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Biennial Report January 1997 - December 1998

The Cooperative Fish and Wildlife Research Units Program was established to facilitate cooperation among the U.S. Department of the Interior (currently through the US Geological Survey-Biological Resources Division), universities, state fish and wildlife agencies, and private organizations, by developing and conducting programs of research and education related to fish and wildlife resource conservation. The Minnesota Cooperative Fish and Wildlife Research Unit emphasizes research on impacts of human activities on aquatic and terrestrial ecosystems that are of state, regional, and national significance. The research program addresses not only the biological, but also social and economic aspects of both game and nongame fisheries and wildlife management in the context of maintenance of biological diversity, and integrity and sustainability of ecosystems. The Minnesota Cooperative Fish and Wildlife Research Unit was established in 1987, and staffed beginning in 1988. This is the 5th biennial report produced by the Minnesota Coop Unit and summarizes Unit activities during 1997 and 1998. The period from 1997-1998 was one of relative stability for both the Coop Unit Program and the Minnesota Unit. The Coop Unit Program was moved to the US Geological Survey-Biological Resources Division in 1996, and has remained within that agency since. The Minnesota Coop Unit has continued to serve its federal, state, and non-governmental partners, and furthered its mission through research, teaching, and technical assistance. With the addition of a social scientist (Dr. David C. Fulton, Assistant Leader-Wildlife) to our staff at the end of 1998, we are now positioned to more fully address social aspects of natural resource conservation into the 21st century. Three research scientists currently staff the Minnesota Unit. I continue my position as Leader, Dr. Bruce Vondracek continues in his position as Assistant Leader-Fisheries, and Dr. David C. Fulton joined the Unit as Assistant Leader-Wildlife in October 1998. As always, we welcome your comments and questions concerning the focus of our research and specific research projects, and look forward to continued cooperation with partners old and new.

Dr. David E. Andersen, Leader

Minnesota Cooperative Fish and Wildlife Research Unit

March 1999

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Updated December 5, 2008 by hattie@umn.edu.


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Applied Ecology

Anurans and Invertebrates as Indicators of Wetland Condition in the North Dakota Prairie Pothole Region

Investigators: Bruce Vondracek, David E. Andersen, Francesca J. Cuthbert, and Ralph W. Holzenthal

Students: David J. Anderson, M.S. and Dorothy G. Bowers, MS

Duration: January 1995 to December 1997

Funding Source: National Biological Service/U.S. Geological Survey

Project Location: Northern Prairie Science Center, North Dakota and the Minnesota Cooperative Fish and Wildlife Research Unit

Wetland complexes in the Prairie Pothole Region (PPR) of North Dakota have been severely impacted by agricultural practices. Efforts to evaluate the health of these wetland ecosystems may be hampered by their dynamic nature. A long-term, landscape-based approach may be needed for conservation efforts to succeed. To address this need, potential indicators of wetland condition are being evaluated across three ecoregions within the PPR. Two groups, insects and anurans (frogs and toads), are being assessed for their potential as biological indicators of wetland and landscape condition.

Insects have been useful in monitoring other aquatic habitats, and hold promise for wetland systems. For insects our objectives were to 1) develop an effective sampling strategy, 2) describe insect taxa richness and abundance in sampled areas, and 3) evaluate relationships between regional wetland condition and insect taxa richness and abundance. Insects were collected by placing light traps near six seasonal and semi-permanent wetlands within each site. There was a strong temperature, seasonal, and ecoregion effect on community-level insect taxa richness, abundance, and diversity. Taxa richness and abundance were higher for the second and third sampling periods than for the first period, and higher in the Drift Plain and Red River Valley ecoregions than in the Missouri Coteau ecoregion. Little evidence was found to suggest a difference in insect taxa richness, abundance, or diversity between cropland-dominated and grassland-dominated landscape condition. However, some individual taxa measures showed consistent differences between condition, including number of Corixidae (Hemiptera) genera and abundance of Hydropsychidae (Trichoptera), and should be examined further. Relationships with landscape condition may also become more evident if temperature-related variability can be reduced or controlled.

Conclusion: For anurans, we conducted nocturnal calling and driving surveys at 45 sites three times each. Additionally, at several sites we used automated recorders to record calling anurans during four 10-minute intervals throughout the night. We detected nine species of anurans. Relative abundances of the American toad (*Bufo americanus*) and the gray treefrog (*Hyla versicolor/chrysoscelis*) appeared greater in grasslands than agricultural lands, whereas relative abundance of the Great Plains toad (*B. cognatus*) was greater in agricultural landscapes than in grasslands. Distributions of the gray treefrog and the Plains spadefoot toad (*Spea bombifrons*) were more extensive than previously documented, whereas distributions of the Canadian toad (*B. hemiophrys*) and the northern leopard frog (*Rana pipiens*) were less extensive. Relative abundance and distribution of some anurans species may be related to land-use patterns at multiple spatial scales.

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Assessing Ecological Structure, and Dynamics of Undisturbed and Restored Northern Prairie Wetlands

Investigator: John R. Tester and Susan Galatowitsch

Student: Paul M. Mayer, Ph.D.

Duration: September 1992 to September 1998

Funding Source: US Bureau of Reclamation

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Project Location: Waubay National Wildlife Refuge and the University of Minnesota, St. Paul

We assessed ecological integrity and recovery in recently (6-8 yrs) restored prairie wetlands in eastern South Dakota, USA, by examining three ecological indicators: 1) diatom species assemblages, 2) the relationship between diatom production and diatom community structure, and 3) community respiration:biomass ratios. Integrity of eight restored wetlands was based on comparisons with eight reference wetlands. Diatoms were collected from artificial substrates that allowed communities to be transplanted from restored to reference wetlands and vice versa. Diatom production was estimated from cell volumes and abundances. Respiration was estimated from biological oxygen demand and biomass was estimated from phytoplankton chlorophyll concentration and from seston carbon mass.

Conclusion: Species richness, diversity and equitability at restored and reference sites were similar but seasonal differences were apparent. Based on multidimensional scaling results, restored and reference sites could not be distinguished by species assemblages. Transplanted diatom species assemblages became similar to those in the wetlands to which they were transferred suggesting a strong environmental control over diatom communities. Diatom production was negatively related to the number of functional groups at restored but not at reference wetlands. Communities transplanted from reference to restored wetlands exhibited a diversity-production relationship like that observed among control samples in restored wetlands. Likewise, communities transplanted from restored to reference wetlands apparently lost any such relationship after being relocated. Wetland sites possessing a unique combination of three functional groups had higher production than sites having any other combination. Restored sites exhibited high production as a function of N-fixing diatoms. No difference was observed in respiration:biomass ratios in restored and reference wetlands. However, high variability in respiration:biomass ratios was observed among sampling periods and wetlands.

Diatom species assemblages alone may not be appropriate ecological indicators of recovery because diatoms may be adapted to the drought-like conditions imposed by drainage. Respiration:biomass ratios may be insensitive indicators of disturbance because plankton communities may recover quickly after restoration and/or plankton species are redundant with respect to production and respiration. Restored and reference wetlands could be distinguished by their respective diversity-function relationships, but knowledge of species composition revealed the mechanisms connecting diversity and function.

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Biodiversity Monitoring: Breeding Productivity, Habitat, and Winter Distribution of Nongame Birds

Investigators: David E. Andersen and Francesca J. Cuthbert

Student: James Manolis, MS/Ph.D. and Ethan F. Perry, MS

Duration: September 1991 to May 1997

Funding Source: US Global Climate Change Research Program, US Fish and Wildlife Service Cooperative Research Units Center, Region 3 Division of Migratory Birds and Refuge Biology, and the US National Biological Service, Division of Cooperative Research

Project Location: Chippewa National Forest and the Minnesota Cooperative Fish and Wildlife Research Unit

Recent declines in forest songbird populations have received considerable attention, and appear pronounced in some species in eastern North America. These declines have been attributed both to fragmentation/loss of breeding habitat and to deforestation of neotropical wintering habitat, but in many cases it is difficult to discern which factor is most important. Few long-term population studies have been conducted in extensive forest tracts, and even fewer have monitored breeding productivity along with analysis of vegetation. Breeding productivity information will be vital for developing sound management practices.

During May-July of 1992-1996, we monitored nesting success of forest birds in the Chippewa National Forest, Minnesota. We established six 40-50 ha permanent plots in a mature (ca. 80 years post-harvest) maple-basswood forest, and during the 5-year study period located and monitored 1,423 nests of 46 species. In 1993 and 1994, we investigated effects of clearcut edges on reproductive success using artificial and natural nests. In 1993, 61% of artificial nests placed 0-10 m from clearcut edge were depredated, compared to 38% of nests placed 200 m from edge ($P < 0.001$). In 1994, predation rates were higher at the edges (34%) than at distances 25-200 m from edge, (18-22% $P < 0.01$). In natural nests, edge effects appeared to extend > 200 m into adjacent habitat in the landscape. These results suggest that edge effects observed in highly fragmented landscapes may also occur in predominantly forested regions.

In 1995, we began investigating the nesting distribution of least flycatchers (*Empidonax minimus*) on our permanent plots. Several alternative hypotheses related to clumped nesting were tested, including differences in habitat characteristics and potential food resources, predator deterrence,

and the potential for extra-pair copulations. Our results exhibit strong support for the predator-deterrence hypothesis. In 1995, we detected no effect of location within the aggregation on nesting success but there was a strong location effect in 1996. We mapped the distribution of territorial male flycatchers through the breeding season, and assessed the effect of location within the nesting aggregation on nesting success.

Conclusion: Results suggest that edge effects on forest-nesting birds exist in predominantly forested landscapes and may extend a considerable distance into older forested habitats. Landscapes thought to support source populations of forest-nesting birds may include significant areas affected by edges. Within this landscape, one of the most abundant breeding birds nests in aggregations, which appears related to predator-deterrence and offers reproductive advantage to interior-nesting individuals in at least some years.

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Paleolimnology: Reconstructing the Chronology of Fish Residency in Alpine and Subalpine Lakes of Glacier National Park, Montana

Investigators: Dirk Verschuren and Herbert E. Wright

Duration: January 1996 to August 1997

Funding Source: US National Biological Service

Project Location: Glacier National Park, Montana and the University of Minnesota, Minneapolis

Student: Steven Pothoven, MS

The westslope cutthroat trout (*Oncorhynchus clarki lewisi*) has declined throughout much of its original range in western North America due to destructive land-use practices and ecological disturbance caused by the introduction of non-native trout species. Surviving genetically pure populations in Glacier National Park could play an important role in managed recovery of the westslope cutthroat trout fishery throughout the region, but uncertainty exists of whether the populations in some of the more isolated headwater lakes are truly indigenous or became established via undocumented introductions before park establishment in 1910. A pilot study focused on reconstruction of the historical status of a cutthroat trout fishery in one such headwater lake through examination of fossil zooplankton in a dated sediment core, based on the premise that the sedimentary archive of lake history preserved a record of changes in zooplankton community structure that would have resulted from introduction of planktivorous trout to a previously fishless lake. The validity of this approach was tested by establishing a correlation between live population density of the fish-sensitive cladoceran, *Daphnia*, and the abundance of its resting eggs in the surface sediments of eight headwater lakes with and without fish. This study aimed to further validate paleolimnological reconstruction of fisheries by comparing the sediment records of headwater lakes with known and contrasting fishery histories. Sediment cores were collected during July-August 1996 in six headwater lakes of Glacier National Park. Three were subalpine lakes (mid-summer surface-water temperature >16 °C) that are potentially inhabited by two groups of fish-sensitive zooplankton, the cladoceran, *Daphnia*, and the phantom midge, *Chaoborus*. Three other sites were alpine lakes (MSSWT <14 °C) that were too cold for *Chaoborus* but can sustain *Daphnia*. The chronology of the cores over the historical period was established by ²¹⁰Pb dating.

