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Todd W. Morrison and David L. Johnson
The Ohio State University

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Ohio Sea Grant College Program
The Ohio State University
1314 Kinnear Road
Columbus, Ohio 43212-1194
614/292-8949
Fax: 614/292-4364

www.sg.ohio-state.edu/

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A Cost-Effective Trap to Remove Carp and Bullhead from Diked Wetlands[1]

Todd W. Morrison and
David L. Johnson

The Ohio State University
School of Natural Resources
2021 Coffey Road
Columbus, Ohio 43210

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FINAL REPORT

for

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Abstract

The management of nuisance fish in diked wetlands is essential for the production of aquatic macrophytes. High densities of benthic fish such as common carp *Cyprinus carpio*, goldfish *Carassius auratus*, and bullhead *Amieurus spp.* have been shown to negatively impact aquatic communities. In response to these impacts managers are forced to eliminate the entire fish and invertebrate communities using rotenone. We developed an alternate method for fish removal using water current. Two styles of current traps were developed and tested. The first style was constructed with panels and a trap net. The second style used a trap net wrapped in silt fabric. Two of each style were built to test water input source (recirculation and Sandusky River) and placed in Tawa Swale, a 40 hectare diked wetland owned by Ottawa Shooting Club. An electrofishing survey was conducted in 1996 and all common carp, goldfish, and bullhead captured were fin clipped to determine the traps' efficiency. The traps were run each day for about 5 days May-June, 1996 and April-May, 1997. Fish were identified and target fish were measured, weighed, and checked for marks. All fish were then released in the Sandusky River. A total of 1085 fish and 10 different species were collected during 11.9 days of sampling. During both years we removed 90 common carp, 787 goldfish, and 58 bullhead. During 6.5 days of sampling in June, 1996 over 100 kg of common carp were taken from the wetland. Only four marked fish were recovered in 1996, however, the electrofishing gear and the current traps sampled different sized fish. Flooding of Tawa Swale by the Sandusky River terminated the study in June, 1997 so trap efficiency and water input source could not be tested. The fabric-wrapped trap net proved to be the easiest to build and set-up and also produced almost all the common carp and all the bullhead. Although the panel trap produced fish, it was unclear if the current was the primary attractant and responsible for fish capture or if the trap nets were acting to catch fish with their leads. The traps were most successful during the spawning seasons for the target species and selected for large mature fish. We feel that with more study this method of removal can be cost-effective.

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Introduction

Earthen dikes encircle about 85% of the remaining wetland areas along the Ohio coast of Lake Erie (Bookhout et al. 1989). These dikes afford protection against extreme water level fluctuations, wind and wave action (Herdendorf 1987). They shield organic layers within and allow managers to manipulate water levels and thereby select for desired wetland flora and fauna. Water exchange is typically limited creating an environment of partial although not total isolation.

Water management regimes in diked wetlands are commonly cyclic and include drawdowns in the spring followed by reflooding in the fall. Lower water levels during spring allow for the production of both emergent and submergent macrophytes resulting in some of the most diverse habitat along the southern Lake Erie coast. Production and diversity of these macrophytes in turn provides habitat for macroinvertebrates (Merritt and Cummins 1984) and increases food resources for other wildlife such as waterfowl (Riley 1989). Reflooding events in the fall are associated with migrations of waterfowl; raising water levels provides easier access to, and maximizes use of, these food resources.

Diversity in aquatic habitats has proven to sustain rich and often complex fish communities. Wetlands in general fall in this category because of their high productivity and diversity. Coastal wetlands along the Lake Erie have often been cited as important nursery areas (Verduin 1969; Herdendorf et al. 1981), feeding areas (Tilton and Schwegler 1978; Shenker and Dean 1979), and refuges for prey fishes (Herdendorf 1987). However, the isolating nature of dikes and their associated wetlands has not kept up with this paradigm (Johnson et al. 1997). Fish species enter these wetlands during water level changes forming a seed population within. While fish communities flourish behind dikes, they are essentially isolated and are believed to function without impact on the communities from which they came (Johnson et al. 1997). These communities do affect their wetlands and pest fish species can reach population densities that negatively impact both diversity and production of plants and animals. Therefore, management of fish communities is necessary and two approaches are common.

