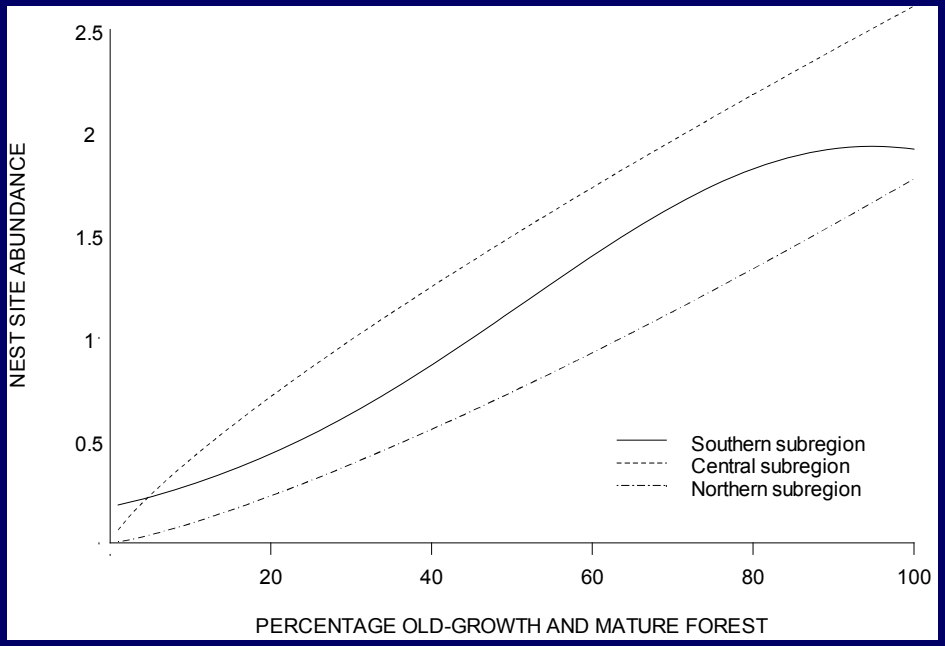
The relationship between Northern Spotted Owl viability and habitat: Insights from new range-wide models



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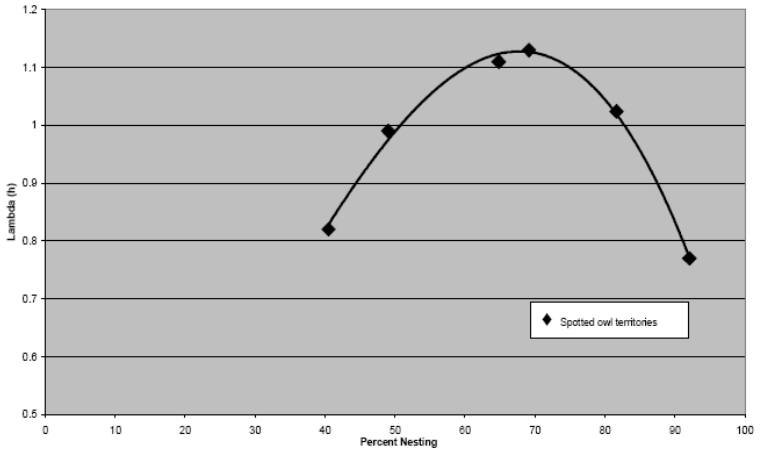
The draft recovery plan's major hypotheses concerning the relationship between owl demography and habitat

1) There is a quadratic relationship between lambda and the proportion of old forest within an owl territory

2) This relationship is stronger in the southern portion of the range

Figure D.2. Lambda $_{(h)}$ plotted against the percentage of spotted owl nesting habitat within sampled home ranges (adapted from Olson *et al.* 2004).



Several studies address these hypotheses: all are models developed from data from a single Demographic Study Area (DSA), (i.e., at the within-DSA scale)

1) Franklin et al. 2000 in NW CA found a quadratic relationship between owl fecundity and the amount of edge between old forest and other habitat
2) Olson et al. 2004 in westcentral OR found that a small amount of the variance in lambda was linked to a quadratic relationship with the proportion of old forest in a territory
3) Dugger et al. 2005 in southcentral OR found a pseudo-threshold relationship between lambda and old forest
4) Carlsen and Higley in prep.
5) Diller et al. in prep.

Whether or not the draft recovery plan accurately characterizes the results of the studies, it is still relevant to test these hypotheses:

1) What is the relationship between older forest and either owl demography (lambda) or abundance (linear, quadratic, or threshold)?

2) Does this relationship vary across the range, e.g., in response to changes in prey communities?

This study

(Carroll and Johnson. Conservation Biology in press.)

- Owl data: ~9000 owl nest site and activity center locations collected by USFS, BLM, and CA DFG
- Habitat data: Forest age class as derived from Landsat imagery (Strittholt et al. 2006)
  - Old-growth (OG): 150+ years
  - Mature (MAT): 50-150 years
- Extent: Most of NWFP area (excluding N. Coastal CA)
- Grain: FIA hexagons of 24 km^2
- Methodology: Hierarchical Bayesian spatial model

Hierarchical Bayesian (HB) spatial autoregressive models

Count at a cell depends both on local habitat covariates and influence of neighboring cells

May help account for spatial autocorrelation due to

a) unmeasured environmental covariates,
b) spatial population processes (dispersal), or
c) spatially varying survey effort (survey bias).

