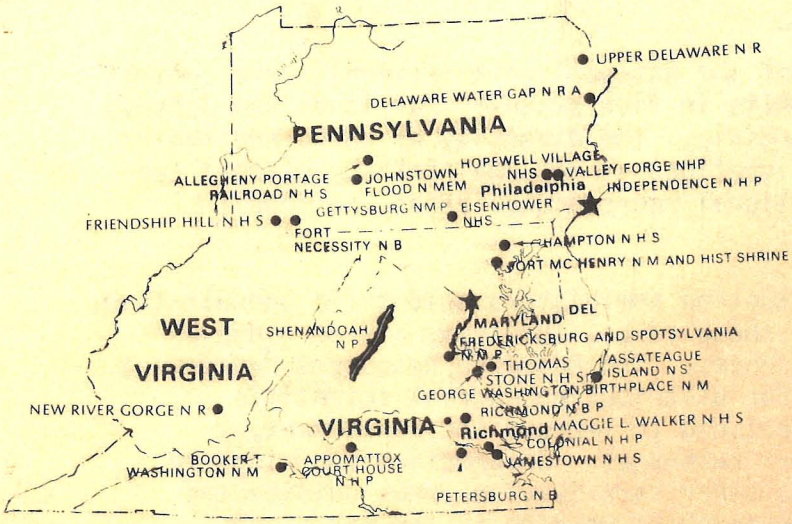

MID-ATLANTIC REGION

RESEARCH/RESOURCES MANAGEMENT REPORT

APPROPRIATE RIVER RECREATION USE STUDY

Identification and Preliminary Analysis of River Recreation Impacts on Fish and Wildlife:

Upper Delaware Scenic and Recreational River

U.S. DEPARTMENT OF THE INTERIOR

NATIONAL PARK SERVICE

MID-ATLANTIC REGIONAL OFFICE
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A report of the Ecological Impact Working Group,
Use Allocation Project, U.S.D.A. Forest Service, North
Central Forest Experiment Station, in cooperation with
the Mid-Atlantic Region, U.S.D.I. National Park Service

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November 1988

Abstract

The goal of this research project was to identify wildlife species on the Upper Delaware Scenic and Recreational River that are or might in the future be impacted by river recreation use. Telephone interviews with 20 people believed to be knowledgeable about wildlife on the river identified 11 potentially impacted species. A questionnaire was then sent to the experts to obtain more information on the nature and seriousness of the perceived impacts, behavior of recreationists causing the impacts, and possible strategies to reduce impacts. The survey also provided respondents the opportunity to add other species to the study list, and eight species were added.

While opinion among experts varied a great deal, there was greatest consensus and concern about impacts to rattlesnakes and bald eagles. Respondents concerned about rattlesnakes most often cited killing by recreationists as the major problem for this species. Several experts felt that recreational activities may alter bald eagle feeding behavior and may also prevent bald eagles from nesting on the river. Study respondents were about evenly divided on whether smallmouth bass, American shad, walleye, mallard, river otter, and blue-winged teal were or might in the future be adversely affected by recreational use. At least two respondents felt that the smallmouth bass and the rainbow trout were the most seriously impacted species. Most experts expressing an opinion felt that bobcats, woodcock, and great blue herons were not being significantly disturbed by river recreation use.

Respondents were not able to provide much detail on the specific location of the impacts or on management programs to reduce them. This likely reflects lack of knowledge about recreational use patterns, user characteristics, and the complex relationships between recreation use and impacts. Increased monitoring of recreational use patterns, species' populations, and species' distributions is needed. Species showing declines should be examined in more detail. The National Park Service should determine management objectives for these species, specify criteria defining unacceptable recreational impacts, and identify all factors contributing to the change in abundance.

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INTRODUCTION AND OBJECTIVES

Nonconsumptive uses of wildlife have increased dramatically in recent years, and research suggests that such values may outweigh direct consumptive values (Shaw and King 1980, Lyons 1982). Resource planners and managers in agencies such as the National Park Service must not only respond to the growing demands for wildlife study and observation, they must also assess the impacts of these and other recreational activities (rafting, camping, etc.) on wildlife and wildlife habitat.

Boyle and Samson (1983) recently published a bibliography with 536 references on the effects of nonconsumptive outdoor recreation on wildlife. In addition, bibliographies by Ream (1980) and Hall and Dearden (n.d.) contain many references dealing with such impacts. However, most of the cited papers are anecdotal in nature, while long-term, quantitative studies are rare (Boyle and Samson 1985). Only a relatively small proportion of the studies considered riverine wildlife species or habitats. There have apparently been almost no studies of recreational impacts on wildlife on National Park Service rivers in the eastern United States. Dawson et al. (1981) found no specific data on recreation impacts to fish and wildlife on the Upper Delaware Scenic and Recreational River. Managers of New River Gorge National River and the Delaware Water Gap National Recreation Area know of no such study in their areas.

The few studies dealing with recreational impacts in riverine environments have indicated that wildlife impacts may occur along high

use rivers. Boating has caused waterfowl and bald eagle behavioral changes and movements to less disturbed areas on the Mississippi, Skagit, and Nooksack rivers (Thornburg 1973, Batten 1977, Knight and Knight 1984, Stalmaster and Newmann 1978). Camping along rivers can reduce habitat diversity by trampling of vegetation and compaction of soil (Liddle 1975). This can increase the numbers of some common or widespread wildlife species, but reduce the overall number of species and diversity of wildlife (Garton et al. 1977, Guth 1978). Visits by recreationists to passerine and waterfowl nests can increase nest losses to predators (Dwernychuk and Boag 1972, Bart 1977, and Lenington 1979). Colonially nesting birds are particularly vulnerable, and disturbance by recreationists can cause nest abandonment (Hunt 1972, Ellison and Cleary 1978), trampling of nests (Johnson and Sloan 1976), intraspecific predation (Hand 1980), and interspecific predation (Schreiber and Risebrough 1972, Anderson and Keith 1980).

Wildlife observers and photographers seek out and approach wildlife, especially rare or unusual species. Ospreys and eagles are a favorite target on and along rivers. Research on the impacts of such activities has produced mixed results. Some indicate little impact due to human intrusion (Ames and Mersereau 1964, Schroeder 1972, French and Koplin 1977), while others suggest that human disturbance may significantly impact reproductive success (Garber 1972, Swenson 1979).

Rock climbers on cliffs in riverine environments may disturb nesting raptors (Olsen and Olsen 1980) and other cliff-dwelling

species. Disturbance of even one nesting pair of rare or sensitive species, such as the peregrine falcon, may be unacceptable.

Finally, Marnell et al. (1978) have reported concern among river managers in the Ozarks that canoeists were disturbing stream substrates near beaches and popular camping spots. This may be reducing or locally eliminating such benthic invertebrates as mayflies and stoneflies. Also, this Ozark research indicates that recreational watercraft disrupted the nest guarding behavior of male longear sunfish and caused temporary nest abandonment. This appeared to result in increased nest predation.

The research presented here had two broad goals: (1) to determine if knowledgeable individuals felt that recreation was affecting fish and wildlife on the Upper Delaware Scenic and Recreational River; and (2) to use information acquired in this manner to suggest strategies managers might use to lessen such impacts. More specific objectives are:

1. To identify fish and wildlife on the study river that appear to be currently impacted by river recreation. Particular attention will be given to sensitive, rare, and endangered species.
2. To estimate the kind, extent, and severity of current recreation impacts upon fish and wildlife.
3. To identify fish and wildlife that will likely be impacted if river recreation use continues to grow.

4. To identify critical fish and wildlife habitat that is or will likely be impacted by river recreation use.
5. To identify the river use or user characteristics that appear to cause the fish and wildlife impacts.
6. Where possible, to suggest management programs to both reduce fish and wildlife impacts and maintain high quality river recreation experiences.
7. Where possible, to suggest a program of research to gain information to reduce critical impact problems.

PROCEDURES

Two strategies were used to identify and gain understanding of the impacts of recreationists on wildlife within the Upper Delaware Scenic and Recreational River. The first was to obtain lists of the fish, birds, and mammals of the river from area managers, area wildlife inventories, and state lists. A general literature review was then completed to document studies of recreational impacts on these species and their habitats.

The second strategy was more focused. We identified and questioned area managers, scientists, and other people knowledgeable about Upper Delaware wildlife to obtain their opinions on the amount, type, location, and severity of recreational impacts on wildlife and wildlife habitat. This was done in a two-step process. First, we asked the area's resource management specialist to suggest the names of people knowledgeable about the river. We interviewed these individuals

by phone to obtain preliminary lists of possibly impacted species, reasons for the impacts, and names of other individuals believed to be knowledgeable about the subject matter. These individuals were then telephoned to obtain their views, and they too were asked to provide additional names. This iterative process continued until the same names kept reappearing. Twenty "experts" were thus identified for the Upper Delaware (Appendix A).

We then developed a questionnaire to obtain additional information from the study participants. The survey form (Appendix B) requested opinions on (1) wildlife species currently impacted or likely to be impacted in the future by river recreationists; (2) the seriousness of such impacts; (3) the nature, location, time and consequences of the impacts; (4) the recreationists' characteristics or behavior causing the impacts; (5) possible means to reduce the impacts; (6) and the existence and severity of detrimental alteration of wildlife habitat. After a postcard reminder and two questionnaire follow-ups, 18 of the 20 experts (90%) returned a completed survey.

Data were gathered to identify recreational impacts by asking our respondents to describe in their own words the impacts they believed were occurring, where and when the problems were occurring, and the consequences of the impacts to the wildlife species in question. Data were summarized for those species most frequently believed to be receiving serious impacts and for sensitive species.

LITERATURE REVIEW

The literature review on documented impacts of recreationists to wildlife species found on the New River was obtained through standard library searches of books and periodicals and resource agency research project reports. Few studies of recreational impacts were found, even though the literature review was not limited to studies of the Delaware River or even rivers in general.

BLACK BEAR

The primary recreational impact on black bears (Ursus americanus) appears to be habituation to unnatural food supplies associated with recreational use (Hammitt and Cole 1987). Artificial food sources have lead to concentrations of bears in areas which would not ordinarily support such populations (Zardus and Parsons 1980). In the 1960's Yellowstone National Park had two separate bear populations. One population utilized backcountry areas and the other roadside areas (Barnes 1967, Bray 1967). The most important component of the roadside bear population's diet was artificial food. In Kings Canyon and Sequoia National Parks, availability of unnatural food supplies has been identified as the cause of increased bear/human conflicts. (Zardus and Parsons 1980).

