Conservation and management of woodpecker populations

Allan Carlson
Gustaf Aulén
(Eds.)

Campephilus imperialis

Swedish University of Agricultural Sciences
Department of Wildlife Ecology
Uppsala 1990

Report 17

ISSN 0349-1404
ISBN 91-576-4144-7
THE DYNAMICS OF RED-COCKADED WOODPECKER RARITY AND CONSERVATION

J. Michael Reed

Introduction

Because of their potential for extinction, rare species are a central focus for conservation. Rarity, however, is a subjective term, and there are many ways a species can be rare. Rabinowitz (1981) classified types of rarity using a 2x2x2 table based on local population size, habitat specificity, and geographic range. She applied this classification system to the flora of the British Isles (Rabinowitz et al. 1986) and it has been applied to butterfly species (Thomas and Mallorie 1985). Of the eight categories in this classification scheme, species in only one "can be considered "common": those with a wide geographic distribution coupled with broad habitat specificity, with at least one large population (Rabinowitz et al. 1986).

Each of the seven remaining categories can be considered rare in one way or another. An interesting point to these rarity classifications is that species in different categories vary greatly in their susceptibility to extinction, and consequently in the conservation methods required for species management. For example, Rabinowitz et al. (1986) stated that species having small geographic range, broad habitat use, and large populations should have threat of extinction because the species probably has ecological plasticity, environmental tolerance and uncolonized suitable habitat. Species with large populations and geographic ranges but restricted habitat requirements are more threatened, and probably occupy all existing suitable habitat. The former category suggests that transplanting individuals to unused habitat could be successful, while it would not be for species in the latter category (Rabinowitz et al. 1986).

I believe there are five major threats to species extinction; and they can be placed into the above classification scheme in the categories in which they threaten extinction (Table 1).

(1) Human-associated habitat loss is a threat to species, with specialized habitat requirements (Temple 1986), and particularly, to species that also have only small populations (Shaffer 1987). (2) Catastrophes, including disease, threaten species with a narrow geographic range because they tend to be local.' (3) Systematic exploitation threatens small populations and species, with restricted habitat. (4) Demographic stochasticity and (5) loss of genetic variation exist in all populations, but they are a threat to extinction only to small populations (Table I). These five threats are both direct: through" individual death, and indirect, through problems caused by population') fragmentation (Wilcove et al. 1986). It should be noted that the extreme: case of (3), overexploitation, can affect all of the categories in Table 1 so it is not useful in discriminating conservation strategies among the types
Table 1 - Five major threats to species survival are catastrophe (C), habitat loss (H), and systematic loss due to exploitation (S), and demographic (O) and genetic (G) stochasticity. Threats significant to each abundance category are listed below, as is a ranking of the degree of susceptibility to extinction for each cell.

<table>
<thead>
<tr>
<th>Local Population Size</th>
<th>Habitat Specificity</th>
<th>Broad</th>
<th>Restricted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Geographic Distribution</td>
<td>Wide</td>
<td>Narrow</td>
</tr>
<tr>
<td>Somewhere Large</td>
<td>(1) C</td>
<td>(2) H,S</td>
<td>(4) H, C, S</td>
</tr>
</tbody>
</table>

Rank susceptibility to extinction by cell: 8 > 4, 7 > 6 > 5, 3 > 2 > 1

of rarity. Overexploitation can result in extinction even in the "common" category, e.g., Passenger Pigeon (Ectopistes migratorius) (Matthiessen 1987). In Table 1 I have also ranked the categories by what I perceive is their degree of susceptibility to extinction.

This method of classifying species and threats to their extinction is static, and has been used to view species at only one point in time. However, as Harper (1981) points out, species are not static in their numbers or distributions, and can change over time from common to rare. I expand his observation by applying Rabinowitz's (1981) classification system to categorize changes in rarity as a species declines. This dynamic classification scheme for a species can provide insight on the mechanism of species decline and how degree of susceptibility to extinction changes. I will apply this system to the Red-cockaded Woodpecker (Picoides borealis), and show that the species has changed rarity categories over time in a predictable fashion, providing useful suggestions for successful conservation.

