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Private Conservation Case Study

The Wood Duck

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The wood duck has long occupied a special place in the hearts of waterfowl fanciers, hunters, bird watchers, and others because of the male's striking plumage. Along with the mandarin duck of China and Japan, it is widely regarded as one of the most beautiful species of waterfowl in the world.

The wood duck's conservation is one of the most outstanding examples of private environmental initiative in American history. By installing well over 100,000 artificial nest houses and raising wood ducks in captivity, private citizens have played a key role in the conservation and recovery of this species.

Historically the wood duck is thought to have been the most abundant species of waterfowl east of the Mississippi River.¹ However, around the turn of the century many people thought the wood duck was headed towards extinction. These fears were exaggerated but not entirely without merit. Wood duck populations had declined precipitously in some areas. Yet with the active involvement of private citizens and associations across the country, the wood duck made a spectacular recovery and is abundant once again.

Private efforts helped the wood duck specifically in two ways: by creating artificial nesting habitat and propagating them in captivity. The wood duck is a cavity-nesting species, and the older trees containing suitable cavities have become increasingly scarce. As its habitat was destroyed, the wood duck suffered. In response, private citizens installed nest boxes across the country. Nest boxes played a key role in restoring the wood duck to marginal habitat from which it had been largely extirpated and to core habitat where populations had declined. There were also significant efforts to raise wood ducks captively and then release them to the wild. The wood duck is now the second most common species of waterfowl in hunter's bags east of the Mississippi River. Private efforts to conserve the wood duck are evidence of the strong tradition of American conservation.

Hunting and Wood Duck Decline

The wood duck is a forest nesting species. Historically, the eastern U.S. was largely forested. As the country grew, the forests were felled, wetlands drained, flood control projects built and streams channeled. As a result, wood duck populations, both rangewide and in specific areas, experienced declines in the late 1800s and early 1900s.² A significant cause of the decline was overhunting, both by sportsmen and professional hunters who shot large numbers of ducks for later sale. The wood duck was especially vulnerable to hunting because it was considered one of the best species of waterfowl to eat, and because of the long hunting season which ran from September to April in most states. The ever-improving quality, and hence efficiency, of firearms and ammunition also subjected the wood duck to further hunting pressures.³

Portions of the wood duck's range put it in close proximity to areas of relatively dense human habitation as opposed to other species of waterfowl that nested farther north and west in lightly-inhabited areas of the U.S. and Canada. In regions that were heavily populated or had easy access to transportation, hunting took a significant toll on the wood duck.⁴ The concern about overhunting was understandable because, after all, it was hunting that drove the passenger pigeon to extinction and severely depleted other game birds including the eskimo curlew, hudsonian godwit, golden plover and greater prairie chicken. There was fear that the wood duck might suffer a similar fate.⁵

Wood ducks and these other species suffered because they were common resources that could not be owned unless they were reduced to personal possession, which almost always meant killing them. In the absence of any form of private ownership, if one hunter did not kill them then another might, and no benefit would accrue to the person who did not take them. Thus, killing as many wood ducks as quickly as possible was a perfectly rational decision. Absent the ability to prevent others from taking the valued resource, hunters have a strong incentive to take as many wood ducks as possible before others did the same, lest they get fewer wood ducks for themselves.⁶ This situation did not bode well for the wood duck.

How Endangered?

Even though overhunting took a heavy toll on the wood duck, it is doubtful the species was ever close to extinction as was widely believed. Nonetheless, it was nearly eliminated from some parts of its range, particularly in New England.