Conclusion: Analysis of downcore distributions of *Daphnia* and *Chaoborus* fossils in relation to fishery history cautiously confirm the potential of fossil zooplankton assemblages to reconstruct trout fishery histories, but reveals various complications related to the quality of the sedimentary archive that may jeopardize the interpretation of fossil stratigraphies in some lakes. In shallow exposed lakes, sediment mixing due to wind-induced bottom turbulence may smooth the fossil record and compromise the ²¹⁰Pb-derived sediment chronology. Lack of zooplankton fossils in the sediment record of Babbe Lake, despite high zooplankton abundance in live collections and a turbulence-free hypolimnion, appears to reflect intensive consumption by benthic invertebrates prior to burial.

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Winter Ecology of Ferruginous Hawks at Rocky Mountain Arsenal, Colorado

Investigator: David E. Andersen

Student: David L. Plumpton, Ph.D.

Duration: July 1992 to September 1997

Funding Source: US Fish and Wildlife Service, US Army, and Rocky Mountain Arsenal National Wildlife Refuge

Project Location: Rocky Mountain Arsenal National Wildlife Refuge, Colorado and the Minnesota Cooperative Fish and Wildlife Research Unit

The ferruginous hawk (*Buteo regalis*), North America's largest buteo, was once found in most

states west of the Mississippi River and the prairie provinces of Canada. Populations are thought to have been declining in recent decades, primarily due to loss of habitats and attendant declines in prey populations. Ferruginous hawks currently occupy one of the smallest breeding ranges of any North American buteonine hawk. First-year mortality is approximately 66%, yet little information exists regarding habits and habitat use of ferruginous hawks outside the breeding season.

Although Colorado supports a nesting population of ferruginous hawks, it contributes far more to the global population of ferruginous hawks in terms of the number that overwinter there. There is currently considerable concern for the ferruginous hawk, as large-scale conversion of winter habitat by human development proceeds. The ferruginous hawk was previously listed as a Category 2 species under the Federal Endangered Species Act.

In 1992, we initiated an investigation of the winter ecology of ferruginous hawks in eastern Colorado. Thirty-eight ferruginous hawks were equipped with radio transmitters and monitored for 1,325 hours during 148 complete winter days. Home range size and activity levels were not different between hawks in highly fragmented (urban and suburban) habitats and hawks using the Rocky Mountain Arsenal (single contiguous block of habitat). In the suburban site, ferruginous hawks appeared to modify their behavior to exploit small, isolated colonies of black-tailed prairie dogs (*Cynomys ludovicianus*), underscoring the importance of this prey resource during winter months. Prairie dog densities declined dramatically between the winters of 1993-94 and 1994-95 on the Rocky Mountain Arsenal, and ferruginous hawks numbers exhibited a concurrent drop on the arsenal, but not the suburban site.

Conclusion: Ferruginous hawks appear to be able to modify their behavior to exploit a variety of landscapes during the winter. As long as suitable prey are available, ferruginous hawks appear capable of exploiting urban and suburban landscapes. Unlike many other raptors that benefit from changes in urban and suburban landscapes, however, ferruginous hawks are dependent upon black-tailed prairie dogs during winter in eastern Colorado, and many human activities negatively impact this prey species.

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Contaminants

PCB Congeners in Marsh Birds in Green Bay Coastal Wetlands

Investigator: Deborah L. Swackhamer

Duration: August 1995 to June 1997

Funding Source: US Fish and Wildlife Service and the Green Bay Ecological Services Office

Project Location: Green Bay, Wisconsin, and the University of Minnesota, Minneapolis

Green Bay has been highly contaminated with PCBs, and is designated as an "Area of Concern" by the International Joint Commission of the Great Lakes. PCBs are persistent, toxic pollutants that bioaccumulate, and have been shown to cause detrimental effects in wildlife and fish-eating bird populations in Green Bay and other locations in the Great Lakes. There has been little work done on the effects of toxic pollutants on passerines or marsh birds. The yellow-headed blackbird (*Xanthocephalus xanthocephalus*) feeds almost exclusively on aquatic insects during its breeding stage, and thus it is during this stage that eggs and nestlings are exposed to PCBs and are potentially subjected to toxic effects.

In conjunction with an ongoing project on yellow-headed blackbirds, the objectives of this project were to determine PCB concentrations in adult and nestling blackbirds from 2 field sites in Green Bay, and to relate observed PCB concentrations with reproductive and population parameters.

Conclusion: PCB concentrations in yellow-headed blackbirds ranged from 20 ng/g to 380 ng/g wet weight, averaging 210 ng/g. Lipid-normalized concentrations ranged from 300 ng/g to 17 ug/g, with an average of 10.7 ug/g. Eggs had less variability in their concentrations, and averaged 390 ng/g wet weight and 10.3 ug/g lipid weight. Despite the variability in the PCB concentrations in the birds, there was no relationship of PCB concentration to the skewed sex ratios found in the exposed population. Thus, the skewed sex ratios were not attributed to PCB exposure.

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Human Activities, Management, and Conservation

Effects of Land Use, Sediment, and Temperature on the Distribution of Benthic Invertebrates and Fish in the Whitewater Watershed

Investigator: Bruce Vondracek

Student: Brian Nerbonne, MS and Carson Cox, MS
Duration: June 1996 to December 1998
Funding Sources: Minnesota Pollution Control Agency
Project Location: Olmstead, Wabasha, and Winona Counties, Minnesota and the Minnesota Cooperative Fish and Wildlife Research Unit

Conventional agricultural practices have been shown to have several negative effects on streams. Conventional agricultural land use deposits large amounts of sediment in streams, which impacts habitat for aquatic organisms. Best management practices (BMPs) such as vegetated buffer strips or no-till plowing have been purported to reduce sediment delivery rates. The goal of our study is to determine if BMPs are beneficial to instream organisms and stream quality.

Benthic macroinvertebrate, fish, and habitat assessments have been conducted at 20 sites in 1996 and were repeated in 1997 with the addition of 7 new sites in the Whitewater Watershed. The objectives were to: 1) document land use using existing GIS databases, and perform statistical evaluation of physical and biological data in relation to land use, 2) evaluate effects of land use on fish and invertebrate community structure, and 3) evaluate potential changes in substrate composition and associated aquatic community along where BMPs have been implemented.

We sampled sites on the three main branches of the Whitewater Watershed. Agricultural sites were selected to include both conventional and BMPs. By design, we selected conventional and BMP sites along woody or grass buffers in clusters to characterize local effects and minimize larger-scale effects. Physical habitat assessments were also conducted to examine both instream and riparian conditions.

Conclusion: Physical habitat characteristics differed across buffer types, but not upland land use. Percent fines and embeddedness were negatively correlated with buffer width. Grass buffers generally had significantly lower % fines, embeddedness, streambank bare soil, and higher % cover and pool area when compared with grazed or wooded buffers. RBP and IBI scores were not significantly different across land uses, but were correlated with instream physical habitat variables. RBP and IBI scores were both negatively correlated with % fines and embeddedness, and positively correlated with width-to-depth ratio.

The cumulative amount of agricultural land within 100 meters of a stream was positively correlated with increased sedimentation, higher percentages of omnivorous fish and white sucker, and more tolerant and less diverse macroinvertebrate communities. In contrast, the amount of riparian deciduous forest, as well as riparian areas with a combination of grasses, shrubs, and deciduous trees, were positively correlated with larger substrate sizes, larger percentages of insectivorous fish, and higher macroinvertebrate species richness. This study supports the use of vegetated riparian buffer strips to reduce stream sediment inputs, and indicates that management efforts may be most efficient when focused within the cumulative riparian buffer.

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Impact of Management Intensive Grazing Practices on the Stream Biota and Stream Habitat of Five Southeastern Minnesota Farms

Investigator: Bruce Vondracek
Student: Laurie Sovell, MS and Julia Frost, MS
Duration: June 1994 to November 1997
Funding Source: Minnesota Institute for Sustainable Agriculture
Project Location: Dodge, Goodhue, Scott, and Winona Counties, Minnesota and the Minnesota Cooperative Fish and Wildlife Research Unit

The National Research Council's 1989 report entitled "Alternative Agriculture" identified a number of environmental and economic problems associated with conventional US agriculture including surface water and groundwater pollution, and soil erosion. From 1994 to 1996, aquatic biota and stream habitat were monitored as part of a team approach to evaluate the economic, social, and ecological impacts of Management Intensive Grazing (MIG) practices on farms in southeastern Minnesota.

MIG is a farming system under which plots of grass are grazed by livestock rotated among numerous small paddocks. Water chemistry, physical habitat, benthic macroinvertebrate, and fish data were collected from five streams on MIG farms and paired conventional farms (continuously-grazed or row-cropped) to compare water quality impacts of these farming systems. In addition, the influence of grass and woody riparian buffer zones on stream habitat and biota were evaluated.

Conclusion: Principal Components Analysis (PCA) distinguished stream systems, indicating a watershed effect. Water chemistry and physical habitat PCAs distinguished stream reaches with continuous grazing from reaches with rotational grazing, and reaches with wood-buffers from reaches with grass or no buffer, indicating a local management effect. Monthly and mean fecal

coliform and turbidity were consistently higher along continuously-grazed than rotationally-grazed reaches. Width:depth ratios and substrate % fines were significantly higher along wood-buffers than grass and no-buffer areas. Canopy cover was significantly higher along a grass buffer than a wood-buffer on one system. Benthic macroinvertebrate indices suggested better relative water quality along wood-buffers than grass or no-buffers. Fish density and community composition were related to riparian condition, as opposed to grazing practices. Substantially fewer fish were found at the wood-buffer station, than at the grass or no-buffer stations on one system. On a second system, fewer large fish were found at the wood-buffer and no-buffer/rotationally-grazed stations than at the grass buffer/rotationally-grazed stations.

The results of this study have important implications for stream restoration programs in the midwestern United States. Riparian management comparisons suggest further consideration and study of a combination of grass and wood riparian buffer strips as midwestern stream management options. The use of ecological monitoring to implement rotational grazing may provide an intermediary land use tool in the agricultural midwestern United States. Results were used to identify indicators of stream quality as part of a monitoring toolbox developed to facilitate on-farm ecological, financial, and quality of life monitoring.

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Individual-Based Walleye Simulation Model

Investigator: Ira Adelman and Yosef Cohen

Students: Jingyin Li, Ph.D.

Duration: July 1996 to July 1997

Funding Source: Minnesota Department of Natural Resources

Project Location: Department of Fisheries and Wildlife, University of Minnesota

Walleye (*Stizostedion vitreum vitreum*) stocking has been a standard management practice in Minnesota for over half a century. Since the 1950s, more than 7.5 billion young and adult walleye have been stocked in numerous Minnesota waterbodies. This walleye stocking program comprises an important portion of the budget of the Minnesota Department of Natural Resources (MNDNR), Section of Fisheries. Although walleye stocking has been extensively practiced in North America, its effectiveness has not been investigated quantitatively on a broad scale.