Count of owl sites within a cell modeled as a Poisson response.

Assumed to be imperfect surrogate for true abundance.

Modeling as binomial response at this scale would yield little information.

Why use HB spatial models?

STRENGTHS:

More geographically extensive and representative than demography/habitat models from DSAs

More robust to survey bias than non-spatial (RSF) models

More interpretable than Biomapper model (Davis and Lint 2005)

WEAKNESSES:

Potentially imperfect match between abundance and lambda (attractive sink). This may be less of a problem at the range-wide scale.

Counts are only surrogate for true abundance, inferior to abundance estimates derived from mark/recapture studies on DSAs, but again more geographically representative.

HB spatial models represent middle ground between non-spatial distribution models and DSA-level habitat models.

Nine candidate models

RELATIONSHIP:

1) Linear
2) Pseudo-threshold (log(x))
3) Quadratic

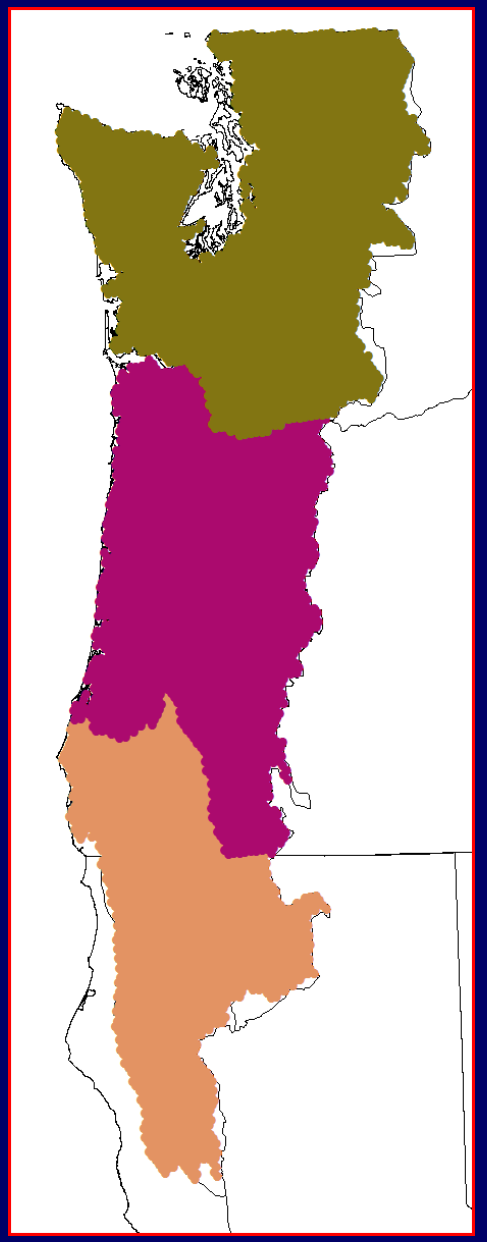
FOREST AGE CLASS VARIABLE:

1) Proportion of OG alone,
2) Proportion of OG and MAT (together), or
3) Proportion of OG and MAT (as separate variables)

Models ranked by Deviance Information Criterion

Candidate models

Owl range divided into southern, central, and northern subregions based on contrasting prey communities and dispersal barriers



Results varied by subregion:

SOUTHERN SUBREGION:

1) Best model: quadratic of (OG+MAT)
2) Closest competing model: quadratic of (OG,MAT)