The wood duck requires deciduous forest adjacent to or near a pond, lake, swamp, river or other type of standing water for nesting. This habitat type, also known as bottomland hardwood forest, was largely intact, according to early observations by naturalists and ornithologists, in the late 1700s and early-to-mid 1800s. The large number of mature, dying and dead trees provided many nesting cavities, and cavity creation and augmentation by pileated woodpeckers created additional nesting sites. In addition, the extensive amount of wetland and riparian habitats in the southeastern and, to a lesser degree, the mid-Atlantic and northeastern U.S., provided abundant nesting and foraging habitat.⁷

From 1850 to 1920, large numbers of wood duck nesting cavities were destroyed as bottomland hardwood forests were logged, cut, burned and drained for a variety of reasons, often for conversion to croplands.⁸ By the turn of the century some prominent observers feared the wood duck faced imminent extinction. "Being shot at all seasons of the year they are becoming very scarce and are likely to be exterminated before long," said George Bird Grinnell, noted sportsman and naturalist, in 1901. "So persistent has this duck been pursued that in some areas it has practically been exterminated," stated W. W. Cooke in 1908. "As a result the wood duck is constantly diminishing in numbers, and soon is likely to be known only from books or by tradition."⁹

Yet the wood duck was probably not in as much trouble as these and other contemporary accounts reported. Massachusetts (which contained relatively little suitable habitat) was "the focal point for the plight of the wood duck." Concern over the wood duck's decline was also expressed along the Atlantic coast from Maryland to Maine and west to Ohio, Michigan, Iowa, Washington and California. The wood duck was probably more susceptible to overhunting in these states because they contained relatively large human populations in proportion to relatively small amounts of bottomland forest, compared to the lower Mississippi River valley and those areas of the southeast that comprised the wood duck's core habitat.¹⁰

From roughly 1907 to 1925 wood ducks were reported as being fairly common to locally abundant throughout their core range.¹¹ Habitat fragmentation was highly problematic for the wood duck at the periphery of its range where, due to the lack of suitable habitat, it was particularly susceptible to population declines. Yet as it turns out, predictions of the wood duck's extinction were a function of geography. According to Frank Bellrose, one of the world's foremost experts on the wood duck:

Most concern about the precarious status of the wood duck was voiced in large urban areas populated by hunters, and in areas where ornithologists were most active. Further, ornithologists were most likely to be familiar with the more accessible areas where wood ducks were under greatest pressure from sport and market hunters; also, in these regions most wetland habitats suitable for wood ducks were limited in area or were fragmented. Rivers and creeks brought the wood duck within the province of human population centers in the East and Midwest but less so in much of the South.¹²

In some regions (eastern Maine, parts of Florida, southeastern Missouri, large areas of the Carolinas, Georgia and other Gulf states) that contained large areas of inaccessible swamps, the wood duck "... remained abundant," and "[t]hese 'reservoirs' of abundance" maintained healthy populations. These areas were sparsely inhabited, and so the wood duck suffered little from the habitat destruction and fragmentation and overhunting that plagued it in more urbanized regions.¹³

Protective Legislation

In response to the wood duck's actual and perceived decline, legal protections were enacted by various states. After the turn of the century, twenty-three states prohibited hunting for wood ducks for varying numbers of years.¹⁴ The federal government followed the states' lead

and passed the Weeks-McLean Bill in 1913, prohibiting the hunting of wood ducks. Yet this law was not actually implemented until the passage of the Migratory Bird Treaty Act in 1918 which prohibited wood duck hunting nation-wide. This ban remained in effect until 1941.¹⁵

As a result of the hunting bans, wood duck populations began to increase, and within twenty years there was widespread consensus that the wood duck had recovered in many of the areas from which it had been severely depleted.¹⁶ This was probably due to a number of factors.

The “reservoirs of abundance” in the wood duck’s core habitat provided the birds that slowly repopulated areas from which they had been reduced. Also, while the wood duck’s bottomland habitat made it vulnerable to hunters – it is essentially the only species of waterfowl that nests there – it also served to conceal them from hunters, as opposed to other species of waterfowl that nest in more exposed habitats. Thus, there were probably wood ducks throughout most of their range, even when their extinction was thought to be imminent.