In Yosemite, bear/human interactions have resulted in changes in bear behavior, foraging habits, distribution, and population levels (Keay and Van Wagtendonk 1983). While studying radio collared black bear in Idaho, Amstrup and Beecham (1976) found that alterations in

bear behavior induced by human disturbance was only short lived. In the Great Smoky Mountains National Park, bear activity on a park wide scale seemed to be independent of visitor use (Pelton 1972). However, density of bears in local areas appeared to be influenced by people.

Manville (1980) felt that human activity near bear dens in the winter could have a negative impact. Bears in the lower Michigan peninsula fled dens during 49 % of his attempted approaches, 82 % fleeing while he was still 70 - 125 m from the den. However, a female used a den which was only 70 m from a snowmobile trail, even though the trail was actively used all winter. A second female denned 90 m from a snowmobile trail, abandoning it only after researchers attempted to anesthetize her. In Shenandoah National Park, six females utilized ground dens within 30 m of heavily used foot trails (Carney 1985). Similar, unused den sites were available at distances farther from the trails. Three of these females successfully raised cubs. Visitor use appeared to cause den abandonment in only one instance. This den was only 10 m from a popular overlook. In Pennsylvania, a female black bear with two newborn cubs was found denning in a drainage pipe under Interstate 84 (Alt 1983).

In Great Smoky Mountains National Park, black bears used areas around limited access roads and frequently crossed them (Carr and Pelton 1984). However, in some areas roads appear to influence bear movement. Male black bears in Shenandoah National Park avoided light duty roads, primary roads, and fire roads (Garner 1986). Abandoned roads and jeep trails received little use. Female bears seemed to

prefer fire roads, but avoided light duty and primary roads. Black bears in Maine avoided major highways (Hugie 1982). While these highways were not absolute barriers to movements, they were found to restrict bear movements.

WHITETAIL DEER

Disturbance of whitetail deer (Odocoileus virginanus) during winter may lead to behavior which is inconsistent with energy conserving adaptations (Moen 1976). Possible consequences of recreational harassment to deer include:

1. Increased metabolism which leads to increased energy demands
2. Death, illness, or decreased productivity
3. Displacement
4. Avoidance or abandonment of specific areas
5. Inefficient foraging patterns (Geist 1978).

Research has centered on the impacts of snowmobiles. However Eckstein et al. (1979) noted that deer in Minnesota appeared to react more to a walking person than a snowmobile, and Behrend and Lubeck (1968) observed that deer in the Adirondacks were more sensitive to approach by vehicle than by canoe.

Several studies have addressed the impact of snowmobiling on whitetail deer. Deer in Minnesota reacted to low intensities of vehicular traffic (Dorrance et al. 1975). Displacement occurred in

areas adjacent to snowmobile trails. Furthermore, deer movement increased when snowmobiles were in use. Dorrance et al. (1975) found no significant difference between home range sizes when comparing an area with snowmobile use to one without snowmobile use, but did note a trend toward larger home range sizes in the area with snowmobile use. Some deer completely changed the location of home ranges when their original home ranges were subject to intrusion by men and vehicles. However, deer may change winter home ranges even in the absence of snowmobile use (Bollinger et al. 1973).

In Minnesota, deer home range size and habitat use did not differ significantly between areas with and without snowmobile use (Eckstein et al. 1979). Snowmobiling did cause some deer to leave the immediate vicinity of snowmobile trails, but snowmobile use appeared to have little impact on daily activity patterns of deer. Deer were most affected when within 61 m of a snowmobile trail. In Maine, snowmobiling did not cause deer to desert preferred bedding areas and feeding sites (Richens and Lavigne 1978). Deer fed along snowmobile trails even when the trails were used by snowmobilers several times a day. Deer were also found to use snowmobile trails as paths between deer trails, especially as the severity of the weather increased. Richard and Lavigne (1978) considered this to be a beneficial impact since snowmobile trails were more compacted and reduced energy expenditure.

Some researchers suggest that deer might become accustomed to disturbance through prolonged exposure (Behrend and Lubeck 1968,

Dorrance et al. 1975, Richens and Lavigne 1978). However, Moen (1982) deer may react to snowmobiles without changing observable behavior (Moen 1982). For example, Moen reported that heart rates of captive deer exposed to snowmobiles averaged 2.5 to 2.9 times greater than predisturbance rates, and found no evidence of habituation in this type of response.

RIVER OTTER

Otters (Lutra spp.) appear to show a high degree of tolerance to human activity providing there is sufficient food and escape cover (Melquist and Hornocker 1983, Mason and Macdonald 1986). Otter sign has been located in the cities of Glasgow and Aberdeen (Mason and Macdonald 1986). In Idaho, several otter were frequently found on a river within the McCall city limits (Melquist and Hornocker 1983). The lake most frequently used by otter in the study by Melquist and Hornocker was also one of the most popular recreational lakes in the valley. In Portugal, washing and bathing activities and riverside gypsy camps did not alter otter distribution (Mason and Macdonald 1986).

INDIANA BAT

Indiana bat (Myotis sodalis) populations have declined in recent years (Humphrey 1978). The decline has been attributed to a variety of factors including destruction of summer and winter habitat, pesticides, and disturbance by biologists and amateur speliologists (Humphrey 1978, Greenhall 1973). Since 87 % of all known Indiana bats

hibernate in only seven caves, human disturbance of bats in winter hibernacula is of particular concern (Humphrey 1978). Vandalism is partially responsible for the problem. For example, in 1961, 10,000 bats were stoned or torched in Carter Caves State Park, Kentucky (Humphrey 1978). Mohr (1977) believed that 20 years of commercial cave and amateur spelunker traffic caused three bat populations in Pennsylvania to abandon their winter hibernacula. At Carter Caves State Park in Kentucky, a population decline of 60,000 between 1955 and 1975 has been attributed to disturbance by park visitors (including vandals and park organized tours) and biologists (Humphrey 1978).

Even mild light and sound stimuli are sufficient to arouse bats during winter hibernation (Humphrey 1978). Heat produced by humans under bat clusters on low ceilings may cause arousal and flight. When disturbed, bats may not recluster for 30-60 minutes. Repeated disturbance during a winter may result in malnourished bats and higher than normal spring mortality.

Little is known about the summer activities of this bat; however it appears to be restricted to riparian forests during the summer (Cope 1978). Loss of this type of habitat through channelization of streams and construction of reservoirs is considered to be the major human/bat conflict during this time of year.

OTHER MAMMALS

Research concerning recreational impacts to small and medium sized mammals has dealt mainly with impacts at campgrounds and impacts

by off road vehicles. Deer mice (Peromycus maniculatus) in Yosemite showed increased populations at campgrounds (Foin et al. 1977). Aitchison et al. (1977) found that the populations of skunks, rock squirrels, ringtail cats, and mule deer had increased as a result of artificial food supply associated with recreation use of the Colorado River. Clevenger and Workman (1977) concluded that generalists (e.g. deer mice and woodrats (Neotoma spp.) may be found in higher densities in campgrounds due to their ability to capitalize on the new food source. On the other hand, specialists with limited dietary adaptability do not exhibit higher densities in campgrounds.

In addition to providing alternative food sources, recreational use of campgrounds may affect small mammals indirectly through alteration of the habitat. Clevenger and Workman (1977) believed that reduced ground cover caused by heavy recreationtal use resulted in increased predation of small mammals at study sites in Utah.

Snowmobiles have a negative impact on subnivean mammals through compaction of snow. Compaction can form a mechanical barrier which inhibits movement (Bury et al. 1976). Compaction along snowmobile trails also resulted in abnormally cold temperature in subnivean habitat (Neumann and Merriam 1972). As an example of the seriousness of this impact, Neumann and Merriam stated that for a 20 gram shrew (Blarina brevicauda), a 3 degree celsius drop in temperature, would increase metabolic demands by 25 calories per hour. Data collected by Neumann and Merriam in Ontario also indicated that snowshoe hare (Lepus americanus) avoided snowmobile trails, while red fox (Vulpes

vulpes) activity was greater near trails. The increase in fox activity is believed to result from increased mobility along snowmobile trails.

OSPREY

Research concerning recreational impacts to osprey (Pandion haliaetus) has produced conflicting results. Swenson (1979) found lower osprey reproduction at Yellowstone Lake than along streams in Yellowstone National Park. The major problem was low hatching of eggs, which he attributed to higher incidence of human disturbance occurring at Yellowstone Lake. Nests more than one km from campsites were more successful than those closer to campsites. Boating seemed to have less of an impact on nesting success than activities occurring along the shoreline. Garber (1972) reported that 36% of osprey egg and nestling loss in 15 California nests were caused by human disturbance. Campers parked near one nest caused the adults to desert it, despite the fact that it contained eggs.

At Eagle Lake in Lassen National Forest, moderate losses due to human disturbances occurred during incubation (Kahl 1972). Four eggs in one nest were lost when the adults were prevented from incubating for two days by a group camped near the nest. Eleven birds were frightened from nests during fledgling counts, apparently flying for the first time. Some losses occurred when fledgings were forced from nests before they were ready for flight. Reese (1977) stated that human disturbance of incubating or brooding birds may be the most important

factor influencing the nesting success of osprey in the central Chesapeake Bay area.

On the other hand, Ames and Mesereau (1964) did not believe that human disturbance was a major factor in the low hatching rates of nests observed in Connecticut. Fifteen of 19 young hatched on Great Island from 1960 to 1963 were in nests frequently visited by boaters and fishermen. Furthermore, a greater number of inland nests (which received less visitation) showed low hatchability. However, two nests were deserted in 1960 due to the repeated presence of picnickers which prevented the birds from incubating, and speeding motorboats were found to cause the loss of several eggs from ground nests. These eggs were damaged because birds left the nest directly from the incubation position. French and Koplin (1977) found no evidence that camping, fishing, swimming, or sightseeing had negative impacts on nesting success of osprey in northwestern California. One nest was in a 76 m redwood in a median between lanes of US highway 101. A second nest was located in a 70 m redwood 6 m from an off ramp of the same highway.

Young were successfully hatched from two osprey nests in Idaho despite frequent occurrence of recreational boating (Schroeder 1972). Schroeder concluded that human disturbance was not seriously impacting overall osprey reproductive success despite occasional failures due to human disturbance. Poole (1981) found equivalent reproductive rates when comparing isolated nests to nests exposed to continuous activity. He found no evidence to suggest that trapping breeding adults, research activities, or other human activities caused adverse affects, although

he noted that climbing nest trees may have attracted raccoons and resulted in a greater incidence of predation.

Swenson (1979) suggested that one possible explanation for the mixed findings may be due to differences in both the timing of disturbance and the degree of habituation of the osprey involved. For example, where human use is already present when ospreys initiate nests, birds may be more tolerant of human activity.