In a previous study, we used data from MNDNR lake surveys and stocking records to examine the effects of walleye stocking on the abundance, size of fish, and year-class strength in walleye populations and to determine to what extent and under what conditions these effects occurred. We used 4,470 lake surveys from 1,924 lakes and 20,634 walleye stocking records from 1,716 lakes. These data provided a vast amount of information on the effects of stocking on fish populations, which was not available from site-specific studies reported in the literature. Based on our analysis of these data, we found that stocking increased the abundance of the stocked year class, with a larger increase in lakes without natural walleye reproduction than in lakes with natural walleye reproduction. However, stocking also had negative effects. These were a decrease in the strength of the year classes adjacent to the stocked year class in lakes with natural walleye reproduction. Walleye stocking is most likely to contribute to walleye population abundance in lakes where walleye reproduction is limited but food is not limiting. This study confirms what fisheries managers have long believed but had not been able to verify on a broad scale, i.e., walleye should not be stocked in lakes where natural reproduction occurs.

To further explore the effects of walleye stocking, we developed an individual-based simulation model for walleye populations based on data from the literature and our own study. The model is window and menu based and has a user friendly interface. The model has the capacity to incorporate information about system carrying capacity, stocking strategy, and fishing pressure, and predicts how stocking and other management strategies will affect the fish population.

Conclusion: The current model replicates the empirical findings of the effect of stocking and harvest regulations on population structure and abundance. A subsequent project, funded by the Minnesota Legislature, has enabled us to validate the model by field testing its predictions and to further refine the model so that it is even more "user friendly." That work is underway and should be complete in about 12 months. MNDNR managers are currently using the model to explore various management options.

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Status Assessment for the Great Lakes Population of Common Terns

Investigator: Francesca J. Cuthbert

Student: Kristina Timmerman, Ph.D.

Duration: September 1995 to December 1997

Funding Source: US Fish and Wildlife Service
Project Location: University of Minnesota, St. Paul

During the past several decades a number of studies have reported significant declines in local populations of the common tern (*Sterna hirundo*) in the Great Lakes region. The purpose of this study was to: evaluate the current status of the Great Lakes population, summarize common tern life history, determine major threats to common terns in the Great Lakes region, and summarize management/protection efforts and priorities for this species.

When examined on a state or provincial basis, there is very strong evidence that common terns have experienced significant population declines. Using this historical perspective, only one state (Vermont) has recorded a population increase (+1100%). Three populations in states (Illinois, Indiana, Pennsylvania) with historically small numbers (<25 pairs) are essentially extirpated. The remaining populations in 5 states (Minnesota, Wisconsin, Michigan, Ohio, New York) and 1 province (Ontario) have declined approximately 20-99% during the 1900s.

The most serious threats to common terns include destruction and modification of habitat and predation. Habitat loss is caused by competition with ring-billed gulls (*Larus delawarensis*) for nest habitat and annual variation in the amount of available habitat based on fluctuating Great Lakes water levels. Predation causes mortality of eggs, chicks and adults and results in significantly lowered reproductive success at some colony sites. Other important threats include human disturbance and contaminants. Threats impacting terns have resulted in extensive knowledge and tested methodology to enhance colony productivity and protection in the Great Lakes. These include habitat management (e.g., habitat restoration, enhancement, creation, and acquisition), predator control, eliminating or minimizing competition for nest sites, and prevention of human disturbance.

Conclusion: Long-term survival of the common tern in the Great Lakes region requires monitoring, intensive local management, communication and conservation. The following are region-wide research and management priorities: (1) a reliable, periodic, coordinated international census, (2) identification of a network of important breeding sites, (3) identification of important colonies in need of special attention, (4) communication with state and provincial governments regarding the importance of consistent and coordinated monitoring and management, (5) standardized methods for collecting and reporting population trend data, (6) collation of extensive information on methodology for enhancing common tern survival and reproductive success, (7) analysis of North American band recoveries to assess certain biological population boundaries and facilitate management coordination, (8) recognition of the potentially important role contaminants may play in the protection of this species, and (9) the need for information on the biology and distribution of Great Lakes common terns during migration and winter.

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The Effect of Human Disturbance on the Endangered Great Lakes Piping Plover

Investigator: Francesca J. Cuthbert
Student: Lauren Wemmer, Ph.D., Alice Doolittle, MS, and Lisa Climo, MS
Duration: May 1994 to June 1997
Funding Source: US Fish and Wildlife Service, East Lansing Field Office, Michigan
Project Location: Northern Michigan and the Atlantic Gulf Coast

This study addresses several aspects of piping plover (*Charadrius melodus*) biology and management needed for recovery of the endangered Great Lakes population. Work was done on the breeding population in northern Michigan and also on wintering birds along the Atlantic Gulf Coast.

Winter ecology and distribution:

Objectives were to locate plovers wintering along the Gulf Coast, determine daily patterns of habitat use, identify plovers from reading leg band combinations and evaluate habitat quality.

Conclusion: Several hundred piping plovers were located, but only one was identifiably (banded) from the Great Lakes population. Based on observation of plovers in winter, analysis of winter habitats was conducted to determine if plovers select wintering sites containing certain configurations of landcover components. A Geographic Information System was used to calculate the areas of landcover types within one km of shorebird sites on the Gulf Coast of Florida. Results of statistical tests indicated a significant difference in three cover types between plover and non-plover sites. Percentage of coastal sand and open water were significantly higher around plover sites than non-plover sites; percentage of marsh was significantly lower around plover sites than non-plover sites. These results indicate that piping plovers are selecting high energy shorelines that are sparsely vegetated. This analysis will be expanded to include an examination of land use, land ownership, and human population density to identify conservation concerns and

provide additional management guidelines for wintering piping plovers.

Breeding population research:

We continued to monitor the breeding population of piping plover in northern Michigan.

Conclusion: The number of nesting pairs increased from 21 to 23 from 1995 to 1996. An effort to develop a population model is continuing using recent data. This model incorporates use of captive rearing to enhance the population. Work to identify important habitat features and to evaluate habitat availability in northern Michigan was continued in 1996. All active plover sites and important historical nesting sites in northern Michigan were photographed using aerial videography. Sites were ground truthed and data on human disturbance and prey availability were collected for integration into the evaluation of habitat requirements of plovers during the breeding season.

Trophic Ecology of Young-of-the-Year Walleye in Minnesota Rearing Ponds

Investigator: George R. Spangler

Student: Alan McClure, Ph.D.

Duration: June 1991 to June 1998

Funding Source: Minnesota Department of Natural Resources

Project Location: University of Minnesota, St. Paul

We review some methods that have been used to grow walleye (*Stizostedion vitreum*) fingerlings for release into natural waters. Results are discussed in the context of the autecology of larval and juvenile walleye. Ecological processes thought to be important in the small, shallow, productive lakes that are used for fingerling culture are examined through two new techniques: otolith increment analysis and stable isotope nutrient pathway analysis.

Conclusion: Stable isotope analysis indicates that biological production pathways may differ significantly in ponds that appear somewhat similar in their morphology and biological communities. Carbon and nitrogen stable isotope ratios were determined for samples of terrestrial vegetation from Gunclub pond, Camp Galilee Pond, and La Lake, all within a 30-km radius of St. Paul, Minnesota. Most of the samples of terrestrial vegetation clustered around $\delta^{15}\text{N}$ and $\delta^{12}\text{C}$ values of $+1.5\text{‰}$ and -29‰ respectively. Values of $\delta^{15}\text{N}$ for aquatic macrophytes and phytoplankton were similar within both the Gunclub and Camp Galilee Ponds, although they were slightly more depleted in ^{14}N in Gunclub Pond. The relationships between the isotope ratios observed in the different trophic categories generally conform to expectations. In both Gunclub and Camp Galilee Ponds the sampled sources of production can not fully explain isotope ratios observed for chironomids, and to a lesser degree, zooplankton. The unusually large (less negative) $\delta^{12}\text{C}$ values in the Camp Galilee pond are reflected at higher trophic levels and result in distinctly different isotope signatures for comparable trophic categories in the Camp Galilee Pond and in Gunclub Pond. Relatively low $\delta^{12}\text{C}$ of walleye in La Lake suggests that processes there differed also from the Camp Galilee pond. We conclude that significant differences exist in the pattern of community carbon fixation in these ponds.

High-resolution growth analysis based upon short-term otolith increments offers promise for defining critical periods in the life of juvenile walleye. Otolith images clearly exhibit banding patterns that are likely correlates with daily growth. In many cases, counting the bands will result in a "number of days" corresponding to the known age of the fish. A small part of the growth record at the center of an otolith is used to divide each growth increment into a part due to location on the otolith (angle and radius), and a part due to age, past growth, and "environment." This allows otolith shape to change as the fish grows. The angle between a given transect and individual growth rings is used to predict this effect at all distances along all transects resulting in a factor that can be used to expand or contract the spatial scales so that distance along the transect corresponds to the same time on all the transects. Even though analytical advances have been made in interpreting otolith banding patterns, we are still unable to interpret absolute growth events in the walleye ponds.


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Ongoing Research January 1997 - December 1998

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Applied Ecology

Age and Growth of Lake Herring in Lake Superior

Investigator: George R. Spangler and Donald L. Peireira

Duration: September 1993 to present

Funding Source: Minnesota Department of Natural Resources

Project Location: Lake Superior and Department of Fisheries and Wildlife, University of Minnesota

The shallow-water cisco, (*Coregonus artedii*), also known as the "lake herring" has been rebounding in abundance in Lake Superior since 1980, nearly three decades after the collapse of the lake trout (*Salvelinus namaycush*) community. Lake herring in Lake Superior suffered drastic declines in the 1950s and 60s and remained at low abundance through the 70s and early 80s. However, there have been several large year classes recently and it is generally believed that the lake herring population is recovering lakewide. A comprehensive record of relative growth for this period may lead to a better understanding of the complex dynamics involved in lake herring growth and abundance. Comparisons of growth histories between different geographic regions of the lake should help us to understand whether regional differences between stocks should be taken into account in the lakewide management of this species. To further understand lake herring growth dynamics, we are developing separate biochronologies for four different sites on Lake Superior. The chronologies span a period extending back from the present until the early 1960s and are based on scale sample collections on loan from the Wisconsin DNR, Minnesota DNR and the Ontario Ministry of Natural Resources. Once the chronologies have been established, they will be compared to site specific temperature and abundance time series. Lake herring growth is thought to be density dependent, and thus, should reflect differences in their own densities, as well as the abundance of competing species. If cisco growth is sensitive to annual variations in water temperature, we expect to find some degree of correlation between temperature time series and the lake herring biochronologies.

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Eastern Prairie Population Canada Goose Breeding Ecology

Investigators: David E. Andersen and Donald H. Rusch

Students: James C. Manolis, M.S./Ph.D. and Ethan F. Perry, MS

Duration: Ongoing

Funding Sources: U.S. Fish and Wildlife Service, Mississippi Flyway Council, (EPP Canada Technical Committee), Manitoba Department of Natural Resources, Minnesota Department of Natural Resources, Iowa Department of Natural Resource, Missouri Department of Conservation, Arkansas Game and Fish Commission, Canadian Wildlife Service

Project Location: Cape Churchill, Manitoba, Minnesota Cooperative Fish and Wildlife Research unit, Wisconsin Cooperative Wildlife Research Unit

Eastern Prairie Population (EPP) Canada geese (*Branta canadensis*) breed in the Hudson Bay Lowlands in northeastern Manitoba. This group of birds migrates through southern Manitoba and western Minnesota, and historically wintered in Missouri and Arkansas. Because they nest in the sub-Arctic, EPP geese exhibit wide variation in productivity and recruitment, and information regarding breeding ecology and population status is required to effectively manage harvest.

