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APPLICANT BACKGROUND

Ferenc de Szalay is a member of the Water Resources Research Institute (WRRI) at Kent State University. WRRI is an interdepartmental unit within the university that includes faculty from Biological Sciences, Geology, Chemistry, and Geography. Its goals are to facilitate research directed at solving problems of water quality, abundance, and distribution. Its members have worked on such diverse topics as effects of Zebra mussels and *Microcystis* algal blooms on water quality in Lake Erie, phosphate inputs into the Great Lakes, and microbial and limnological factors in the Cuyahoga River basin. Ferenc de Szalay's primary research interest is studying the responses of aquatic invertebrates and plants to wetland management practices. He

has conducted several studies in Lake Erie coastal marshes, including Crane Creek wetland at Ottawa National Wildlife Refuge. Lake Erie Protection Fund, Ohio Sea Grant, Ohio Department of Natural Resources, and other sources have supported his research. He has published in *Wetlands, Freshwater Biology, American Midland Naturalist*, *Environmental Entomology* and other journals.

Mark Kershner is an Assistant Professor in the Department of Biological Sciences and a member of the Water Resources Research Institute, an interdisciplinary unit at Kent State University. His research program combines theoretical and empirical investigations of the role of fish in community structure in wetlands, lakes, and streams; lake community ecology; predator-prey interactions; and the role of invasive species in large lake food webs. The Ohio Department of Natural Resources and Lake Erie Protection Fund have funded his research. He has published in *Journal of the North American Benthological Society, Ecology, Ecological Applications, Canadian Journal of Fisheries and Aquatic Sciences,* and other journals.

Joe Keiper is Curator of Invertebrate Zoology at the Cleveland Museum of Natural History, and Director of the newly formed Ohio Conservation Alliance (OCA). The OCA is a collaborative association of Cleveland area professionals dedicated to research, education, and conservation efforts. Keiper's research foci include the biology, immature stages, and taxonomy of Trichoptera and brachycerous Diptera, ecological control of mosquitoes, and invertebrate colonization of newly constructed wetlands. He has conducted wetlands research at Kent State University, The University of California - Riverside, and The Cleveland Museum of Natural History, and has published in *The Annual Review of Entomology, Annals of the Entomological Society of America*, *Proceedings of the Entomological Society of Washington*, and others.

Ken Krieger joined the Water Quality Laboratory (WQL) in 1978 as a member of a large multidisciplinary group of researchers and institutions performing the Lake Erie Intensive Study. The WQL is an environmental research, monitoring, and educational organization associated with the science departments of Heidelberg College. Its mission is to help protect the aquatic resources of Ohio, the Midwest, and the Lake Erie and Great Lakes ecosystems by assessing impacts of agricultural and other land uses. The mission is accomplished through research, extension activities, and support of the educational programs of the College (see http://www.heidelberg.edu/wql). Ken Krieger's research interests are two-fold: (1) interpretation of changes in the environmental quality of Lake Erie, its wetlands and tributaries through the assessment of structural and functional changes in invertebrate communities; and (2) measurement of the effectiveness of coastal wetlands in mitigating the impacts of pollutants derived the upland watershed of the Great Lakes. Ken has received funding from agencies including the Ohio Sea Grant College Program, the Lake Erie Protection Fund, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and Ohio Dept. of Natural Resources. He has published in *Journal of Great Lakes Research*, *Ecological Applications*, and *Journal of Aquatic Ecosystem Stress and Recovery*.

PROJECT TITLE: Testing flora and fauna indicators of coastal wetland health in Lake Erie

PROJECT NARRATIVE/WORKPLAN

Background

Degradation of Great Lakes coastal wetlands by anthropogenic factors is ongoing and widespread (Maynard and Wilcox 1998). When the United States and Canada signed the Great Lakes Water Quality Agreement of 1978, they agreed "... to restore and maintain the chemical, physical, and biological integrity of the waters of the Great Lakes Basin Ecosystem." Since then they have prepared Lakewide Management Plans (LaMP) to achieve these goals. The 2000 Lake Erie LaMP emphasized the need to develop procedures to accurately measure aquatic ecosystem integrity to gauge the success of management strategies. Methods are being developed to monitor habitat quality by sampling fish and other vertebrates, macroinvertebrates and plants and using these data to calculate metrics (e.g., taxa diversity, abundance of indicator taxa or guilds, health of individual organisms) that are correlated with environmental integrity of these habitats. These metrics are used to calculate multimetric Indices of Biotic Integrity (IBI), which are a composite score of several metrics of the sampled community (e.g., Karr and Chu 2000, Thoma 1999, Plafkin et al. 1989, Hilsenhoff 1987). Often, the IBI score in the site being tested is compared to an IBI at a reference site that has the optimum habitat quality attainable in the region (National Research Council 2000). Different IBI scores at test vs. reference sites indicate that the test site has been affected by pollution or other environmental stressors. Alternately, IBI's can be measured at test sites over time to gauge long-term trends in habitat quality (National Research Council 2000)

Recently, a taskforce assigned to identify methods to monitor ecosystem integrity in the Great Lakes recommended developing IBI's for coastal wetlands to reveal both episodic disturbance and long-term trends of habitat quality (Bertram and Stadler-Salt 2000). However, there are several difficulties in developing an IBI for coastal wetlands. First, each of the Great Lakes has distinctly different physico-chemical conditions (Maynard and Wilcox 1998). For example, Lake Erie is the most shallow and productive of the Great Lakes, and it is particularly subject to effects of seiches and storm action. This indicates that biotic communities in coastal wetlands will be different in each of the Great Lakes, which may affect the choice of metrics to include in an IBI. Second, several types of coastal wetlands are found in the Great Lakes basin, and these differ in hydrogeomorphic conditions (Keough et al. 1999). Although all Great Lake coastal wetlands are affected by water level changes and chemical inputs from the lake, they vary by their connectedness to the Great Lakes and whether they receive river inputs (Keough et al. 1999). Therefore, any IBI's used in coastal wetlands should also be calibrated by wetland type.

Currently, there is interest in developing IBI's using aquatic invertebrates, fish and plants in wetlands. Invertebrates are useful because: 1. they are sensitive to environmental stressors, 2. they have a short life-span and therefore communities will respond rapidly to changes in habitat conditions, and 3. their life-histories are often well understood (Innis et al. 2000). Furthermore, sampling flying adult aquatic insect can be also used to monitor the establishment of functions in constructed wetlands (King and Brazner 1999, Garono and Kooser 1994). We propose to build on previous studies that developed preliminary IBI's (Kashian and Burton 2000, Burton et al. 1999) in Lake Huron coastal wetlands. These papers found that species richness, species diversity, and relative abundance of odonates, gastropods, amphipods, and sphaeriid clams were

useful metrics. All of these taxa are abundant in Lake Erie coastal wetlands (Krieger 1992, de Szalay and Cassidy *In Press*), and these metrics should be useful in our wetlands.