Fish communities are managed both proactively and reactively. Proactive styles include grading, screening, and pumping water into wetlands to prevent large fish from entering. However, larval and juvenile fish are still able to pass through and mature, trapping them behind the physical or mechanical barriers (Petering and Johnson 1991). Managers may also remove most or all the water during a drawdown to stress and kill the community inside. If the drawdown does not remove 100% of the water within, highly tolerant species survive and form the population seeds when the wetland is again reflooded. Reactive management is usually in response to visible changes in water clarity and productivity within the wetland. High densities of fish (especially common carp *Cyprinus carpio*) are often associated with increased turbidity and loss of macrophyte production (Crivelli 1983; Hanson and Butler 1994). A piscicide, such as rotenone, is then applied to eliminate the community. These management styles are usually combined, resulting in a 5 to 7 year cycle of fish community development and elimination.

Why do fish communities within diked wetlands warrant such devastating measures? Diked wetland design and water level regimes play critical although indirect roles. These wetlands are often shallow in design to maximize plant production. Lower water levels in the spring and summer form an environment in which water quality fluctuates. Water temperatures vary considerably between day and night and elevate to extremes on occasion; in turn, creating low dissolved oxygen events (Navarro and Johnson 1992). Shallow water can also promote higher turbidity, especially in high fetch areas when macrophyte growth has been inhibited by fishes (Kolterman 1990), compounding the problems. These factors can have a significant selective influence on which fish species survive and thrive within a diked wetland.

Certainly fish species present and their interactions within diked wetland can determine community changes. Highly tolerant fishes such as bullheads *Amieurus spp.*, common carp, and goldfish *Carassius auratus* are common within the Lake Erie drainage and well suited for these harsh wetland environment. Literature indicates these nuisance species reduce macrophyte growth and production through spawning and foraging behavior. Williams (1970) found black bullhead, *Amieurus melas* dislodged and subsequently destroyed vegetation when searching for food.

Richardson et al. 1995 described goldfish as benthic herbivores, grazing extensively on submergent macrophyte communities. The feeding mechanism used by common carp, which is typically sucking a mouthful of sediment, ejecting the contents and selecting the digestible items, can undermine the root structure of submerged vegetation (Robel 1961; McCrimmon 1968; Sibbing 1991). These detrimental effects may be enhanced since common carp most frequently use shallow areas for feeding and spawning where most submergent vegetation is located (Crivelli 1981).

Since common carp feeding and spawning activities occur in shallow areas near the sediment-water interface, turbidity, in the form of suspended solids, can be increased. Studies attempting to correlate turbidity with common carp biomass have been largely unsuccessful in uncontrolled systems with unimpeded water movement (Tryon 1954; Crivelli 1983; Fletcher et al. 1985; Kolterman 1990). However, studies which used ponds or separate tubs to isolate water and common carp usually made this link. For example, Qin and Threlkeld (1990) found turbidity was enhanced in enclosures containing common carp in the presence of sediment. Cline et al. (1994) also found common carp to increase turbidity alone and in the presence of channel catfish, *Ictalurus punctatus* in a mesocosm study. Both Breulelaar et al. (1994) and Roberts et al. (1995), demonstrated high common carp biomass increased turbidity in experimental ponds. Goldfish, a close relative known to hybridize with common carp, have been directly correlated with increased turbidity in ponds as well (Richardson et al. 1995).

Since benthic fishes can cause so many impacts, diked wetland managers are constantly seeking to avoid and destroy these species when they begin to dominate. Control methods are both labor and cost intensive, directly impacting the entire aquatic community. In most cases, to remove these nuisance fishes the entire fish and aquatic invertebrate community must be sacrificed. An alternative method of wetland-fish control which would spare these communities complete destruction, reduce labor, equipment, and material costs is needed. One such method could be the development of a fish trap which uses flowing water as an attractant.

It has been proven that fish seek out a preferred water flow, temperature, and quality. Common carp, goldfish, and bullhead are no exception. These fish become active in the spring, moving throughout the wetlands in response to spawning urges and changes in water temperature and quality. With this in mind, a trap was developed that created water flow from various sources. This device was designed to captured fish moving into the current. This technology could then be used to remove nuisance fish, keeping their populations down and reducing their impacts within a diked wetland.

Study Objectives

A. To design a cost-effective trapping strategy that uses water flow to attract and facilitate removal of common carp, goldfish and bullhead from diked wetlands.