Research on breeding ecology of this population of Arctic-nesting geese has continued since the 1960s, and information from these studies has been used to develop management and harvest strategies. Long-term monitoring of breeding density, nesting success, gosling production, and other breeding population parameters has resulted in information useful in modeling this populations--these on-the-ground data collection activities are ongoing annually. These monitoring efforts occur in close proximity to the La Perouse Bay snow goose (*Anser caerulescens caerulescens*) colony, and over the past 20 years, snow goose use of the study area has increased dramatically. During the same period, breeding densities of Canada geese have dropped dramatically, and snow geese now dominate numerically in historic Canada goose brood-rearing

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areas. Currently, a research project designed to better understand the relationship between Canada and snow geese on the breeding grounds is under development. Field activities in 1997 and 1998 included monitoring breeding density, nesting success, and other breeding population parameters at the Cape Churchill study area, and assistance in operational banding of EPP Canada geese on the breeding grounds. In addition, surveys for nesting songbirds and shorebirds were conducted in 1998, and these data will be compared to similar data collected in 1984.

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Fall Local Movements, Foraging, and Population Dynamics of Tundra Swans on the Upper Mississippi River

Investigator: James A. Cooper

Duration: October 19998 to September 2000

Funding Source: US Fish and Wildlife Service, Upper Mississippi Science Center, Upper Mississippi River National Wildlife & Fish Refuge, Wisconsin Department of Natural Resources, Minnesota Department of Natural Resources

Project Location: Upper Mississippi River

The Eastern Population (EP) of tundra swans (*Cygnus columbianus*) contains an estimated 90,000 individuals, and has exhibited an annual rate of increase from 1955 to 1989 of approximately 2.4%. The EP now exceeds the North American Waterfowl Management Plan goal of 80,000. The Upper Mississippi River is a major fall stopover site for migrating tundra swans, yet little is known about fall migration ecology of swans that use this site. There are few data on migratory behavior, control and physiology of fall migration, or energy storage and use by fall-migrating swans. Factors that affect fall migration may have important consequences for managing staging areas, such as the Upper Mississippi River National Wildlife and Fish Refuge, which contains a large portion of the area of the Upper Mississippi River used by swans. To begin to address these data needs, the current project will specifically address the following objectives:

- 1) collect locational data from radio-marked family groups and non-breeders during the day and at night to learn about local movements and habitat use
- 2) determine initial body condition and subsequent day and nocturnal time activity budgets for marked family groups and non-breeders
- 3) estimate the length of stay for family groups and non-breeders using radio-marked individuals. Count total number of swans and cygnets on weekly aerial waterfowl surveys
- 4) document use of the Upper Mississippi River National Wildlife and Fish Refuge by trumpeter swans in the fall while tundra swans are present.

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Foraging Behavior of California Sea Lions at San Miguel Island, California

Investigator: Donald B. Siniff

Students: Sharon Melin, Ph.D.

Duration: September 1996 to June 2000

Funding Source: National Marine Mammal Laboratory, Seattle, Washington

Project Location: University of Minnesota, St. Paul and San Miguel Island, California

This project focuses on describing the annual patterns of foraging behavior, movements, and distribution of California sea lions (*Zalophus californianus*) at San Miguel Island, California. The purpose of the study is to identify behaviors that are sensitive to changes in carrying capacity levels for use as indices to evaluate the population status relative to optimum sustainable population levels.

Two reports have been completed as of May 1998. The first, describes the movements of different age and sex classes of individuals from San Miguel Island obtained from a 10-year mark-recapture study. The results indicate that sexual segregation occurs with males dispersing farther north from San Miguel Island as they get older and females contracting their movements with age. The second report contains preliminary analyses of the foraging behavior, movements and distribution of adult females from data collected from Satellite Linked Time Depth Recorders that were deployed on 20 adult female California sea lions in 1992, 1993, 1995, and 1996. The data include foraging and haul-out locations, dive depths, and dive durations. Preliminary analyses indicate that reduced prey availability affects both the foraging distribution and diving behavior of adult females and suggest that these behaviors may change with population density. However, further analyses are required to determine the relationships between different environmental factors and behavior parameters.

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Great Lakes Colonial Waterbird Survey

Investigator: Francesca J. Cuthbert

Duration: May 1997 to June 2001

Funding Source: US Fish and Wildlife Service

Project Location: Great Lakes Ecosystem and University of Minnesota, St. Paul

Colonial waterbirds are a significant biological resource in the Great Lakes ecosystem. Information on their distribution and abundance is essential for implementing effective conservation and management strategies. Comprehensive surveys of colonial waterbirds in the US portion of the Great Lakes were conducted in 1976-77 and 1989-91. Results from these efforts documented significant population increases [especially ring-billed gulls (*Larus delawarensis*) and double-crested cormorants (*Phalacrocorax auritus*)], monitored species with small populations, and identified critical breeding habitat for colonial waterbirds in the Great Lakes. The 1997-99 survey attempts to duplicate surveys conducted in the two previous decades. Analysis of these 3 data sets will provide the first comprehensive picture of 20 year population trends including identification of historically stable colony sites, species-specific habitat requirements, and issues of conservation and management concern.

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Great Lakes Piping Plover Research Review

Investigators: Francesca J. Cuthbert

Duration: August 1998 to June 2000

Funding Source: US Fish and Wildlife Service, Region 3

Project Location: University of Minnesota, St. Paul

Piping plovers (*Charadrius melodus*) historically nested along the shoreline of all the Great Lakes and were once considered locally common throughout the Great Lakes region. Due to loss of breeding sites to development and recreation, the population dropped to 31 pairs in Michigan by 1979. By 1986, when the Great Lakes piping plover was listed as federally endangered, only 17 pairs remained. In 1988 the recovery plan for the Great Lakes and Northern Great Plains populations of the piping plover was approved by the US Fish and Wildlife Service. At the time the recovery plan was prepared, management/monitoring efforts were minimal and knowledge about the biology of the population was limited to several distributional studies. The purpose of this research is to use published and unpublished literature and data to identify current distribution, habitat requirements, and threats to population recovery, and to evaluate current and proposed conservation strategies for the Great Lakes population of piping plovers.

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Microhabitat Selection, Spawning Behavior, and Growth of Three Trout

Investigator: Bruce Vondracek

Student: Gerold C. Grant, Ph.D.

Duration: September 1992 to June 1999

Funding Source: Cargill Fellowship, Kalamazoo Chapter of Trout Unlimited, Sigma Xi, and Special Projects Foundation of the Big Game Club

Project Location: Valley Creek, Washington County, Minnesota and Minnesota Cooperative Fish and Wildlife Research Unit

It has been suggested that stream trout choose microhabitats that optimize their net energy intake and therefore maximize growth. To maximize energy intake, stream trout likely occupy microhabitats with low water velocity to minimize swimming costs, but close to high velocity water, which supplies more drifting prey. Past studies on microhabitat use have relied upon single observations of fish position to quantify microhabitat use. No studies have successfully related microhabitat use and behavior to growth in natural environments.

We are approaching this question using new techniques to quantify microhabitat use, behavior and growth of trout in Valley Creek. Our techniques include using submersible video cameras and a time lapse recorder to remotely observe trout behavior and microhabitat use. In addition to traditional growth measurements, we are measuring RNA/DNA ratios in muscle tissue biopsies, which we have shown to reflect recent growth rates in adult brown trout (*Salmo trutta*). This was the first study in which RNA/DNA ratios were measured from a tissue sample from adult fish without sacrificing the animal.

In 1995 and 1996, we quantified growth rates of sympatric brook (*Salvelinus fontinalis*), brown and rainbow (*Oncorhynchus mykiss*) trout in Valley Creek throughout the year. In summer of both

years, we collected data on microhabitat use and behavior using time lapse video recordings, and quantified habitat availability. In summer 1996, we quantified availability of drifting prey in Valley Creek, as well as diet composition in the three species of trout, to determine how much these fishes rely on drifting prey items. Hypotheses about trout microhabitat use will be tested by comparing microhabitat use and growth rates to those predicted by models for drift-feeding salmonids.

We examined reproductive behavior of brook and brown trout during 1995. Spawning trout were monitored over 24-hour periods using time lapse video recordings and submersible video cameras illuminated by infrared lights. Time budgets were estimated from observations of 13 redds (spawning nests) of brook and brown trout. We quantified the percent time redds were occupied by male and female trout of each species, and the percent time females spent excavating the nest, spawning and covering the eggs as well as the number of males present and percent time males spent in agonistic behavior. Further analysis of these recordings will be performed to quantify intraspecific spawning activity in sympatric brook and brown trout.

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Population Ecology of California Sea Lions in the California Current Ecosystem

Investigator: Donald B. Siniff

Student: Sharon Melin, Ph.D.

Duration: July 1997 to June 1998

Funding Source: National Marine Fisheries Service - National Marine Mammal Laboratory

Project Location: San Miguel Island, California and the University of Minnesota, St. Paul

The National Marine Mammal Laboratory is involved in a study of population biology of pinnipeds at San Miguel Island, California. The work encompasses foraging behavior studies, tagging pups annually to trace movement patterns as individuals mature, and following individual females to maturity and considering longitudinal studies of their reproductive patterns. An understanding of these aspects of the biology of California sea lions (*Zalophus californianus*) is essential to further the understanding of the ecological role of this pinniped species in the California Current Ecosystem and to aid in describing how they compete with other pinniped species for food and other resources. For some of this work the use of satellite-linked time depth recorders will provide the methodology to collect data on movement patterns at sea, and foraging behavior. Sightings of females tagged as pups on San Miguel Island will be used to produce estimates of natality rates, ages of reproduction, and descriptions of the patterns of reproduction of adult females in the population. This project will consist of analysis of existing data to address these and other issues.

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Review of Research Pertaining to Double-crested Cormorants in the Eastern US

Investigators: Francesca J. Cuthbert

Duration: August 1998 to September 1999

Funding Source: US Fish and Wildlife Service, Regions 3, 4, and 5

Project Location: University of Minnesota, St. Paul

Double-crested cormorants (*Phalacrocorax auritus*) have increased significantly in eastern North America during the past several decades and are creating a variety of damage problems, both real and perceived. The purpose of this research is to review existing information on cormorants in the eastern US and assess the status of this species in this portion of its range. The assessment will include the following information: overview of species taxonomy and summaries of life history, population trends, population modeling efforts, and diet studies. Additionally, information on cormorant impacts, management considerations, ongoing cormorant research/monitoring efforts, and priority research needs relevant to management will be included.

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Review of Research Pertaining to Northern Goshawk (*Accipiter gentilis*) in the Western Great Lakes Region and Ontario

Investigator: David E. Andersen, Ted Dick, and David Plumpton

Duration: May 1997 to December 1998

Funding Source: US Fish and Wildlife Service

Project Location: University of Minnesota, St. Paul

Northern goshawks (*Accipiter gentilis*) have been the subject of considerable conservation concern, especially in the southwestern US, the Pacific Northwest, and southeast Alaska. Several petitions for listing under the federal Endangered Species Act have been filed. In the western Great Lakes Region, northern goshawks are considered a sensitive species by the US Forest

Service, and have been considered by several states for listing as species with special status. This project is designed to provide an overview of research activities past and present related to northern goshawks in the western Great Lakes Region.

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Trophic Cascade Interactions in a Coldwater Stream

Investigators: Bruce Vondracek and Raymond M. Newman

Student: Carl Ruetz, Ph.D.