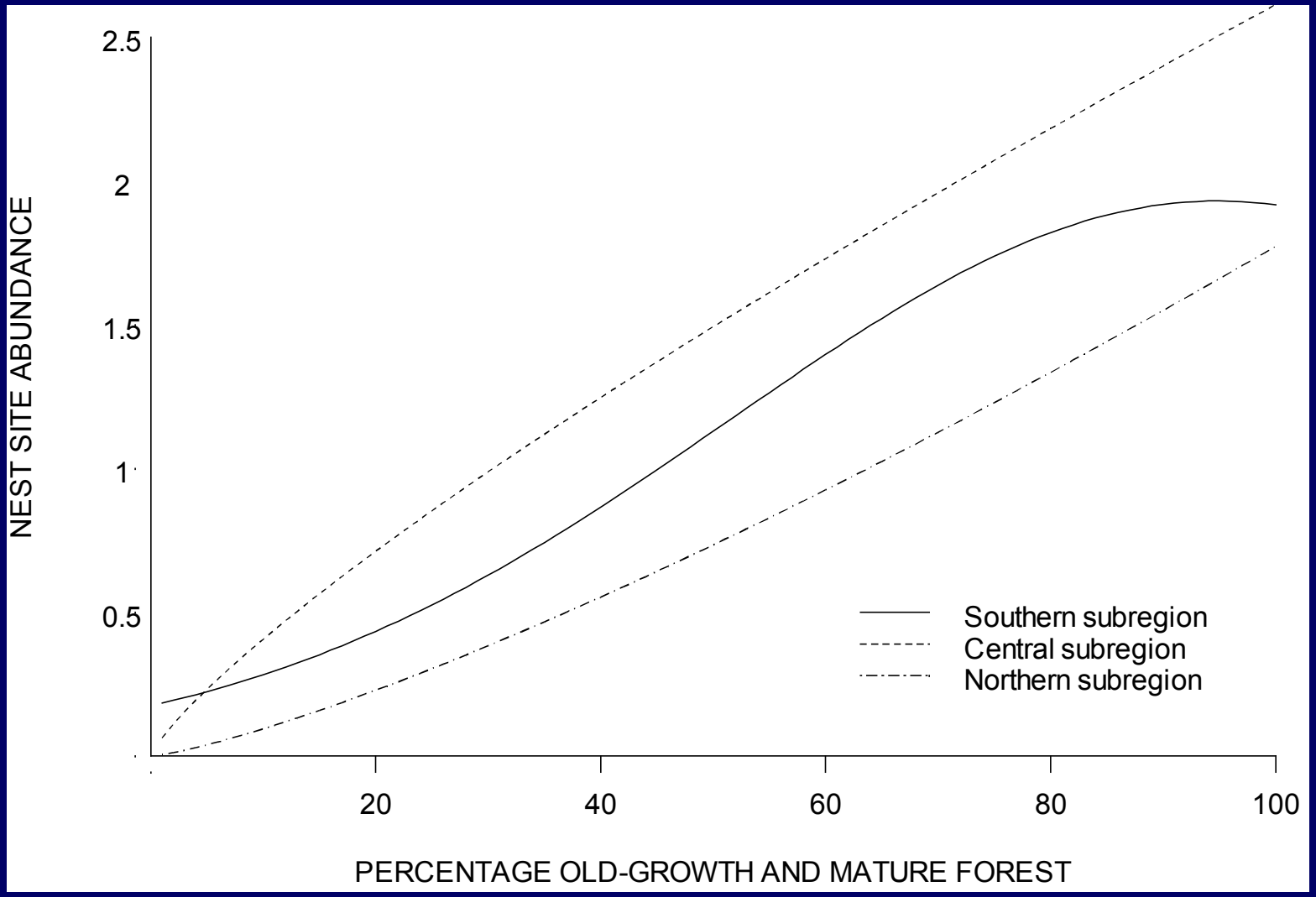
CENTRAL SUBREGION:

1) Best model: pseudo-threshold of (OG,MAT)
2) Closest competing model: pseudo-threshold of (OG+MAT)

NORTHERN SUBREGION:

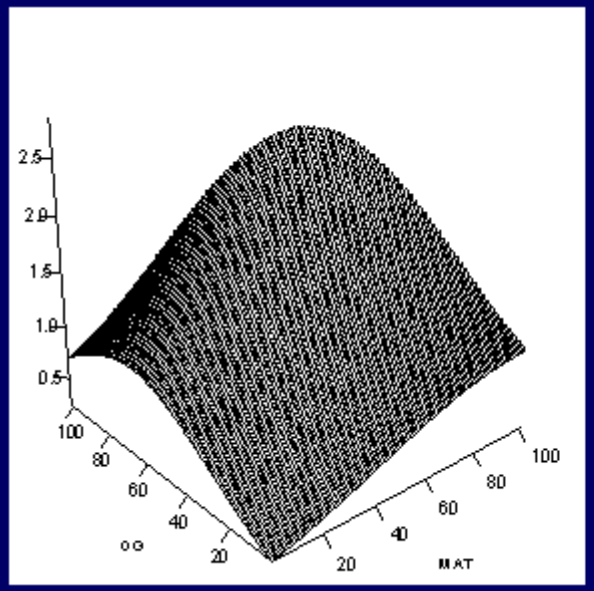
1) Best model: pseudo-threshold of (OG+MAT)
2) Closest competing model: pseudo-threshold of (OG,MAT)