BALD EAGLE

Research regarding the impacts of recreationists on bald eagles (Haliaeetus leucocephalus) has also produced mixed results. In Arizona, hiking and climbing activities near nests were found to cause a high level of disturbance (U.S. Fish and Wildlife Service 1976). Four nests were thought to be abandoned as a result of these activities, but river floating was not observed to create much disturbance. However, recent studies at Jordan Lake, North Carolina show that boaters have altered eagles' habitat use patterns (Fraser unpublished).

Fraser et al. (1985) found no evidence that human activities had a negative impact on the reproductive success of eagles on the Chippewa National Forest in Minnesota. Frequency of human activity within 500 m of nests did not differ significantly between successful and unsuccessful nests. Brooding and incubating eagles were not flushed from nests by aircraft flying 20 - 200 m above the nest. Banding did not reduce the probability of successful nesting during the subsequent year. However, the Minnesota study suggested that eagles avoided areas

of frequent human use when building new nests. During tests of intentionally induced disturbance, eagles flushed from nests at greater distances upon repeated approaches, suggesting that eagles did not habituate to human activity. On the other hand, eagles on San Juan Island, Washington were less easily flushed from nests when exposed to humans for prolonged periods (Retfalvi 1965).

In Florida, production of young appeared to be independent of human activity (McEwan and Hirth 1979). Grier (1969) reported that nest censusing in Ontario, either from a distance or by climbing, did not cause a significant reduction in productivity. Mathisen (1968) worked in Minnesota and found no difference in nest occupancy or nest success between nests in areas reflecting different levels of isolation. He also noted several cases where human activity was frequent around nest sites, but did not cause less than average occupancy or success rates. Mathisen suggested that human disturbance did not have an impact on reproductive success in his study because most human disturbance occurred late in the nesting cycle when the young were half grown.

The effects of human disturbance on wintering bald eagles have also been examined. In South Dakota, as many as 20 eagles at a time used a perch that was only 34 m from a road averaging 80 cars per day (Steenhof 1978). However, during periods of boating activity, eagles avoided a river section which had nine wintering sites. Wintering eagles on the Skagit River, Washington utilized areas with little human use first, moving into areas with more human activity only when food became less available (Servheen 1975). Ingram (1965) reported that

boating and snowmobiling were serious disturbing influences to wintering eagles in Iowa and Wisconsin.

Stalmaster and Newman (1978) reported that the mere presence of humans disrupted eagle feeding activity on the Nooksack River, Washington. Once disturbed, eagles would not return until several hours after the disturbance ended. Overall, adults were more sensitive than immature birds. Eagles were more tolerant of disturbances when the source of the disturbance was obscured from view. Activities which occurred directly on the river channel (e.g. boating and fishing) were most disturbing if the activities did not occur regularly in that area, suggesting that eagles might become habituated to prolonged use. Knight and Knight (1984) studied the responses of wintering eagles to boats on two rivers in Washington. Eagles flushed less frequently on a river which received heavier use, and there was a decreasing tendency to flush as winter progressed, suggesting habituation. However, the eagles may have been responding to decreased food abundancy rather than disturbance.

TURKEY VULTURE

Coleman (1985) studied turkey vultures (Cathartes aura) in Gettysburg National Military Park. He reported that these birds apparently were not disturbed by moving vehicles, but were often flushed from roosts when cars stopped or people approached on foot. He felt that birds avoided roost trees in one area during the summer due to high levels of human activity. Coleman suggested that frequent

human visitation of potential nesting caves in one area may have discouraged vultures from nesting.

TURKEY

Lindzey (1967) believed that heavy recreational use was not compatible with turkey (Meleagris gallopavo) management and that even light use may cause nest abandonment. During a study of nesting turkeys in Florida, 11 of 64 hens were flushed when investigators discovered the nest, resulting in seven nest abandonments (Williams et al. 1971). Hens only flushed from nest when investigators were within 8 feet (2.4 m), and since turkeys prefer to nest in brushy areas, Williams (1981) suggested that this type of disturbance may not be important where high quality nesting habitat is available. Some hens were flushed repeatedly without causing them to desert nests. On 20 occasions, research investigators frightened hens away while they were returning to the nest, but this did not result in any nest abandonments.

At Land Between the Lakes, Kentucky, no turkeys were found to inhabit areas closer than one km to active campgrounds, although one adult utilized a campground when it was closed in the winter (Wright and Speake 1975). In 1973, a new trail was opened in an area which had a high turkey population the previous year. The trail was used by 100 visitors per week in 1973 and 125 people per week in 1974. Suitable habitat along the trail was searched for turkeys and turkey sign in 1973 and 1974. In 1973, only one turkey was observed and no turkey sign

was located; while in 1974, no turkeys or evidence that turkeys were present were ever observed. On the other hand, turkeys and fresh turkey sign were always observed on control areas, suggesting that hiking trails and associated human disturbance may reduce the amount of available turkey habitat.

However, turkey populations can be established in agricultural areas which have only 25-30% forest cover and which receive considerable human activity (Wunz 1985). One wild trapped and released turkey population in Pennsylvania has been self-sustaining for 14 years in an area where road density is 2 km/square km and human density is 67 people/square km. However, Wunz described another area where turkeys avoided open forests and sought brushy areas to avoid human contact. This was thought to result in greater predation. Wunz (1971) stated that hikers also used the brushy areas (up to two per hour), but the dense cover reduced the likelihood of visual contact.

Disturbance is thought to have caused turkeys to increase their home range size or abandon their territories in some areas. Wheeler (1948) believed that frequent disturbance caused turkeys in Alabama to abandon one area. Mosby and Handley (1943) suggested that turkeys exposed to continuous disturbance have larger home range requirements than turkeys in undisturbed areas. Bowman et al. (1979) suggested that unusually extensive fall movement of two radio collared hens in North Carolina was caused by disturbance by deer hunters.

However, turkeys in Florida did not desert home ranges as a result of hunting, even though 80% of the population was harvested

annually. He also reported that normal hunting, logging, and agricultural activities did not cause turkeys to abandon home ranges. In Georgia, movement and behavior of turkeys did not appear to be affected in areas used by deer hunters even though hunter densities reached 17.1 hunters/km (Folk and Marchinton 1980). Everett et al. (1978) reported that deer hunter densities of 1 hunter/42 ha caused only minor turkey movements and did not result in movement out of established ranges.

Two studies have examined the effects of off-road vehicles on turkeys. Wright and Speake (1975) reported that a flock of 3 hens and 24 poults abandoned their initial brooding area and moved 3.2 km after being disturbed by ORVs at least twice in one week at Land Between the Lakes in Kentucky. However, male turkeys intentionally harassed by motorcycles on several occasions did not abandon their summer range. Turkey observations and track counts in Pennsylvania revealed that turkeys avoided areas receiving high levels of snowmobile use (Hayden 1972).

Turkeys may avoid larger roads. Adams and Geis (1981) found no turkey sign within 400 m of interstate highways and county roads. In a study in West Virginia, only 1% of all turkey sign along a new four lane highway was closer than 160 m to the road (Michael 1978). However, infrequently used forest roads may be beneficial to turkeys. Turkeys may use these roads for loafing, as a source of heat on cold days, as feeding areas, as strutting areas, or as a source of grit (Mosby and Handley 1943, McDougal 1986). Turkeys have also been found nesting

within 50 ft (15 m) of roads receiving only light traffic (Williams 1981).

WOOD DUCK

Wood ducks (Aix sponsa) in Missouri were sensitive to disturbance by fishermen (Hartman 1972). Disturbance appeared to be related to the amount of noise. Birds were frightened by boats making loud noises at distances of approximately 137 m. During one observation of a silent canoe approach, a pair allowed a canoe to approach within 47 m before moving. Hens were much more tolerant during incubation, often allowing boats to approach within a few meters before flushing. However, Hartman observed an increase in nest abandonments in popular fishing areas and on Easter and Memorial Day weekends. This may have been caused by vandalism and intentional disturbance. Fishermen were seen striking nest boxes with oars and fishing poles and one clutch is known to have been taken by humans. If hens were disturbed while calling young from the nest, they would lead the brood away from the area, deserting any chicks which remained in the box. Chicks abandoned in this manner either perished in the box or were forced to survive without the hen's protection.

HERON

Human disturbance of great blue heron (Ardea herodias) nesting colonies has been cited as a major problem in Alberta (Markham and Brechtel 1978). Harassment has resulted in increased nestling

mortality, abandonment of nests, and even abandonment of colonies. Taylor and Michael (1971) observed complete reproductive failure in a little blue heron (Florida caerulea)/green heron (Butorides striatus)/common egret (Casmerodius albus) colony in Texas. The failure was due primarily to predation, which the investigators believed was enhanced by human activity in the colony. In Quebec, Tremblay and Ellison (1979) found that visitation of black-crowned hight heron (Nycticorax nycticorax) colonies caused nest abandonment and increased egg predation. Early visits to colonies inhibited laying, and frequent visits apparently discouraged late nesting birds from attempting to nest. However, in successful nests initiated early in the season, clutch size and fledging success did not differ between frequently (10 - 15 visits) and infrequently (2 visits) disturbed colonies.

Human activity has also been found to disturb feeding herons. Snowy egret (Egretta thula) and little blue heron nestlings in Florida regurgitated their last meal when disturbed by investigators (Jenni 1969). Green heron use of the main river channel in Ozark National Scenic Waterway for feeding decreased as human use increased (Kaiser and Fritzell 1984). The length of foraging bouts were also reduced during periods of high human use.

RAVEN

Two studies suggest that ravens (Corvus corax) can successfully nest in proximity to humans. Craighead and Mindell (1981) found four successful nests within 0.5 km of houses in Wyoming. Three of these

nests were also within 100 m of a paved road. In a Virginia study, successful nesting attempts were typically closer to roads and dwellings than unsuccessful nests (Hooper 1977). Successful nests less than 0.4 km from roads averaged more fledglings than nests farther away.

Hooper also reported that four young ravens successfully fledged from one nest, even though a researcher had rappelled to it once a week during incubation. The nest had also been successful the previous year when a researcher had rappelled to it one time. However, the nesting site was not used during the next two years even though a pair of ravens was seen in the area.

OTHER BIRDS

While studying canada geese (Branta canadensis), brant (Branta bernicla), and other birds in Alaska, Mickelson (1975) observed temporary nest abandonment caused by human presence and the sounds of boats, resulting in increased exposure to predators. He estimated that losses to avian predators doubled when a researcher was present. Common golden eyes (Bucephala clangula) in Cannock Reservoir, England were disturbed by sail boats, power boats, and shoreline activity (Hume 1976). Sailboats caused flight when birds were approached within 350 - 500 m. One powerboat was observed to cause flight while still 550 m from the flock. Birds often took flight when people on the shoreline were closer than 100 - 200 m.