Specifically, my objectives are to (1) look at historic and current population trends of the Red-cockaded Woodpecker, and show how the species has changed rarity categories, (2) compare population parameters of populations of different sizes to look for the effects of habitat fragmentation, (3) look for signs of population decline and degradation in one of the largest extant Red-cockaded Woodpecker populations, and (4) assess how the rarity trend observed can direct conservation efforts for the Red-cockaded Woodpecker, and discuss specific conservation methods for this species.

**Historic distribution and current population decline**

understory, which is maintained by regular fires (Jackson 1971). Cavity
trees are distinctive because the woodpecker flakes bark from the cavity
tree giving the tree a reddish hue, and because the woodpeckers peck
resin wells around the tree above, below, and at cavity height, causing
sap to flow (Jackson 1977a, 1978a). Long-used cavity trees often take on
a white candle-like appearance from sap buildup on the bole. Red-
cockaded Woodpeckers are also known for their unusual cooperative-
breeding mating system (Walters et al. 1988a).

Historically the Red-cockaded Woodpecker ranged from Texas
through Florida and north to Kentucky and Maryland, with individual
sightings outside these bounds (Fig.1a) (Jackson 1971, Hooper et al.
1980). At one time it may have been the most abundant woodpecker
species in the southeastern United States, but it has been on the decline
since colonial times (Jackson 1971), particularly during the last century.
The major causes of Red-cockaded Woodpecker decline have been
habitat loss and a decline in habitat quality through fire suppression
allowing uncontrolled understory growth, and a shorter rotation period
for tree harvest (Ligon et al. 1986). These factors have not only reduced
the numbers of individuals (Fig.1b), but they have also caused
populations to become fragmented and isolated.

The apparent abundance of Red-cockaded Woodpeckers in Fig.1 is
deceptive because the values are counts of the number of counties that
have at least one cluster of trees used by Red-cockaded Woodpeckers,
although these are not ideal data, they are all that are available
historically for most regions. Trees used by this species are typically
censused because the birds distinctly mark them, then clusters are
translated to numbers of groups (Harlow et al. 1983, Reed et al. 1988a).
One cluster is generally equated with one family group of birds, but this
should be considered a maximum because one group may defend more
than one cluster (Walters 1989). The counts in Fig. 1 are deceptively
optimistic in two ways. First, clusters of trees that are counted may not
have been active, i.e., no Red-cockaded Woodpeckers present. Second, a
county with even one cluster was counted as having Red-cockaded
Woodpeckers present, which can give a false impression of a healthy
woodpecker population. For instance, as of 1982 only 14 of the 29
counties in North Carolina that had clusters of Red-cockaded
Woodpecker cavity trees had more than ten clusters (Carter et al. 1983).
Therefore, bar height in no way indicates viable woodpecker populations.

The trend from Fig.1a to 1b is the general trend up to 1971. Since
1971 most populations have continued to decrease in size and become
more isolated, and none have been shown to increase in size. For
example, Thompson (1976) surveyed 312 Red-cockaded Woodpecker
clusters (hereafter clusters) in ten states that were active in 1969-70,
then resurveyed them in 1973-74 and found a 13.1% decline in active
clusters. Baker (1983) reported on a population from Florida that
decreased from 40 individuals and 11 nests in 1970 to 0 birds in 1981.
This decline occurred with no habitat loss. Jackson et al. (1978) found
only 11 of 23 clusters active in three Texas national forests. Conner and
Fig. 1. The number of counties, by state, with at least one cluster of Red-cockaded Woodpecker cavity trees. (A) Historic distribution, with individual bird sightings in the northern-most states, and (B) distribution by 1971. Adapted from Jackson (1971) Hooper et al. (1980) with an update for Maryland by Devlin et al. (1980).
Rudolph (1987) updated Jackson et al.’s count and estimated the annual rate of decline in active clusters as 8.4-14.5%.

The active clusters surveyed on private land in Texas fared no better, with, 31. colonies in 1969-77 reduced to 9 active colonies in 1985-87 (Ortega and Lay 1988). Even one of the largest extant Red-cockaded Woodpecker populations, located in the Sandhills region of North Carolina (Lennartz et al. 1983), declined from 264 active clusters in 1981 to 222 active clusters in 1985 (Walters et al. 1988a). I conclude that the Red-cockaded Woodpecker has continued the decline that resulted in its first becoming endangered, and that the end is not in sight.