B. To test the effects of pump water source and the time of year on numbers and sizes of carp and bullhead removed from a diked wetland.

C. To estimate percentages of carp and bullhead removed by the trap from a 40 ha diked wetland.

Study Site

Tawa Swale is a 40 hectare diked wetland located within Ottawa Shooting Club in Sandusky County, Ohio. Ottawa Shooting Club is a private waterfowl hunting club located on the western edge of Sandusky Bay, Lake Erie. The wetland is managed for macrophyte production and is connected to the Sandusky River via a culvert pipe into a pumphole. The average depth within the wetland was 0.73-m and maximum depth was 2-m during normal summer drawdown conditions. Electrofishing surveys in 1996 indicated the wetland was dominated by common carp, goldfish, and bowfin (*Amia calva*).

Methods

Trap Construction

Two basic current trap designs were employed for fish capture during the study. The first style involved the use of panels to streamline flow with a trap net placed at the opening to capture fish. Panels were constructed of 2.4-m T-bar metal fence posts bolted horizontally to 2.1-m T-bar posts. About 0.5-m of the vertical posts were left unrestricted in order to anchor the panels into the sediment. Weld wire metal fencing was attached to the rectangular frame and silt fabric was secured to the fencing completing the panels. Panels were driven into the sediment as far as possible while still leaving their top above the water surface. Panels were secured using 20 gauge metal wire. Each side of the trap contained three panels. A forth was positioned across the front of the trap leaving an opening as wide as the trap net which was then put into position (Figure 1). South Dakota style trap nets were used with a 30-m lead and 12-mm mesh bar. A 76-mm diameter gasoline powered pump was used to discharge water into the trap at a rate of about 1875-L per min. The pump was equipped with an 8-m intake hose, a 30-m discharge hose, and a remote 45-L gas tank allowing it to operate continuously for 12-hrs. This completed the first design.

The second style of current trap was much simpler in design and construction. A South Dakota style trap net with 12-mm bar mesh and no lead was wrapped in silt fabric. The fabric was sewn onto the outside of the net covering the total length (Figure 2). The net loosely resembled a culvert pipe in shape and color and acted to concentrate flow. A 76-mm diameter gasoline powered pump was used to discharge water directly into the cod end of the trap at a rate of about 1875-L per min. The pump was equipped with an 8-m intake hose, a 30-m discharge hose, and a remote 45-L gas tank allowing it to operate continuously for 12-hrs.

Fish Collection

To determine the efficiency of the current trap in removing nuisance fish we conducted an initial electrofishing survey. A standard boat electrofisher was used, electric field levels were 275-300 volts at 4-6 amps. All common carp, goldfish, and bullhead species were targeted. Fish were measured, fin clipped (right pectoral), and released back into the wetland.

Research sites for current traps within Tawa Swale were chosen based on four criteria. First, all sites were along dikes that could be accessed by a vehicle. Second, each site was wadable to allow easy setup and sampling. Third, each site was adjacent to deep water within the wetland (water > 1.5-m deep). Finally, the pumps had to be able to consistently draw water from their input source, i.e. areas with too high dike slopes were avoided. Three areas within the wetland possessed these attributes and were chosen as study sites.

Two of each style of current traps were built to collect fish and examine any differences in catch rates between intake sources and over time. Water was drawn from the Sandusky river as an outside source and from the wetland as a recirculation source. The traps were run for five consecutive days within each month April-August when possible. The nets were sampled every 24-hrs and the pumps were stopped every 12-hrs to refuel, check the oil, and record water temperatures at the input and discharge before being restarted. All fish were identified, measured, and checked for marks. Any common carp, goldfish, and bullhead were also weighed. The fish were then released into the Sandusky River.

Results and Discussion

The primary goal of this study was to design a fish trapping device using current which could be used by marsh managers to remove nuisance species. Two basic methods of capture and pumping were employed during the 1996 field season to develop the best strategy. The first style involved the use of both panels and trap nets to streamline flow. This method proved to be time consuming during the initial set-up and actual sampling. The construction of panels was labor intensive at 1.5-human hours per panel (12-human hours per trap) and the setup of both traps took 9-human hours. Sampling the nets for fish averaged 1-human hour per net; however, this effort also included fish identification, measurement, and weight when needed. In addition to high labor input, the trap design did not produce a strong exiting flow unless the discharge hose from the pump was placed within a meter of the opening created by the panels. Because of the high labor requirements and relatively inefficient design, it is unlikely that wetland managers can incorporate this style current trap into their management strategies cost-effectively.