Human disturbance has been observed to cause reduced reproductive success in gulls. Ringbilled gull (Larus delawarensis) reproductive success averaged 60% higher in minimally disturbed colonies compared to colonies which were severely disturbed (Fetterlof 1981). Hunt (1972) found that the amount of disturbance by picnickers was inversely related to hatching success in herring gull (Larus argentatus) colonies in Maine. The picnickers caused gulls to leave eggs exposed to the sun until addled. Fetterlof (1978) reported that researcher disturbance was the major cause of egg loss in his study of herring gulls.

Portnoy (1974) reported that red shouldered hawks (Buteo lineatus) abandoned four nests when disturbed by humans during incubation. Craighead and Mindell (1981) believed that increasing human disturbance had a role in decreasing raptor populations in the Jackson Hole area. In 1975, three red tailed hawk nesting attempts within 0.6 km of houses or paved roads failed.

Owen and Morgan (1975) examined the impact of night lighting and banding operations on American woodcock (Philohela minor) in Maine. No increase in predation was observed as a result of these activities, and birds remained in the same vicinity after the disturbance. However, birds avoided the site of disturbance for at least a week.

Nest record data for robins (Turdus migratorius), redwing blackbirds (Agelaius phoeniceus), mourning doves (Zenaida macroura), and eastern bluebirds (Sialia sialis) indicated higher nest loss on the first day after a visit during the egg laying period than on subsequent days (Bart 1977). Data on barn swallows (Hirundo rustica)

did not exhibit this trend. During the incubation period loss rate increased on the first day after visitation for robins and bluebirds (data for other species was not available). During the nestling phase, mourning doves showed an increase in mortality on the first day after visitation (data for other species was not available). Bart concluded that the increase in mortality was caused by humans leading predators to the nest site.

Reviewing 12 studies on redwing blackbirds nesting in marshes, Lenington (1979) found that nesting success declined an average of 22.9% after the first year of study. He attributed this decline to researchers leading predators to nests. Lenington's review of five studies in upland sites yielded mixed results. Predation increased in two studies, but decreased in three. Around six lakes in Ontario, Robertson and Flood (1980) found eastern kingbirds (Tyrannus tyrannus) had reduced nesting success in areas which received recreational use along the shoreline. They believed that recreational use attracted raccoons and resulted in increased nest predation.

FISH

Impacts of recreational use on fish populations are poorly documented. Most impacts are thought to be indirect effects such as eutrophication, increased turbidity, and mechanical disturbance of vegetation (Hammitt and Cole 1987). Lagler et al. (1950) concluded that prolonged use of outboard motor boats on experimental ponds did not affect fish production or fishing success. Mueller (1980) found that

longear sunfish (Leponis megalotus) in the Ozark National Scenic Riverways were often chased from their nests when paddled and motor driven canoes were driven near nests (0 - 4.5 m) at slow speeds (1 m/sec). This increased the potential for nest predation. Canoes moving at fast speeds (5 m/sec) or at greater distances rarely caused nest abandonment. High speed passes did increase turbidity and could possibly increase nest predator success.

RESULTS

QUESTIONNAIRE RESPONSE

List of Impacted Species

During telephone interviews the wildlife experts identified 11 species as currently or likely in the future to be subject to river recreation impacts: rattlesnake, bald eagle, smallmouth bass, American shad, walleye, great blue heron, mallard, otter, blue-winged teal, bobcat, and woodcock (Table 1). These 11 species were listed in a questionnaire which was mailed to the twenty experts for further evaluation of impacts.

A clear majority of experts expressing an opinion felt that the rattlesnake and bald eagle are currently or will likely in the future be impacted by recreational use of the area (Table 1). Most experts expressing an opinion felt that the woodcock, bobcat, and great blue heron are not likely to be impacted by recreational use of the area. The respondents were approximately evenly divided over whether the remaining species (i.e. smallmouth bass, American shad, walleye,

mallard, otter, and blue-winged teal) are or might be adversely affected by recreational use.

The questionnaire also provided space for respondents to add species to the list (species which they felt were now or might in the future be impacted by recreationists but which they forgot to mention in the phone interviews). Eight species were added: brown trout, rainbow trout, turkey, common merganser, black bear, green heron, kingfisher, and osprey (Table 2). Brown and rainbow trout were added to the list by six respondents. Two people listed the turkey and common merganser, and one each added the black bear, green heron, kingfisher, and osprey to our list.

Smallmouth bass and brown trout were most frequently cited as one of the three most seriously impacted species at this time (Table 3). The rattlesnake, receiving three votes, was most frequently cited as receiving the most serious impact at the present time (Table 3). The bald eagle, smallmouth bass, and rainbow trout each received two votes for being the most seriously impacted species. Additionally, American shad, great blue heron, otter, and brown trout each received one vote as the most seriously impacted species at the current time. When concerns about future impacts were combined with perceived present impacts, rattlesnakes and bald eagles received the most votes.

Of the wildlife species listed by our experts, the bald eagle has federal and state (New York) endangered status. The New York Department of Environmental Conservation lists the timber rattlesnake

and osprey as threatened. Special attention will be given to these species in the discussion below.

Description of Impacts by Species

Our study participants identified 19 species that may be receiving impacts from river recreationists. We used four criteria to select study species for further discussion of impacts and possible management or research needs: (1) the species was listed as receiving current or future impacts by more than half of our respondents who had an opinion (rattlesnake, bald eagle, smallmouth bass), (2) the species was listed as the most seriously impacted species by at least two respondents (rattlesnake, bald eagle, smallmouth bass, rainbow trout), (3) the species was listed as one of the three most seriously impacted species at this time by at least three study participants (brown trout, American shad, walleye), or (4) the species occurred on state or federal threatened and endangered species lists (bald eagle, timber rattlesnake, osprey).

Rattlesnake

All six respondents who listed rattlesnakes as one of the three most seriously impacted species, now or in the future, felt destruction of snakes by recreationists was the primary impact. Additionally, one respondent noted a problem with the amount of illegal collection. These impacts were thought to be occurring primarily during the summer, although two of the respondents listed the entire period from spring

through summer. Most respondents felt these impacts are causing declining populations, while one respondent felt the entire population is in danger of being eliminated. Another respondent was concerned about the potential for human injury.

Two respondents offered only a general location for these impacts. One stated that impacts are occurring riverwide, while the second said any potential denning area is subject to exploitation. A third gave detailed locations (Figure 1). Most respondents suggested that all recreationists are equally likely to kill rattlesnakes because of fear and ignorance. One believed that some recreationists intentionally tried to locate and kill snakes if they were aware that snakes inhabited a certain area.

All respondents suggested public education as a way to solve this problem. One suggested that trails be routed to avoid snake habitat. He also felt that trail brochures should contain a section informing hikers about the protected status of the snake and methods by which hikers might avoid problems with snakes. However, another individual cautioned that care should be taken when educating the public because drawing attention to the snakes might encourage people to look for them.

Bald Eagle

The six respondents who listed bald eagle as one of the three most seriously impacted species at this time or in the future described two types of impacts: disturbance of feeding behavior and interference

with nesting along the river corridor. Three respondents felt that disturbance to feeding behavior is currently a problem. Two listed winter (November-April) as the most critical time. One believed that serious impacts are also occurring during the summer, and the final respondent felt that this type of impact is greatest during the summer from mid-May through mid-July. The consequences of these impacts were thought to be loss of feeding time, increased energy expenditure, and possibly a change in distribution. One respondent stated that the change in distribution actually benefited the eagles because it kept them in more remote, less frequently visited areas of the river.

All respondents felt that these impacts are occurring along the entire river. Impacts were considered to be concentrated in high recreational use areas, especially from Callicoon to Sparrowbush. One respondent was not familiar enough with human use patterns to identify areas of greatest impact, but did identify areas frequently used by eagles (Figure 2).

There was little agreement about the type of characteristics of recreationists which are responsible for the feeding disturbances. Prolonged use (e.g. camping) was considered to be detrimental to the eagles. One expert felt that individuals and groups were equally disturbing, while another said that large, noisy groups caused most of the problems. The final respondent said people specifically seeking out eagles are most likely to disturb eagles.

Suggested solutions were primarily restrictive in nature. These included limiting camping to certain areas, restricting users to the

river channel rather than allowing them to wander along the shoreline, and restricting all types of use in areas of particular importance to the eagles. Respondents suggested offsetting these restrictive measures by creating observation areas, informing the public of eagle sightings in the observation areas, and educating the public about the consequences of disturbance to the eagles.

Three respondents felt that recreationists might interfere with eagle nesting along the river corridor in the future. Potential consequences include reduced productivity through failed nesting attempts and possibly failure to establish a breeding population. One respondent did not consider any specific type of user or activity to be more disturbing than another. Two felt that people actively searching for eagles and nests would cause the greatest problems. Both thought that these people might interfere with feeding behavior of adults in addition to disrupting nesting behavior. One respondent felt there was no possible solution to this problem. One recommended limiting the number of river users and creating buffer zones around nests. Finally, one respondent felt that educational programs were the only methods which would successfully control disturbance of nesting eagles.

Smallmouth Bass

Five respondents discussed impacts to smallmouth bass in greater detail. Three thought overharvest is a problem and three were concerned about disruption of spawning. One respondent said that noise from

aluminum canoes seems to shock the fish, turning them into nocturnal species. Overharvest was most commonly thought to occur during spawning periods, but one respondent felt that overfishing occurred throughout the open season. The respondent who felt recreational use was changing the behavior of fish stated that impacts were occurring in the spring and summer. Four respondents listed declining populations as the consequence of these impacts. One respondent who listed disturbance of spawning as a problem thought that this had only minimal implications for the population as a whole.

Three respondents thought that these impacts are occurring throughout the river. One respondent felt that impacts are greatest between Callicoon and Narrowsburg, and least between Hancock and Callicoon.

Recreationist behaviors thought to cause disturbance of spawning included any walking, wading, swimming, or boating activity in spawning areas. As mentioned previously, one respondent said that the noise created by recreationists in aluminum canoes was the primary factor causing fish to alter their diurnal behavior.

Two of three respondents felt that disturbance of spawners was not a significant enough impact to warrant protective measures at the current time. One respondent suggested placing time and space limitations on fishermen to control this problem. Solutions to the overharvest problem were a closed season and more restrictive angling regulations. The respondent who felt canoeists were changing the

behavior of the smallmouth bass suggested a permit system to limit the number of users.