Another factor is that wood ducks return to their area of birth and will nest there unless there is not sufficient habitat, but they are slow to pioneer into areas of unoccupied habitat that are far from where they were hatched. The existence of remnant populations seems to be the most plausible explanation why Ludlow Griscom, one of the most prominent ornithologist of his time, noted in 1919 that the wood duck was increasing in New England.¹⁷

When the nationwide ban was lifted in 1941, a limit of one duck per bag was allowed. One of the reasons for lifting the ban was “concern ... about the large number mistakenly shot for other ducks and left to waste.”¹⁸ There was, however, a notable population decrease in 1952 and 1953 in the Mississippi flyway, and the season on this flyway was closed in 1954 and 1956. A one duck limit was allowed by the federal government in 1957 and 1958, but in 1957 eight states, concerned that this would be detrimental to the species, opted to keep the season closed. Nine states did the same in 1958. By 1962 the population in the Mississippi flyway was deemed healthy enough for the federal government to permit a two duck per bag limit.¹⁹ Protection measures and hunting bans in the eastern flyway were somewhat similar.²⁰

In the first half of this century, there is no doubt that hunting regulations were the most important factor that allowed the wood duck to rebound. These regulations were especially effective where populations had not been overhunted (because they could rebuild more rapidly) and where nesting habitat was sufficient. “Although wood duck populations had partially recovered from their low of the early 1900s, they had not reached optimum levels by the 1950s,” observed Frank Bellrose. “What had been achieved in population recovery was due solely to limiting the harvest to reasonable levels.”²¹

The claim has been made that the Migratory Bird Treaty Act was the first legislative effort responsible for the wood duck’s resurgence.²² On the contrary, the active involvement of the states and their willingness to prohibit wood duck hunting well before the federal government provides a very clear indication that the states played a key role in the wood duck’s conservation. Additionally, these hunting bans were commonly passed at the behest of the hunters themselves.²³

Habitat Destruction

Overhunting is the most commonly cited reason for the wood duck's decline, but habitat destruction became progressively more significant throughout this century. Immediately following the lifting of the nationwide hunting ban in 1941 the wood duck "was still rare in many places where it was once abundant" in large part because of habitat destruction, particularly of wetlands that contained the mature, dead and dying trees necessary for nesting cavities. Even though "poachers and indiscriminating hunters take their toll . . . operations, such as drainage, timber cutting and burning, which destroy the habitat, cause even greater inroads on the population of this handsome duck."²⁴

So during this time period – the late 1930s and early 1940s – there were two countervailing trends. On the one hand, some wood duck populations were increasing because regulations had greatly reduced the threat of overhunting. Yet on the other hand, habitat destruction, largely due to government programs, was putting the wood duck under increasing pressure. While the amount of wood duck habitat destroyed is impossible to quantify precisely, there are some data which give a sense of the extent to which this occurred.

Prior to the mid-1800s, habitat destruction took place largely on a piecemeal basis by private and public entities, but it became more systematic as the government got involved in the mid-1800s. With the passage of the Swamplands Drainage Acts of 1849, 1850 and 1860, Congress transferred federal domain wetlands to fifteen states (Alabama, Arkansas, California, Florida, Illinois, Indiana, Iowa, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Ohio, Oregon and Wisconsin) on the condition that these states would then dedicate the proceeds from the sale of the wetlands to private citizens in order to assist them with flood control and drainage projects on their newly acquired property. A total of 65 million acres of wetlands were transferred to private hands, much of which were destroyed due to the federally-mandated subsidy that encouraged their destruction.²⁵ By the turn of the century the extent of wetlands destruction had increased; "The drainage of vast areas of land by organized enterprises was well underway."²⁶

This was also the period in which the wood duck faced extirpation in some areas. It is only logical then to assume that government-sponsored efforts to destroy wetlands were a significant cause of the wood duck's decline. By 1920, 65.5 million acres were part of efforts to drain wetlands.²⁷ These efforts (e.g. flood control, drainage, irrigation, channelization and hydroelectric projects) were almost always government-sponsored.²⁸ Another cause was that increasing amounts of mature hardwoods were being cut by timber companies because of the high demand for wood and wood products.