Fish assemblages are also sensitive to environmental conditions, making them quite amenable to use in assessments of system integrity (Karr 1981). Given the importance of coastal wetlands as spawning, nursery, and foraging areas, fish should be sensitive to differences in habitat quality among coastal wetlands. Previous research has demonstrated the importance of turbidity and macrophyte cover and diversity as critical variables for characterizing fish assemblages, likely due to the role these variables play in determining fish recruitment along trophic gradients (Brazner 1997, Brazner and Beals 1997). In this study, we propose to build upon ongoing efforts to develop preliminary IBI's for coastal wetland fish assemblages (e.g., Thoma 1999). For example, in an IBI developed for Lake Erie drowned river mouths (i.e., lacustuaries), Thoma (1999) included a broad range of diversity and abundance metrics including species richness, # sunfish species, # cyprinid species, % phytophilic individuals, % non-indigenous species, % DELTs. These metrics (and others) will likely prove to be appropriate for other coastal wetland as well.

For the purposes of vegetation IBI development, the goal is to correlate a wetland's aggregate vegetation characteristics to measures of wetland disturbance and quality. Major concerns in selecting a sampling method are ease of use, cost, reproducibility of results, obtaining as complete a list of plant species at a wetland as possible. This last concern is related to Ohio's use of a Floristic Quality Assessment Index (FQAI) (Andreas and Lichvar 1995) that requires a relatively complete flora of a site. In coastal marshes, a narrow shrub zone typically gives way to a broad emergent zone which grades into a floating-leaved marsh to open water zone. This spatial heterogeneity must also be taken into account by the sampling design. Although some methods are being tested in inland wetlands, (e.g., Mack 2001, Andreas and Lichvar 1995) no methods have been widely adopted in Great Lake coastal marshes.

Proposed project outcome

The goal of this project is to sample invertebrate, fish and plant communities in Lake Erie coastal marshes to provide data for four proposed SOLEC coastal wetland indicators outlined in Bertram and Stadler Salt (2000): #4501 (invertebrate community health); #4502 and #4503 (fish community health and DELTS); and #4513 (plant community health). Furthermore, we will compare two types of coastal wetlands in Lake Erie: 1) protected embayment wetlands that are largely protected from wave action in the lake by a partial barrier beach or dike across the mouth of the wetland, and 2) open lacustrine wetlands that lack the protective barrier beach and are largely exposed to wave action. These data will be useful to 1) select metrics that are correlated with habitat quality, 2) establish baseline conditions existing in these wetlands to allow managers to measure long-term changes in response to management strategies, and 3) show how metrics are affected by habitat types. Our project will be coordinated with projects conducted at other Great Lake sites to show how these metrics should be calibrated across different lakes.

Habitat Selection and Sampling

A difficulty of selecting reference sites in the Lake Erie basin is that all coastal wetlands have been disturbed to varying degrees by pollution, invasion by exotic species, diking or other anthropogenic factors, and most habitats are highly impacted. (Maynard and Wilcox 1998,

Herdendorf 1987). Therefore, we cannot find sufficient reference wetlands to serve as a comparison between pristine and disturbed wetlands. Instead, we will estimate the relative amount of environmental degradation in each wetland and compare this with the invertebrate, fish and plant community IBI's (USEPA 1998). The results of this study will also establish baseline information on community structure that is needed to measure future changes in habitat integrity.

Table 1 lists the wetlands that we chose for our study. From this list, we will randomly select 3 open lacustrine wetlands and 3 protected embayments (6 wetlands total) to sample for this study. Although some protected embayments have a rip-rapped dike, all are permanently open to the lake (i.e., their water levels are controlled by water level changes in Lake Erie). All sites are located in western Lake Erie because this area has almost all open lacustrine and protected embayment wetlands along the United States border of Lake Erie (Maynard and Wilcox 1997). We did not include any Canadian sites because it would create significant added expenses and logistical difficulties for this project. However, our sampling methods will be the same as S. Timmermans' methods in Long Point marshes (see "Project Team" below), which allows a comparison of IBI's in United States and Canadian marshes within Lake Erie.

Table 1. Coastal marshes in Lake Erie that are included in this survey. Three open lacustrine and three protected embayment wetlands will be randomly chosen and sampled in summer 2002.

Type	Name, Location	Access
Open Lacustrine		
	Potters Pond at Cedar Point Unit of Ottawa NWR (Oak Harbor, OH)	USFWS
	Muddy Creek Bay (Fremont, OH)	Ohio DNR
	Pointe Mouille State Game Area (Detroit, MI)	Michigan DNR
	Put-in Bay Harbor (South Bass Island, Ohio)	Ohio DNR
	Maumee Bay State Park (Toledo,OH)	Ohio DNR
Protected Embayment		
	Fox's Marsh (North Bass Island, OH)	Ohio DNR
	Sheldon's Marsh State Nature Preserve (Huron, OH)	Ohio DNR
	Woodtick Peninsula/Erie State Game Area, (Monroe, MI)	Michigan DNR
	Willow Point Marsh WA (Fremont, OH)	ODNR
	Metzger Marsh WA (Oak Harbor, OH)	USFWS, ODNR
	North Pond NP (Kelleys Island, OH)	Ohio DNR
	Young Marsh at Darby Unit of Ottawa NWR (Oak Harbor, OH)	USFWS

In June 2002, we will visit each wetland to identify sampling locations and reject any unusable sites. Reasons for rejecting a site would be signs that the habitat was drastically disrupted in the present year (e.g., impoundment, fire, mowing) or other events that are likely to affect some of the taxa groups disproportionately (e.g., the use of pesticides will kill insects but not harm plants or fish). We will return to all wetlands in early August 2002 to sample invertebrates, fish, and plants (see details below). We chose this date because this is the period of the greatest invertebrate biomass and diversity and before most plants begin to senesce (Burton et al. 1999, Fennessy et al. 1998, F. de Szalay, unpubl. data). Our field crew will sample wetlands sequentially as we travel along the coastline, and we estimate that it will take 30-36 hours with

travel time to complete all duties at each wetland. We will collect positional information at all sampling locations with GPS units.

We will sample physical characteristics in each wetland by measuring abiotic conditions (dissolved oxygen, conductivity, pH, temperature and turbidity) with field meters. We will measure water depths at each sampling location with meter sticks and compare this to historic Lake Erie water levels (http://www.glerl.noaa.gov/data/now/) to estimate how frequently these sites are dewatered during seiches and by seasonal water level changes. We will also collect water samples at each wetland in each of two representative locations, immediately preceding invertebrate sampling. Each sample will be collected from the midpoint of the water column in a 1-L prewashed, acid-rinsed polyethylene bottle without disturbing the bottom sediments or adjacent submergent vegetation, if any. The samples will be placed on ice for delivery to the Heidelberg's WQL as soon as practical, but in all cases within three days. Each sample will be analyzed by automated methods (USEPA 1979) for total suspended solids, soluble reactive phosphorus, total phosphorus, nitrate, nitrite, ammonia, total Kjeldahl nitrogen, chloride, sulfate, soluble reactive silica, and specific conductance.

To describe landscape measures and areal extent of each wetland, we will obtain high resolution aerial photographs of all wetlands from online USGS databases (http://terraserver.homeadvisor.msn.com). Furthermore, Kent State University has purchased Landsat 7 imagery for the western Lake Erie region. We will use these images when we visit the sites to identify current land use adjacent to the sample sites (urban, agricultural, and undisturbed land cover). We will also to identify factors that affect habitat quality in the wetlands including proximity to navigable channels and recreational boating, and dredged canals in the wetland.