Brown and Rainbow Trout

All experts listing these two species among the top three impacted species, now or in the future, stated that both are receiving the same types of impacts. However, among experts, there was little consensus about the nature of the impacts. One respondent believed that recreationists disturb already stressed fish congregating in cold pockets. He also felt that trout are being overharvested. He stated that both impacts would cause population declines. As with the smallmouth bass, one respondent believed recreational use was turning trout into nocturnal species. One respondent believed that canoe traffic temporarily disrupts feeding activity, but he thought the primary impact would be on fishermen through reduced success or enjoyment, and did not describe any negative consequences to the trout. Another respondent described conflicts between trout fishermen and canoeists rather than impacts to trout. The final respondent listed impacts which were not related to recreation (irregular water flow and unfavorable temperature regimes).

All impacts were described as occurring during the spring and summer. Recreational behaviors associated with these impacts were merely described as intensive canoeing and boating use. Two believed that impacts are greatest from Hancock to Callicoon. The respondent who felt recreation was changing the behavior of fish felt impacts are

greatest from Callicoon to Narrowsburg, least from Hancock to Callicoon, and intermediate over the rest of the river. Recommended solutions included placing time and space limitations on fishermen, limiting boat rental activity, and establishing a permit system. The respondent who felt that overharvest is a problem believed that fishing regulations are already quite restrictive.

Walleye

Three of the four experts who listed walleye as one of the three most seriously impacted species described overharvest as the primary impact. Two thought that overharvest was currently occurring, while the other listed it as a future impact. Additionally, the respondent who said recreational use was changing the diurnal behavior of smallmouth bass also identified this impact for walleye. One respondent stated that overharvest is occurring during the entire open season, but a second believed the problem is removal of spawners from mid-March to early May. The final respondent thought the critical time is mid to late summer. The respondent who felt recreational disturbance is causing walleye to become a nocturnal species listed spring and summer as the critical period. The consequence of all impacts was described as declining populations, but one expert stated the reduction due to overharvest is "tolerable".

One respondent was not certain where the overharvest might be occurring, while a second listed the portion of the river from the Pennsylvania border downstream to Lordsville. The respondent who was

concerned about the change in walleye behavior felt that impacts were greatest between Callicoon and Narrowsburg, and least between Hancock and Callicoon.

One expert stated that overharvest occurs because fishermen are focusing on walleye when the fish are concentrated during spawning. The other respondents said that overharvest simply resulted from normal fishing activity. The change in fish behavior was attributed to noise produced by large numbers of recreationists using aluminum canoes.

One respondent suggested time and space limitations as a method for reducing overharvest. Another stated that no management actions are necessary because walleye populations are not seriously threatened by the overharvest. The respondent who felt canoeists are changing the behavior of the walleye suggested a permit system to limit the number of users.

American Shad

Although three respondents listed shad among the top three impacted species, none described any significant impacts related to recreational use. One respondent stated that shad was heavily fished throughout the year, but was not certain if there were any negative impacts associated with this fishing pressure. He listed Skinner's Falls, Ten Mile River, Narrowsburg, the Mongaup Area, and Barrysville as heavily impacted sites. A second expert stated that heavy fishing pressure occurred during the spring spawning run, but felt this was not threatening the population and required no remedial steps. The

final respondent listed irregular water flows and unfavorable temperature regimes as the primary problems facing shad.

Osprey

One respondent added osprey to the list of impacted species. He was concerned about future impacts. However, he did not list osprey as one of the three most seriously impacted species and therefore did not describe the potential impacts in more detail.

REVIEWERS' RESPONSE

Description of Impacts by Species

When the resource managers at the Upper Delaware Scenic and Recreational River reviewed a draft of this report, they suggested that two additional experts familiar with the river review and make suggestions about wildlife impacts. These two individuals were Mr. Fred Johnson, former Water Resources Coordinator of the Pennsylvania Fish Commission and Mr. Doug Sheppard, Fisheries Biologist, Bureau of Environmental Protection, New York State Department of Environmental Conservation.

Fred Johnson felt that five fish species in the following order of seriousness were being impacted now on the Upper Delaware: brown trout, rainbow trout, smallmouth bass, walleye, and American shad. When providing details on the two species most impacted, i.e., rainbow trout and brown trout, he identified low flows from upstream reservoirs

during periods of drought as the most serious limiting factor. During such periods, water flow is sometimes reduced to 1% of average daily flow. The flow at Hancock may be 5% of ADF or less, and water temperature may reach 80 degrees Fahrenheit. Such temperatures for extended periods are lethal to trout. Those which do survive concentrate at the mouths of cold water tributaries, making them vulnerable to exploitation. When flows are normal, angler exploitation becomes the limiting factor. For smallmouth bass and walleye, overharvest is probably the limiting factor under most conditions, since the temperature is within their tolerance limits. Angling pressure has not keep pace with the expanding shad fishery, so more restrictive regulations are not necessary now, but may become so in the future.

Mr. Johnson believed the impacts on the trout species were occurring from Hancock to Callicoon, and on the entire river for smallmouth bass and walleye. Angler exploitation is occurring during the months of May and June for trout, May through September for bass and April through June for shad. The water flow and temperature problems generally occur in July and August, and in October for spawning brown trout. The consequences of these impacts to the fishery are limits to the population, particularly of more desirable, older, larger fish.

Fred Johnson's recommendations to solve these problems include more restrictive creel and size regulations for all fishes and not cutting flows so quickly and so drastically during drought events.

Creel limits for trout on the Delaware might be set at two trout over 14 inches in length. Current creel limitations for bass and walleye should be cut in half, and minimum size increased by two inches.

Doug Sheppard reviewed a draft of this report, and expressed concern over impacts to river invertebrates, amphibians, some reptiles including rattlesnakes, smallmouth bass, brown and rainbow trout, and American shad. He recognized that eagles might be threatened, but did not think that there was too large a problem because eagles are mostly present in winter when boaters are not. Invertebrates are often overlooked, but they have intrinsic value and value as food for organisms higher on the food chain in the ecosystem. People harvest frogs along the river, but we lack knowledge of the extent of this exploitation. Rattlesnakes are in jeopardy because of intentional killing by recreationists. .li 6 The impacts to smallmouth bass are temporary loss of preferred habitat, especially abandonment of nests in small pools due to passage of boats. Smallmouth bass guard and protect their nests, and disruption of this behavior causes stress to adults and increases the likelihood of loss of eggs and fry. The problem for trout is the one emphasized also by Fred Johnson: reduced water flows during time of drought, increases in water temperature, the fish using up stored energy just to keep alive, concentration in pools at the mouths of cold water tributary streams, and increasing vulnerability to exploitation and predation. Shad live throughout the river and impacts to them are small. Sheppard did express some concern

that when the spawned-out shad drift back out to sea, they are very lethargic and are very susceptible to harassment by boaters.

Finally, Sheppard noticed two other potential impacts which indirectly involve people-wildlife conflicts. There is a limited commercial America eel fishery on the Upper Delaware, and eel fishermen build rock cribs to funnel the eels into weirs. These rock cribs cause problems for canoeists, and conflicts between eel fishermen and recreationists result. Also, as the population of recreationists increases, there will likely be greater amounts of trash and picnicking wastes left along the river. This will increase the probability of negative people-wildlife interactions, most notable are potential safety problems from more frequent human encounters with bears.

Shepperd listed several potential solutions to these problems:

1) Increase base water flows during times of drought. This would solve problems of algal blooms, depleted oxygen levels, and reduce impacts on invertebrates and trout.

2) Education. Education is perhaps the best solution for a host of wildlife impact problems on the Upper Delaware. Education is needed to inform recreationists about the nest protection behavior of smallmouth bass, and the potential impacts of invasion of small pools and harassment of fish at this critical time. Education too can inform boaters about the life cycle of the American shad, about their condition after spawning, and of the need to leave the fish alone during this time. Information/education brochures could be prepared by the National Park Service to inform the public about critical

locales for species such as trout and rattlesnakes, and the need to protect these places from human invasion during some time periods. For example, during warm water spawning during May and June in shallow pools on the river, smallmouth bass should not be disturbed. Recreationists need to know that rattlesnakes are present, and that they--if left alone--will not bother humans. There is a potential problem that site specific information will attract people to critical locales, research is needed to find out if this potential problem would outweigh the benefits of a more informed public. Finally, general information is needed to inform the public about the impacts and nuisances they are causing. Often human impacts are nonmalicious. For example, recreationists may not realize that the noise of their aluminum canoes and radios on the river not only bother other people, they also reduce the likelihood of seeing wildlife.

3) Manage developments in the river corridor. With increased recreational use of the river will come increased liveries, stores, and other developments along the river. These developments can result in habitat loss along the river's edge, alteration of the river bottom to facilitate canoe launching, potential loss of water quantity and quality along the corridor, and increased problems with human trash and wastes. Amount, type, and location of developments must be controlled to limit potential impacts.

4) Zone the river spatially to reflect and guide amount of development and types of experience provided. Three recommended zones would be Hancock to Callicoon, Callicoon to Narrowsburg, and

Narrowsburg to Port Jervis. The Hancock to Callicoon segment merits the most careful management attention because it is currently the most pristine, has the cold water fishery, offers a unique boating experience, and should have little recreational development. The Callicoon to Narrowsburg section should be intermediate in amount of development, and concern should be for the impacts of erosion, siltation, and recreational use upon invertebrates and the warm water fishery. The zone from Narrowsburg to Port Jervis currently has the heaviest development, and restrictions here would be minimal. The National Park Service should implement this zoning policy, limit the number of boat rentals available by river segment, and inform recreationist of the experience differences available in the three river segments.

5) Establish temporal zoning along the river. This is to reduce conflicts between anglers and boaters. Anglers might have first priority for river use before 8 in the morning and after 6 in the evening. The daylight hours from 8 am to 6 pm might be for boat rentals.

CRITICAL HABITAT

Questionnaire Respondents

The 18 experts listed 11 different kinds of wildlife habitat that are now, or in the future would be, vulnerable to disturbance by river recreationists (Table 4). The most frequently cited vulnerable habitat

type was coldwater tributaries. The next two most frequently described habitats were river shoreline/streambanks and riparian/floodplain habitats.

All five respondents who listed coldwater tributaries as one of the most vulnerable habitats believed that impacts were occurring at the current time. All respondents emphasized the important role these areas play in maintaining the trout populations in the entire river. Two were primarily concerned with maintenance of suitable habitat and water quality for spawning. Another stressed the importance of tributary mouths as thermal refuge zones for trout during summer droughts. He was concerned about harassment of trout concentrated in these zones and about the amount of poaching occurring in these areas. A second felt that these areas should not be subjected to extensive float use. He recommended establishing access river areas with use limits. He felt only small groups should be allowed to use these access points. All respondents listed the river from Hancock to Callicoon as the primary location of these habitats.