Results by subregion: univariate model

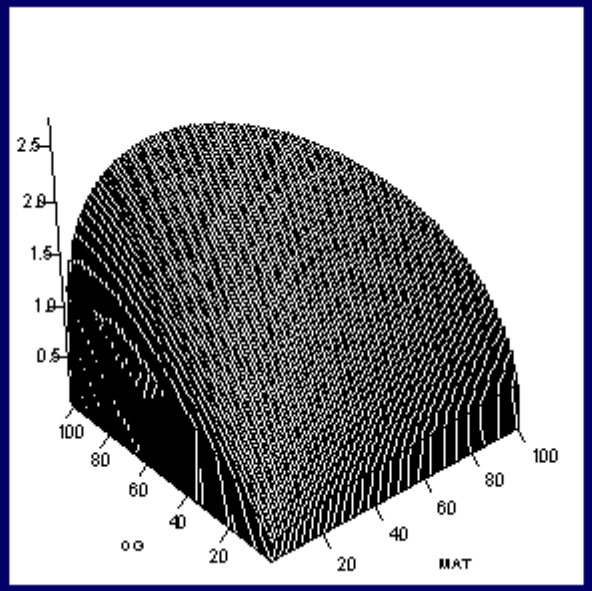


Results by subregion: multivariate model

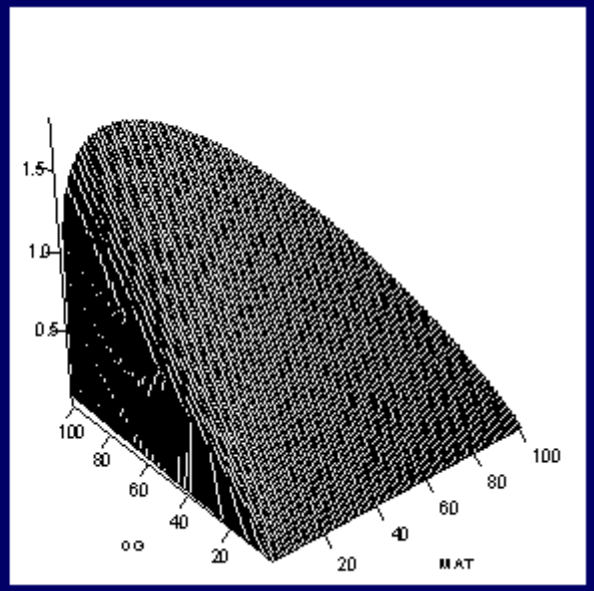
CA



OR



WA



Major themes of results

RELATIONSHIP BETWEEN OWL ABUNDANCE AND OLDER FOREST

1) Is generally positive
2) There are contrasts between southern and northern range
3) The degree of contrast in habitat value between OG (>150 years) and MAT (50-150 years) is variable and poorly defined at this scale, although OG has larger coefficient in multivariate models

INTERPRETATION:

1) Supports Franklin et al. 2000's conclusions as to a quadratic relationship in south, but only evident in landscapes with highest levels of LSOG
2) Draft recovery plan's generalization of quadratic relationship to northern and central range not supported
3) Forest contributes to SPOW abundance before reaching oldest age classes (150+ years)

Results contrast with relationships hypothesized in recovery plan

Figure D.2. Lambda $_{(h)}$ plotted against the percentage of spotted owl nesting habitat within sampled home ranges (adapted from Olson *et al.* 2004).

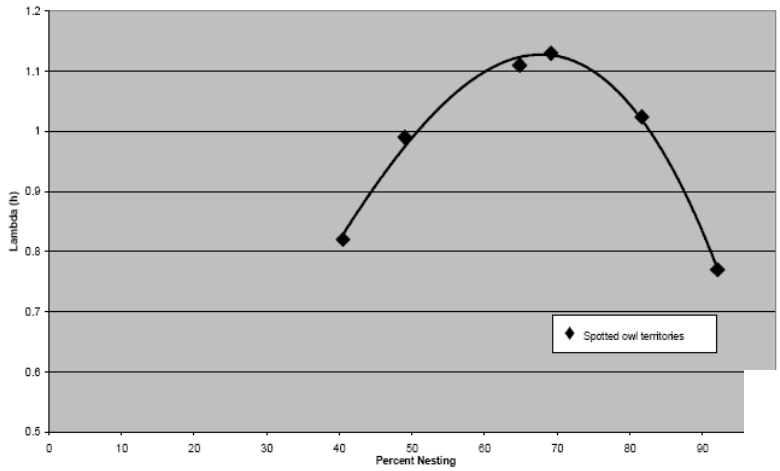


Figure D.1. Lambda $_{(h)}$ and adult survival plotted against the percentage of spotted owl nesting habitat within sampled home ranges (adapted from Franklin *et al.* 2000).

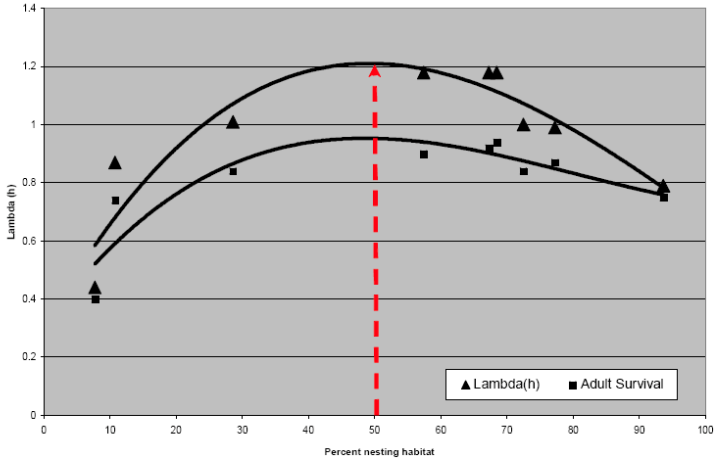
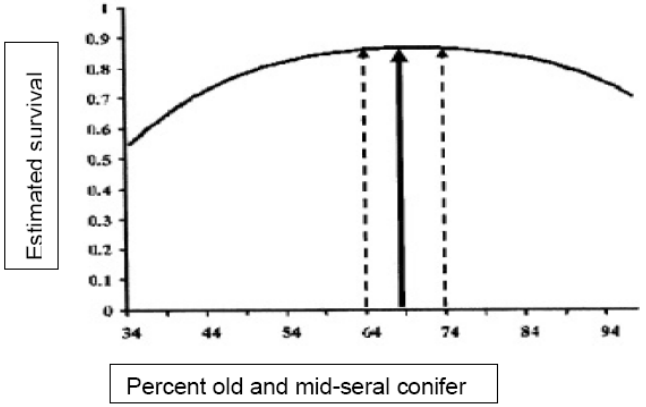