Duration: September 1997 to August 2002

Funding Source: Cargill Fellowship

Project Location: Valley Creek, Washington County, Minnesota and the Minnesota Cooperative Fish and Wildlife Research Unit

A three-year field study is underway to investigate the effects of fish on benthic macroinvertebrates, benthic algae, and leaf litter processing in Valley Creek, Minnesota. This study will provide a better understanding of multiple trophic level interactions in streams. Spatial and temporal scales are important experimental and ecological components of food web studies that have not been well assessed. This study will address these factors by increasing the size of the experimental unit in manipulations and repeating experiments each season. Further, there is conflicting evidence about predator-prey interactions in streams between fish and benthic macroinvertebrates. A better mechanistic understanding of predator-prey interactions would allow experimental results to be understood in a more meaningful general context. The objectives are to determine: 1) the effect of sculpin (*Cottus cognatus*) on benthic macroinvertebrates, periphyton, and leaf litter processing within riffles, 2) if the relationships between sculpin, benthic macroinvertebrates, periphyton, and leaf litter processing vary over space (i.e., within riffle vs. whole riffle) and time (i.e., between seasons), and 3) if the relationships between sculpin, benthic macroinvertebrates, periphyton, and leaf litter processing change when the spatial scale is increased to pool-riffle habitats and trout are included in the food web.

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Human Activities, Management, and Conservation

Breeding Ecology of Forest-nesting Birds in North-central Minnesota

Investigators: David E. Andersen

Students: James C. Manolis, MS/Ph.D.; Ethan F. Perry, MS; and John Sammler, MS

Duration: May 1997 to April 2002

Funding Sources: US Global Climate Change Research Program and US Geological Survey-Biological Resources Division

Project Location: Chippewa National Forest and the Minnesota Cooperative Fish and Wildlife Research Unit

Considerable concern exists regarding the status and population trends of nongame birds. However, little information is available regarding nesting success and productivity for many species, and the impacts of forest management practices on nesting birds are not well understood. Beginning in 1992, we have monitored nesting and reproduction of forest-nesting birds on from 4-6, 40-50 ha plots on the Chippewa National Forest in north-central Minnesota.

Over the 7-year study period, we located and monitored 1669 nests of 47 species on permanent plots in mature northern hardwood forest. During that period, habitat nesting success estimates were 0.55 for all species combined and 0.42 for Neotropical migrants. Northern Minnesota is thought to serve as an important source area for many forest-nesting birds, as it remains predominantly forested. To date, our efforts have focused on dealing with methodological problems associated with estimating nesting success with forest-nesting passerines, the effects of forest management practices on nesting success, and the ecology of an interior forest-nesting species that has experienced long-term population decline. This project is a continuation of a previous project (see Biodiversity Monitoring: Breeding Productivity, Habitat, and Winter Distribution of Nongame Birds).

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Citizen Monitoring: Can Widely-used Protocols Discriminate Benthic Communities in Relation to Land Management Changes?

Investigator: Bruce Vondracek

Student: Julia Frost, MS

Duration: June 1997 to June 1999

Funding Source: National Fish and Wildlife Foundation and the Department of Fisheries and

Wildlife at the University of Minnesota

In the past ten years, biological monitoring has become a popular way to identify pollution problems. Since the advent of Hillsenhoff's Biotic Index and the US Environmental Protection Agency Rapid Bioassessment protocols, monitoring benthic communities has helped agencies, researchers, and citizen groups to classify streams as poor, fair, good, or excellent. Invertebrate metrics have given researchers the ability to compare the relative health of different streams and to gain a richer understanding of how the biotic community has responded to changes in land use.

While this approach may be informative, it is not clear that changes in agricultural land use will yield quantifiably different communities in a reasonable amount of time after the changes have taken place. In addition, it is labor intensive and may require identification of organisms to a level that can be prohibitive for those without extensive training, such as farmers or citizen monitoring groups. In this project we are: 1) Surveying the macroinvertebrate community in a small, diversely utilized watershed in southeastern Minnesota to determine whether there are differences in the macroinvertebrate community within the range of different types of current land use, 2) Investigating the ability of existing national monitoring protocols to serve the needs of farmers and citizen volunteers, and 3) Creating a new monitoring protocol, specific to the southeast Minnesota region, that will better serve the local communities.

Preliminary analysis indicates that volunteers who are new to monitoring identify less than half of the taxa correctly. With the use of a confusion matrix analysis we gained insight into the nature of their mistakes, learning that many errors were systematic, and could be correlated with a lack of representation on identification cards. National monitoring protocols may have to regionalize identification cards to better serve volunteers.

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Data Acquisition, Analysis, and Presentation in Support of Comprehensive Management Planning

Investigators: Thomas E. Burk

Duration: August 1997 to September 1999

Funding Source: US Fish and Wildlife Service

Project Location: University of Minnesota, St. Paul

As a public land managing agency, the US Fish and Wildlife Service (FWS) policy is to manage its lands in accordance with an approved Comprehensive Management Plan (CMP). The FWS is expanding its efforts to complete CMPs for its lands within Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, Ohio, and Missouri. To ensure that FWS lands contribute to the conservation of biological diversity and to the structure and function of the ecosystem in which they are located, it is necessary to acquire, analyze, and present data in a geo-referenced system. Many data exist, but they are commonly not organized in a way that is useful for specific study areas. In some cases data are available, but not in digital form. In those instances, data must be converted into a digital format. Once the data are organized in a compatible system, it must be further manipulated so that its presentation is understandable to managers and the public. This project is designed to facilitate acquisition and management of these data.

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Development of a Research and Monitoring Framework for Northern Goshawks in the Western Great Lakes Region

Investigators: David E. Andersen and Patricia L. Kennedy (Colorado State University)

Duration: January 1998 to April 1999

Funding Source: US Fish and Wildlife Service, Minnesota Department of Natural Resources, National Council of the Paper Industry for Air and Stream Improvement, Inc., College of Natural Resources (University of Minnesota), Minnesota Cooperative Fish and Wildlife Research Unit, US Forest Service, and the Wisconsin Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Northern goshawks (*Accipiter gentilis*) have been the subject of considerable conservation concern, especially in the southwestern US, the Pacific Northwest, and southeast Alaska. Several petitions for listing under the federal Endangered Species Act have been filed. In the western Great Lakes Region, northern goshawks are considered a sensitive species by the US Forest Service and have been considered by several states for listing as species with special status. This project is designed to provide a framework for research on and monitoring of northern goshawks in the western Great Lakes Region. In January 1998, we convened a meeting of representatives of state and federal conservation agencies and non-governmental conservation organizations to develop a regional perspective on goshawk conservation and management issues. Based on the priorities set by this group and a summary and evaluation of existing information on goshawks in this region, we

developed a regional research and monitor picture for northern goshawks.

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Evaluation of the Effects of the Grass Lake Wetland Restoration on Migratory Birds

Investigator: David E. Andersen, James A. Cooper, Francesca J. Cuthbert, and Susan M. Galatowitsch

Duration: September 1997 to December 2002

Funding Sources: US Fish and Wildlife Service

Project Location: Grass Lake, Minnesota and the Minnesota Cooperative Fish and Wildlife Research Unit

One of the primary justifications for restoring wetlands through the North American Waterfowl Management Plan program is to provide benefits to migratory birds and other wildlife. However, there is currently not a plan in place to monitor use of these, or most other, restored wetlands by migratory birds, or to evaluate the effects of restoration on birds and other wildlife. Wetland restoration at Grass Lake and the Eagle Lake wetland complex in northern Iowa affords a unique opportunity to evaluate and monitor response of migratory birds to wetland restoration. The purpose of this initial project is to develop research protocols and plans to evaluate the effects of these restorations and to collect baseline data prior to lake restoration.

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Larval Fish Populations on Tributaries of the Red River

Investigator: Bruce Vondracek and Jay Hatch

Student: Maija Meneks, MS

Duration: January 1998 to June 2000

Funding Source: Minnesota Department of Natural Resources

Project Location: Polk, Norman, Clay, and Wilkin Counties, Minnesota and the Minnesota Cooperative Fish and Wildlife Research Unit

Information on early life stages of fishes in tributaries of the Red River of the North is needed for policy recommendation in relation to extensive alteration of streams and land use practices within the watershed. The extent to which these changes have affected fish production in the tributaries is unknown. This study proposes to answer questions about the distribution of larval fishes as related to available habitat, chronology of reproduction of each species, and effects of stream alteration on fish communities. Specifically, we compare larval fish assemblage and abundance in relation to tributary characteristics, degree of alteration, availability of habitats, and describe phenology of larval fish production in tributaries. Study sites include channelized and unchannelized reaches of the Buffalo and Sandhill Rivers, major tributaries to the Red River.

Preliminary analysis indicates a higher number of species, higher average number of species, and a higher percentage of larval fish in unchannelized stream within both watersheds. Fathead minnows (*Pimephales promelas*) dominate samples from channelized sites. A higher percentage of species tolerant of habitat degradation, especially fathead minnows and carp (*Cyprinus carpio*), are also found in channelized reaches.

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Stream Fish Distribution and Habitat in Relation to Land Use, Geology, and Geomorphology in Southeastern Minnesota

Investigator: Bruce Vondracek

Student: Kristen Blann, MS

Duration: September 1997 to August 1999

Funding Sources: Minnesota Department of Natural Resources

Project Location: Root, Zumbro, and Cannon River Watersheds, Minnesota Cooperative Fish and Wildlife Research Units, and the Main Office of the Department of Natural Resources

Stream ecologists stress the need to understand the relative influences on stream processes of effects at different scales. Concern over the alarming rate of habitat alteration and increasing pressure on aquatic systems has translated into primarily site-level restoration and management strategies, while larger-scale processes (at the watershed or subwatershed level) that may account for many of the observed habitat losses at a site are left unresolved or remain poorly understood.

Existing data on hydrology and hydrography, geology, stream morphology, and land use are being combined in a geographic information system (GIS) with stream survey data regarding physical

habitat, presence/absence and relative abundance of stream fish, and patterns of assemblage structure in fish communities in three major watersheds in southeastern Minnesota. These data are being analyzed to: a) identify landscape-level patterns in fish species distributions, b) characterize relationships between drainage basin variables and instream fish habitat, and c) develop a model for identifying and classifying southeastern Minnesota streams according to their potential for rehabilitation, maintenance, protection, or restoration based on fish community composition. The degree to which landscape level variables such as geology, land use, drainage area, and local groundwater inflow can explain reproductive success and allopatry versus sympatry in native brook trout (*Salvelinus fontinalis*) and introduced brown trout (*Salmo trutta*)--whether through direct impacts or through influence on microhabitat--is a particular focus of investigation.

In addition, factors influencing the modern-day distributions of nongame fishes are being investigated as a baseline for further inquiry regarding historical changes. Research is focused within the Root, Zumbro, and Cannon River watersheds. Both coldwater and warmwater streams in the study watersheds will be included in the analysis.

Preliminary analysis in the Whitewater watershed suggests that land use in the cumulative riparian buffer combined with watershed geology explains the greatest amount of variation in fish and invertebrate communities. Riparian buffers appear more important than watershed land use in mitigating sediment delivered primarily from bed load and streambanks, as streams adapt to mitigated flow regimes by cutting into earlier floodplain deposits. Although cumulative watershed and buffer analysis explain significant variation, other spatial habitat conditions, such as downstream land use, may limit the potential of historically degraded streams to be recolonized by nongame fishes (e.g., mottled and slimy sculpin--*Cottus bairdi* and *Cottus cognatus*) following habitat improvement.