The status of the Red-cockaded Woodpecker can be shown to have changed categories in Table 1 over time. I believe Red-cockaded Woodpecker populations have become so isolated and reduced from their former large population size that none can be considered large (cf., Reed et al. 1988b), pushing the species from its "Historic" to its "Current" category (Table 2). I will support this assertion in a later section. Given current population trends' and continued habitat loss, the species is destined for a second category change to small populations with a narrow range and restricted habitat -(Table 2), which is the most tenuous existence for any species (Rabinowitz et al. 1986). The transition from the "Current" to "Future" category has already occurred regionally, and this change is accompanied by catastrophe becoming a major extinction threat. The entire transition has been accompanied by an ever-increasing susceptibility to extinction (Table 2).

Table 2 – The transition between rareness categories for Red-cockaded Woodpeckers from historic to current distribution. The future distribution is projected based on current population decline.

<table>
<thead>
<tr>
<th>Local Population Size</th>
<th>Geographic Distribution</th>
<th>Habitat specialist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>Wide</td>
<td>Historic</td>
</tr>
<tr>
<td>Large</td>
<td>Somewhere</td>
<td>Current</td>
</tr>
<tr>
<td>Everywhere</td>
<td></td>
<td>Future</td>
</tr>
<tr>
<td></td>
<td>Small</td>
<td></td>
</tr>
</tbody>
</table>
Small populations and isolation

Red-cockaded Woodpeckers represent a classic case of species decline due to habitat fragmentation, which results in decreased population size and increased isolation. Habitat fragmentation is a multifaceted problem that once had a strong effect on species extinction in the north-temperate zone and is now also a problem in the tropics (Wilcove et al. 1986). Decreased habitat area and increased isolation result in species extinction, which decreases species richness in a given habitat (e.g., Wilcox 1980, Wilcox and Murphy 1985, McLellan et al. 1986). The increase in a bird population's susceptibility to extinction may be due to environmental stochasticity (catastrophe) (Shaffer 1981, Quinn and Hastings 1987), increased nest predation via the large number of "edge" species present in fragmented populations (Wilcove 1985), or high levels of population fluctuation (Diamond 1984). Deep-woods species in fragmented habitats are also subjected to other edge effects, such as temperature, wind, and humidity gradients, not typically found in the forest, interior (Harris 1984, Lovejoy et al. 1986, Wilcove et al. 1986).

Habitat fragmentation isolates populations, and isolated populations lose genetic variability over time (Denniston 1978): Genetic variability is lost through the processes of inbreeding and drift (Crow and Kimura 1970), and loss of genetic variability can result in decreased individual fitness in a population (e.g., Ralls and Ballou 1983, Allendorf and Leary 1986). This decrease in fitness can result in species extinction, so a population or species must be managed in such a way as to maintain genetic variability (e.g., Franklin 1980). Habitat fragmentation also decreases population size, and small populations retain a smaller amount of genetic variability and lose it more quickly than do large populations (Denniston 1978).

All of the above factors, catastrophe, loss of genetic variability, and edge effects, along with demographic stochasticity (Shaffer, 1981), combine to affect a population's viability, or probability of extinction (Gilpin and Soule 1986). Probabilities, of course, vary by species, and Terborgh and Winter (1980) addressed the question of taxonomic patterns of extinction. They examined land-bird faunas of five islands of different sizes, and they compared past and present species presence to look for taxa showing unusual resistance or susceptibility to extinction. Woodpeckers (Picidae) were among the particularly extinction-prone families. Extinction-prone species are those that are more susceptible to the problems of isolation and small population size than are other species (Terborgh 1974, Temple 1986). I argue that the Red-cockaded Woodpecker is an extinction-prone species and that it is showing some effects of small population size and isolation, aside from the extirpation of small populations mentioned earlier.