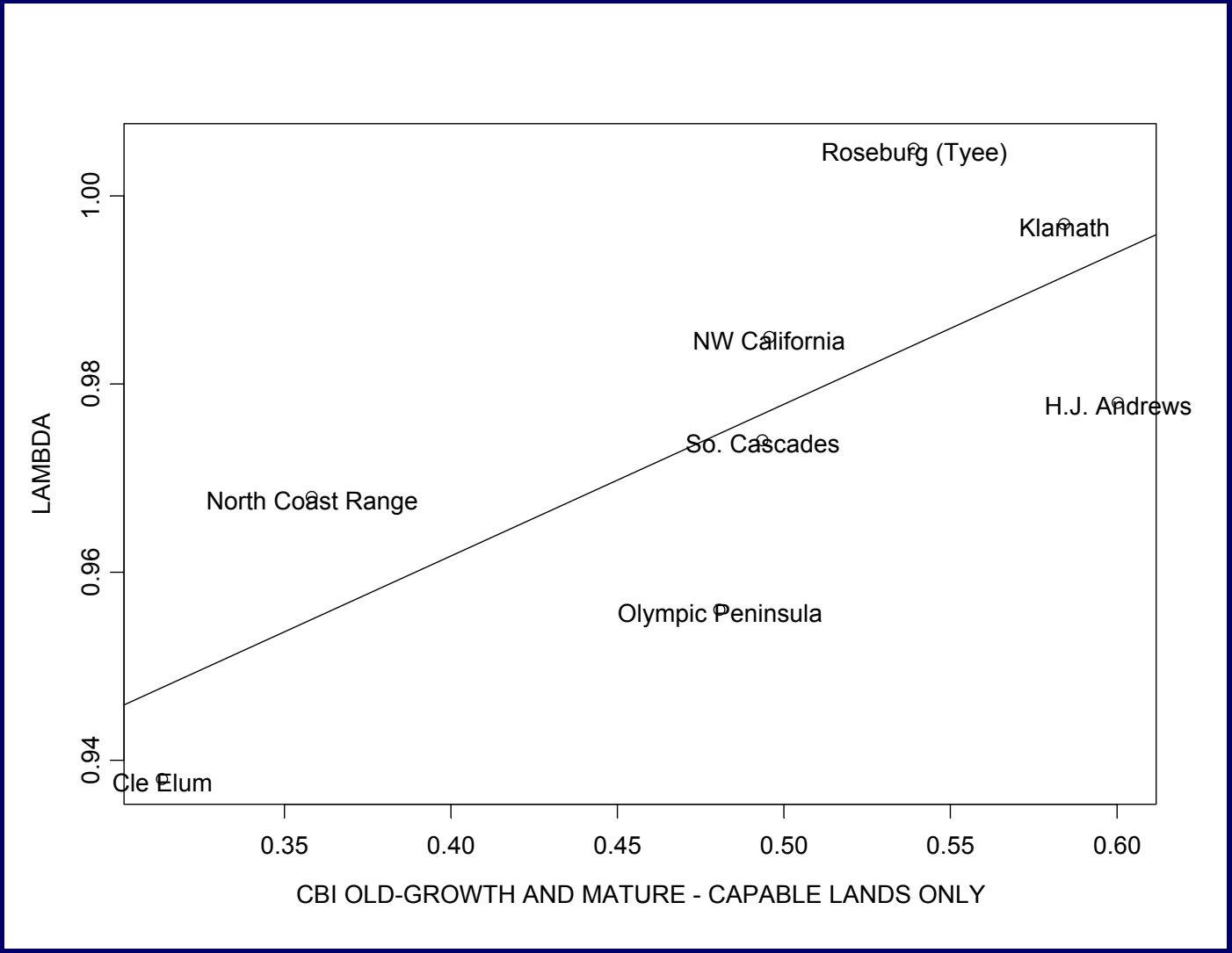
Figure D.3. Estimated spotted owl survival plotted against the percentage of spotted owl nesting habitat within sampled 1,500-meter circles centered on spotted owl activity centers (adapted from Olson *et al.* 2004).

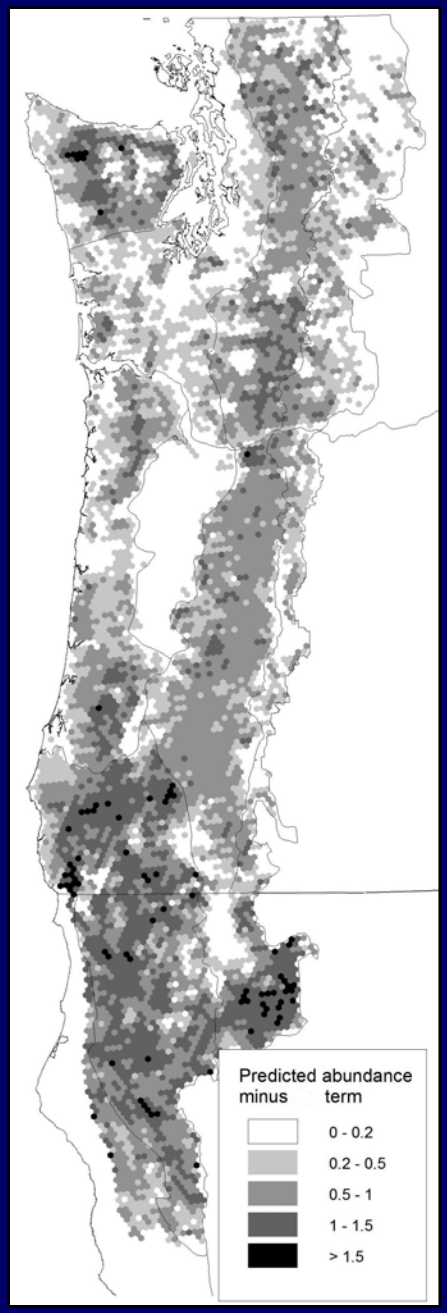


Potential reasons for discrepancies between results of range-wide modeling and demography/habitat hypothesis in draft plan