The federal government became actively involved in destroying wetlands with the passage of the Flood Control Act of 1928. Continuing into the 1930s, wetlands suffered from federally-sponsored projects to provide protection to people living in flood plains. With the passage of the Flood Control Act of 1944 federal efforts shifted from flood control to draining wetlands for agricultural development.²⁹ In 1950 the amount of land that was part of these efforts was 102.7 million acres, and an additional 50 million acres not part of these organized

efforts were altered by drainage. A large portion of these lands were simply saturated soils, and so were unsuitable for wood ducks, but enormous amounts of wood duck habitat were destroyed.³⁰

Additional federal legislation – the Watershed Protection and Flood Protection Act of 1954 and the Flood Control Act of 1965 – furthered the destruction of wetlands in the Mississippi River Delta (Kentucky, Tennessee, Missouri, Arkansas, Louisiana and Mississippi).³¹ Federal crop subsidies also played a key role in wetlands destruction. By distorting the marketplace through artificially inflated commodity prices, federal crop subsidies provided farmers with increased incentives to convert wetlands for agricultural production.³²

The estimated amount of wood duck habitat destroyed by 1960 in each of the three flyways was: Mississippi flyway, 66.64 million acres; Atlantic flyway, 3.38 million acres; and Pacific flyway, 1.91 million acres.³³ When compared with the best estimate of the amount of pre-settlement wetlands in the lower 48 states (215 million acres, of which only a portion would have been suitable for wood ducks) the 71.93 million acres of wood duck habitat destroyed by 1960 is staggering.

Estimates of the amount of bottomland hardwood forest destroyed gives a more precise picture of the wood duck's habitat destruction. The destruction of this habitat type was especially pronounced, as it was often drained for agriculture or destroyed in flood control efforts. It has been roughly estimated that in pre-settlement times 67.2 million acres of forested wetlands existed in the lower 48 states. By the mid-1950s forested wetlands were reduced to 55.8 million acres. This trend continued apace, and in 1974, 49.7 million acres remained. During this time period (the mid-50s to mid-70s) 5.8 million acres of forested wetlands, 4.5 million acres in the Mississippi flyway alone, were lost to agricultural development.³⁴

The destruction of bottomlands in the Mississippi Delta (especially Arkansas, Louisiana and Mississippi) has been the most pronounced in the entire U.S. The 24 million acres of wetlands in this region is key habitat for the wood duck. It is both vital for breeding and the species' primary wintering area. Unfortunately, greater than 80 percent of this habitat has been destroyed, and the remaining 20 percent is under constant pressure.³⁵

By 1937, approximately 11.8 million acres of bottomland hardwood habitat remained in the lower Mississippi Delta. Of this, around 6.6 million acres had been destroyed by 1978, "concomitant with the incentive of federal water-development programs," according to Frank Bellrose. During this period the amount of land devoted to agriculture grew by 5 million acres, with much of this on extremely marginal (i.e. flood prone) lands.³⁶

After 1978 the destruction of bottomlands in the Mississippi Delta continued at a slower pace. By 1988, bottomlands had decreased from 5.2 million acres to 4.5 million acres.³⁷ Low commodity prices have provided incentives not to clear additional land, and the loss of bottomlands has largely been curtailed.³⁸

While this has given the wood duck some respite, the damage done by centuries of habitat destruction has taken a permanent toll. Yet many of the accounts and papers dealing with the conservation of the wood duck emphasize overhunting as the cause of the wood duck's decline and hunting restrictions as the most significant cause of its increase. They pay much less attention to the detrimental effect of habitat destruction, particularly by government programs, which after WWII was the greatest threat to the wood duck. There are several reasons why this is likely.

The extent of habitat destruction, particularly prior to the advent of major government-sponsored drainage and flood control projects, typically occurred on a more piecemeal basis and was not as easily identifiable. Also, many of the early observations of the wood duck's decline were by sportsmen and ornithologists who, while no doubt aware of habitat destruction in their region, would naturally be more attuned to the effects of hunting. In addition, as noted, these observers tended to be in those more peripheral areas of the wood duck's range where overhunting was a serious problem.