<u>SOLEC Indicator #4501 (Invertebrate Community Health)</u>

We will use three methods to sample wetland invertebrate populations in summer 2002. First, we will use D-frame sweep nets to collect invertebrates in flooded vegetation using methods described in Burton et al. (1999). We will collect sweep samples in each of four flooded vegetation zones: wet meadows, *Typha* stands, inner *Scirpus* stands, and outer *Scirpus* stands. Each sample will consist of combined sweeps along the surface, in mid-water column and above the sediment to ensure an array of microhabitats are sampled. Three replicate samples will be collected at random locations in each vegetation zone in each wetland (12 samples per wetland). 200 invertebrates per sample will be live-sorted in the field by visually inspecting the samples in shallow white pans. Care will be taken that small and sessile taxa are also collected. Specimens will be preserved in ethanol in the field and sorted, identified to lowest possible taxon and enumerated at the laboratory. Invertebrates will be identified to lowest possible taxonomic category (usually genus or species) and will be assigned to various functional feeding group and trophic group categories. We will calculate the invertebrate community metrics (e.g., Richness, % Trichoptera, % Predators, % Filterers) to test how they differ among wetlands. We will collect one additional sweep sample in each of the four vegetation zones from each wetland (4 zones X 6 wetlands = 24 samples) and preserve the entire sample in the field. In the laboratory, we will pick out all invertebrates from the sample with dissecting microscopes to determine if more intensive sampling provides the same patterns observed in the field collected data.

Second, we will use activity traps to collect nektonic invertebrates. Activity traps will be modified from Murkin et al. (1983). Traps will be constructed from 1-L plastic bottles with a funnel (small opening: 2 cm; large opening: 11 cm) attached in a hole cut in the bottle lid and a second funnel attached in a hole cut in the bottom of the bottle. In each site, we will use 12 traps attached to wooden stakes at random locations along the emergent vegetation/open water interface. Traps will remain in place for 24 hours, and trapped invertebrates will be collected in a 250 micron screen and preserved in the field with ethanol.

Third, we will sample adult aquatic insects with ultraviolet light traps for one night at each wetland. Specimens will be collected in ethanol in the field, and sorted, identified to species and enumerated in the laboratory. Burton et al. (1999) did not sample with light traps, but we have used these in wetlands and found that they are a cost-effective sampling method. One advantage is that they collect adult insects, which can be identified to species. Species level identification is not possible for most larval aquatic insects that will be collected with D-frame sweep nets or activity traps. Our experimental design will allow us to determine whether future research developing IBI procedures in Great Lakes coastal wetlands should also incorporate ultraviolet light trapping to sample aquatic insect populations.

SOLEC Indicators #4502 and #4503 (fish community health and DELTS)

We will use two methods to sample wetland fish assemblages during summer 2002. First, we will use two sets of paired fyke nets (0.2 cm and 1 cm mesh; square 1-m openings) that are fished in tandem and set lead-to-lead (for a given mesh size; with wing nets on sides) for 24 h. Paired nets will be fished in vegetated and unvegetated habitats. Second, we will use nighttime electrofishing with a backpack electroshocker mounted on a punt boat to supplement fyke net sampling. Electrofishing will be conducted along 100-m transects in vegetated and unvegetated habitats (2 transects/habitat type). All fish that are captured using these two sampling protocols will be identified, counted, measured, and weighed. When possible, fish will be identified and immediately released. Unidentified fish or uncertain identifications will brought back to the lab and will be keyed to species. Using these data, we will calculate appropriate metrics including (but not limited to) species richness and abundance (fish/m), % phytophilic fishes, % non-indigenous species, # of sunfish species (see Thoma 1999 for further details). All captured fishes will be inspected for externally observable deformities, eroded fins, lesions, and tumors. Resulting numbers will be used to calculate the incidence rate for each of these categories, and these data will be used for the % DELT IBI.

SOLEC Indicator #4513 (plant community health)

We will adopt the plant sampling methods used by the Ohio EPA (Mack 2001). At each site, a plot will be established consisting of a 2x5 array of 10m x 10m modules, i.e. 20m wide by 50m long (= 0.1 ha) within the jurisdictional boundary of the wetland. The plots will be randomly located within the dominant vegetation community. Nested 1m X 1m quadrats located in opposite corners of four randomly chosen modules ("intensive modules") will be intensively sampled. If there are more than one dominant plant community in a wetland, we will sample one plot in each community.

For a vegetation IBI development, it is important to include the presence and percent cover of the species in the shrub and floating-leaved zones, but the main focus should be on the emergent

zone (Mack 2001). Therefore, we will locate the plots so that the intensively sampled quadrats are located within the emergent zone but the "tails" of the plot include portions of the shrub and aquatic bed zones. At smaller wetlands, we will use a 2x2 array and every module will include intensively sampled quadrats. We will first measure % cover of all species in the entire 0.1 ha plot. We will measure and record % cover separately in each intensively sampled module and within each 1m X 1m quadrat. We will also use ground truthing to determine vegetation types on the aerial photographs and estimate % cover of the dominant plant types throughout the entire marsh. We will collect voucher specimens at every site, especially the more taxonomically difficult genera and any unidentified specimens. Vouchers will be retained in the Kent State University herbarium and the Cleveland Museum of Natural History herbarium.

Plants will be identified to lowest possible taxonomic category (usually species or genus) and will be assigned to various ecological categories (Reproductive strategies, Life form, Wetland indicator status, Tolerant/intolerant to disturbance, native/nonnative). We will calculate the following vegetation community attributes: Richness, % invasives, % natives, % wetland obligate species, and % floating/submerged cover of turbidity tolerant taxa.

Data Analyses

We will analyze invertebrate, fish and plant data with the same statistical techniques in order to compare how each respond to changes in habitat quality and wetland type (protected embayment vs. open lacustrine). This will help determine which IBIs should be adopted in future long-term monitoring plans. Furthermore, we will compare results for data collected with different sampling techniques within each taxa (i.e. sweep samples, activity traps and light traps for invertebrate data) to determine which techniques hold the most promise for future bioassessment protocols.

We will analyze the data with two primary statistical methods. First, we will use multivariate analyses to group wetlands by habitat quality. We will use these techniques in addition to *a priori* estimations of habitat quality that are based on onsite surveys of physical and landscape characteristics. For all taxa groups (invertebrates, fish and plants), we will classify species assemblages of wetlands with Two-Way Indicator Species Analyses (TWINSPAN; Hill 1979), and we will ordinate species assemblages with Canonical Correspondence Analyses (CCA; ter Braak 1986). This will allow us to examine how wetlands group together and plot relationships between sites and environmental variables. We will also test if wetland types cluster together, which would indicate that IBIs should be calibrated for each wetland type in future monitoring plans.