These findings led to the development of an alternate style current trap. This design used a modified trap net (lead removed) wrapped in silt fabric with the pump outflow hose attached to the cod end of the net. The silt fabric concentrated flow and without a lead on the trap net, current became the sole attractant. Effort required to build and setup this trap was greatly reduced. Construction of each trap took 8-human hours and setup for both traps was 3 human-hours. Sampling time remained constant since the same methods of fish processing were used. We believe this style of current trap has the greatest potential to be used cost-effectively in removing nuisance fish from wetlands.

Collection results from 1996 were mixed but promising. Marking target species by electrofishing yielded 248 common carp, 193 goldfish, and 2 bullhead. These numbers were low, especially for bullhead, and probably the result of gear bias and low spring water temperature. The mean length of common carp collected was 250 mm and immature carp comprised 95% of the sample. These data indicate that immature carp either comprised a majority of the population in the wetland or they were more vulnerable to our gear or both. These data then provided an initial pool of marked fish to judge the efficiency of our traps.

Both styles of current traps used in 1996 captured 66 common carp, 776 goldfish, and 15 bullhead (Tables 1 and 2). The first style current trap sampled the greatest numbers of fish and all the goldfish. Although this method produced fish, it was unclear if the current was the primary attractant and responsible for fish capture or if the trap nets were acting to catch fish with their leads. To eliminate this variable another design was tested. The fabric-wrapped current trap caught all the bullhead and almost all the common carp. During 6.5 days of sampling in June we removed over 100 kg of common carp from the wetland. The average length of all common carp removed was 516-mm and 91% were considered mature. Only 4 marked fish were recaptured during sampling, two carp and two goldfish.

Initially, these results suggest that the traps are not efficiently removing common carp and goldfish; however, there are a few points worth mentioning. First, electrofishing and the fabric-wrapped current trap were clearly sampling different size components of the common carp population within Tawa Swale. Figure 3 clearly illustrates the disparity in lengths selected by the two sampling gears. Of the marked common carp only 12 were greater than 361 mm (length at maturity for common carp; Carlander 1969, Portt et al. 1988) and 17% (2 common carp) were recaptured in the current trap. To further underscore this difference, only 2 fish were collected in the current traps ≤ the mean length of common carp marked during electrofishing. The year class which was marked in 1996 will mature in 1997 and may be more vulnerable to our trap. Additionally, the mature common carp collected in the current trap were post-spawn fish suggesting that these large carp may prefer to exit the wetlands after spawning. Armed with these results then, we developed a sampling strategy using this style current trap for the 1997 field season to address the second and third objectives of this study.

Results from 1997 were limited to April and May because of flooding along the Sandusky River the first week in June. The 5.4 days of effort in April and May yielded 24 common carp, 11 goldfish, and 43 bullhead (Table 3). The study plan called for monthly sampling April-August, followed by wetland drawdown and a total fish kill using rotenone. This would have allowed us to estimate the percentages of common carp, goldfish, and bullhead the current traps removed and examine any selection the traps had with regard to the sizes of fish present, the water input source, and the time of year. However, flood waters compromised the dike at Tawa Swale and allowed fish the enter and exit at will. These dramatic changes in water level and fish community prompted direct intervention by the marsh manager and the study was terminated.

The sample size was too small to test statistically for differences in water input source; however, some trends were evident. The water input from the Sandusky River consistently sampled greater numbers of species and total numbers of fish with exception to the last two sample dates in May. After May 20, the recirculation trap had to be moved because the water level was too low in the wetland. The new site chosen was adjacent to the pumphole culvert pipe for the wetland and seemed to attract a greater diversity and abundance of fish. At this site the recirculation trap was successful in capturing fish including the majority of common carp, goldfish, and bullhead sampled in 1997. This suggests that fish capture at different locations is variable and may confound future results. While recirculation would be ideal for wetland managers because water levels remain constant when the trap is running, more research needs to be completed before any determinations can be made.