Another reason for the emphasis on hunting restrictions is that many of the people who have published papers and accounts on the wood duck are state and federal wildlife biologists for whom hunting restrictions are a major focus of their efforts. But micro-manipulations of season and bag limits, in response to perceived changes in year-to-year populations, do not address the larger and more significant problem of habitat loss. As with the regional bias that largely accounts for the mistaken perception that the wood duck was going extinct, much of the emphasis on overhunting as the cause of the wood duck's decline was certainly a function of the interests of those who conducted most of the research.

A final reason is that the terms and duration of legislation prohibiting wood duck hunting are widely known and easy to research, providing a much more easily identifiable reason for the wood duck's decline and subsequent increase. Season and bag limits, like prohibition, are easily implemented, and because they are formulated from data (albeit rather sparse and speculative) and mathematical models they have an aura of certainty and definiteness. By contrast, habitat loss is, by nature, dispersed and therefore much more difficult to get good data on and point to with much certainty. It is ironic that the federal government was touting the effectiveness of their season and bag limits while actively engaging in efforts that destroyed millions of acres of wood duck habitat.

Nest Boxes

Although hunting restrictions were vitally important for the wood duck, there was still a major population bottleneck due to habitat destruction. "Because of the drainage of swamps and the clearing of bottomland timber . . . the wood duck will never return to its pre-1900 abundance; breeding habitat destruction has been too enormous," stated Frank Bellrose.³⁹

Habitat destruction was also a more difficult problem to address than overhunting. Once habitat is destroyed and replaced by farms or flood control impoundments, for example, it is very difficult if not impossible to restore it. Trees large enough to have nesting cavities take many

years to mature. Red maples take around 40 years, aspen 50 years, black oak 60 to 70 years and northern hardwoods around 100 years.⁴⁰ As one can imagine, trees this old were increasingly scarce as habitat was destroyed, and the largest trees were usually the first to be cut for timber. Compounding this problem were the facts that suitable nesting cavities are naturally scarce, and of those cavities that are available only about one in four are actually used by wood ducks.⁴¹ Species of trees more likely to have cavities are more prevalent in the north than the south, and injured trees in the south heal more quickly, further reducing the chance they will develop suitable cavities.⁴² However, wood ducks are the only species of North American waterfowl known to raise two broods in one season, and they are much more likely to do this in the south where, due to the warmer climate, there is a longer nesting season.⁴³ Also, while upland forests contain more suitable cavities than bottomland forests, they tend to be farther from water.⁴⁴ The longer the journey to water the greater the risk for ducklings, as they have more of a chance of encountering predators.

Although the increase of wood ducks due to hunting prohibitions was readily apparent, as Bellrose observed, wood ducks nesting in the region of the Illinois River where he conducted his initial studies, "appeared to be approaching a saturation point in utilization of their nesting habitat; nests were found in cottage chimneys and in poorly situated natural cavities; one was found in an open-stick hawk nest. It was apparent that suitable nesting sites were in short supply."⁴⁵

Consequently, Bellrose and Arthur Hawkins, colleagues at the Illinois Natural History Survey, began a study of the wood duck's life history and nesting requirements, including examining the effectiveness of artificial nest houses to compensate for the lack of natural cavities.⁴⁶ "Obviously, with much of its original habitat destroyed . . . the species would never again be so numerous as formerly. But help with its housing problems seemed to offer a possibility for increasing or at least maintaining its numbers," noted Bellrose.⁴⁷