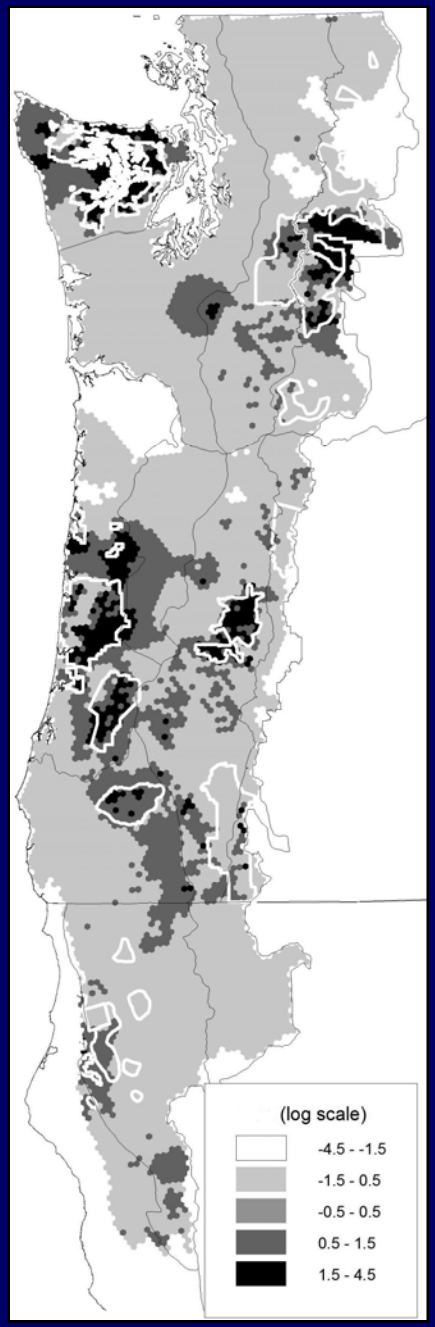
1) Misinterpretation of results of demography-habitat studies in draft recovery plan
2) Contrast in spatial grain: 24 km^2 vs. 1-7 km^2
3) Contrast in extent of analysis: DSAs with demography/habitat studies not fully representative of range-wide habitat gradient
4) Contrast in habitat definitions
5) Survey bias not fully resolved by HB method
6) Abundance gradient not matching lambda gradient: unlikely at this scale

Proportion of old and mature forest vs. lambda for demographic study areas (R^2 = 0.570, p = 0.030, n = 8).





Results of best HB models: Variation in predicted owl abundance



Results of best HB models:

Variation in spatial random effect (rho)

Evaluation of alternate reserve proposals

	Area	Abundance	Biomapper score
1992 critical habitat	28.72/27.79*	35.48	35.77
2007 critical habitat	20.01/19.86	21.99	25.65
LSRs	27.06/26.65	32.68	32.53
MOCAs (Option 1)	20.39/20.17	26.06	25.96
Habitat Blocks (Option 2)	17.78/17.61	21.99	22.27

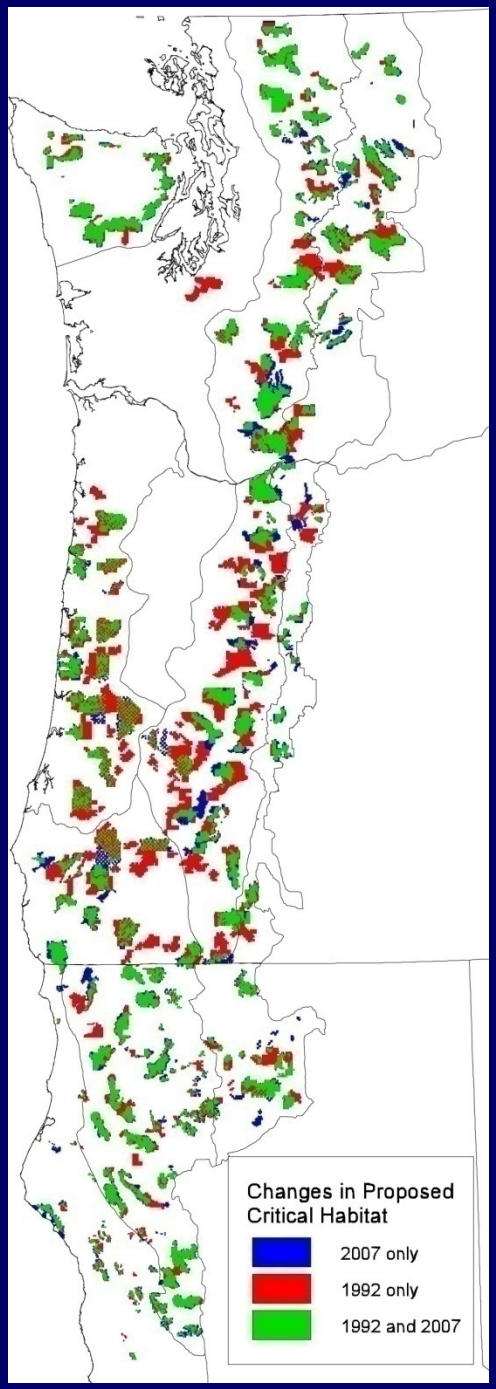
Figures are for federal lands only, excluding congressionally reserved areas, which are reserved from timber harvest under all alternatives, and represent 27% of federal land area, 18.83% of predicted abundance, and 19.53% of Biomapper habitat value