Three respondents described shoreline and streambanks as the most vulnerable habitats at this time. Most concern was expressed about the loss of this habitat to development (construction, docks, etc.). Respondents were also concerned about decreasing water quality due to sedimentation associated with development and camping. One respondent felt that impacts were occurring along the entire river corridor, while a second believed impacts were most severe from Callicoon downstream.

Two respondents cited riparian or floodlight habitats as the most vulnerable to disturbance, while a third described it as the second most vulnerable. Two thought impacts were occurring now and a third thought impacts would occur in the future. One respondent was most concerned about floodplain habitat with regard to bald eagle perching sites, and one expert recommended maintenance of at least 200-foot wide undisturbed zones in areas utilized by eagles (Figure 1). A second respondent was concerned about disturbance to waterfowl nesting areas in riparian zones.

Reviewers' Comments

Our two reviewers of a draft copy of this report provided limited comments about wildlife habitat concerns. Fred Johnson felt that there was currently a small problem with recreationists constructing rock dams, especially in tributary streams. This problem might get larger if the number of recreationists increases. These rock dams can preclude passage of spawning trout or trout seeking colder water during thermal crisis episodes. These tributary streams are critical to the well being of trout, and they are already threatened by acid deposition. The most frequent locations of recreationist-constructed rock dams are at tributary mouths, popular picnicking and camping spots, and beside human habitations.

Doug Sheppard expressed concern over temporary or interim loss of habitat when recreationists enter and disrupt the living space of wildlife. He cited disturbance of the nest protection behavior of the

smallmouth bass as an example. Second, he noted potential recreational impacts to threatened, rare, or endangered plants along the river. Finally, he cited direct impacts to river shoreline through tree cutbacks and beach construction at recreational, residential, or commercial developments.

DISCUSSION

For any given species, between 27 and 55% of the respondents did not express an opinion. This reflects the diverse backgrounds of our respondents and the array of species presented in the questionnaire. Additionally, in a few cases, individuals felt they were not knowledgeable enough about the Upper Delaware to offer an opinion, even though others had identified them as being familiar with the area.

HIGH PRIORITY CONCERNS

Respondents showed a general consensus of concern with regard to the existence and nature of recreational impacts in the case of the rattlesnake and bald eagle. At least 67% of those expressing an opinion believed that these species are or will in the future be subject to river recreation impacts. Both species also received at least two votes as the most seriously impacted species and six votes as one of the three most seriously impacted species. We believe that these species should be given high priority status and evaluated in greater detail.

Rattlesnake

Four of the five individuals who were concerned about impacts to the rattlesnake described it as one of the two most seriously impacted species in the area. All agreed that the major problem is the number of snakes killed by recreationists, and most thought this was resulting in declining populations. We believe that the Park Service should try to alleviate this problem using two approaches. First, it should attempt to educate the recreationists about the status of this species and the importance of protecting it. Second, they should attempt to locate hibernation and basking areas. If necessary, hiking trails should be routed away from these areas, and future recreational developments in these areas should be discouraged.

Bald Eagle

Six of the eight individuals who were concerned about impacts to the bald eagle thought it was one of the three most seriously impacted species. These respondents were concerned about two problems: interference with nesting along the river and disruption of feeding behavior. To address the nesting concern, the Park Service should determine its goals for eagle management by:

1. Identifying zones on the river where eagle nesting is possible and desirable;
2. Determining the desired nesting population in these areas;

3. Determining the productivity necessary to maintain the population at the desired level;
4. Developing criteria to define unacceptable recreational impacts in nesting zones.

The Park Service should begin to actively survey for eagle nests between January and April. If nests are located, they should be observed to determine whether or not recreational use is causing disturbances, and if so, the consequences of these disturbances. If unacceptable impacts are detected, the Park Service should consider creating a buffer zone around each nest such as that used in the Chippewa National Forest in Minnesota (Table 5). If productivity is low, the Park Service should conduct a detailed study which examines all the factors which might be responsible, rather than focusing solely on the effects of recreational activity.

To resolve the issue of disturbance to feeding activities, the Park Service should initiate a study of nonbreeding eagles to locate areas which are used by eagles, and the extent to which recreational use influences distribution and activity patterns. This project should be coordinated with the northern Chesapeake bald eagle study, now in its fifth year (Fraser et al. unpublished data). The Park Service should also outline its management goals for the wintering population in a manner similar to that described above for the nesting population.

LOWER PRIORITY CONCERNS

Study participants showed a lack of consistency regarding the existence of recreational impacts to several wildlife species (smallmouth bass, American shad, walleye, brown and rainbow trout, mallard, river otter, and blue-winged teal). However, of these species, at least three respondents rated the smallmouth bass, walleye, American shad, and rainbow and brown trout among the three most seriously impacted species. We believe that these five species should be placed on a lower priority list, and be examined for their recreational impacts when sufficient financial and human resources are available.

Smallmouth Bass, Walleye, American Shad, and Brown and Rainbow Trout

The number of individuals who thought recreational impacts were occurring to smallmouth bass was approximately equal to the number who thought no impacts were occurring. However, five of the six respondents who were concerned about impacts thought that the bass was one of the three most seriously impacted species, so we believe that this species warrants further consideration. The primary concern expressed was overharvest by fishermen. Although three respondents mentioned disturbance to spawners as an impact, two thought this was only a minor disturbance, and the final was not sure what the consequences might be. This issue should be addressed in greater detail only if population monitoring indicates a decline.

The primary concern expressed for walleye was overharvest. Two thought that overharvest is currently a problem and another thought it will become a problem in the future.

Six individuals felt American shad was being impacted. Two respondents mentioned that this species is heavily fished, but one thought that this is not causing a major impact and the other was not sure of the consequences. The third respondent discussed problems associated with waterflow and temperature regimes.

Five individuals discussed concerns about rainbow and brown trout, but only two described recreational impacts. They did not agree on the types of impacts. One was concerned about overharvest and stress of trout congregating in pools. The other thought recreational use was causing trout to become more nocturnal. Impacts discussed by two other respondents dealt with impacts to fishermen rather than trout. The final respondent discussed impacts related to waterflow and temperature regimes.

The National Park Service should cooperate with state agencies and regional commissions to monitor the size and health of the smallmouth bass, walleye, American shad, and brown and rainbow trout populations, and determine whether these populations are increasing, decreasing, or stable. Once greater relevant population parameters have been acquired, management objectives can be established. If the current fish populations do not meet standards, causes of problems should be identified. If problems are being caused by overfishing or by

recreationists in general, then more strict creel limits or restrictions on recreationists might be promulgated and enforced.

SPECIES OF SPECIAL CONCERN - OSPREY

One respondent expressed concern about future impacts to the osprey, but did not consider the osprey to be one of the three most seriously impacted species and did not discuss his concerns in detail. Because the osprey is on New York's list of threatened species, we have listed it as a species of special concern. We believe that Park Service managers should address this issue in the following manner. They should determine their objectives for osprey management by:

1. Identifying zones on the river where osprey nesting is possible and desirable;
2. Determining the desired nesting population in these areas;
3. Determining the level of productivity necessary to achieve and maintain this population;
4. Developing criteria to define unacceptable recreational impacts in nesting zones.

The Park Service should begin surveys for nesting osprey. These surveys should be conducted between January and April. If located, nests should be observed to determine the existence and consequences of recreational disturbance. If unacceptable impacts are detected, the Park Service should consider creating a buffer zone around each nest

such as that used around bald eagle nests in the Chippewa National Forest in Minnesota (Table 5). If productivity is low, but disturbance at the nest site is not a problem, the Park Service should examine the effects of recreational use on osprey foraging behavior and also examine other factors which might be influencing productivity.

CONCLUSIONS

When we began this study, we expected to find a great degree of consensus about the wildlife species adversely impacted by recreational use on the Upper Delaware Scenic and Recreational River. In general, we did not find unanimity of opinion among our respondents. Several factors might explain this. Wildlife studies in general show a lack of knowledge of the baseline condition, complex relationships between recreational impacts, and a time lag effect in impacts due to recreational use (Hall and Dearden n.d.). Also, managers, interested biologists, and area users are often not well informed on the amount of current recreational use and the behavior of recreationists at the resource areas under consideration. Finally, in this study as well as other similar surveys, species identified as potentially impacted tended to be high profile species (e.g. bald eagle or trout), or species in the respondent's area of expertise.

In spite of these notes of caution, and in part because of the varied professional interests and training of our respondents, we did identify two species for which there was considerable concern about impacts: rattlesnake and bald eagle. These species deserve immediate

study or management action. There was some concern expressed for the smallmouth bass, walleye, American shad, and brown and rainbow trout. We have assigned a lower priority of concern to these species. Finally, we have listed the osprey for the Park Service's attention, but we have done so primarily because of its presence on New York's list of threatened and endangered species. Any Park Service effort to study, protect, and/or manage these species should be done in cooperation with other state and federal agencies concerned about these species.

Finally, Doug Sheppard, one of our draft report reviewers, suggested three areas of needed research to help wildlife along the Upper Delaware. First, we need to discover appropriate measures to mitigate the inevitable impacts of increases in recreational use. Second, research is needed to understand and shape human perceptions, attitudes, and behavior about wildlife in a positive direction. Finally, greater knowledge is needed on the severity of impacts discussed in this report on individual animals, species, communities, and ecosystems.

Table 1. Number of experts (N=18) who believed various wildlife species receive river recreation impacts at Upper Delaware Scenic and Recreational River, 1986.

Species	Current Impacts	Future Impacts	No Impacts	Don't Know/ No Response
Rattlesnake	5	4	4	5
Bald Eagle	4	4	4	7
Smallmouth Bass	6	-	5	7
American Shad	5	-	6	7
Walleye	4	1	6	7
Great Blue Heron	3	1	7	7
Mallard	2	2	5	9
Otter	2	2	6	8
Blue-winged Teal	1	2	5	10
Bobcat	-	1	8	9
Woodcock	-	-	9	9

Table 2. Number of respondents who added wildlife species potentially impacted by river recreation use at Upper Delaware Scenic and Recreational River, 1986.

Species	Current Impacts	Future Impacts
Brown Trout	6	-
Rainbow Trout	6	-
Turkey	2	-
Common Merganser	2	-
Black Bear	1	1
Green Heron	1	-
Kingfisher	1	-
Osprey	-	1

Table 3. Number of respondents assigning various ranks of seriousness of impacts to wildlife at Upper Delaware Scenic and Recreational River, 1986.