Second, we will examine metrics among wetlands with standard box and whiskers plots and coefficiency of variability (CV) calculations (USEPA 1998). Metrics with a high CV are unlikely to be effective for assessment, and metrics that differ greatly between open lacustrine and protected embayment wetlands may need to be calibrated by wetland type. Potential metrics will also be correlated with each other to test for colinearity. Highly correlated metrics will be examined and redundant metrics will be eliminated. We will develop scoring criteria for metrics using methods developed by Karr et al. (1986). Because there are few (if any) pristine reference sites along the United States coastline of Lake Erie, we will trisect the 95^{th} percentile of pooled values among all wetlands to assign which metric scores indicate low, medium and high habitat

quality (USEPA 1998). Afterwards, we will examine patterns of metric scores to determine which could be used to develop IBI's to estimate habitat quality in coastal wetlands.

PROJECT TEAM

This is a collaborative project between investigators at Kent State University, Heidelberg College and the Cleveland Museum of Natural History. Each of us has conducted research in inland marshes and Great Lakes coastal wetlands. F. de Szalay is presently conducting projects on plant and invertebrate ecology funded by Lake Erie Protection Fund, Ohio Sea Grant, and Ohio DNR in coastal marshes in Lake Erie. J. Keiper is currently examining the colonization of newly constructed vernal pools at Mentor Marsh Nature Preserve, and studying benthic invertebrate assemblages of wetlands constructed by the Ohio Department of Transportation. M. Kershner is currently conducting projects on the role of fish and piscivorous waterbirds in structuring plant and macroinvertebrate assemblages in Lake Erie coastal marshes. He is also developing an Index of Biotic Integrity for the offshore fish assemblage in Lake Erie, funded by the Lake Erie Protection Fund. K. Krieger has performed macroinvertebrate surveys of Metzger Marsh, Potters Pond, and Old Woman Creek Wetland (Krieger 1999, 1995a, 1995b). The specific responsibilities of each team member are listed in Table 2.

We have established cooperative agreements with researchers at other institutions to increase the cost-efficiency of this project. We contacted Thomas Burton (Michigan State University, (517) 353-4475, burtont@msu.edu) who will submit a CWC grant proposal to sample flora and fauna in Upper Great Lakes coastal wetlands. We have also contacted Steve Timmermans (Bird Studies Canada, (519) 586-3531, stimmermans@bsc-eoc.org) who will submit a proposal to sample Long Point Marsh in Lake Erie. We will coordinate our teams' sampling methods to ensure that all fish, invertebrate and plant data will be comparable among sites. Steve Timmermans' team will also collect data on bird and amphibian indicators in Lake Erie. We will coordinate our sampling with him to allow his team to organize additional personnel that will collect bird and amphibian data at our sampling locations. We will meet with Tom Burton and Steve Timmermans at the coordination meeting being organized by the GLC and discuss details about our projects to coordinate our efforts. Furthermore, John Mack (Ohio EPA, (614) 644-3076, john.mack@epa.state.oh.us) and Dave Johnson (Ohio State University, (614) 292-9803, johnson.46@osu.edu) are developing a vegetation IBI for Ohio's Lake Erie coastal wetlands. They are funded by grants from the US EPA and the Great Lakes Protection Fund, and they will sample coastal wetlands in the state of Ohio in summer 2002. We will collaborate with John Mack to ensure that we do not have duplicate sampling efforts. We have agreed that our team will sample fish and invertebrates in Ohio wetlands, and he will sample plants. Data collected by the Ohio EPA is public information and will be shared with us, and we will share fish and invertebrate data collected by us with the Ohio EPA. Our team will collect all fish, invertebrate and plant data in Michigan wetlands for this project. Because John is not submitting a proposal to the Coastal Wetland Consortium, we have organized a meeting with his team at his office in Columbus, Ohio to discuss sampling methods. In addition, Tim Matson and Jim Bissel, Cleveland Museum of Natural History, will serve as consultants and provide taxonomic assistance to confirm the identity of plant and fish species we collect. We will also send invertebrate specimens to other taxonomic specialists for identification as needed.
We will work closely with habitat managers at each wetland site, and we have already contacted relevant agencies in Michigan and Ohio. All personnel that we spoke with voiced their support

for this project, and our discussions with them were helpful in choosing the study sites. Our contacts are: Michael Thomas and Barbara Walker, Michigan DNR, Division of Fisheries; Dan Frisk, USFWS at Ottawa NWR and Chris Dwyer, Ohio DNR, Division of Wildlife.

Table 2. Project team and their responsibilities

Duties	F. de Szalay	J. Keiper	M. Kershner	K. Krieger	Collaborators
Field Sampling					
Invertebrates	X	X			
Fish			X		
Plants	X				J.Mack, OEPA
Laboratory Work					
Sort/ID Invertebrates	X	X		X	
ID plants	X				J.Bissel, CMNH
ID Fish			X		T.Matson, CMNH
Water Quality Analysis				X	

References cited

Andreas, B.K. and R.W. Lichvar. 1995. Floristic index for establishing assessment standards: a case study for northern Ohio. Technical Report WRP-DE-8, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Bertram, P. and N. Stadler-Salt. 2000. Selection of Indicators for the Great Lakes basin ecosystem health. 1998 State of the Lakes Ecosystem Conference. Environment Canada and U.S. Environmental Protection Agency.

Brazner, J.C. 1997. Regional, habitat, and human development influences along coastal wetland and beach fish assemblages in Green Bay, Lake Michigan. Journal of Great Lakes Research 23:36-51.

Brazner, J.C. and E.W. Beals. 1997. Patterns in fish assemblages from coastal wetland and beach habitats in Green Bay, Lake Michigan: a multivariate analysis of abiotic and biotic forcing factors. Canadian Journal of Fisheries and Aquatic Sciences 54:1743-1761.

Burton, T.M., D.G. Uzarski, J.P. Gathman, J.A. Genet, B.E. Keas, and C.A. Stricker. 1999. Development of a preliminary invertebrate index of biotic integrity for Lake Huron coastal wetlands. Wetlands 19: 869-882.

de Szalay, F.A. and W. Cassidy. *In Press*. Effects of muskrat lodge construction on invertebrate communities in a Great Lakes coastal wetland. American Midland Naturalist *In Press*

Fennessy, M. Siobhan, Robert Geho, Bonny Elfritz, and Ricardo Lopez. 1998. Testing the Floristic Quality Assessment Index as an Indicator of Riparian Wetland Disturbance. Final Report to U.S. Environmental Protection Agency. Wetlands Unit, Division of Surface Water. Grant CD995927.

Garono, R.J. and J.G. Kooser. 1994. Ordination of wetland insect populations: evaluation of a potential mitigation monitoring tool. p. 509-516 in W.J. Mitsch (ed.) Global Wetlands: Old World and New. Elsevier Science, New York.

Herdendorf, C.E. 1987. The ecology of the coastal marshes of western Lake Erie: a community profile. U.S. Fish Wildl. Serv. Biol. Rep. 85(7.9).

Hill, M.O. 1979. TWINSPAN - A FORTRAN program for arranging multivariate data in an ordered two-way table by classification of individuals and attributes. Cornell University, Ithaca, NY.

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomol. 20:31-39.

Innis, S.A., R.J. Naimen, and S.R. Elliot. 2000. Indicators and assessment methods for measuring the ecological integrity of semi-aquatic terrestrial environments. Hydrobiologia 422/423:111-131.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6(6):21-27.