HB model results similar to results from Biomapper (Davis and Lint 2005) at this scale;

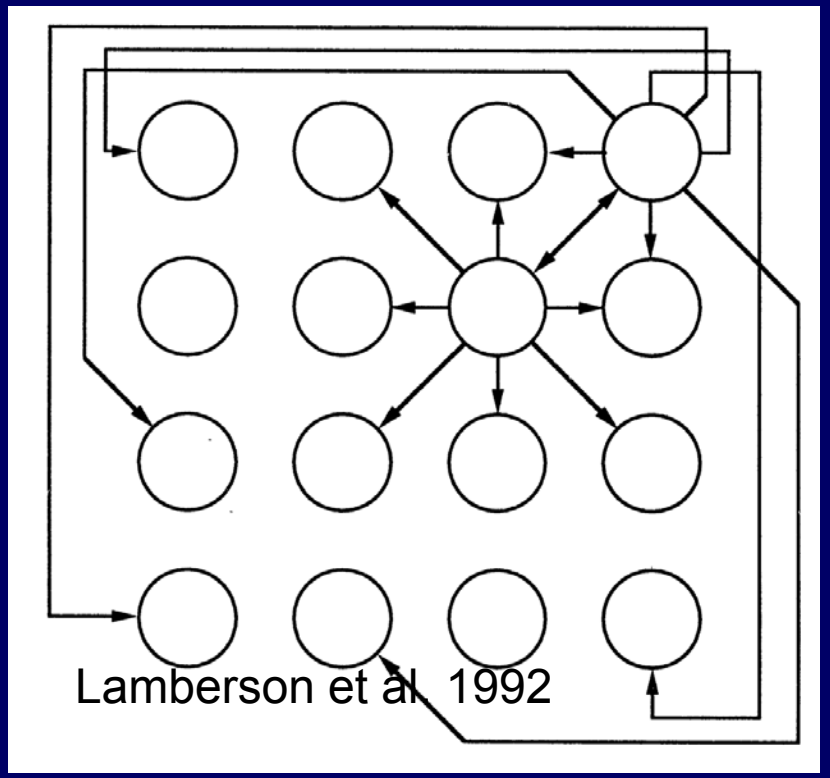
Both predict current proposals will result in substantial loss in area and habitat protected

Critical Habitat for Northern Spotted Owl – contrasts between 1992 and 2007 proposals