The Red-cockaded Woodpecker has a much shorter dispersal distance than is typical for a bird of its size (Walters et al., 1988c). This is presumably the mechanism for this species showing greater levels of genetic differentiation than is typically found for birds (P. Stangel,
pers.commun.). This differentiation would be increased by habitat fragmentation, which would further limit gene flow. For Red-cockaded Woodpeckers a distance of only 10 km between populations can restrict gene flow more than is typical for other species that was recently widespread and common and has since been fragmented, Red-cockaded Woodpeckers have a greater level of heterozygosity than do other woodpeckers in the southeastern United States, and small populations have less genetic variability than do larger populations.

One of the current goals of wildlife conservation to maintain genetic variability (e.g., LaCava and Hughes 1984, Lehmkuhl 1984, Reed et al. 1986). The Red-cockaded Woodpecker Recovery Plan (USFWS 1985) has a goal of maintaining genetic variability; specifically, a population with an effective size (a measure of rate of loss of genetic variability) of 500 reaches their goal Reed et al. (1988b) estimated the effective size for Red-cockaded Woodpeckers and concluded that, given current knowledge of population sizes and boundaries, no populations were larger than this critical size. It is for this reason that I place extant Red-cockaded Woodpeckers in the "Current" or "Future" category in Table 2; in my opinion a population must be much larger than the minimum. size estimated to be viable to be considered "large".

Degeneration of a larger population?

While small populations may readily show the effects of fragmentation the problems for larger populations may be more insidious. Documenting actual population problems, if they occur, can be a long-term process.' For example, Red-cockaded Woodpeckers may take a year or more to abandon a territory, that has been partially cleared (Newbitt et al. 1983). Below I present data that may indicate problems due to habitat fragmentation. The' data come, from: the Sandhills population of North Carolina (see Carter et al. 1983, Walters et al. 1988a for description),' one of the largest extant Red-cockaded Woodpecker populations (Lennartz et al.1983).

As mentioned earlier, this population steadily declined in breeder number from 1980-1986 (Walters et al. 1988a) (Fig.2). This decline" however, is more complicated than it first appears . .The decline in breeding groups has primarily been through the loss of unpaired territorial males which are considered potential breeders (Walters et al., 1988b). This apparently represents the end of a recent population decline in the mid to late 1970's (Walters et al. 1988b). Although the numbers of breeding pairs has been stable in recent years, large parts of the population have almost no helpers at present (Walters et al. 1988b). This' means the population is vulnerable to a rapid decline if breeders are lost because no helpers are available to replace lost breeders (cf. Woolfenden and Fitzpatrick 1984).
Fig. 2. The number of breeding groups, including unpaired territorial males, for a relatively large population of Red-cockaded Woodpeckers in the North Carolina Sandhills. Adapted from Walteres et al. (1988a).

Associated with this population decline has been an increase in whole-brood loss rate, which increased over a 6-year period (1980-85) from 0.2 to 0.31, a significant increase (Mann Trend Test, P=0.008) (LaBranche 1988) (Fig.3). The cause for this trend is unknown, but LaBranche (1988) suggested it may be associated with an increase in cavity competitors and nest predators. If inbreeding depression were the cause of whole-brood loss, production of inviable eggs would be correlated with year (Frankel and Soule 1981). Pettersson (1985a) observed this correlation for an isolated population of the Middle Spotted Woodpecker (*Dendrocopos medius*), but it was not present in this study of Red-cockaded Woodpeckers.

Degeneration of available habitat, particularly for a species with narrow habitat requirements, can cause problems for even a relatively large population. Habitat quality is difficult to assess for Red-cockaded Woodpeckers because territories are so large (125+ ha), and because nesting and foraging habitat requirements differ (USFWS 1985). In habitat that has not been timbered, a single Red-cockaded Woodpecker territory may contain over 30 cavity trees, including cavity starts, active and inactive cavities (personal observation). It is reasonable to believe that this number of cavities per territory was typical before habitat destruction was widespread. In a study area in the Sandhills of North Carolina, Reed et al. (1988a) found on average more than one active cavity per adult, but found the number of active cavities per adult declined over a 5-year period (Fig.4), and since Red-cockaded Woodpeckers are cavity-limited, this certainly represents a decrease in
one aspect of habitat quality. The mechanism for this decreased ratio is unknown, but may be a result of habitat destruction or competition for cavities.

