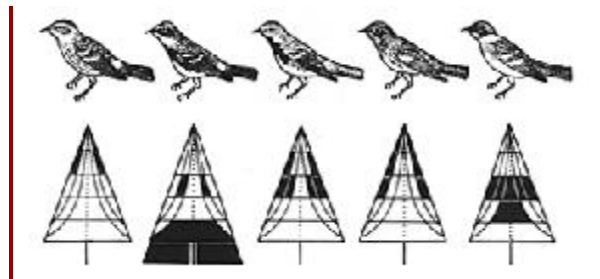


## MacArthur's Warblers

Five species of insectivorous wood warblers -- Cape May, Yellow-rumped, Black-throated Green, Blackburnian, and Bay-breasted -- were the subject of a classic study of community ecology (the science of interpreting species interactions). These species often share the same breeding grounds in mature coniferous forests. They had been thought by some ornithologists to occupy the same niche -- in other words, they appeared to assume identical roles in the same bird community. These five warblers would thus be an exception to the ecological rule of competitive exclusion. The rule states that two species with essentially the same niche cannot coexist because one will always out-compete and displace the other.

For his doctoral dissertation, the late Robert MacArthur, who became one of the nation's leading ecologists, set out to determine whether the five species of warblers actually did occupy the same niche. By measuring distances down from the top and outward from the trunk of individual spruce, fir, and pine trees, MacArthur divided the trees into zones and recorded feeding positions of the different warblers within each. A record in zone "T3" indicated a bird feeding among the abundant new needles and buds of the tip of a branch, between 20 and 30 feet from the top of the tree. A record of "M3" signified feeding mostly among dead needles at the same height but in the middle zone of a branch. A record of "B2" represented a warbler feeding on the bare, lichen-covered base of a branch. In all, 16 different positions were distinguished,

MacArthur found that each warbler species divided its time differently among various parts of the tree. The Cape May, for instance, stayed mostly toward the outside on the top, the Bay-breasted fed mostly around the middle interior, while the Yellow-rumped moved from part to part more than either of the other two. This is shown in the accompanying diagrams, in which the zones that contained 50 percent of the birds' feeding activity are blackened.



Left to right: Cape May, Yellow-rumped, Black-throated Green, Blackburnian, and Bay-breasted Warblers. Black areas in stylized conifers show where feeding is concentrated.

MacArthur also recorded details of the warblers' foraging habits and discovered that they differed too. For example, the Cape May warbler hawks flying insects much more often than does the Blackburnian and tends to move vertically rather than horizontally (matching its tendency to remain on the outside of the tree). The Black-throated Green hovers much more than the Bay-breasted, and the more variable Yellow-rumped has the most varied feeding habits. In addition, MacArthur found evidence that food shortage limited the size of the warbler populations.

Overall, MacArthur concluded that "the birds behave in such a way as to be exposed to different kinds of food." They also have somewhat different nesting times, and thus the times of their peak food requirements are not the same. They are partitioning a limiting resource -- their supply of insects, and, in the process, occupying different niches.

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Now, with the above information in mind and thinking about how biodiversity is maintained by species niches, let's consider the role of forest layers (see figure below). All layers of a forest provide different niches for different species of flora and fauna. When any of these layers is missing, species may not be present.

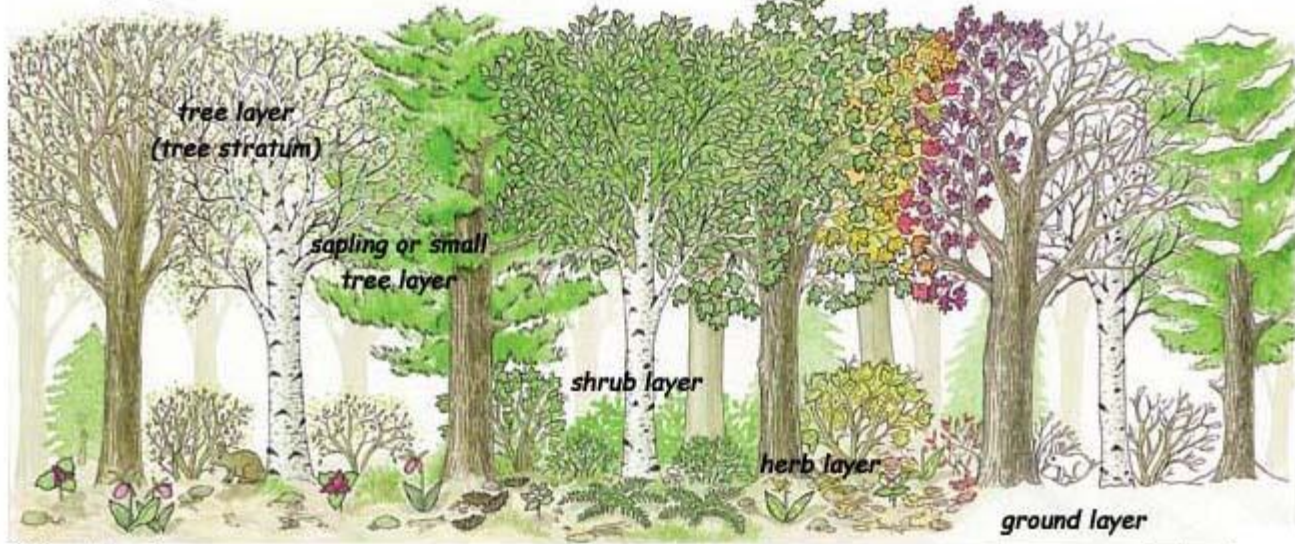
# The Four Seasons of Deciduous Forests

Spring

Summer

Fall

Winter



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