Hawkins and Bellrose's work grew out of an effort started in 1936 by the U.S. Biological Survey, the predecessor to the U.S. Fish and Wildlife Service. The USBS erected 486 houses made out of thick slab wood at the Chataqua National Wildlife Refuge near Havana, Illinois.⁴⁸ These slab boxes proved to be ineffective – fewer than 12 percent of them were occupied by wood ducks, and they suffered high rates of predation. Slab boxes were also problematic because they were very heavy and therefore difficult to affix to a tree ten-to-twenty feet off the ground. They were also not very sturdy. Two-thirds of the slab boxes in Chataqua National Wildlife Refuge fell apart after only five years.⁴⁹

It quickly became apparent to Hawkins and Bellrose that, due to the easily-identifiable problems with the boxes, a new and improved design was badly needed. The first prototype was a rectangular box made of rough-cut cypress lumber, with a round entrance and a removable lid for inspection. A few inches of sawdust were spread evenly over the bottom of the box to provide nesting material.⁵⁰

In early 1939 the Survey first tested these houses by installing about 450 of them in groups of ten to seventy around the state of Illinois. Two hundred fifty more were erected in

1940. While there is no published account on the location of these boxes, it is clear that many citizens were involved, as many of the boxes were placed on private land. Prior to the 1942 breeding season the U.S. Fish and Wildlife Service installed 400 boxes based on the new design at Chataqua National Wildlife Refuge.⁵¹

Preliminary observations were encouraging because wood ducks immediately used the boxes, but predation by raccoons and fox squirrels soon became a significant problem. Fox squirrels destroyed more nests, but raccoons were the leading predator of wood ducks. Raccoons not only killed one hen in every three nests they raided, but they also accounted for the destruction of more nests in the latter stages of incubation than any other predator.⁵²

To prevent this, Hawkins and Bellrose began to experiment with entrances of varying shapes and sizes in 1941. Around 1944, after many trials and errors, they discovered that a 4" by 3" elliptical entrance proved ideal because, by conforming to the hen wood duck's body shape, it allowed her to slip through but excluded the more round-shaped raccoon. This design proved extremely successful, and in six years of observations only once was a raccoon able to enter a box of this type, but this was because of an improperly cut entrance, not because the design concept was unsound.⁵³

Overall, nest boxes rapidly proved their worth, as the ducks' immediate, widespread use of them showed a significant latent demand for suitable nest sites. In seven years of observations (1939-1945), an average of 49 percent of the boxes were occupied and 36 percent had successful nests. These rates were roughly on par with those of natural cavities.⁵⁴ The willingness of wood ducks to accept artificial nest houses also demonstrated the species' adaptability, a trait that made the development of nest houses possible.

Building on their initial success, Hawkins and Bellrose continued their research and focused on improved ways to protect nest boxes from predators. A determined raccoon could still raid a nest box by gnawing at the entry hole until it was sufficiently large to permit it to squeeze through. In 1948 Hawkins and Bellrose addressed this problem by fortifying the entrance with a metal sheet, cut with the proper sized ellipse, placed over the round entrance.⁵⁵

Nest predation by fox squirrels proved to be the other main problem, accounting for 51 percent of nests destroyed between 1939 and 1945. Preventing this proved more difficult than predation due to raccoons because building an entrance that would have excluded fox squirrels also would have excluded hen wood ducks. Various designs were tried, but it was not until 1954 when, after seven years of experimenting, a final design had been settled on. It was a house made out of a galvanized tube of sheet metal with a conical metal roof, wood bottom and lined with a mixture of vermiculite and automobile undercoating to keep it cool and provide a rough surface for the ducklings so they could climb out. This proved to be the most predator-proof and durable nest house devised.⁵⁶

Over the years other innovations were made. A house that initially showed promise at preventing starlings from occupying nest boxes later had mixed success when tested by numerous different investigators.⁵⁷ Success has been had in preventing snakes from raiding nest

houses by wrapping the trees on which boxes hang with a piece of sheet metal several feet wide.⁵⁸ Another innovation was the placement of an inverted metal cone around poles on which nest boxes were mounted. When properly constructed, this successfully deterred raccoons and other predators.⁵⁹ In 1946 boxes were erected on poles placed in standing water, usually marshes or ponds. Not only were these boxes preferred by wood ducks but they proved very effective at preventing predation.⁶⁰