Although, the field work in 1997 was interrupted, we can draw some conclusions from this study. First, the current traps successfully caught and removed fish; 1085 total fish and 10 different species were collected during 11.9 days of sampling. Second, many fish collected were either in spawning condition or had just spawned indicating that the capture of fish seems to be related to spawning events. Table 4 further illustrates this point showing monthly catch rates for all species collected using the fabric-wrapped current trap. Both bullhead and common carp catch rates are greatest in June corresponding to their spawning time in late spring early summer. Black crappie, *Pomoxis nigromaculatus* and bowfin catch rates were highest during their spawning events as well. Third, although we have no way of knowing what impact our traps had on the fish populations in Tawa Swale in 1996-1997, there is the potential to have a significant impact on breeding fish within these wetland communities, thereby affecting he population size and structure. In addition, mature common carp, goldfish, and bullhead are considered to be the most destructive group within their populations because of their increased biomass, feeding behavior, and spawning (Williams 1970, Crivelli 1981, Richardson et al. 1995, McLean 1996). Removal of the largest size groups of these fish should benefit plant growth and improve water quality within any diked wetlands.

Is this trap cost-effective? The highest biomass of common carp (considered by most marsh managers as the primary nuisance) we caught was about 100-kg over a 6.5 day period in June 1996. Excluding equipment, total cost for gas and labor during that period of time was around $227. Therefore, removal of common carp during June cost about $2.27 per kg. By way of comparison, in 1997 the marsh manager at Ottawa Shooting Club lowered water levels in the wetland past normal summer pool and then applied rotenone to eliminate the fish community. Cost totals were about $3880 and should result in clear water for 5-7 years. Since the actual density of common carp in Tawa Swale could not be determined it is not easy to predict whether running this trap will be cheaper. It is our feeling that with more study, this method of removal will be cost-effective.

Research Needs and Conclusions

Many questions remain to be answered. Are these fish (common carp, goldfish, and bullhead) more vulernable at night or during the day? Does water input from an outside source attract more fish because it suggests an exit? Does the use of multiple locations remove more fish than one stationary site? Answers to these questions could cut down on operating costs and increase performance making this method viable and easy.

This study has demonstrated that current alone does capture fish. A trap can be produced easily with equipment that is simple and inexpensive (< $1500). Many wetland owners use pumps to control water levels making this design even cheaper (< $600). The trap works best during the target specie's spawning season and selects for large mature fish. Late spring and early summer seems to be the prime time for removal of common carp and bullhead. This trap may allow managers to control these species without the need for total extermination of all fish. Current traps may also prove to be popular with managers that stock predators in wetlands. Periodic use of this trap can help to control nuisance fish, thereby providing better water quality for predators and improving their efficiency to control fish populations. By integrating this method into wetland management, fish and invertebrate communities can continue to remain diverse and enhance wildlife within their watersheds.

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References

Bookhout, T.A., K.E. Bednarik, and R.W. Kroll. 1989. The Great Lakes marshes. pp. 131-156. *In* L.M. Smith, R.L. Pederson, and R.M. Kaminski (eds). Habitat management for migrating and wintering waterfowl in North America. Texas University Press. Lubbock, TX.

Breukelaar, A.W., E.H.R.R. Lammens, J.G.P. Klein Breteler, and I. Tatrai. 1994. Effects of benthivorous bream (*Abramis brama*) and carp (*Cyprinus carpio*) on sediment resuspension and concentrations of nutrients and chlorophyll *a*. Freshwater Biology 32:113-121.

Carlander, K.D. 1969. Handbook of Freshwater Fishery Biology. Vol. 1. Iowa State University Press. Ames, IA.

Cline, J.M., T.L. East, and S.T. Threlkeld. 1994. Fish interactions with the sediment-water interface. Hydrobiologia 275/276:301-311.

Crivelli, A.J. 1981. The biology of the common carp, *Cyprinus carpio* L. In the Camargue, southern France. Journal of Fish Biology 18:271-290.

Crivelli, A.J. 1983. The destruction of aquatic vegetation by carp. Hydrobiologia 106:37-41.

Fletcher, A.R., A.K. Morrison, and D.J. Hume. 1985. Effects of carp, *Cyprinus carpio*, on communities of aquatic vegetation and turbidity of waterbodies in the lower Goulburn River Basin. Australian Journal of Marine and Freshwater Research 36:311-327.