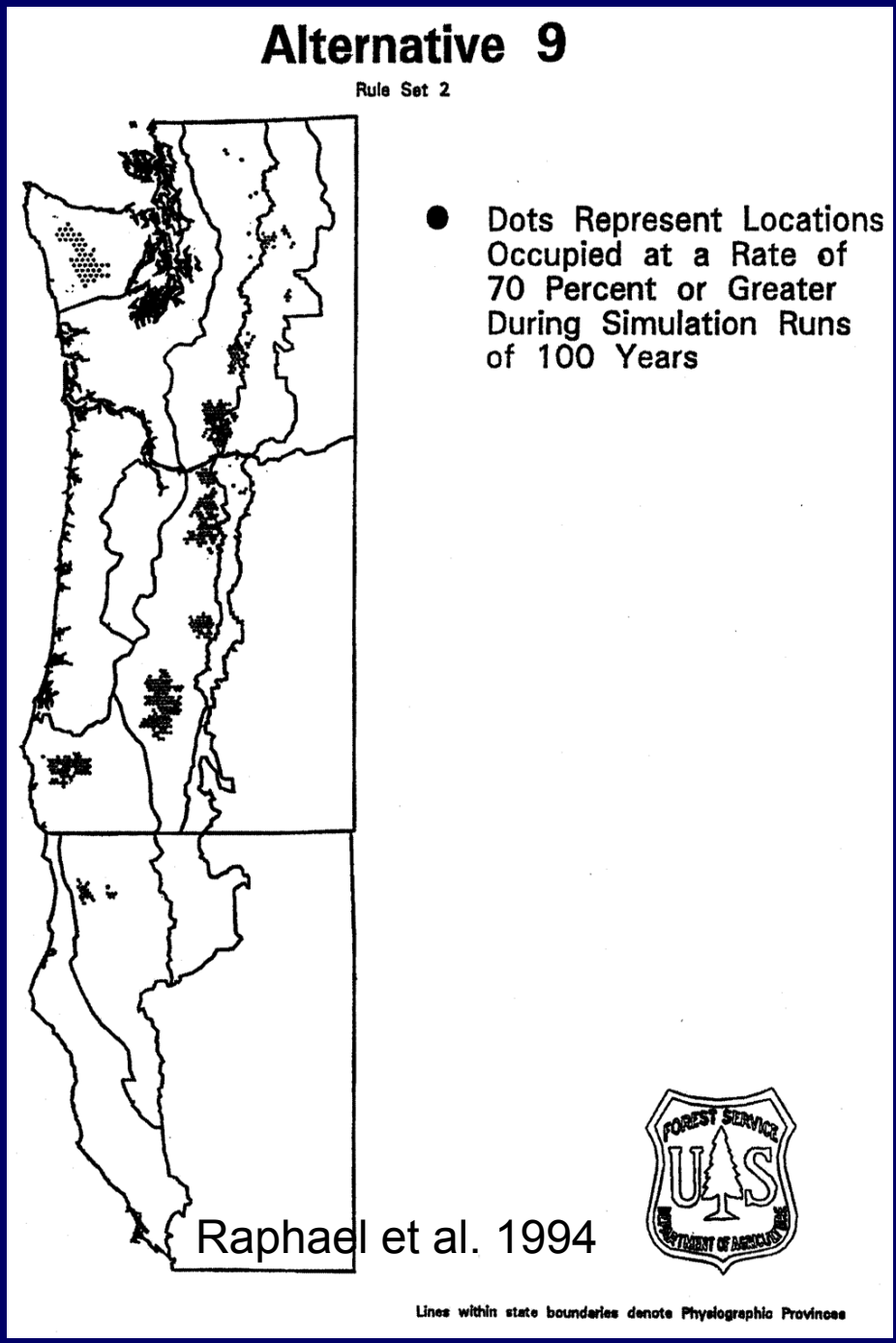
- Approximately four times as much area of critical habitat is lost as is gained between the 1992 and 2007 designations, a reduction of 30% in area and 38% in potential population size.
- The reduction in size of the largest areas of critical habitat is tied to the plan's assertion that habitat patches supporting clusters of 20 owl territories were adequate for sustaining the metapopulation.



"more recent modeling suggests that carrying capacities of perhaps 30-40 pairs per HCA are needed. In addition, a few large reserves (>100 pairs) significantly safeguard against population extinction. For these reasons, the original reserve design proposed by the ISC represents a minimum system, with greater risks to persistence than originally envisioned." (Noon and McKelvey 1996)

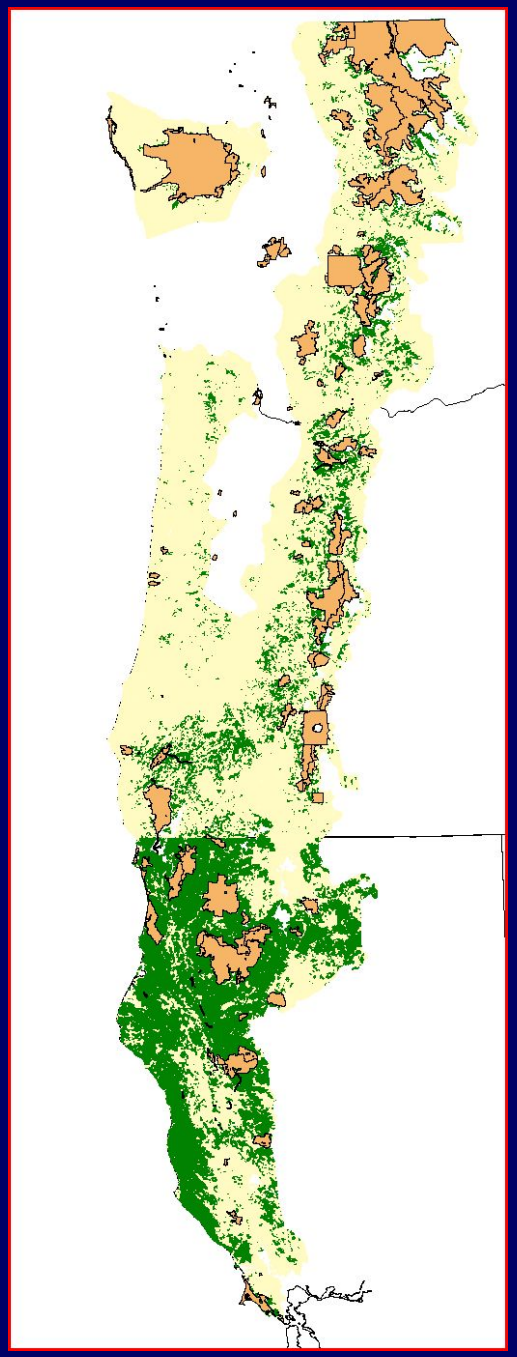


The question
"How much is enough?"
cannot be directly answered by static habitat models.
Dynamic population models (Raphael et al. 1994, Holthausen et al. 1995, Raphael et al. in prep.) can address this, but were not utilized in the draft plan.



Draft recovery plan's
Options 1 and 2 combine:

1) Inadequate standards for habitat within reserves, based on mischaracterization of habitat relationships
2) A reserve network that is significantly reduced in area and habitat value



Effect of compounded thresholds proposed in draft recovery plan. Areas above threshold are shown in green.