Fig. 3. Whole-brood loss rate decreased significantly over time (Mann, Trend Test) (LaBranche 1988) for the same population depicted in Fig. 2. Adapted from LaBranche (1988).

Fig. 4. The change in the ratio of active cavities per adult for the same-population depicted in Fig. 2. Vertical bars are 1 S. E. Approximately. 50% of the increase in 1986 was due to a decrease in adult number (Walters et al., unpubi. data.). From Reed et al. (1988a)
I conclude that biological problems for this relatively large population are showing themselves in nestling mortality and habitat quality. For any given year the problems may not be substantial, but the individuals in this population are not replacing themselves (P. Manor, in prep.), and the above observations may indicate a trend leading to local extinction.

The dynamics of rarity and conservation

Rarity

As I showed in Table 2, the historic and foreseeable distributions of the Red-cockaded Woodpecker result in increased susceptibility to extinction. The most significant transition in Table 2 was a result of the loss of large populations through habitat fragmentation. Catastrophe, systematic exploitation, and habitat loss are extrinsic threats to population survival, while problems due to demographic and genetic stochasticity are inherently a biological consequence of small numbers of individuals. This is an important distinction that affects conservation measures. Threats that are a result of the biology of the species require direct intervention with the biological processes of the species, while extrinsic threats require manipulating the species environment. This distinction will be expanded upon in the next section.

The transitions in Table 2 also alert conservation biologists to the urgency for conservation measures. A species in the "Historic" category (Table 2) is in little need of conservation measures (Rabinowitz et al. 1986), while a species in the "Future" category is in immediate need of protection.

Conservation: Within-species Threats

Demographic and genetic stochasticity are inherent in the biology of the species and vary by species in the population size at which they actually become a threat. Shaffer (1987) stated that the threat due to demographic stochasticity decreases rapidly as population size increases. Although Lande (1988) has argued that demographic stochasticity is more of a threat to species survival than is genetic stochasticity, it actually depends on a species' genetic load (cf. Frankel and Soule 1981); the more deleterious alleles present, the more important genetic stochasticity becomes. The genetic load of Red-cockaded Woodpeckers is not known and would be difficult to estimate.

Since the threat to extinction from demographic stochasticity is a result of small population size (and nuances of sex ratio and age structure), the obvious conservation measure is to increase population size. This can be done through introducing new individuals to a population or setting up circumstances that increase probability of individuals immigrating into the population. The former method can be done using large or captive populations, if any exist, as a source of
individuals, while the latter method might be accomplished by constructing habitat corridors.

Although it should not be ruled out as a possibility, transferring Red-cockaded Woodpeckers among areas has been unsuccessful so far, Rabinowitz et al. (1986) would have predicted this because Red-cockaded Woodpeckers fit the category of a species with no available habitat. However, this does not preclude creating new habitat for the species which has resulted in successful transfer of the Noisy Scrub-bird, (Atrichomis clamosus) in Australia (Smith 1985). In part the lack of success for the woodpecker may be due to the small numbers of individuals transferred (cf., Ellis et al. 1977), and it may be confounded by the need to move entire social units to appropriate habitat (Jackson et al. 1983). Populations with a high percentage of helpers might act as a buffer to allow removal of breeding groups from a source population. The helpers from adjacent territories would be available to fill the vacated breeding space (Woolfenden and Fitzpatrick 1984). Jackson, (1976) has suggested uniting populations with habitat corridors along highway right-of-ways to encourage immigration. One observation of a long-distance Red-cockaded Woodpecker dispersal by Walters et al., (1988c) that may have been along just such a corridor indicates that this may be a possibility for conservation, but no formal studies have been done. The above measures for increasing population size assume that once individuals immigrate there will be appropriate habitat to allow an increase in population size, and this is a problem in itself.