Karr, J.R. and E.W. Chu. 2000. Sustaining living rivers. Hydrobiologia 422/423: 1-14.

Karr, J,R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Illinois Natural History Survey, Special Publication 5.

Kashian, D.R. and T.M. Burton. 2000. A comparison of macroinvertebrates of two Great Lakes coastal wetlands: testing potential metrics for and Index of Biotic Integrity. J. Great Lakes Res. 26: 460-481.

Keough, J.R. T.A. Thompson, G.A. Guntenspergen, and D.A. Wilcox. 1999. Hydrogeomorphic factors and ecosystem responses in coastal wetlands of the Great Lakes. Wetlands 19: 821-834.

King, R.S. and J.C. Brazner. 1999. Coastal wetland insect communities along a trophic gradient in Green Bay, Lake Michigan. Wetlands 19: 426-437.

Krieger, K.A. 1992. The ecology of invertebrates in Great Lakes coastal marshes: current knowledge and research needs. J. Great Lakes Res. 18:634-650.

Krieger, K.A. 1995a. Spatial and seasonal distributions of nonplanktonic aquatic invertebrates in the Old Woman Creek National Estuarine Research Reserve. Final report, ODNR Div. Of Natural Areas and Preserves. 47 pp. + app.

Krieger, K.A. 1995b. Pre-dike survey of aquatic macroinvertebrate communities of Metzger marsh. Final Rept., Ohio Div. of Wildlife. 22 pp.

Krieger, K.A. 1999. Aquatic macroinvertebrate communities of Potters Pond, with comparison to Metzger Marsh. Final Rept., U.S. Geological Survey, Ann Arbor, MI. 13 pp. + app.

Mack, John J. 2001. Standardized Vegetation Sampling Procedures Field Manual v. 1.1. Ohio EPA Technical Report WET/2001-2. Ohio Environmental Protection Agency, Division of Surface Water, 401 Wetland Ecology Unit, Columbus, Ohio.

Maynard, L. and D. Wilcox. 1997. Coastal wetlands. 1996 State of the Lakes Ecosystem Conference (SOLEC) Background paper. Environment Canada and U. S. Environmental Protection Agency EPA 905-R-97-015.

Murkin, H.R., P.G. Abbott, and J.A. Kadlec. 1983. A comparison of activity traps and sweep nets for sampling nektonic invertebrates in wetlands. Freshw. Invert. Biol. 2:99-106.

National Research Council. 2000. Ecological indicators for the nation. National Academy Press, Washington D.C.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Grass, and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: benthic macroinvertebrates and fish. Office of Water, U.S. Environmental Protection Agency. EPA/440/4-89-001.

ter Braak, C.J.F. 1986. Canonical correspondence analysis: A new eigenvector technique for multivariate direct gradient analysis. Ecology 67: 1167-1179.

Thoma, R.F. 1999. Biological monitoring and an index of biotic integrity for Lake Erie's nearshore waters. Pp. 417-461. In T.P. Simon (ed.) Assessing the sustainability and biological integrity of water resources using fish communities. CRC Press, NY.

USEPA. 1979. Methods for analysis of water and wastes. EPA 600/4-79-020, US Environmental Protection Agency. Washington, D.C..

USEPA. 1998. Lake and reservoir bioassessment and biocriteria. Technical guidance document. EPA 841-B-98-007. US Environmental Protection Agency. Washington, D.C.

PROJECT SCHEDULE / TIMELINE

December 2001: prepare Quality Assurance Project Plan; Attend Coastal Wetlands Consortium meeting to meet with other project teams including T. Burton and S. Timmermans to discuss sampling techniques

February - April 2002: acquire aerial and satellite photographs and maps of all potential coastal wetlands study sites; assess land use surrounding each wetland; submit 1st quarterly project report

May 2002: meet J. Mack's team and cross-train plant sampling techniques. Prepare 2nd quarterly project report

June2002: visit all potential coastal wetland sites to choose sampling locations in each coastal wetland, ground truth land use surrounding each wetland

August 2002: visit all wetlands and sample fish, plants, invertebrates, and abiotic conditions

September-October 2002: sort invertebrate samples, process water quality samples, analyze data; submit 3rd quarterly project report

November 2002: prepare final report

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I. Educational Background

B. A., Biology, 1987, New York University
M. S., Biology, 1991, New York University
Ph. D., Entomology, 1995, University of California, Berkeley

II. Academic Work Experience

1987-1989:	Teaching Assistantship Department of Biology New York University New York, NY
1989-1995:	Teaching and Research Assistantships Department of Entomology University of California Berkeley, CA
1996-1997:	Postdoctoral Fellow Department of Environmental Science, Policy and Management University of California Berkeley, CA
1998-present:	Assistant Professor Department of Biological Sciences Kent State University Kent, OH

III. Recent Publications

de Szalay, F.A., D.P. Batzer, E.B. Schlossberg, and V.H. Resh. 1995. A comparison of small and large scale experiments examining the effects of wetland management practices on mosquito densities. *Proc. Calif. Mosq. Vector Control Assoc.* 63:86-90.

de Szalay, F.A., D.P. Batzer, and V.H. Resh. 1996. Mesocosm and macrocosm experiments to examine effects of mowing emergent vegetation on wetland invertebrates. *Environ. Entomol.* 25:303-309.

de Szalay, F.A. and V.H. Resh. 1996. Spatial and temporal variability of trophic relationships among aquatic macroinvertebrates in a seasonal marsh. *Wetlands* 16:458-466.

de Szalay, F.A. and V.H. Resh. 1997. Responses of wetland invertebrates and plants important in waterfowl diets to burning and mowing of emergent vegetation. *Wetlands* 17:149-156.

Batzer, D.P., F.A. de Szalay, and V.H. Resh. 1997. Opportunistic response of a benthic midge (Diptera: Chironomidae) to management of California seasonal wetlands. *Environ. Entomol.* 26:215-222.

de Szalay, F.A., N.H. Euliss, and D.P. Batzer. 1999. Seasonal and semipermanent wetlands of California; invertebrate community ecology and responses to management methods. pp 829-855 *in* Invertebrates in Freshwater Wetlands of North America: Ecology and Management. (ed. by D.P. Batzer, R.B. Rader, S.A. Wissenger). John Wiley and Sons, Inc., New York, NY.

de Szalay, F.A. and V.H. Resh. 2000. Factors influencing macroinvertebrate colonization of seasonal wetlands: responses to emergent plant cover. *Freshw. Biol*., 45: 295-308.

de Szalay, F.A. and W. Cassidy *In Press* Effects of Muskrat (Ondatra zibethicus) Lodge Construction on Invertebrate Communities in a Great Lakes Coastal Wetland. Am. Midl. Nat.

IV. Recent Funded Proposals

Ohio Biological Survey, Columbus, Ohio. Post-dike surveys and monitoring at Metzger's Marsh. 1998-2001 $35,500.

Ducks Unlimited, Sacramento, CA. Grassland invertebrates, Phase III. 1998-1999. $3,000.

Ohio Department of Natural Resources / Division of Wildlife, Columbus, Ohio. Effects of nutrient enrichment by Canada Geese on algae and macrophytes in urban lakes. 1999. $3,954.