Rank	1*		2		3		1,2, or 3	
	Now	Future	Now	Future	Now	Future	Now	Future
Smallmouth Bass	2	-	1	-	2	-	5	-
Brown Trout	1	-	2	-	2	-	5	-
Rattlesnake	3	-	1	2	-	-	4	2
Rainbow Trout	2	-	2	-	-	-	4	-
Bald Eagle	2	2	1	-	-	1	3	3
Walleye	-	1	2	-	1	-	3	1
American Shad	1	-	1	-	1	-	3	-
Otter	1	-	-	-	1	-	2	-
Common Merganser	-	-	-	-	2	-	2	-
Great Blue Heron	1	-	-	-	-	-	1	-
Green Heron	-	-	1	-	-	-	1	-
Black Bear	-	1	1	-	-	-	1	1
Blue-winged Teal	-	-	-	1	-	-	-	-
Mallard	-	-	-	-	1	1	-	-

*Rank 1 is most serious.

Table 4. Number of respondents assigning various ranks of vulnerability of wildlife habitat at Upper Delaware Scenic and Recreational River, 1986.

Habitat Type	Rank 1*		Rank 2		Rank 3	
	Now	Future	Now	Future	Now	Future
Shoreline; Stream Banks	3	-	-	-	-	-
Coldwater Tributaries	4	-	1	-	-	-
Coldwater Ground Influxes	-	-	-	-	1	-
Talus Areas	1	-	-	-	-	-
Riparian Habitat; Floodplains	2	1	-	-	-	-
Shallow, Quiet Spawning and Nursery Pools	1	-	-	-	-	-
River Bottom		1	-	-	-	-
Rattlesnake Dens	1	-	-	-	-	-
River Itself	-	-	2	-	-	-
Woods, Mixed Forest	-	1	-	-	-	-
Wetlands	-	1	-	1	-	-

*Rank 1 is most vulnerable.

Table 5. Buffer zones around bald eagle nests in the Chippewa National Forest (Mathisen et al. 1977).

Zone	Description
330 ft (100 m)	No activity allowed.
660 ft (200 m)	No activity allowed from Feb 15 - Oct 1. and then little.
1320 ft (400 m)[1]	No activity from Feb 15 - Oct 1. No restrictions at other times.

[1]Zone may be altered on individual basis to meet differences in sensitivity among individuals.

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APPENDIX B
QUESTIONNAIRE

Recreational Impacts on Wildlife Species in the
Upper Delaware Scenic and Recreational River

I. Through telephone interviews with many of you, we have identified the following wildlife species as possibly impacted by recreationists on the river and within the river corridor. We define such impacts to be recreationist-caused destruction of wildlife habitat, or disturbance of wildlife resulting in displacement or disruption of such essential activities as breeding, feeding, or nesting. Please place a check in the appropriate blank to tell us the extent to which you think recreationists are impacting each. (Be sure to check one of the blanks in each row.)

	1 Impacts occurring now	2 No impacts now, but likely in future.	3 No impacts that I know of	4 I don't know
1. American Shad	_____	_____	_____	_____
2. Smallmouth Bass	_____	_____	_____	_____
3. Walleye	_____	_____	_____	_____
4. Rattlesnakes	_____	_____	_____	_____
5. Bald Eagles	_____	_____	_____	_____
6. American Woodcock	_____	_____	_____	_____
7. Blue-winged Teal	_____	_____	_____	_____
8. Mallard	_____	_____	_____	_____
9. Great Blue Heron	_____	_____	_____	_____
10. Otter	_____	_____	_____	_____
11. Bobcats	_____	_____	_____	_____

List any other wildlife species you think should be included and check whether the impacts are occurring now or will likely occur in the future.

_____	_____	_____
_____	_____	_____
_____	_____	_____

II. In the blanks provided, rank the wildlife species checked in Column 1 of Question I in order of the <u>seriousness</u> of the impact (list the species subjected to the most serious impacts first).

1. _____

2. _____

3. _____

III. Please tell us the impacts that you believe recreationists are currently having on the wildlife species you ranked 1, 2, and 3 in Question II. Start with the species listed as most seriously impacted. (If you need additional space to answer any question, use the back of the page.)

1. Most seriously impacted species is _____(taken from 1 in Question II).
   a. Describe the impact that you believe is occurring (e.g. disturbance of nesting behavior, disturbance of spawning, etc.)

   b. What are the consequences resulting from the impact described above? (e.g.declining populations, change in species distribution, etc.)

   c. What are the recreationists' characteristics (e.g. group size or type of boating uses), use patterns (e.g. number of recreationists or time of use) and behaviors (e.g. activities or noise level) that you believe are causing these impacts?

   d. Where on the river or in the river corridor do you believe the impacts are occurring. Describe these places as specifically as you can (e.g. the impacts are occurring along the entire river, or they only occur on certain cliffs, or in certain pools). Also mark these areas on the attached map with a "1".

   e. What time period do you feel the impacts are most critical (e.g. during nesting season, during winter, etc.)?

   f. What suggestions do you have for reducing the severity of these impacts?

If you listed only one wildlife species in Question II, go to Question IV. on page 5.

2. Second most seriously impacted species is _____ (taken from 2 in question II).

   a. Describe the impact that you believe is occurring.

   b. What are the consequences resulting from the impact described above?

   c. What the recreationists' characteristics, use patterns and behaviors that you believe are causing these impacts?

   d. Where on the river or in the river corridor do you believe the impacts are occurring? Describe these places as specifically as you can. Also mark these areas on the attached map with a "2".

   e. What time period do you feel the impacts are most critical?

   f. What suggestions do you have for reducing the severity of these impacts?

If you listed only two wildlife species in Question II, go to Question IV on page 5.

3. Third most seriously impacted species is _____ (taken from 3 in Question II).

   a. Describe the impact that you believe is occurring.

   b. What are the consequences resulting from the impact described above?

   c. What are the recreationists' characteristics, use patterns and behaviors that you believe are causing these impacts?

   d. Where on the river or in the river corridor do you believe the impacts are occurring? Describe these places as specifically as you can. Also mark these areas on the attached map with a "3".

   e. What time period do you feel the impacts are most critical?

   f. What suggestions do you have for reducing the severity of these impacts?

IV. In Column 2 of Question I you checked the wildlife species that you feel are not currently being impacted by recreationists but are likely to be impacted in the future. Rank these species in terms of their likelihood of being impacted, where 1 is the species most likely to be affected.

1. _____

2. _____

3. _____

V. We would like you to discuss the impacts you believe that recreationists will likely have on the wildlife species you ranked 1, 2 and 3 in Question IV, starting with the species most likely to be impacted.

1. Species most likely to be impacted is _____. (taken from 1 in Question IV.).

   a. Describe the impact that you believe will occur.

   b. What will be the consequences resulting from these impacts?

   c. What are the recreationists' characteristics, use patterns, and behaviors that you believe will cause these impacts?

   d. What time period do you feel the impacts will be most critical?

   e. What suggestions do you have for postponing or reducing the likely severity of these impacts?

If you listed only one species in Question IV, go on to Question VI, on page 8.

2. Species second most likely to be impacted is _____ (taken from 2 in Question IV).

   a. Describe the impact that you believe will occur.

   b. What will be the consequences resulting from these impacts?

   c. What are the recreationists' characteristics, use patterns and behaviors that you believe will cause these impacts?

   d. What time period do you feel the impacts will be most critical?

   e. What suggestions do you have for postponing or reducing the likely severity of these impacts?

If you listed only two species in Question IV, go on to Question VI on page 8.

3. Third species most likely to be impacted is _____.
(taken from 3 in Question IV).

a. Describe the impact that you believe will occur.

b. What will be the consequences resulting from these impacts?

c. What are the recreationists' characteristics, use patterns and behaviors that you believe will cause these impacts?

d. What time period do you feel the impacts will be most critical?

e. What suggestions do you have for postponing or reducing the likely severity of these impacts?

Recreationists Impacts on Wildlife Habitat

VI. In telephone interviews, some of you did not identify individual wildlife species impacts, but you expressed concern over current or potential alteration of wildlife habitat by recreationists or recreational development. Please describe as specifically as you can any sensitive habitats (e.g. cattail marshes, talus slopes, etc.) that you believe are now, or will likely be, impacted and should therefore be protected.

1. Describe the habitat type most vulnerable to disturbance by recreational development or use.

   a. In your opinion, is this habitat disturbed now, or will it likely be in the future (check one)?
      _____Now
      _____Not now, but in future How soon? ____

   b. Describe where along the river that this habitat exists. (Be as specific as possible.)

2. Describe the habitat type next most vulnerable to disturbance by recreational development or use.

   a. In your opinion, is this habitat disturbed now, or will it likely be in the future (check one)?
      _____Now
      _____Not now, but in future How soon? _____

   b. Describe where along the river that this habitat exists. (Be as specific as possible)

3. Describe the habitat type third most vulnerable to disturbance by recreational development or use.

a. In your opinion, is this habitat disturbed now, or will it likely be in the future (check one)?

_____Now
_____Not now, but in future How soon _____

b. Describe where along the river that this habitat exists. (Be as specific as possible).