One of the findings that came out the research by Hawkins and Bellrose was that the overall value of boxes varied.⁶¹ In those houses that experienced high rates of predation, nesting success was a significant factor in determining nest usage the following year. Annual inspection to check if any of the houses needed repair or replacement and removing nests of squirrels, bees and other animals was required as well. Location also proved to be significant, as it played an important role in whether the nest boxes were safer than natural cavities. "Boxes located in areas of relatively high human activity were of the greatest value for wood ducks," noted Bellrose.⁶²

Wood ducks' ability to nest successfully in close proximity to people was also noted by some of the early published reports and studies. Prior to 1900 there were apparently few reports of wood ducks nesting in towns and villages. While this was surely due in part to the relatively few number of observers, it was also likely due to the large amounts of high-quality habitat that still existed. But in the mid 1900s, as wood duck habitat continued to be destroyed, there were an increasing number of reports of wood ducks nesting in trees located in parks, cemeteries, courtyards, and along roads close to water. One investigator queried hunters, scientists and river men as to why this was occurring. The answers ranged from the building of government dams, to the cutting of large soft-maples for the furniture trade, to increased predation.⁶³

Frederic Leopold, brother of the great American naturalist Aldo Leopold, was another early observer of the wood duck's increasing use of cavities in urbanized areas. Frederic lived in Burlington, Iowa, a town near the banks of the Mississippi River. It was in 1939 that the Illinois Natural History Survey, as part of Hawkins' and Bellrose's research, provided 50 nest boxes to the Crystal Lake Club, a private duck hunting club near Burlington. Leopold helped inspect the boxes for four years, but a low percentage of them were used due to predation.⁶⁴

In 1943 three of these boxes were moved to the yard of his house where he had seen a pair of wood ducks searching for a nest site. All three boxes were used that year, and in subsequent years Leopold increased the number of boxes until he had a total of 24.⁶⁵ His efforts proved highly successful.⁶⁶ As of 1988, over 80 percent of the eggs laid hatched. This is quite impressive when compared with the average rate of less than 50 percent in the wild. All told, around 6,000 ducklings left his boxes, and boxes put up by neighbors who followed his example produced hundreds more.⁶⁷ Nest predation was not much of a problem compared with more wild conditions, and Leopold believed that this accounted for the steady increase in the size of his nesting colony.⁶⁸

Hawkins and Bellrose continued their research, and while a large percentage of their boxes had been subject to predation the initial results were still encouraging. They concluded that "the provision of nesting boxes for this species appears to offer not only the best, but also the

only formula for prompt management, in habitats which, except for a scarcity of hollow trees, are suitable for breeding wood ducks."⁶⁹ Moreover, they noted that "many years would be required to increase substantially the number of natural cavities. Nesting boxes can be built quickly, easily, cheaply and in such a manner as to be acceptable to wood ducks."⁷⁰

Following the initial research by Bellrose and Hawkins, wildlife biologists around the country conducted numerous studies over the next twenty-five years to examine the effectiveness of nest boxes. Not all of these proved successful, as evidenced by efforts in the 1940s in Connecticut.⁷¹ Most studies, however, demonstrated the value of nest boxes for wood duck conservation.

In 1943, Charles McLaughlin and David Grice of the Massachusetts Division of Fisheries and Game started what would turn out to be one of the key studies of nest boxes. By 1951 Massachusetts state personnel, with the active involvement and help from sportsmen's clubs and wildlife enthusiasts, had put up nearly 2,000 boxes, and 4,000 military surplus ammunition boxes were converted for use to nest boxes and distributed to hunting clubs, conservation groups and individuals throughout the state.⁷² Given that almost all of the land in Massachusetts was privately owned, it is clear that the majority of the boxes were placed on private property.

McLaughlin and Grice were well aware of the need to garner public support for their efforts:

When the program first started there was no open season for the wood duck, and many sportsmen resented its completely protected status. Perpetual protection was not the answer.