The problem inherent in genetic stochasticity is allele loss (Shaffer 1981). One way to decrease the rate of loss of genetic variability is to increase population size, but this requires increasing habitat availability. There are methods for slowing the rate of loss of genetic variability however, that do not require more habitat. What is important, is, not necessarily increasing numbers of individuals; rather, it is introducing new genetic material into a population. This requires only, the temporary introduction of breeders into a population. Breeders can be introduced from other populations by moving adults or producing corridors to allow natural transfer. The problems of moving adults were mentioned above, but transferring eggs or nestlings among populations would suffice (Ligon et al. 1986). This has not been attempted for Red-cockaded Woodpeckers. More eggs or nestlings' than adults; would have' to be transferred for an equal probability of breeding because of early mortality. Actually transferring eggs or nestlings' among populations would be labor intensive. Nestlings can easily be removed from a cavity, but it is not known whether adults will accept nestlings introduced to a nest.

Other methods of decreasing the rate of loss of genetic variability that might apply to Red-cockaded Woodpeckers is to increase survival and, reproductive output (Reed et al. 1988b). Clutch size is generally limited to 4 eggs (although there is a record of 5 fledglings from a single nest, P.' Manor, pers. commun.), and cavity size or energy restrictions probably maintain this maximum. Therefore, increasing' the: number of, eggs
produced is unlikely. In the North Carolina Sandhills annual adult survival is very high for this species, approximately 85% (P. Manor, in prep.) and would probably be difficult to improve. Nest failure (whole-brood loss), on the other hand, varies from <10->20% (LaBranche 1988) and a model of Red-cockaded Woodpecker population dynamics indicates that changes in population size are sensitive to changes in early mortality rates (Spellman 1987). Therefore, reducing nest loss may be a viable option for species conservation.

Whole-brood loss is probably due to interspecies competition or predation. Most competitors for cavities can enter a Red-cockaded Woodpecker cavity only if another woodpecker has enlarged the entrance (Jackson 1987b). Carter et al. (1989) is successfully reducing interspecific competition for cavities by placing metal "restrictors" at enlarged Red-cockaded Woodpecker cavity entrances to exclude competitors that are larger than Red-cockaded Woodpeckers. Red-cockaded Woodpeckers have successfully nested in restricted cavities that were originally excavated by Red-cockadeds but were subsequently taken over by other bird species (Carter et al. 1989). However, these restrictors do not exclude the primary egg and nestling predator, flying squirrels (Glaucomys volans). No method short of intensive individual squirrel removal from each cavity, or destruction, has been suggested as a control measure; at best, this is only a short-term labor-intensive solution.

Ultimately the optimal solution to the problem of maintaining genetic variability is to increase population size to the point that there is no, or a trivial, net loss of genetic variability (Franklin 1980), which would also solve the demographic stochasticity problem. The only way to achieve this for Red-cockaded Woodpeckers is to increase the habitat availability for natural population increase. If it can be shown that Red-cockaded Woodpeckers will regularly use corridors to migrate among populations, a corridor would be a useful tool in areas where habitat availability cannot be increased.

Conservation: Environmental Threats

It is significant that the three environmental threats presented here can be divided into two categories that affect conservation. Catastrophe and systematic exploitation are threats to the individual, and if either threat is removed a species can immediately increase its numbers (e.g., many Charadriidae after restrictions placed on millinery trade reduced systematic exploitation [Dought 1975]). Habitat loss, on the other hand, does not immediately threaten an individual's life, but its cessation does not allow a species to recover until habitat is replaced. This makes habitat loss a more serious threat to species survival in the sense that stopping the threat is not enough - it must be reversed.

Although systematic exploitation is a threat to some birds (Temple 1986), it is not a threat to Red-cockaded Woodpecker survival except indirectly through habitat exploitation. Catastrophe can be biotic or abiotic (Shaffer 1981). Biotic catastrophe includes the introduction of a
disease into a population (Dobson and May 1986), while abiotic
catastrophes can be, intense fire or tornadoes. Disease has not been
reported as a problem for Red-cockaded Woodpeckers and is not likely
to be a species-wide problem because it is not a colonial species, does
not aggregate in foraging areas, and has widely separated populations
(cf. Dobson and May 1986). Abiotic catastrophes threaten Red-
cockaded Woodpeckers by threatening their habitat. One natural cause
or cavity tree loss is high winds (Beckett 1971). Although Red-cockaded
Woodpeckers are adapted to living in habitat that is burned regularly,
fire suppression by man results in unnatural fuel buildup, and an
ensuing fire can destroy rather than maintain the habitat. The only
solution to abiotic threats is to maintain suitable habitat for the Red-
cockaded Woodpecker and increase population; size and species
range. Increasing population size, however, does not result in an equal
corresponding decrease in population susceptibility to catastrophe
(Ewens et al. 1987). This is why several populations must be
maintained in different geographic regions (USFWS 1985).