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Winged Mapleleaf Mussel (*Quadrula fragosa*) Host Fish Experiments, Phase II

Investigator: Anne R. Kapuscinski and Mark Hove

Duration: December 1998 to July 1999

Funding Sources: US Fish and Wildlife Service

Project Location: Department of Fisheries and Wildlife, University of Minnesota, St. Paul

Freshwater mussels are among the most imperiled biological groups in North America. The federally endangered winged mapleleaf (*Quadrula fragosa*) is thought to occur in only three locations, and the population in a short reach of the St. Croix River bordering Minnesota and Wisconsin is at risk of zebra mussel (*Dreissina polymorpha*) colonization. Low numbers occur in this 10 mile reach of the St. Croix River and evidence suggests that recruitment is limited. Also, gravid specimens have not been found during the presumed summer gravidity period suggesting the occurrence of reproductive failure.

Describing the reproductive life history of the winged mapleleaf is an important research objective identified by the Winged Mapleleaf Recovery Team. The host requirements of winged mapleleaf larvae (glochidia) are unknown. Lack of this information makes it nearly impossible to determine the viability of imperiled mussel populations either in degraded habitats, where they now occur, or in habitats being considered for translocation of mussels to rescue them from spread of zebra mussels or from other adverse effects.

The objective of this research is to identify suitable hosts for winged mapleleaf glochidia. This study will involve conducting 43 additional trials on 24 fish species and the mudpuppy.

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Activities 1997-1998

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Publications

Peer-Reviewed

1997

Plumpton, D.L. and D.E. Andersen. 1997. Habitat use and time budgeting by wintering ferruginous hawks. *Condor* 99:888-893.

1998

Bowers, D.G., D.E. Andersen, N.H. Euliss, Jr. 1998. Anurans as indicators of wetland condition in the prairie pothole region of North Dakota: An environmental monitoring and assessment program (EMAP) pilot project. Pages 369-378 In Lannoo, M.J., ed. *Status and Conservation of Midwestern Amphibians*. University of Iowa Press, Iowa City, IA. 507pp.

Dykstra, C.R., M.W. Meyer, D.K. Warnke, W.H. Karasov, D.E. Andersen, W.W. Bowerman, IV, and J.P. Giesy. 1998. Low reproductive rates of Lake Superior bald eagles: Low food delivery rates or environmental contaminants? *Journal of Great Lakes Research* 24:32-44.

Kontio, B.D., D.L. Garshelis, E.C. Birney, and D.E. Andersen. 1998. Resilience of a Minnesota black bear population to heavy hunting: Self-sustaining population or population sink? *Ursus* 10:139-146.

McLeod, M. A. and D. E. Andersen. 1998. Red-shouldered hawk broadcast surveys: Factors affecting detection of responses and population trends. *Journal of Wildlife Management* 62:1384-1396.

Plumpton, D. L. and D. E. Andersen. 1998. Anthropogenic effects on winter habitat use and behavior of ferruginous hawks. *Journal of Wildlife Management* 62:340-346.

In Press

Andersen, D.E., T.R. Laurion, J.R. Cary, R.S. Sikes, M.A. McLeod, and E.M. Gese. In Press. Aspects of swift fox ecology in southeastern Colorado. *Proceedings of the First North American Swift Fox Symposium*.

Manolis, J.C., D.E. Andersen, and F.J. Cuthbert. In Press. Forest harvest edge in northern hardwood-conifer landscapes: Minnesota results and retrospective power analysis of published studies. *Wildlife Society Bulletin*.

Pothoven, S.A, B. Vondracek, and D.L. Pereira. In Press. An evaluation of the indirect effects of flouridone on the fish communities of two Minnesota lakes. *North American Journal of Fisheries Management*.

Non-Refereed

1997

Phifer, P., W. Cunningham, and B. Vondracek. 1997. Urban growth and environmental protection: Searching for balance at Eagle Creek. *University of Minnesota, Center for Urban and Regional Affairs* 27:1-7.

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Andersen, D.E. and J.C. Bednarz. 1997. RRF and raptor conservation. Wingspan 6:6-7.

1998

Blann, K.L. and B. Vondracek. 1998. Stream fish distribution, community structure, and habitat in relation to land use, geology, and geomorphology in southeastern Minnesota. In: Research and monitoring in the Cannon River Watershed: a compilation of abstracts on surface water and related resource studies. Cannon River Watershed Partnership. 3pp.

Lane, W.H., D.E. Andersen, and T.H. Nicholls. 1998. Distribution, abundance, and habitat use of territorial male boreal owls (*Aegolius funereus*) in northeast Minnesota. Pages 246-247 in J.R. Duncan, D.H. Johnson, and T. H. Nicholls, eds. Biology and conservation of owls of the northern hemisphere. U.S. Department of Agriculture, Forest Service General Technical Report NC-190.

Lane, W.H., D.E. Andersen, and T.H. Nicholls. 1998. Habitat use and movements of breeding male boreal owls (*Aegolius funereus*) in northeast Minnesota as determined by radio telemetry. Pages 248-249 in J.R. Duncan, D.H. Johnson, and T. H. Nicholls, eds. Biology and conservation of owls of the northern hemisphere. U.S. Department of Agriculture, Forest Service General Technical Report NC-190.

Vondracek, B., L.A. Sovell, and J.A. Frost. 1998. Impacts of rotational grazing and riparian buffer strips on the physicochemical characteristics and biological communities of southeastern Minnesota streams. Proceedings of the 23rd Annual Minnesota Forage Conference. 18pp.

Technical and Semi-Technical

1997

Mundahl, N.D., B.A. Nerbonne, and B. Vondracek. 1997. Whitewater Watershed project: 1997 fish, benthic macroinvertebrate, and habitat assessments. Report to the Minnesota Pollution Control Agency, Water Resources Division, Nonpoint Source Section.

Perry, E.F., J.C. Manolis, D.E. Andersen, and F.J. Cuthbert. 1997. Biodiversity monitoring: Breeding productivity, habitat, and winter distribution of nongame birds. 1996 Annual Progress Report to U.S. Geological Survey, Biological Resources Division, Cooperative Research Units.

Sovell, L., J. Frost, and B. Vondracek. 1997. Biological, financial, and social monitoring to develop highly sustainable farming systems. Report to the Minnesota Institute for Sustainable Agriculture.

1998

Anderson, D.J. and B. Vondracek. 1998. Insects as indicators of wetland condition in the Prairie Pothole Region of North Dakota. Report to Northern Prairie Wildlife Research Center.

Bowers, D.G. and D.E. Andersen. 1998. Anurans as indicators of wetland condition in the North Dakota Prairie Pothole Region. Report to Northern Prairie Wildlife Research Center.

Cox C. B. and B. Vondracek. 1998. Fish and invertebrate communities in the Whitewater River Watershed: a GIS based examination of land use effects. Report to the Minnesota Pollution Control Agency, Water Resources Division, Nonpoint Source Section.

Perry, E.F., J.C. Manolis, D.E. Andersen, and F. Cuthbert. 1998. Biodiversity monitoring: Breeding productivity and habitat requirements of nongame birds in north-central Minnesota. 1997 Annual Progress Report to U.S. Geological Survey, Biological Resources Division, Cooperative Research Units, Reston, VA.

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Completed Theses and Dissertations

Completed Theses and Dissertations of Minnesota Coop Students

1997

Anderson, D.J. 1997. Insects as indicators of wetland condition in the Prairie Pothole Region of North Dakota. M.S. Thesis, University of Minnesota, St. Paul. 75pp.

ABSTRACT

I compared insect community-based measures (i.e., taxa richness, abundance, and diversity) and taxon abundance across three ecoregions in the Prairie Pothole Region of North Dakota, and determined whether relationships existed between these descriptors and "landscape condition" measured at multiple scales. Insects were sampled with light traps at 126 wetland basins. Sampling was conducted three times each year during the spring and early summer in 1995 and 1996. Landscape condition was based on the proportion of cropland to grassland, hayland, and Conservation Reserve Program land surrounding selected wetland basins. In my analyses, landscape condition was classified as either grassland-dominated or cropland-dominated, based on this proportion. I concluded that there was a strong temperature, seasonal, and ecoregion effect on community-level insect taxa richness, abundance, and diversity. Taxa richness and abundance were higher for the second and third sampling periods than for the first period, and higher in the Drift Plain and Red River Valley ecoregions than in the Missouri Coteau ecoregion. Little evidence was found to suggest a difference in insect taxa richness, abundance, or diversity between cropland-dominated and grassland-dominated landscape condition. However, some individual taxa measures showed consistent differences between condition, including number of Corixidae (Hemiptera) genera and abundance of Hydropsychidae (Trichoptera), and should be examined further. Relationships with landscape condition may also become more evident if temperature-related variability can be reduced or controlled.

Lane, W.H. 1997. Distribution and ecology of boreal owls in northeast Minnesota. M.S. Thesis, University of Minnesota, St. Paul. 89pp.

ABSTRACT

Nocturnal surveys were conducted in northeast Minnesota from 1987 to 1992 (inclusive), to locate singing territorial male boreal owls (*Aegolius funereus*). Vocalizing owls were detected on 234 occasions, with 171 of the detections (73.1%) categorized as unique (i.e., individual owls), and 63 detections (26.9%) categorized as owls previously detected (heard during > 1 survey effort). The rate of encountering singing owls ranged from a low of 0.028 owls heard/km surveyed (all detections) in 1991, to 0.091 owls/km surveyed in 1989. Indices for the abundance of individual owls located per route length ranged from 0.056 in 1987, to 0.219 owls/linear km of survey route in 1989. Boreal owl singing activity increased towards 15 April, and decreased thereafter. Territorial boreal owls used pole-sized trees in upland-mixed forest stands greater than expected and open/brush/regenerative stands significantly less than expected for courtship activities. Stands supporting vocalizing male owls were generally located in mature, mixed forest tracts, containing sawtimber-sized quaking aspen (*Populus tremuloides*).

I monitored 10 radio-equipped male boreal owls in northeast Minnesota from 1990-1992; four in 1990, four in 1991, and two in 1992. Owls were captured at singing perch or cavity site locations and monitored while they remained within the study area or until transmitters were removed following the breeding season. Owls most often roosted in lowland conifer forests, even though these forest-types represented only 8.3% of the study area. Black spruce (*Picea mariana*) was identified as the roost tree on 94 (81.7%) of 115 observations. Only three marked owls remained in the study area into the summer: six owls presumably left the study area and one was killed by an avian predator, most likely a great-horned owl (*Bubo virginianus*). All monitoring efforts of owls that ended in loss of signal were males that were either unpaired, or had experienced nest failure shortly after egg laying. Minimum Convex Polygon (MCP) home range estimates for four male owls in 1991 averaged 1202 ha (range=742-1,444 ha), but when limited to movements prior to nest failure, the average MCP estimate was 425 ha (range=203-742 ha). Fifty percent Harmonic Mean Transformation-Activity Areas (HMT-AA) averaged 141 ha (n=4, range=101-208 ha), also indicating that boreal owls restricted their movements to relatively small areas during the breeding season.

Sovell, L.A. 1997. Impacts of rotational grazing and riparian buffer strips on the physicochemical characteristics and biological communities of southeastern Minnesota streams. M.S. Thesis, University of Minnesota, St. Paul. 160pp.

ABSTRACT

Farmers in Minnesota are currently adopting rotational grazing as a potentially sustainable farming system, but they lack information and tools to evaluate the effectiveness of management changes instituted. Impacts of livestock grazing and riparian buffer strip management to stream resources were assessed as part of a larger evaluation of the biological, financial, and social aspects of adopting sustainable farming practices in southeastern Minnesota. I used water chemistry, physical habitat characteristics, benthic macroinvertebrates and fish as indicators of stream quality along 4 stream systems in southeastern Minnesota. A longitudinal design was used on 3 systems, and a paired watershed design on 1 system, to collect data at 17 stations under different combinations of grazing and riparian management. Continuous and rotational grazing were compared on 2

systems, and riparian buffer management was the primary factor of interest on the other 2 systems.

