

substantive variation or trends through time. No linear trend in fecundity could be identified.

Although the projection matrix approach showed a decline and there was a weak, nonsignificant decline in annual λ estimates using Pradel's method, the mean λ was statistically stationary using Pradel's methodology. This is more meaningful than with the other study areas. Recall that using Pradel's method, the population could appear stationary or growing, even if the population growth is caused by outside immigration. For this study area, recruitment cannot likely be attributed to immigrants entering the study area, as the study area is relatively isolated. Thus, the disparity between the projection matrix estimate and the estimate using Pradel's method could be a result of either (1) measurement error in survival rates of juveniles or adults, or (2) the presence of unlocated floaters in the study area (Franklin 1992). Regardless, we have insufficient certainty as to the status of this population to conclude that it is either declining, increasing, or stationary.

Meta-Analysis Results

The meta-analysis used the Pradel method to evaluate data from various study areas, as described above. The analysis was also applied to some aspects of the population as a whole. The estimated mean lambda for each of the individual studies was not significantly different than 1.0 over the periods analyzed. The meta-analysis did not estimate a mean overall value of lambda for all study areas combined. Examination of trends in annual λ over the periods analyzed for each study area showed no evidence of a trend for the Lassen study, a significant decline for the Eldorado study, a significant quadratic trend (decline, then increase) for the Sequoia and Kings Canyon study, and a weak (nonsignificant) decline for the Sierra study. The overall trend in annual lambda rates for these four Sierra Nevada study areas was declining, then increasing. The trend in annual rates for the San Bernardino study was a weak (nonsignificant) decline for the period analyzed.

Adult survival rate for the Lassen, San Bernardino, Sierra, and Eldorado study areas combined was 0.819, which was substantially lower than the mean estimate (0.850) for adult northern spotted owls across 15 study areas (Franklin *et al.* 1999). Except for the Sierra study area, fecundity estimates for the California spotted owl study areas were so variable through time that linear trends could not be identified. The Sierra study showed a negative

trend in fecundity, which could have been driven by a high reproduction year early in the study.

Conclusions—In total, the findings reported above are not conclusive with respect to the population status of the California spotted owl. There is no definitive evidence that the population is decreasing across its range, and various analytical results of the individual study areas are not wholly supportive of conclusions regarding declines in any given study area. Low levels of declines may be occurring in some study areas, but if so, they are not clearly evident using existing analytical techniques. The strongest support for a possible decline is on the Sierra study area, and the strongest support for a possible stationary population is on the Sequoia and Kings Canyon study area. The combined rate of adult survival for all study areas except the Sequoia and Kings Canyon study area may be of concern, as it is substantially lower than that reported for the northern spotted owl. However, Pradel's λ estimate for each study area consistently showed statistically stationary populations, so we cannot conclude that this lower adult survival rate is causing a decline in California spotted owl populations. At this time we have no clear statistical evidence to show that the California spotted owl is declining throughout its range.

Summary of Factors Affecting the Species

Section 4 of the Act (16 U.S.C. 1531 *et seq.*) and the regulations (50 CFR part 424) that implement the listing provisions of the Act set forth the procedures for adding species to the Federal lists. A species may be determined to be an endangered or threatened species due to one or more of the five factors described in section 4(a)(1). These factors and their application to the California spotted owl are as follows:

A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

There are two categories of possible threats to the California spotted owl that are related to habitat. The first is the current threat related to the condition of existing populations and habitat, and existing, ongoing habitat modification. The second is the potential threat that may result from future management of habitat.

Threats related to current condition of populations and habitat. Numerous authors have expressed concern over the current status of the California spotted owl, and much of this concern is related

to the quality of the habitat available to the subspecies at the present time. The best scientific information available indicates that high survival of spotted owls is achieved by maintaining large, unfragmented areas of suitable habitat (Moen and Gutiérrez 1997, Franklin *et al.* 2000, Blakesley *in litt.*, 2002a). Important habitat components, especially large trees, large snags, and large down logs, are currently in short supply across the range of the California spotted owl (Verner *et al.* 1992b, USFS 2001a). The diameter of nest trees selected by owls in the Sierra Nevada is significantly greater than the average diameters of conifers in the Sierra Nevada. Large trees become future large snags and large downed logs, the latter providing important habitat attributes for some prey species. The length of time required to recover old trees and increase their density over the landscape raises the level of concern associated with their decline (USFS 2001a).

Concern has been exacerbated because, although harvest volume was declining markedly in the 1990s, existing management direction did not appear to be sufficient to arrest completely habitat decline (USFS 2001a), and because, until recently, most of the remaining old growth in national forests in the Sierra Nevada remained in areas available for timber harvest (Franklin and Fites-Kaufmann 1996, Beardsley *et al.* 1999). Thus, Blakesley and Noon (1999) argued that the most positive step that can be taken to reverse apparent declines of California spotted owls would be to increase retention and recruitment of large trees and closed canopy conditions throughout the Sierra Nevada.

Concern also exists because the existing habitat used by California spotted owls appears to be vulnerable to stand-replacing catastrophic fire. Removal of large overstory trees in conjunction with fire exclusion has led to changes in forest structure that favor spread of high intensity fire. Conifer stands have become denser and composed mainly of trees in small and medium size classes (University of California 1996). The species composition of these forests has also shifted, from more shade intolerant, fire-hardy species such as ponderosa pine and black oaks to more shade tolerant, fire sensitive species such as white fir and incense-cedar (Verner *et al.* 1992, Weatherspoon *et al.* 1992). Similar increases in density and changes in species composition have been documented for coniferous forests of southern California (Weatherspoon *et al.* 1992, Minnich *et al.* 1995). Forests in