adequately surveyed). The population(s) declined by an estimated 10.4% annually from 1992-2002, with a decline of 35% between 2001 and 2002. In 2002, the breeding population was estimated at fewer than 33 pairs. Reasons for decline are thought to include past and ongoing harvest, Barred Owls, weather, prey, and predation. However, data on these factors are relatively sparse.

The Canadian population has reached the point that it is now vulnerable to stochastic demographic events, that could cause further declines and perhaps extirpation. This high vulnerability is expected to last for a long period, because forest regrowth is unlikely to lead to major increases in habitat in the short term. Some factors, notably past and current harvest and Barred Owl populations may continue to act deleteriously on the Northern Spotted Owl population. Generally, there is some suggestion that, compared to US populations, Canadian Northern Spotted Owls have a more dispersed population, suffer higher mortality, have larger ranges, produce fewer young at longer intervals, and require higher quality habitat to reproduce successfully (Simpson 2004). Innes (2004) summarizes not only the information that is known about this small population, but also the many information gaps, and uncertainties.

Clearly, managers of the Canadian population are faced with significant challenges. There has been continuing debate among scientists, managers and interested parties over what conservation measures to enact. The 1997 Spotted Owl Management Plan had an estimated 60% chance of population stabilization, leading the first Canadian Spotted Owl Recovery Team not to endorse the plan. A new (2002) Spotted Owl Recovery Team has developed a recovery strategy that is deemed ecologically and technically feasible, but details on the plan are unavailable. Hence our comments on scientific strategies must necessarily be limited.

We feel that Canadian scientists have correctly identified that extremely small population size is a unique issue for their population. They are also correct in identifying demographic stochasticity and other random events as operating at these levels. The basic conservation principles that are being considered include reserves and matrix management, exactly as in the NWFP. Canadian scientists are also concerned about loss of habitat due to harvest and fire, and the spread of the potentially competing and hybridizing Barred Owl. Dispersal of owls is seen as a key to long-term recovery; a central plank in the Canadian strategy is that the owls exist in a metapopulation, and may be supplemented with owls dispersing from the US. Hence the Canadian strategy to a large extent relies upon the success of US plans such as the NWFP. Scientists and managers are also concerned about the ability of reserves and small populations to resist emerging threats such as Barred Owls and West Nile Virus. Just as in the US, adaptive management is advocated, but has not yet been widely implemented.

Overall, the Canadian population of Northern Spotted Owls is clearly at a critically endangered state. Some issues, mostly as a consequence of extremely low population size, are considered unique to Canada (viz. demographic stochasticity, risks from hybridization). Whether or not emergency or recent efforts to save the owl and its habitat succeed, Canadian biologists appear to

be using the best available information and scientific knowledge to understand the situation, and draft their recovery strategies. We single out two issues for favorable comment. First, there is an attempt to integrate science and management into a comprehensive model of owl populations (there is no such model for the US). Secondly, there is a strongly coordinated process for cooperation among interested parties. This typically Canadian approach might be useful south of the border, where there is a need for a systemic and long-term coordinated program of research, monitoring and management.