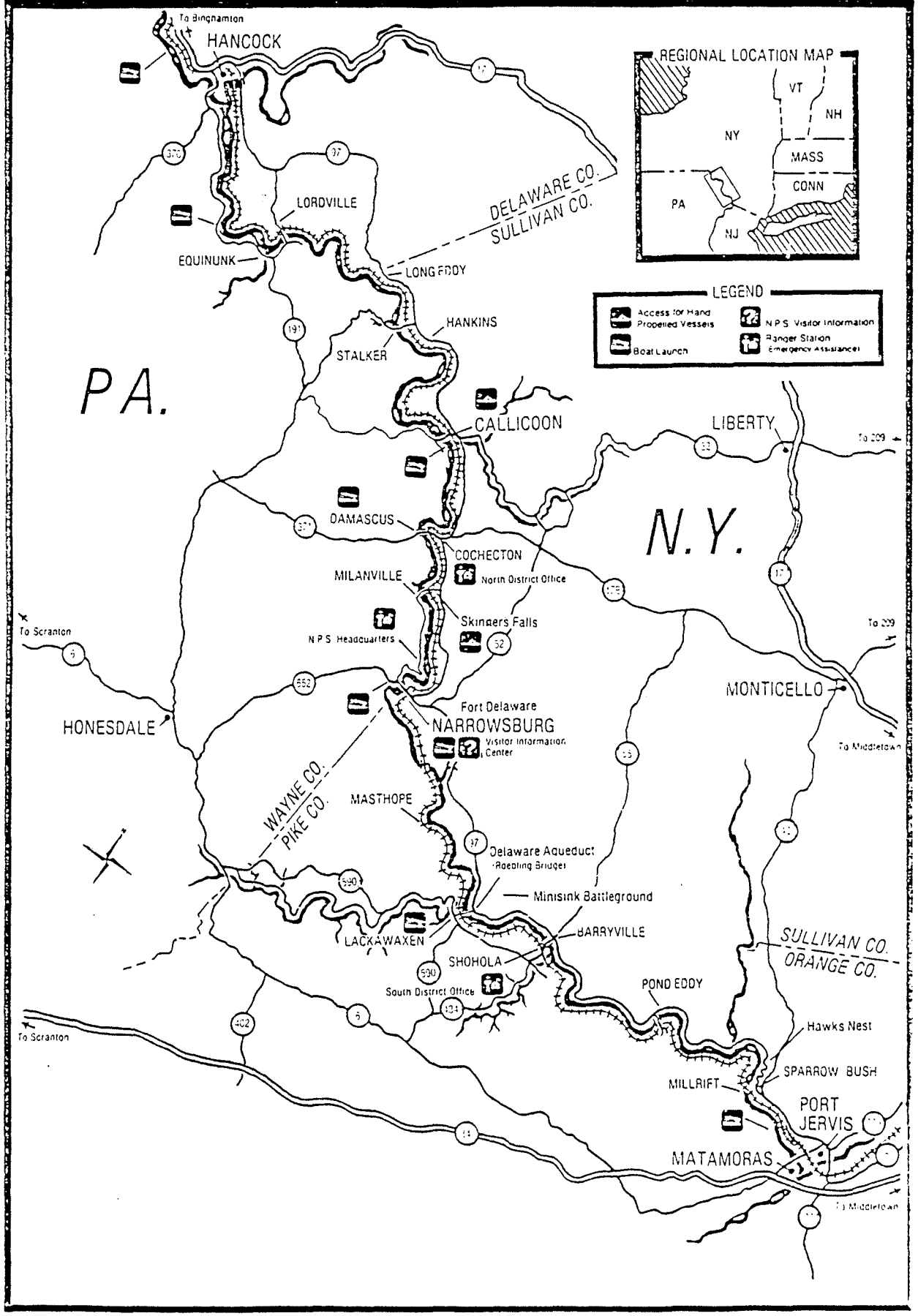
Thank you for your participation in this important study. Your ideas will help the National Park Service select its management strategies and prioritize research efforts.

Would you like a copy of the study results?

_____Yes
_____No

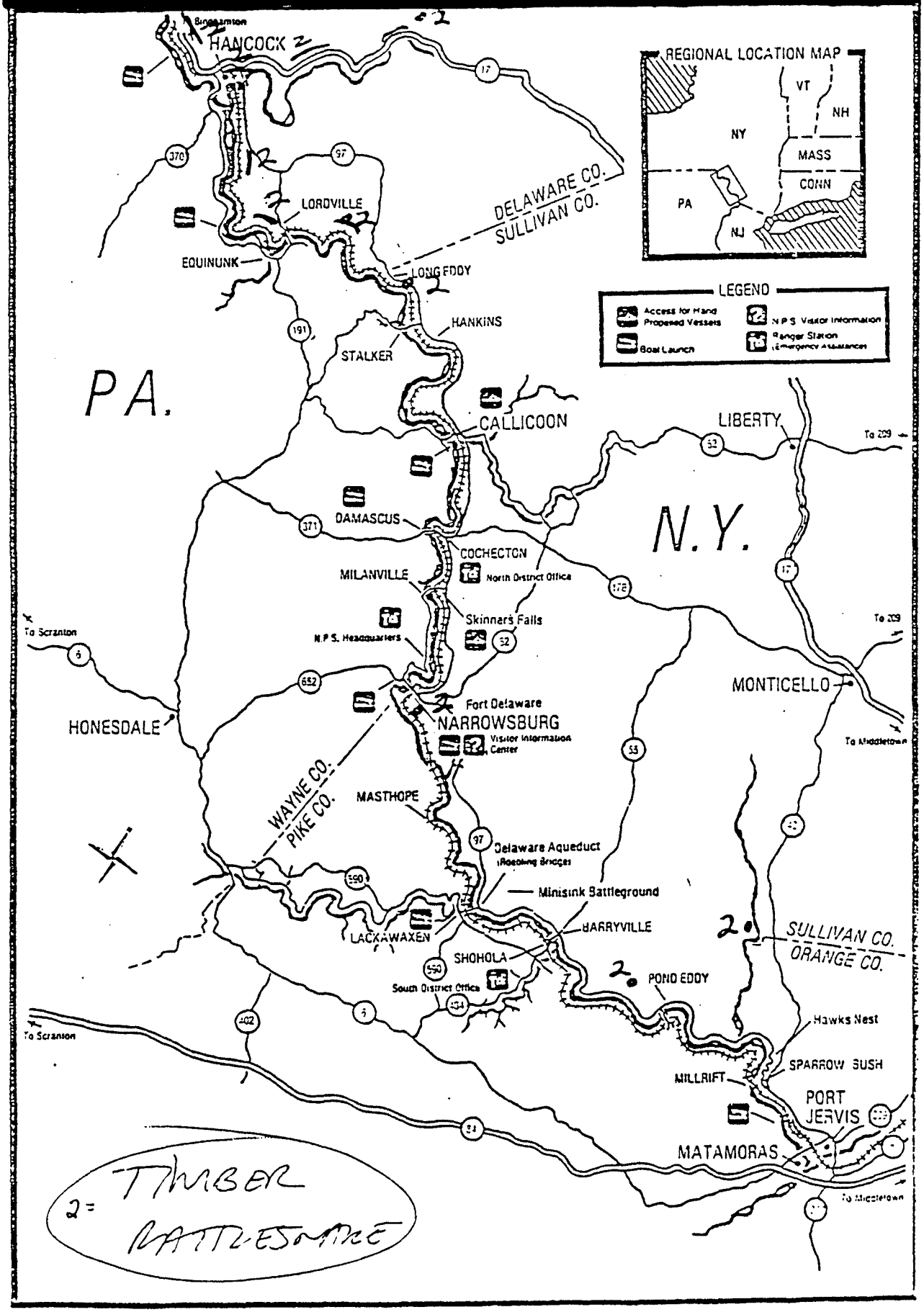
Please use the remaining space for any additional comments you may have.

Upper Delaware Scenic & Recreational River



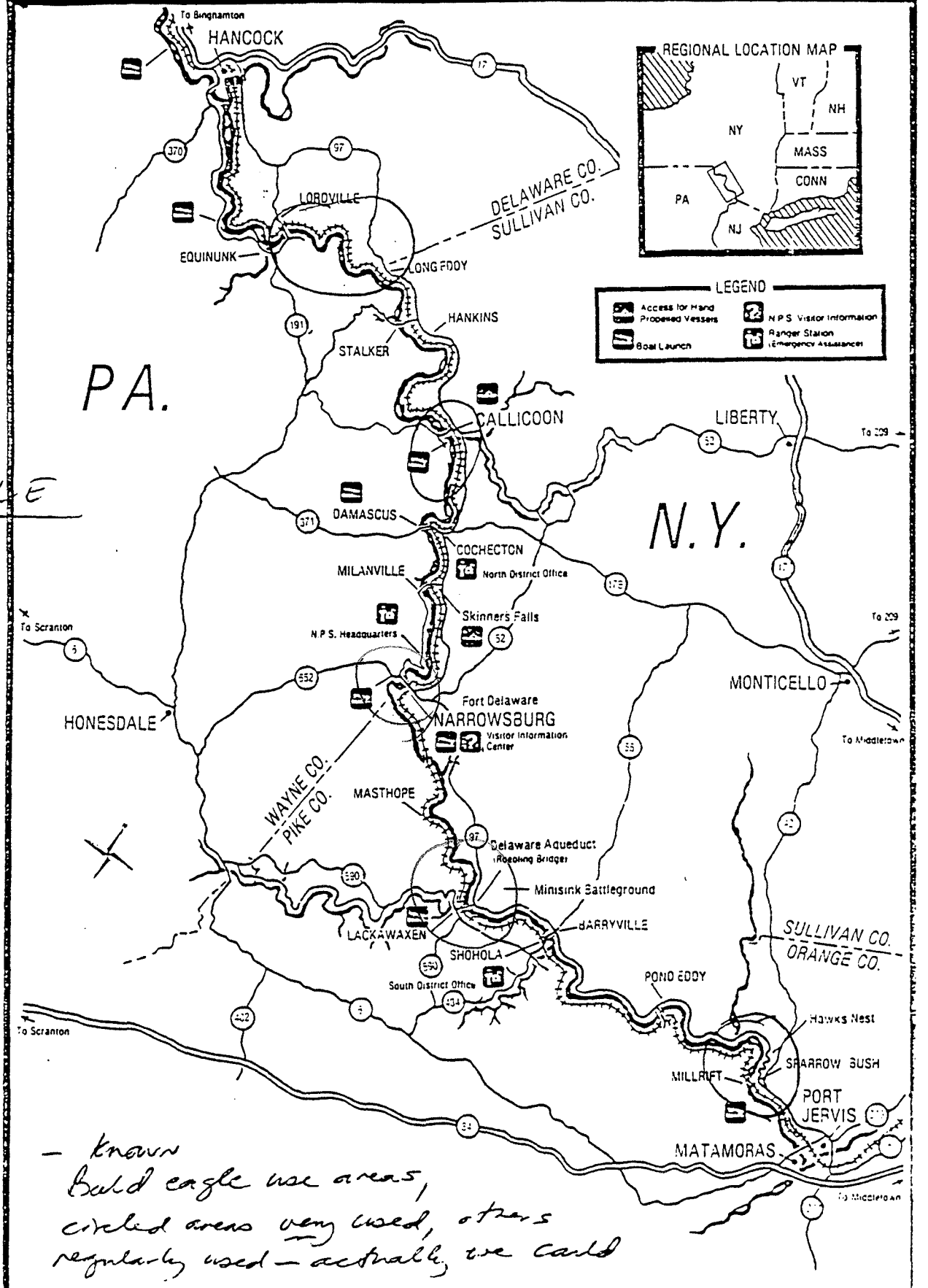
MAP FOR FIGURE 1
RATTLESNAKE LOCATIONS

Upper Delaware Scenic & Recreational River



MAP FOR FIGURE 2
BALD EAGLE LOCATIONS

Upper Delaware Scenic & Recreational River



BALD EAGLE

– known Bald eagle use areas, circled areas very used, others regularly used – actually we could probably hi-lite the whole river – they fly/use the whole thing.