As part of the overall study, I evaluated the fixed-count subsample method for calculating benthic macroinvertebrate Rapid Bioassessment metrics. Of the five benthic macroinvertebrate metrics used, the two taxa richness metrics (EPT index and number of families) increased with larger subsample size. Results support earlier work which suggests that methods for measuring taxa richness are biased when the 100 organism fixed count method is used; results further suggest that FBI, % dominance, and EPT/C metrics are not affected by the number of organisms included in a subsample.

Principal Components Analysis (PCA) distinguished stream systems, indicating a watershed effect. Water chemistry and physical habitat PCAs distinguished stream reaches with continuous grazing from reaches with rotational grazing, and reaches with wood-buffers from reaches with grass or no buffer, indicating a local management effect. Monthly and mean fecal coliform and turbidity were consistently higher along continuously-grazed than rotationally-grazed reaches. Width, depth, and substrate % fines were significantly higher along wood-buffers than grass and no-buffer areas. Canopy cover was significantly higher along a grass buffer than a wood-buffer on one system. Benthic macroinvertebrate indices suggest better relative water quality along wood-buffers than grass or no-buffers. Fish density and community composition were related to riparian condition, as opposed to grazing practices. Substantially fewer fish were found at the wood-buffer station than at the grass or no-buffer stations on one system. On a second system, fewer large fish were found at the wood-buffer and no-buffer/rotationally-grazed stations than at the grass buffer/rotationally-grazed stations.

The results of my study have potentially important implications for stream restoration programs in the midwestern United States. Riparian management comparisons suggest further consideration and study of a combination of grass and wood riparian buffer strips as midwestern stream management options. The use of ecological monitoring to implement rotational grazing may provide an intermediary land use tool in the agricultural midwestern United States. Results were used to identify indicators of stream quality as part of a monitoring toolbox developed to facilitate on-farm ecological, financial, and quality of life monitoring.

1998

Belleman, B.A. 1998. Red-shouldered hawk breeding ecology and habitat use in central Minnesota. M.S. Thesis, University of Minnesota, St. Paul. 71pp.

ABSTRACT

Red-shouldered hawk breeding ecology was studied during the 1994 and 1995 breeding seasons in central Minnesota because little is known about this aspect of red-shoulders in the state. Mean egg-laying and hatching dates were 18 April and 16 May, respectively, for each year; chicks fledged by late June or early July. We located 38 breeding areas during the study period (19 in 1994 and 19 in 1995), resulting in an overall (both years combined) nesting success estimate of 72%. Successful nesting attempts produced 24 young in 1994 and 31 young in 1995 and the minimum number of young produced per breeding area was 1.26 in 1994 and 1.07 in 1995. Average breeding density, estimated from two forest stands of approximately 400 ha each, was one pair/1.02 km² (0.97 pair/km²). Observations of prey delivered to young or remains found in or below the nest suggest the diet consisted of small mammals and amphibians. This information is useful for appropriate timing of red-shoulder surveys and forest management activities and serves as a baseline to monitor reproductive success and future population trends.

Habitat characteristics were measured at 38 red-shouldered hawk nest sites and paired random sites in upland hardwood forest stands in central Minnesota during 1994 and 1995 to identify characteristics that differentiate nest sites from surrounding forest and are useful in potentially predicting red-shoulder nest sites. Five tree species were used for nesting, of which quaking aspen (*Populus tremuloides*) was used more than expected based on occurrence. Nest tree age ranged from 50-90 years and averaged 59 years for aspen (*Populus* spp.) (n=8 cores) and 67 years for oak (*Quercus* spp.) (n=11 cores). Compared to random sites, paired t-test results (p<0.05) indicated that nest sites had larger average diameter at breast height (dbh) (AVGDBH), had higher basal area (BASAL), canopy height (CANHT), percentage of trees in plot > 37.8 cm dbh (DNR6), and were lower in elevation (ELEV), closer to water (PERMW) and had shorter shrub height (SHHT). Nominal logistic regression models indicated that the combination of habitat characteristics important in distinguishing upland hardwood nest sites from random sites were distance to water (PERMW), overstory dbh (OVDBH), basal area (BASAL), elevation (ELEV), nest tree dbh (NTDBH), and a height variable [nest tree height (NTH) and/or canopy height (CANHT)].

Bowers, D.G. 1998. Anuran survey methods, distribution, and landscape-pattern relationships in the North Dakota Prairie Pothole Region. M.S. Thesis, University of Minnesota, St. Paul. 152pp.

ABSTRACT

Anuran calling surveys, night driving surveys, and automated recording surveys were conducted for nine species of anurans in the North Dakota Prairie Pothole Region during 1995 and 1996. Eight, nine, and eight species were detected using anuran calling surveys, night driving surveys, and automated recording surveys, respectively. *Bufo hemiophrys* was not detected during anuran calling surveys and *Spea bombifrons* was not detected with automated recordings surveys. Two years of survey data provided more complete data on species distributions and composition in hexagons than surveys conducted in 1995 ($t_{43}=4.97$, $P=0.0001$) or 1996 ($t_{43}=6.05$, $P=0.0001$) alone. Probabilities of detecting species varied among methods and species; suggested survey methods for each species are provided. No differences in relative abundance of six species were found between calling survey stations located on roads adjacent to wetlands and stations systematically located along roads. Finally, the influence of date, time of day, temperature, and relative humidity on calling activity was assessed and comparisons between our findings and those of other researchers are presented.

Anuran calling, night driving, and automated recording surveys were used to determine anuran distributions, species composition, and relative abundance in 21 40-km² study sites in 1995 and 1996 in the North Dakota Prairie Pothole Region. Distribution of eight species varied from previously documented ranges: three species had more extensive ranges, two species had less extensive ranges, and three species were more uniformly distributed within their ranges. Further surveys are recommended to enhance current distributional data. Anuran species richness was highest in the most agriculturally impacted ecoregion (the Red River Valley) studied; six, seven, and eight species were detected in the Missouri Coteau, Drift Prairie, and Red River Valley, respectively. Relative abundance within species varied among hexagons and across years. Estimated numbers of calling male *Bufo cognatus* and *B. woodhousii* were significantly higher in 1995 than 1996, while the opposite was true for *Rana sylvatica*, *Pseudacris triseriata*, and *Hyla versicolor/chrysocephala*. The lowest relative abundances of *P. triseriata* were in the Red River Valley, whereas relative abundances of *B. americanus*, *B. cognatus*, and *B. woodhousii* were highest in Red River Valley hexagons. Compared across species, *Pseudacris triseriata* had the highest relative abundance in the Missouri Coteau and Drift Prairie, but no one species had consistently high relative abundances in Red River Valley hexagons. Compared across species, *Pseudacris triseriata* had the highest relative abundance in the Missouri Coteau and Drift Prairie, but no one species had consistently high relative abundances in Red River Valley hexagons. Relative abundance estimates compared across species should be interpreted with caution due to unequal detectabilities among species.

Automated recording systems and anuran calling surveys were used to evaluate whether anurans might serve as biological indicators of wetland condition in the North Dakota Prairie Pothole Region. Recorded detections of *Pseudacris triseriata* at paired wetlands predominantly surrounded by either croplands or grasslands were concordant; both methods exhibited the same result of either a detection or no detection. Additionally, no differences in relative abundance of *Bufo cognatus*, *B. woodhousii*, *P. triseriata*, and *Rana sylvatica* were found between wetlands surrounded by croplands compared to those surrounded by grasslands. Regression models assessing relationships between wetland condition and anuran relative abundance were evaluated at three scales: hexagon (40 km²), station (0.50 km²), and quadrant (0.13 km²). Based on these regression models, two species show potential for use as bio-indicators; *Bufo americanus* was positively associated with croplands at the quadrant scale and *Rana sylvatica* was negatively associated with croplands at the station scale.

Cox, C.B. 1998. Fish and invertebrate communities in the Whitewater River Watershed: A GIS based examination of land use effects. M.S. Thesis, University of Minnesota, St. Paul. 46pp.

ABSTRACT

The relative impacts of different types of land use on stream ecosystem structure was examined at 14 sites, on three streams, in the Whitewater River watershed of Southeastern Minnesota. Geographic Information System technology (GIS) was used to characterize land use and bedrock geology at four spatial scales. After the effects of geology were accounted for, redundancy analysis (RDA) explained up to 34% of the observed variation in stream physical habitat condition, and 67% of the variation in biotic community composition as a function of land use. Only riparian land uses had significant effects on stream habitat and biotic communities, and only when viewed cumulatively, was riparian land use significantly related to in-stream physical habitat condition and to both fish and invertebrate community structure. The cumulative amount of agricultural land (cultivated land and farmstead/rural residence) within 100 meters of a stream was positively correlated with increased depositional sedimentation, higher percentages of omnivorous fish and white sucker, and more tolerant and less diverse macroinvertebrate communities. In contrast, the amount of riparian deciduous forest, as well as riparian areas with a combination of grasses, shrubs, and deciduous trees, were positively correlated with larger substrate sizes, larger percentages of insectivorous fish, and higher macroinvertebrate species richness. This study supports the use of vegetated riparian buffer strips to reduce stream sediment inputs, and indicates that management efforts may be most efficient when focused within the cumulative

riparian buffer.

Perry, E.F. 1998. Clustered nesting of least flycatchers (*Empidonax minimus*) in north-central Minnesota. M.S. Thesis, University of Minnesota, St. Paul. 102pp.

ABSTRACT

The nests of some bird species that defend all-purpose territories may be clustered within apparently uniform habitat, but advantages of clustering have seldom been studied. Dense aggregations of least flycatcher (*Empidonax minimus*) territories are documented from a wide geographic area. In north-central Minnesota I investigated several potential reasons for clustered nesting in least flycatchers, including selection of patchy habitat features or food supplies, and exclusion of predators or competitors. In 1995 and 1996 I compared arthropod abundance and 51 variables representing the structure and composition of the forest inside and outside of nine aggregations. I also compared the response of forest birds to hawk displays and used point count surveys to detect any exclusion of potential predators or competitors from the aggregations. The predator deterrence hypothesis received the strongest support. In response to hawk displays inside the aggregations 2.8 times more birds gave 5.8 times more alarms than outside. Additionally, alarms were given sooner inside aggregations. Little evidence of habitat selection was found. Five variables showed statistically significant differences inside and outside aggregations, but they seemed insufficient to produce the sharp divisions between occupied and unoccupied areas. Neither arthropods as a group nor any of the five most frequently trapped orders provided more potential food inside the aggregations. One potential competitor, the black-throated green warbler (*Dendroica virens*), was detected 2.2-5.4 times less frequently inside the aggregations than outside, but the difference in density may also be a result of habitat selection. The tremendous response of least flycatchers to the hawk displays provides the first evidence that anti-predator behavior may contribute to the clustering of their territories.

Some bird species nest in colonies to reduce predation through collective anti-predator behavior. In north-central Minnesota I searched for evidence of a reduction in nest predation within aggregations of least flycatchers, a species that defends all-purpose territories. With no solitary nests available, I compared the rate of predation at interior and peripheral nests. Additionally, I compared the rate of predation on ovenbird (*Seiurus aurocapillus*) nests inside and outside least flycatcher aggregations. Nests of both species were monitored in and around nine aggregations in northern hardwood forest from 1992 to 1996. Predation accounted for 97% of all least flycatcher nest failures and 91% of all ovenbird nest failures. The effect of distance to aggregation edge on least flycatcher nest fate (fledged or depredated) was modeled by logistic regression using data from 1995 and 1996, with aggregations as a blocking variable. In 1996 the model revealed a strong influence on nest fate, with greater success at interior nests, but in 1995 no influence was detected. The discrepancy may be due to changes in predator populations (e.g. a 56% decrease in corvids between 1995 and 1996). Another logistic regression model demonstrated that ovenbird nests from 1992 to 1996 were equally successful inside and outside least flycatcher aggregations, possibly because the predators most responsible for their nest failures differ from those important for least flycatchers. The greater success of interior least flycatcher nests in 1996 provides the first evidence of reduced predation within the nesting aggregations of a species that defends all-purpose territories.