The presence of suitable habitat is responsible for the distribution of
many bird species, including other woodpeckers (e.g. Pettersson 1985b),
In a review of threats to endangered birds, Temple (1986) noted that all
six of the endangered woodpecker species are threatened by habitat loss.
Habitat degeneration, such as allowing understory development has the
same effect on Red-cockaded Woodpeckers as habitat loss. Therefore, a
suitable area and site quality are essential for species preservation.

The main problem in saving habitat for the Red-cockaded Woodpecker
is that their required habitat, old pine, is also the preferred habitat of
loggers. It has been suggested that selective logging or shelterwood
cutting would, allow sustained timber harvest without destroying the
habitat for Red-cockaded Woodpeckers (Conner and O'Halloran 1987).
The primary concern is to allow enough old-growth for the woodpeckers
to be able to start new cavities to replace dead or unusable roost trees and
to allow enough habitat in which to forage (USFWS 1985). Red-
cockaded Woodpecker territories are a minimum of 50 ha in good habitat
(USFWS 1985), and may be larger than 125 ha in poorer habitat. In
addition, Red-cockaded Woodpeckers, use extra-territory habitat for
foraging (Sherrill and Case 1980), and the extent or importance of this
habitat is yet to be determined.

In addition to maintaining enough habitat to support viable populations
of Red-cockaded Woodpeckers, habitat quality must be maintained. Most
effort for quality maintenance has centered around burning habitat to
reduce the understory height (Conner and Locke 1979), and to increase
stand age by logging on an 80- year rotation (Ligon et al. 1986). These
measures alone are inadequate, however, because Red-cockaded
Woodpeckers breeding groups may abandon a site that has low
understory and old pines (e.g., Baker 1983). Because this species is
cavity-limited, and excavation time for a new cavity may be years
(Jackson 1976), some methods of increasing cavity availability are also
required to encourage individuals to move into new habitat.
Red-cockaded Woodpecker cavities occur more often in trees infected with red-heart fungus \( (\text{Phellinus pini}) \) than expected from random tree selection (Conner et al. 1976, Jackson 1977b). Although the selection is not exclusive, it has been suggested that the presence of the fungus softens the heart wood and eases excavation (Conner and Locke 1982). Consequently Conner and Locke (1983) inoculated old pine with red-heart fungus to encourage cavity excavation. They had moderate success at infecting trees with fungus; but it is not known whether Red-cockaded Woodpecker subsequently chose these trees for cavities.

The cavity restrictors: used: by Carter et al. (1989) act to turn unavailable cavities into available cavities, so in essence, “new” cavities are created for Red-cockaded Woodpeckers. C. Copeyon et al. (pers. commun.) are taking a more direct approach by actually drilling cavities and cavity starts into pine trees. They are doing this in abandoned areas where Red-cockaded Woodpeckers previously roosted in sites where they have never roosted.

Therefore, much can be done to improve habitat quality for Red-cockaded Woodpeckers, both to the territory and the cavity. Preliminary results show that new habitat can be created and naturally invaded. This is a positive note for the Red-cockaded Woodpecker because it indicates that reversing habitat loss and increasing the number and size of populations is an attainable goal.

**Conclusion**

The dynamic application of Rabinowitz's (1981), rarity (classification scheme that I propose here provides insight into the, mechanisms of extinction and conservation efforts for recovery. In particular, Table I identifies threats to a, species, allowing the selection of an appropriate conservation response. This dynamic system can be applied to any species, and can be a useful tool for conservation.