Hanson, M.A. and M.G. Butler. 1994. Response of plankton, turbidity, and macrophytes to biomanipulation in a shallow prairie lake. Canadian Journal of Fisheries and Aquatic Sciences 51:1180-1188.

Herdendorf, C.E. 1987. The ecology of the coastal marshes of western Lake Erie: a community profile. U.S. Fish and Wildlife Service. Biological Report 85.

Herdendorf, C.E., S.M. Hartley, and M.D. Barnes, editors. 1981. Fish and wildlife resources of the Great Lakes coastal wetlands within the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. FWS/DBS-81-82. Vol 1-6.

Johnson, D.L., W.E. Lynch, Jr., and T.W. Morrison. 1997. Fish communities in a diked Lake Erie wetland and an adjacent undiked area. Wetlands 17:43-54.

Kolterman, B.F. 1990. Effects of common carp and black bullheads on sago pondweed. Master's thesis. South Dakota State University. Brookings, SD.

McCrimmon, H.R. 1968. Carp in Canada. Bulletin 165. Fisheries Research Board of Canada, Ottawa.

McLean, V.L. 1996. Carp impacts on diked wetland communities. Master's thesis. Ohio State University. Columbus, OH.

Merritt, R.W. and K.W. Cummins. 1984. General morphology of aquatic insects. pp. 94-125. *In* R.W. Merritt and K.W. Cummins (eds). An introduction to the aquatic insects of North America. Kendall/Hunt Publishing Company. Dubuque, Iowa.

Navarro, J.E. and D.L. Johnson. 1992. Ecology of stocked northern pike in two Lake Erie controlled wetlands. Wetlands 12(3):171-177.

Petering, R.A. and D.L. Johnson. 1991. Distribution of fish larvae among artificial vegetation in a diked Lake Erie wetland. Wetlands 11:123- 138.

Portt, C.B., C.K. Minns, and S.W. King. 1988. Morphological and ecological characteristics of common fishes in Ontario Lakes. Canadian Manuscript Report of Fisheries and Aquatic Sciences 1991, Great Lakes Laboratory for Fisheries and Aquatic Sciences, Canada Center for Inland Waters. Burlington. Ontario, Canada.

Qin, J. and S.T. Threlkeld. 1990. Experimental comparison of the effects of benthivorous fish and planktivorous fish on plankton community structure. Archive fur Hydrobiologie 119:121-141.

Richardson M.J., F.G. Whoriskey, and L.H. Roy. 1995. Turbidity generation and biological impacts of an exotic fish *Carassius auratus*, introduced into shallow seasonally anoxic ponds. Journal of Fish Biology 47:576-585.

Riley, T.Z. 1989. Response of aquatic macroinvertebrates and waterfowl to early-spring drawdown on Lake Erie marshes. Ph.D. Dissertation. The Ohio State University. Columbus, OH.

Robel, R.J. 1961. The effects of carp populations on the production of waterfowl food plants on a western waterfowl marsh. Transactions of the North American Wildlife and Natural Resources Conference 26:147-159.

Roberts, J.A., A. Chick, L. Oswald, and P. Thompson. 1995. Effects of carp, *Cyprinus carpio*, an exotic benthivorous fish, on aquatic plants and water quality in experimental ponds. Marine and Freshwater Research 46(8):1171-1180.

Shenker, J.M. and J.M. Dean. 1979. The utilization of an intertidal salt creek marsh by larval and juvenile fishes: abundance, diversity, and temporal variation. Estuaries 2:154-163.

Sibbing, F.A. 1991. Food capture and oral processing. pp. 377-412. *In* I.J. Winfield and J.S. Nelson (eds). Cyprinid fishes: systematics, biology, and exploitation. Chapman and Hall. London, England.

Tilton, D.L. and B.R. Schwegler. 1978. The values of wetland habitat in the Great Lakes basin. pp. 267-277. *In* P.E. Greeson, J.R. Clark, and J.E. Clark (eds.). Wetland Functions and Values: the State of Our Understanding. American Water Resources Association. Minneapolis, MN.

Tryon, L.A.,Jr. 1954. The effect of carp enclosures on growth of submerged aquatic vegetation in Pymatuning Lake, Pennsylvania. Journal of Wildlife Management 18:472-486.