Ohio Sea Grant, Columbus Ohio. Preliminary tests of seiches on plant litter decomposition and macroinvertebrates in Great Lake coastal wetlands. 1999-2000. $7,500.

Lake Erie Protection Fund, Columbus, Ohio. Native unionid mussels, zebra mussels and host fish distributions in Crane Creek Wetland at Ottawa National Wildlife Refuge (Lucas and Ottawa Co.). 2001-2002. $7,500

V. Recent Technical and Grant Reports

Resh, V.H., E. Schlossberg and F.A. de Szalay. 1994. Large-scale validation of cultural practices for concurrent enhancement of waterfowl populations and control of mosquitoes. Grant report prepared for University of California Mosquito Research Program.

de Szalay, F.A. 1999. Post-dike surveys and monitoring at Metzger's Marsh: invertebrate communities in 1998-1999. Grant report prepared for Ohio Biological Survey.

de Szalay, F.A. 2000. Post-dike surveys and monitoring at Metzger's Marsh: invertebrate communities in 1999-2000. Grant report prepared for Ohio Biological Survey.

de Szalay, F.A., D. Helmers, D. Humberg, S.J. Lewis, B. Pardo, M. Shieldcastle. 2000. Upper Mississippi Valley / Great Lakes Regional Shorebird Conservation Plan. Technical report prepared for the U.S. Shorebird Conservation Plan, Manomet, Massachusetts.

VI. Teaching Assignments

Kent State University

Courses: Entomology (BSCI 30580)
Invertebrate Zoology (BSCI 20360)
Wetland Ecology and Management (BSCI 4/5/70195)

VII. Scientific Society Membership

American Association for the Advancement of Science
North American Benthological Society
Ohio Academy of Science
Ohio Biological Survey
Society for Wetland Scientists

VIII. Awards, Recognitions, Honors

New York University Undergraduate Summer Research Internship, 1987
U.C. Berkeley DuPont DeNemours Travel Award, 1993
Society of Wetland Scientists Graduate Student Travel Award, 1994
Society of Wetland Scientists Best Student Poster Award, 1994
William Reeves New Investigator Award Finalist, 1995
Robert L. Usinger Memorial Award, 1995
U.C. Berkeley Outstanding Graduate Student Instructor Award, 1996
U.C. Berkeley, Department of ESPM, Post-doctoral Fellowship, 1996-1997
Kent State University Research Activity Appointment, 2000
Kent State University Teaching Scholars Program, 2001

Joe B. Keiper, Ph.D. August 2001

Curator of Invertebrate Zoology
Cleveland Museum of Natural History
1 Wade Oval, University Circle
Cleveland, OH 44106

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Education

Raritan Valley Community College
North Branch, NJ
A.S. General Biology, 1989

Bloomfield College
Bloomfield, NJ
B.S. General Biology, 1991

Slippery Rock University
Slippery Rock, PA
M.S. Resource Management, 1993

Kent State University
Kent, OH
Ph.D. Ecology, 1998
Minors: Entomology, General Biology
Doctoral Advisor: Benjamin A. Foote, Ph.D.
Dissertation Title: Biology, larval feeding habits, and resource partitioning by microcaddisflies (Trichoptera: Hydroptilidae)

Awards and Honors

Alpha Chi, 1989
National Dean's List, 1990
USAA All-American Scholars, 1990
Who's Who Among Students in America's Colleges and Universities, 1991
Outstanding Graduate Student Award, Slippery Rock University, 1993
President, Graduate Biology Council, Kent State University, 1996-1997
University Fellowship, Kent State University, 1997-1998
David B. Smith Fellowship, Kent State University, 1998

Professional Experience

Postdoctoral Research Associate, University of California - Riverside, 1998 - 2000.

Department of Entomology
Research in areas of ecology, aquatic entomology, and ecological control of mosquitoes in constructed wetlands; taxonomy of Diptera and Trichoptera.

Curator of Invertebrate Zoology, Cleveland Museum of Natural History, 2000 - present
Responsible for curation of Invertebrate Collection:
Entomology
Malacology
Associate Editor, *Kirtlandia*, February 2001 - present.
Research:
Biodiversity and population ecology studies of aquatic insects.
Biology and immature stages of Diptera and Trichoptera.
Wetlands biology, including constructed wetlands

Adjunct Professor of Biology, Case Western Reserve University, June 2001 - present

Consulting Entomologist, Cuyahoga County Coroners Office, April 2001-present

Director, Ohio Conservation Alliance
Direction and coordination of cosortium of Cleveland Researchers participating in biodiversity and ecological studies in northeastern Ohio. Initiated Summer 2001.

Teaching Experience

Invertebrate Zoology, 1997 (Kent State University)
The Hidden Life of Ohio's lakes and streams (CMNH / Cleveland State University)

Publications

Keiper, J.B. 1996. Monarch transfers: A real concern? BioScience 46: 562.

Keiper, J.B. and B.A. Foote. 1996. A simple rearing chamber for lotic insect larvae. Hydrobiologia 339: 137-139.

Keiper, J.B., E.G. Chapman, and B.A. Foote. 1997. Midge larvae (Diptera: Chironomidae) as indicators of postmortem submersion interval of carcasses in a woodland stream: a preliminary report. Journal of Forensic Sciences 42: 1072-1077.

Collier, A., J.B. Keiper, and L.P. Orr. 1998. The invertebrate prey of the northern Leopard Frog, *Rana pipiens*, in a northeastern Ohio population. Ohio Journal of Science 98: 39-41.

Keiper, J.B., P.L. Brutsche, and B.A. Foote. 1998. Acalyptrate Diptera associated with water willow, *Justicia americana* (Acanthaceae). Proceedings of the Entomological Society of Washington 100: 576-587.

Keiper, J.B., D.A. Casamatta, and B.A. Foote. 1998. Incorporation of *Batrachospermum gelatinosum* (Rhodophyta) into cases of *Ochrotrichia wojcickyi* (Trichoptera: Hydroptilidae). Entomological News 109: 256.

Keiper, J.B., D.A. Casamatta, and B.A. Foote. 1998. Use of algal monocultures by larvae of *Hydroptila waubesiana* and *Oxyethira pallida* (Trichoptera: Hydroptilidae). Hydrobiologia 380: 87-91.

Keiper, J.B. and B.A. Foote. 1998. Biological notes on *Ochrotrichia xena* (Trichoptera: Hydroptilidae), a species newly recorded for Ohio. Proceedings of the Entomological Society of Washington 100: 594-595.

Foote, B.A., L.V. Knutson, and J.B. Keiper. 1999. The snail-killing flies of Alaska (Diptera: Sciomyzidae). Insecta Mundi 13: 45-71.

Keiper, J. B. 1999. Morphology of final instar *Ochrotrichia xena* (Trichoptera: Hydroptilidae). Entomological News 110: 231-235.

Keiper, J.B. and B.A. Foote. 1999. Biology and immature stages of two species of *Hydroptila* (Trichoptera: Hydroptilidae) which consume *Cladophora* (Chlorophyta). Proceedings of the Entomological Society of Washington 101: 514-521.