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Presentations and Meeting Attendance

Invited Presentations

1997

Andersen, D.E. 1997. Monitoring northern goshawk populations in the western Great Lakes Region. Midwest Raptor Management Symposium and Northern Goshawk Symposium, Milwaukee, Wisconsin.

Boody, G. and B. Vondracek. 1997. Measuring agricultural sustainability: An environmental tool kit for farmers. 59th Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin.

Manolis, J.C., D.E. Andersen, and F.J. Cuthbert. 1997. Effects of clearcut edges on nesting success of songbirds in north-central Minnesota: Implications for management of Great Lakes forests. The Wildlife Society Annual Meeting, Snowmass, Colorado.

Vondracek, B. and R. Lentz. 1997. A team approach to research: a new model, people of the land, science, and agencies. Presented at a symposium titled "Common enemies and competing interests of sustainable agriculture and conservation biology" organized in conjunction with the annual

meeting of the New World Agriculture and Ecology Group, St. Paul, Minnesota.

1998

Andersen, D.E. and D.L. Plumpton. 1998. Urban landscapes and raptors: A review of factors affecting population ecology. 5th World Conference on Birds of Prey and Owls, Midrand, South Africa.

Kennedy, P.L. and D.E. Andersen. 1998. Research and monitoring protocol development for northern goshawks in the western Great Lakes region. Midwest Raptor Management Symposium, St. Paul, Minnesota.

Nerbonne, B.A., B. Vondracek, and C.B. Cox. 1998. A comparison of effects on streams of Best Management Practice farms and conventional farms. 128th Annual meeting of the American Fisheries Society, Hartford, Connecticut.

Vondracek, B. and D. French. 1998. Community partnerships: The monitoring team in SE Minnesota. 10th Annual Sustainable Agriculture Research and Education Conference, Austin, Texas.

Vondracek, B., L.A. Sovell, and J.A. Frost. 1998. Impacts of rotational grazing and riparian buffer strips on the physicochemical characteristics and biological communities of southeastern Minnesota streams. 23rd Annual Minnesota Forage Conference, Grand Rapids, Minnesota.

Contributed Presentations

1997

Andersen, D.E., J.C. Manolis, and E.F. Perry. 1997. Broad-winged hawk (*Buteo platypterus*) breeding density and reproduction in northern hardwood forest habitats in north-central Minnesota. The Raptor Research Foundation, Inc., Annual Meeting, Savannah, Georgia.

Anderson, D.J. and B. Vondracek. 1997. Insects as indicators of wetland condition in North Dakota. 1997 Joint Meeting of the Minnesota and Dakota Chapters of the American Fisheries Society, Fargo, North Dakota.

Bednarz, J.C. and D.E. Andersen. 1997. The North American Raptor Monitoring Strategy. The Raptor Research Foundation, Inc., Annual Meeting, Savannah, Georgia.

Grant, G.C. and B. Vondracek. 1997. Feeding, microhabitat and growth in sympatric populations of brook, brow and rainbow trout. 1997 Joint Meeting of the Minnesota and Dakota Chapters of the American Fisheries Society, Fargo, North Dakota.

Grant, G.C. and B. Vondracek. 1997. Using energetic models to explain resource partitioning and species replacement in stream trout populations. 127th Annual Meeting of the American Fisheries Society, Monterey, California.

Lane, W.H., D.E. Andersen, and T.H. Nicholls. 1997. Distribution, abundance, and habitat use of territorial male boreal owls (*Aegolius funereus*) in northeast Minnesota. Second International Symposium: Biology & Conservation of Owls in the Northern Hemisphere, Winnipeg, Manitoba, Canada.

Lane, W.H., D.E. Andersen, and T.H. Nicholls. 1997. Habitat use and movements of breeding male boreal owls in northeast Minnesota. Second International Symposium: Biology & Conservation of Owls in the Northern Hemisphere, Winnipeg, Manitoba, Canada.

Manolis, J.C., D.E. Andersen, and F.J. Cuthbert. 1997. Effects of forest harvest edges on nesting success of songbirds in north central Minnesota. American Ornithologists' Union Annual Meeting, Minneapolis, Minnesota.

Nerbonne, B.A., N.D. Mundahl, and B. Vondracek. 1997. Comparison of best management practices to conventional agricultural practices: Effects on streams. 1997 Joint Meeting of the Minnesota and Dakota Chapters of the American Fisheries Society, Fargo, North Dakota.

Nerbonne, B.A. and B. Vondracek. 1997. Fish and invertebrate responses to agricultural land use. Annual Meeting of the Rivers and Streams Technical Committee of the North Central Division of the American Fisheries Society in Rock Island, Illinois.

Nerbonne, B.A., B. Vondracek, and N.D. Mundahl. 1997. Impacts of upland agricultural practices and riparian buffers on physical characteristics and biological communities in SE Minnesota streams. 59th Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin.

Perry, E.F. and D.E. Andersen. 1997. Aggregated nesting in the least flycatcher in north-central Minnesota. American Ornithologists Union Annual Meeting, Minneapolis, Minnesota.

Pothoven, S.A., B. Vondracek, and D.L. Pereira. 1997. Indirect effects of vegetation removal on fish community structure and predator-prey interactions. Joint Meeting of the New York and Pennsylvania Chapters of the American Fisheries Society, Oswego, New York.

Sovell, L.A., J.A. Frost, and B. Vondracek. 1997. Impacts of rotational grazing and riparian buffers on physicochemical characteristics and biological communities in southeast Minnesota streams. 59th Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin.

Sovell, L.A. and B. Vondracek. 1997. Impacts of sustainable farming practices on streams in southeastern Minnesota: riparian buffers and rotational grazing. 1997 Joint Meeting of the Minnesota and Dakota Chapters of the American Fisheries Society, Fargo, North Dakota.

Sovell, L.A. and B. Vondracek. 1997. Impacts of sustainable farming practices on streams in southeastern Minnesota: Riparian buffers and rotational grazing. 127th Annual Meeting of the American Fisheries Society, Monterey, California.

1998

Andersen, D.E., T.R. Laurion, J.R. Cary, R.S. Sikes, M.A. McLeod, and E.M. Gese. 1998. Ecology of swift fox in southeastern Colorado. First North American Swift Fox Symposium, Saskatoon, Saskatchewan.

Cox, C.B., B.A. Nerbonne, and B. Vondracek. 1998. Fish and invertebrate communities: A GIS analysis in SE Minnesota. 31st Annual Meeting of the Minnesota Chapter of the American Fisheries Society, Camp Ripley, Minnesota.

Frost, J.A. and B. Vondracek. 1998. Citizen macroinvertebrate monitoring: Does it meet the mark? 128th Annual Meeting of the American Fisheries Society, Hartford, Connecticut.

Kennedy, P.L. and D.E. Andersen. 1998. How do we monitor northern goshawks (*Accipiter gentilis atricapillus*) population trends? Annual Meeting of the Raptor Research Foundation, Inc., Ogden, Utah.

Ruetz, C.R., III, B. Vondracek, and R.M. Newman. 1998. Potential top-down effects of slimy sculpin in Valley Creek, Minnesota. 1998 St. Croix River Research Rendezvous, Marine on St. Croix, Minnesota.

Johnson, G.D., B.J. Hansen, P.V. Van Buren, J.L. Nieber, B.A. Nerbonne, B. Vondracek, and N.D. Mundahl. 1998. Paired watershed monitoring in the Whitewater River watershed 319 monitoring project. Sixth National Nonpoint Source Monitoring Workshop, Cedar Rapids, Iowa.

Nerbonne, B.A., B. Vondracek, N.D. Mundahl, and G.D. Johnson. 1998. Biological monitoring and physical assessment of best management practices in the Whitewater watershed of Minnesota. Sixth National Nonpoint Source Monitoring Workshop, Cedar Rapids, Iowa.

SCIENTIFIC MEETING ATTENDANCE

1997

Annual Meeting of the Raptor Research Foundation, Inc., Savannah, Georgia. (D.E. Andersen)

Midwest Raptor Management Symposium and Northern Goshawk Symposium, Milwaukee, Wisconsin. (D.E. Andersen)

Second International Symposium: Biology and Conservation of Owls in the Northern Hemisphere, Winnipeg, Manitoba. (W.H. Lane)

Annual Meeting of the American Ornithologists Union, Minneapolis, Minnesota. (D.E. Andersen, E.F. Perry, and J.C. Manolis)

Annual Meeting of The Wildlife Society, Snowmass, Colorado. (D.E. Andersen and J.C. Manolis)

Mississippi Flyway Technical Section and Council Meeting, Baton Rouge, Louisiana. (D.E. Andersen)

Mississippi Flyway Technical Section and Council Meeting, Hot Springs, Arkansas. (D.E. Andersen)

59th Midwest Fish and Wildlife Conference, Milwaukee, Wisconsin. (B. Vondracek)

Annual Meeting of the New World Agriculture and Ecology Group, St. Paul, Minnesota. (B. Vondracek)

Annual Meeting of the Rivers and Streams Technical Committee of the North Central Division of the American Fisheries Society, Rock Island, Illinois. (B.A. Nerbonne)

1998

5th World Conference on Birds of Prey and Owls, Midrand, South Africa. (D.E. Andersen)

Annual Meeting of the Raptor Research Foundation, Inc., Ogden, Utah. (D.E. Andersen and C.W. Boal)

Midwest Raptor Management Symposium, St. Paul, Minnesota. (D.E. Andersen)

Mississippi Flyway Technical Section and Council Meeting, Biloxi, Mississippi. (D.E. Andersen)

Mississippi Flyway Technical Section and Council Meeting, East Alton, Illinois (D.E. Andersen)

128th Annual Meeting of the American Fisheries Society, Hartford, Connecticut. (B.A. Nerbonne and B. Vondracek)

10th Annual Sustainable Agriculture Research and Education Conference, Austin, Minnesota. (B. Vondracek)

23rd Annual Minnesota Forage Conference, Grand Rapids, Minnesota. (B. Vondracek)

31st Annual Meeting of the Minnesota Chapter of the American Fisheries Society, Camp Ripley, Minnesota. (C.B.Cox, B.A. Nerbonne and B. Vondracek)

128th Annual Meeting of the American Fisheries Society, Hartford, Connecticut. (J.A. Frost and B. Vondracek)

1998 St. Croix River Research Rendezvous, Marine on St. Croix, Minnesota. (C.R. Ruetz, C.R., II, and B. Vondracek)

Sixth National Nonpoint Source Monitoring Workshop, Cedar Rapids, Iowa. (B.A. Nerbonne and B. Vondracek)

60th Midwest Fish and Wildlife Conference, Cincinnati, Ohio. (B. Vondracek and K.L. Blann)

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HONORS AND AWARDS

1997

D.E. Andersen served as Vice President of The Raptor Research Foundation, Inc., from 1997-1998.

1998

B. Vondracek served as President of the Minnesota Chapter of the American Fisheries Society from 1998-1999.

Incoming M.S. graduate student John E. Sammler received a block grant fellowship from the Wildlife Conservation Graduate Program.

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