**Acknowledgements**

I thank M. LaBranche, E. Marschall, and E. Seaman for reviewing this ms, and E. Seaman for discussions during its development. Travel money to this symposium was provided North Carolina State University, in particular by F. Hart. My research was supported by NSF grant BSR-8717683 to J. R. Walters and P. D. Doerr, and K. Reed and G. Taylor encouraged my endeavors.
Abstract

Different combinations of species distribution and population size may be considered rare but differ in their susceptibility to extinction. I apply a dichotomous classification scheme based on geographic range, habitat, specificity, and population size to the Red-cockaded Woodpecker (Picoides borealis): an endangered species endemic to the southeastern United States. Instead of using this system statically, as it has been used in the past, I apply it dynamically to the historic, current, and probable future distributions of the woodpecker. Red-cockaded Woodpecker populations have steadily declined in size and increased in isolation. Data show that associated with this fragmentation are decreased nestling survival, a reduction in a measure of habitat quality, and decreased genetic variability in small populations. The Red-cockaded Woodpecker has changed in its type of rarity to become more susceptible to extinction due to the threats of catastrophe, random loss of genetic variability, demographic, stochasticity, and habitat loss. Habitat loss has been the driving force increasing the species' susceptibility, and continues to be its greatest threat. I discuss management goals and associated conservation methods for the Red-cockaded Woodpecker. The dynamic method I present for using a rarity classification scheme is applicable to any species, and provides insights for directing conservation efforts.

References


Conner, R.N. & Locke, B.A. 1979. Effects of a prescribed burn on cavity
Conner, R.N. & Locke, B.A. 1983. Artificial inoculation of red heart
Woodpecker Symposium II. Fla. Game and Fresh Water Fish.
Comm. and USF&WS, Tallahassee, Fla. pp.81-82.
status and trends on the Angelina, Davy Crockett, and Sabine
National Forests: a report to the National Forest System: Final
Report, USDA Forest Serv., FS-SO-4202-2.4.
dependence on trees infected by fungal heart rots. - Wilson Bull.
88:575-581.
Conner, R.N. & O'Halloran, K.A. 1987. Cavity-tree selection by Red-
cockaded Woodpeckers as related to growth dynamics of southern
Implications for endangered species. - In: Temple S.A. (ed.)
Endangered Birds: Management Techniques for Preserving
Threatened Species. Univ. of Wisconsin Press, Madison. pp. 281-
290.
Devlin, W.J. 1980. History and present status of the Red-cockaded
extinction and fluctuations. - In: Moors, P.J. (ed.) Conservation
Dobson, A.P. & May, R.M. 1986. Disease and conservation. - In: Soule,
M.E. (ed.) Conservation Biology: The Science of Scarcity and
Doughty, R.W. 1975. Feather Fashions and Bird Preservation: A Study in
techniques for Masked Bobwhites. - In: Temple, S.A. (ed.)
Endangered Birds: Management Techniques for Preserving
Threatened Species. Univ. of Wisconsin press, Madison. pp. 345-
354.
viable population size in the presence of catastrophes. - In: Soule,
Frankel, O.H. & Soule, M.E. 1981. Conservation and Evolution. -


Walters, LR., Doerr, P.D. & Carter III, J.H. 1988a. The cooperative
breeding, system of the: Red-cockaded Woodpecker. - Ethology
78:275-305.
Walters, J.R., Doerr, P.D. & Lape, J.J. 1988b: Population status and
population dynamics of the Red-cockaded Woodpecker on Fort
Bragg, North Carolina. - Final Report to the Dept. of Defence, Fort
Bragg; Div. Natural Resources.
Walters, LR., Hansen, S.K., Carter HI, J.H. & Manor, P.M. 1988c. Long-
distance dispersal of an adult Red-cockaded Woodpecker. - Wilson
bull. 100:494-496.
Wilcove, D.S. 1985. Nest predation in forest tracts and the decline of
fragmentation in the temperate zone. - In: Soule, M.E. (ed.)
Wilcox, B.A. (eds.) Conservation Biology: An Evolutionary-
Ecological Perspective. Sinauer Assoc., Sunderland, Mass. pp. 95-
117.
Wilcox, B.A. & Murphy, D.D. 1985. Conservation strategy: the effects of
Press, Princeton, N.L