Keiper, J.B., J. Jiannino, J. Beehler, and W.E. Walton. 1999. Distribution and abundance of Culicidae and Chironomidae (Diptera) following storm damage in a southern California constructed wetlands. Proceedings of the Mosquito and Vector Control Association of California 67: 47-54.

Keiper, J.B. and W.E. Walton. 1999. Biology and morphology of the mature larva of *Oxyethira arizona* Ross (Trichoptera: Hydroptilidae). Pan-Pacific Entomologist 75: 212-220.

Walton, W.E., K. Chan, L.H. Gould, and J.B. Keiper. 1999. Mosquito production from three wetland management practices for constructed treatment wetlands: preliminary findings. Proceedings of the Mosquito and Vector Control Association of California 67: 18-21.

Walton, W.E., P.D. Workman, and J.B. Keiper. 1999. An inexpensive collapsible pyramidal emergence trap for the assessment of wetland insect populations. Proceedings of the Mosquito and Vector Control Association of California 67: 15-17.

Keiper, J.B. and E.M. Espeland. 2000. Spatial distribution and larval behavior of *Glyptotendipes lobiferus* (Diptera: Chironomidae). Hydrobiologia 427: 129-133.

Keiper, J.B. and B.A. Foote. 2000. Biology and larval feeding habits of coexisting Hydroptilidae (Trichoptera) from a small woodland stream in northeastern Ohio. Annals of the Entomological Society of America 92: 225-234.

Keiper, J.B., M. Sanford, J. Jiannino, and W.E. Walton. 2000. Invertebrates colonizing monocots damaged by lepidopteran herbivory. Entomological News 111: 348-354.

Keiper, J.B. and W.E. Walton. 2000. Biology and immature stages of *Ochrotrichia quadrispina* Denning and Blickle (Trichoptera: Hydroptilidae), a spring-inhabiting scraper. Proceedings of the Entomological Society of Washington 102: 183-187.

Keiper, J.B. and W.E. Walton. 2000. Biology and immature stages of *Brachydeutera sturtevanti* (Diptera: Ephydridae), a hyponeustic generalist. Annals of the Entomological Society of America 92: 468-475.

Keiper, J.B. and D.A. Casamatta. 2001. Benthic organisms as forensic indicators. Journal of the North American Benthological Society 20:311-324.

Keiper, J.B., J. Jiannino, M. Sanford, and W.E. Walton. 2001. Biology and immature stages of *Typopsilopa nigra* (Williston) (Diptera: Ephydridae), a secondary consumer of damaged stems of wetland monocots. Proceedings of the Entomological Society of Washington 103: 89-97.

Keiper, J.B., W.E. Walton, and B.A. Foote. 2002. Biology and ecology of higher Diptera from freshwater wetlands. Annual Review of Entomology 47: 207-232.

Selected Funding

Keiper, J.B. and W.E. Walton. 1999. Effects of vegetation species and density on mosquito production in a southern California constructed wetlands. Northwest Mosquito and Vector Control Association. $20,000

Keiper, J.B. and W.E. Walton. 1999. Invertebrate responses to vegetation management strategies in a southern California constructed wetlands, with special emphasis on mosquitoes (Diptera: Culicidae). Orange County Water District. $27,000

Keiper, J.B. and W.E. Walton. 2000. Effects of nutrients and predators on mosquitoes in a southern California constructed wetlands. University of California Mosquito Research Program. $31,500.

Keiper, J. B. and B. A. Foote. 2001. Selected brachycerous Diptera of the Great Smoky Mountains National Park. All Taxa Biodiversity Inventroy, Discover Life in America. $1632

Professional Memberships

American Entomological Society
Center for Systematic Entomology
Entomological Society of America
Entomological Society of Washington
North American Benthological Society
North American Dipterist Society
Ohio Biological Survey
Sigma Xi, Associate Member

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I. Educational background

Ph.D. Zoology, The Ohio State University, 1998.

M.S. Biological Sciences, University of Notre Dame, 1992.

B.S. Biological Sciences, University of Notre Dame, 1988.

II. Academic Experience

December 1999 - present. Assistant Professor in the Department of Biological Sciences at Kent State University.

January 1999 - November 1999. Postdoctoral Research Associate in the Department of Fisheries and Wildlife at Utah State University.

July 1998 - December 1998. Postdoctoral Research Associate in the Department of Evolution, Ecology, and Organismal Biology at The Ohio State University.

III. Recent Publications

Kershner, M.W. and D.M. Lodge. 1990. Effect of substrate architecture on aquatic gastropod-substrate associations. *Journal of the North American Benthological Society* 9(4):319-326.

Lodge, D.M., M.W. Kershner, J.P. Aloi, and A.P. Covich. 1994. Effects of an omnivorous crayfish (*Orconectes rusticus*) on a freshwater littoral food web. *Ecology* 75(5):1265-1281.

Kershner, M.W. and D.M. Lodge. 1995. Effects of littoral habitat and fish predation on the distribution of an exotic crayfish, *Orconectes rusticus*. *Journal of the North American Benthological Society* 14(3):414-422.

Madenjian, C.P., J.T. Tyson, R.L. Knight, M.W. Kershner, and M.J. Hansen. 1996. First-year growth, recruitment, and maturity of walleye in western Lake Erie. *Transactions of the American Fisheries Society* 125:821-830.

Kershner, M.W. and E.A. Marschall. 1998. Allocating sampling effort to equalize precision of electrofishing catch per unit effort. *North American Journal of Fisheries Management* 18:822-831.

Kershner, M.W., D.M. Schael, R.L. Knight, R.A. Stein, and E.A. Marschall. 1999. Modeling sources of variation for growth and predatory demand of Lake Erie walleye, 1986-1995. *Canadian Journal of Fisheries and Aquatic Sciences* 56(4):527-538.

Ludsin, S.A., M.W. Kershner, K.A. Blocksom, R.L. Knight, and R.A. Stein. 2001. Life after death in Lake Erie: nutrient controls drive fish species richness, rehabilitation. *Ecological Applications* 11(3):731-746.

IV. Recent Funded Proposals

Lake Erie Protection Fund, Columbus, Ohio. Development and evaluation of an index of biotic integrity for the offshore fish assemblage of Lake Erie. 2001-2002. $31,686.

V. Recent Technical and Grant Reports

Kershner, M.W. and R.A. Stein. 1998. Food web modeling in the western and central basins of Lake Erie. Fish Management in Ohio, FINAL Performance Report, Project FADR24, Ohio Department of Natural Resources, Division of Wildlife, Columbus. (Also, Annual Reports written each year, 1993-1997.)

Kershner, M.W. and D.A. Beauchamp. 2001. Estimating the impact of lake trout and lake whitefish predation on Flathead Lake food web structure. Grant Report prepared for Montana Fish, Wildlife, and Parks.