It was then decided to take the program to the sportsmen's clubs and all conservation-minded groups and individuals throughout the state, and ask them to aid in the program by putting up nesting boxes in desirable sites in their locality. Because of the visual results obtainable in ducks and broods, the response to the program was heartening; and by tapping the energy and interests of several thousand sportsmen the results were spectacular.

People appreciate and care best for what they themselves produce. Sportsmen who have participated in the program and have a stake in the wood duck's future would be just as anxious as the division [of wildlife] to restrict the season if it should prove necessary.⁷³

The efforts of these sportsmen and others who helped with the nest box program is an example of the tremendous conservation ethic through voluntary cooperation and association that was so instrumental to the conservation of the wood duck.

Most studies of nest box usage were concentrated in the Atlantic and Mississippi flyways, which contained the vast majority of the wood duck's habitat. However, a 1954 study of 39 nest boxes in California's San Joaquin Valley found that a shortage of nest sites might be remedied by boxes that would not only increase the number of nest sites but also reduce dump nesting.⁷⁴ Dump nesting, when a multiple hens lay, or "dump," their eggs in a single nest, was sometimes an indication that there were insufficient nesting cavities.

There has been some concern by those in both the wildlife management and environmental communities that dump nesting can be detrimental to wood duck populations.⁷⁵ To alleviate dump nesting, it has been recommended that houses be out of sight of each other,

although it has been shown that less conspicuous houses suffer the drawback of being used less frequently.⁷⁶ Concerns about dump nesting are valid, but its effect on wood duck populations has been minimal.⁷⁷ While acknowledging that dump nesting can be detrimental in some situations, Bellrose and Dan Holm, co-authors of the definitive book on the wood duck, concluded that “overall dump nesting usually aids productivity.”⁷⁸

The first comprehensive overview of the wood duck’s status and conservation occurred at a national symposium in 1965. By this point it was clear that nest boxes had to be properly constructed and placed so as to exclude or discourage predators. Also noted was that, “In addition to the beneficial aspects of properly built and placed boxes, they serve as a means of stimulating interest among conservation-minded groups or individuals. However, large numbers of the houses must be placed out to attract and increase wood duck populations, and considerable time and expense would be involved in constructing, placing, checking, and cleaning the structures.”⁷⁹ A paper on nest boxes by F. C. McGilvrey of the U.S. Fish and Wildlife Service’s Patuxent Wildlife Research Center in Laurel, Maryland, and Frank Bellrose, stated: “Unquestionably, nest houses can increase local breeding populations of wood ducks.” They also noted that “a high rate of nest-house use indicates a high rate of nest success.”⁸⁰

From the start of research by Bellrose and Hawkins in the late 1930s, the use of nest boxes steadily increased. Bellrose estimated the following number of boxes:

	<u>Atlantic Flyway</u>	<u>Mississippi Flyway</u>
1942	442	4,187
1949-52	2,623	3,055
1980-84	35,670	58,192

According to Bellrose, “Although these inventories of nest boxes represent minimal numbers, they provide an approximation of the magnitude of this management endeavor. It is apparent that, up to the early 1950s, nest boxes played an insignificant role in the comeback of the wood duck; there were just too few boxes.”⁸¹

But by the early 1980s, there were enough boxes installed to influence the overall populations of the flyways. In 1988, at the second national wood duck symposium, Bellrose estimated that there were at least 100,000 nest boxes nationwide. Based on this estimate, nest boxes contribute at least 300,000 ducklings a year, and of these approximately 150,000 become part of the fall population east of the great plains.⁸²

Today, the actual number of nest boxes is likely to be two to three times Bellrose’s conservative estimate. According to Harvey Nelson of the Wood Duck Society, a private organization in the Twin Cities of Minnesota:

We do know that each year 2,500-3,000 nest boxes are added to those in place [in Minnesota], so the total number [in Minnesota] has to be in the tens of thousands. This is