VI. Teaching Assignments

Kent State University
- Population/Community Ecology (BSCI 6/70373)
- Vertebrate Zoology (BSCI 4/5/70556)
- Ecology, Evolution, and Society (BSCI 10002)

VII. Membership in Scientific Societies

American Association for the Advancement of Science
Ecological Society of America
American Fisheries Society

KENNETH ALAN KRIEGER

Titles: Senior Research Scientist, Water Quality Laboratory Business Phone: 419 448-2226
Chairman, Water Resources Program Home Phone: 419 448-9555
Director of Academic Grants, Heidelberg College Email: kkrieger@heidelberg.edu
310 E. Market Street, Tiffin, Ohio 44883

Education:

B.S. , Emory University (1968), Biology; M. S., Emory University (1969), Biology; Ph.D., Emory University (1977), Biology

Experience:

1998 to present – Senior Research Scientist, Water Quality Laboratory
1978 to 1998 Research Associate, Water Quality Laboratory
1985 to present -- Director of Academic Grants, Heidelberg College
1977 to 1978 -- Visiting Assistant Professor, Biology, Emory University
1976 to 1977 -- Visiting Assistant Professor, Queens College, Charlotte, NC

Professional Organizations:

International Society of Theoretical and Applied Limnology (SIL), International Association for Great Lakes Research, North American Benthological Society, Sigma Xi Society, Ohio Academy of Science, Society of Wetlands Scientists

Selected Current and Recent Activities:

Great Lakes Aquatic Ecosystem Research Consortium, charter member, 1993-present
Old Woman Creek National Estuarine Res. Reserve Advisory Council, member, 1984-present
Instructor in Water Pollution Biology and Limnology at Heidelberg College, and Limnology at F.T. Stone Laboratory of Ohio State University (1989-96; 2000-01)
National Project W.E.T. certified workshop leader (1995); conducted 4 workshops.

Selected Recent Grants and Contracts:

2001-02: Mayfly metric of the Lake Erie Quality Index: design of an efficient censusing program, data collection, and development of the metric. P.I. Lake Erie Protection Fund (Ohio). LEQI 01-03. $50,862.

2001-02: Confirmation of rapid population increase of burrowing mayflies in the central basin of Lake Erie. P.I. Lake Erie Protection Fund (Ohio). SG145-01. $7,500.

2000-01: Tracking rapid population change of burrowing mayflies in the central basin of Lake Erie. P.I. Lake Erie Protection Fund (Ohio). SG129-00. $7,500.

1999-2001: Assessment of macroinvertebrate community in and around an open-lake disposal area, western basin of Lake Erie. P.I. U.S. Army Corps of Eng.-Buffalo. $50,751.

1998-99: Collection and identification of stream macroinvertebrates as part of the Cuyahoga River Watershed Project. Cleveland State University. $6,779.

1997-99: Ecosystem change in Lake Erie: Recolonization by burrowing mayflies and their contribution to fish diets. P.I. Lake Erie Protection Fund (Ohio). LEPF 97-30. $96,767.

1996-97: Quantification of pollutant fluxes through **Old Woman Creek coastal wetland**. Ohio Dept. Natural Resources, Division of Natural Areas and Preserves. P.I. $16,000.

1996-97: Field survey of aquatic macroinvertebrate communities of **Potters Pond**. US Geological Survey, Biological Resources Division (Ann Arbor, MI). P.I. $8,000.

1996-98: Effects of habitat modification by *Dreissena* spp. on burrowing mayfly survival and fitness in Lake Erie. Ohio Sea Grant. Co-PI with Dr. D. J. Berg, Miami Univ. $26,000.

1995-97: Ecosystem change in western Lake Erie: cause and effect of burrowing mayfly recolonization. Lake Erie Protection Fund (Ohio). $60,000 + state and federal match.

1994: Effect of dike construction on the benthic macroinvertebrate communities of **Metzger Marsh**. Ohio Dept. Natural Resources, Division of Wildlife. $10,000.

1993-94: Bioindicators of lake quality: burrowing mayflies (*Hexagenia*) and caddisflies (*Oecetis*) as heralds of the recovery of Lake Erie. P.I. (with S. Heady, Ohio State Univ.). Ohio Sea Grant. $6,760.

1992-93: Analysis of benthic macroinvertebrate samples from Lake Erie. Principal investigator. U.S. Fish and Wildlife Service. $9,000.

1991-92: A taxonomic and ecological survey of the microinvertebrates of Old Woman Creek NERR. Principal investigator. National Estuarine Reserve Research System, Office of Ocean and Coastal Resource Mgt., NOAA, $20,000.

1989-91: A comparison of benthic and periphytic invertebrate communities along an elevational gradient in Old Woman Creek NERR. Principal investigator. National Estuarine Reserve Research System, Office of Ocean and Coastal Resource Mgt., NOAA, $14,562.

1988-90: An environmental assessment of the impact of a toluene spill on Sugar Creek, Seneca County, Ohio. Principal investigator. Gannett Foundation, $6,000; Ohio Dept. Natural Resources, $5,000; Izaak Walton League of America Endowment, $3,000; private donation, $1,000.

1987-90: An ecosystem approach to Lake Erie wetlands: sediment, nutrient and pesticide budgets. Ohio Sea Grant; principal investigator. $117,000 (Sea Grant), $22,000 (Ohio DNR)

Selected Publications on Aquatic Invertebrates

Schloesser, D.W., K.A. Krieger, J.J.H. Ciborowski, and L.D. Corkum. In Press. Recolonization and possible recovery of burrowing mayflies (Ephemeroptera: Ephemeridae: *Hexagenia* spp.) in Lake Erie of the Laurentian Great Lakes. *J. Aquatic Ecosystem Stress and Recovery*.

Krieger, K.A. 1999. *Mayfly Watch 1998, report on Year Two of a citizen volunteer project along the Ohio shore of Lake Erie*. 13 pp + app. (Also 1998: report on Year One. 21 pp. + app.)

Madenjian, C. P., D. W. Schloesser, and K. A. Krieger. 1998. Population models of burrowing mayfly recolonization in western Lake Erie. *Ecological Applications* 8:1206-1212.

Krieger, K. A., D. W. Schloesser, B. A. Manny, C. E. Trisler, S. E. Heady, J. J. H. Ciborowski, and K. N. Muth. 1996. Recovery of burrowing mayflies (Ephemeroptera: Ephemeridae: *Hexagenia*) in western Lake Erie. *J. Great Lakes Res*. 22: 254-263.

Krieger, K.A., and D.M. Klarer. 1995. *Spatial and seasonal distributions of nonplanktonic aquatic invertebrates in the Old Woman Creek National Estuarine Research Reserve.* U.S. Dept. Commerce, NOAA. 47 pp. + app.

Krieger, K.A., and L.S. Ross. 1993. Changes in the benthic macroinvertebrate community of the Cleveland Harbor area of Lake Erie from 1978 to 1989. *J. Great Lakes Res*. 19:237-249.

Krieger, K.A. 1992. The ecology of invertebrates in Great Lakes coastal wetlands: current knowledge and research needs. *J. Great Lakes Res*. 18:634-650.

Krieger, K.A. 1991. (Ed.) *Bioindicators of rural nonpoint source pollution in Lake Erie tributaries: measuring responses to improved management technologies, proceedings of a workshop held at Heidelberg College, Tiffin, Ohio 9-10 May 1991*. 71 pp.

Krieger, K.A., and D.M. Klarer. 1991. Zooplankton dynamics in a Great Lakes coastal marsh. *J. Great Lakes Res*. 17:255-269.