Verduin, J. 1969. Man's influence on Lake Erie. Ohio Journal of Science 69:56-70.

Williams, W.E. 1970. Summer food of juvenile black bullheads (*Ictalurus melas*) of Mitchell Lake, Wexford County, Michigan. Transactions of the American Fisheries Society 99:597-599.

Table 1: Date nets were set, pump input source (R-Sandusky River, W-Tawa Swale), effort, water temperature at set and pull times from the wetland and intake source, number of species, total number of fish collected, total number of common carp, total number of goldfish, total number of bullhead, and mean length of common carp for the panel style current traps in Tawa Swale, 1996.

Set Date	Pump Input Source	Effort (min)	Wetland Temp. (° C) Set / Pull	Intake Temp. (° C) Set / Pull	Number of Species	Total Number	Common Carp	Goldfish	Bullhead	Mean Length Common Carp
5/12	R	600	16 / 16	15 / 15	1	402	–	402	–	–
5/13	R	1410	16 / 19	15 / 15	2	270	1	269	–	207
5/14	R	2355	14.5 / 14.5	14.5 / 14.5	3	64	–	61	–	–
5/16	R	1460	16 / 16	16 / 16	2	5	–	4	–	–
5/12	W	540	14 / 14	–	2	5	–	4	–	–
5/13	W	1344	14 / 18	–	3	10	–	7	–	–
5/14	W	2295	18 / 14.5	–	4	16	1	3	–	288
5/16	W	1500	14.5 / 16	–	2	8	–	6	–	–

Table 2: Date net was set, pump input source (R-Sandusky River), effort, water temperature at set and pull times from the wetland and intake source, number of species, total number of fish collected, total number of common carp, total number of goldfish, total number of bullhead, and mean length of common carp for the fabric-wrapped current trap in Tawa Swale, 1996.

Set Date	Pump Input Source	Effort (min)	Wetland Temp. (° C) Set / Pull	Intake Temp. (° C) Set / Pull	Number of Species	Total Number	Common Carp	Goldfish	Bullhead	Mean Length Common Carp
6/18	R	2994	27 / 27	25 / 25	3	18	13	–	3	559
6/20	R	1290	27 / 27	25 / 26	2	31	29	–	2	538
6/24	R	1002	28 / 27.5	27 / 27	2	3	–	–	3	–
6/25	R	978	27 / 28	26 / 28	5	11	4	–	1	401
6/26	R	1380	28 / 28	28 / 26	3	22	15	–	6	491
6/27	R	1650	28 / 30.5	26 / 30	1	3	3	–	–	405
8/21	R	2808	27 / 27	26 / 27	2	8	–	–	–	–

Table 3: Date nets were set, pump input source (R-Sandusky River, W-Tawa Swale), effort, water temperature at set and pull times from the wetland and intake source, number of species, total number of fish collected, total number of common carp, total number of goldfish, total number of bullhead, and mean length of common carp for the fabric-wrapped current traps in Tawa Swale, 1997.

Set Date	Pump Input Source	Effort (min)	Wetland Temp. (° C) Set / Pull	Intake Temp. (° C) Set / Pull	Number of Species	Total Number	Common Carp	Goldfish	Bullhead	Mean Length Common Carp
4/28	R	970	18 / 18	16 / 16	5	8	1	–	1	261
4/29	R	1360	13 / 14	15 / 14	4	20	–	–	–	–
5/19	R	885	21 / 14	17 / 15.5	4	18	1	–	–	450
5/20	R	1430	14 / 13.5	15.5 / 15	4	14	–	–	–	–
5/21	R	1420	13.5 / 14	15.5 / 16	4	26	1	–	2	272
5/22	R	1410	14 / 16	16 / 17	5	19	1	–	–	291
4/28	W	1050	18 / 18	–	3	4	–	–	–	–
4/29	W	1370	13 / 12	–	2	2	–	–	–	–
4/30	W	1400	12 / 8.5	–	2	3	–	–	–	–
5/20	W	1435	14 / 15	–	3	5	–	–	3	–
5/21	W	1405	18.5 / 19	–	6	97	16	11	35	296
5/22	W	1355	18 / 17	–	3	17	5	–	2	43

Table 4: Daily catch rates (number of fish per 24 hour net set) by month of fish species collected in the fabric-wrapped current trap pumping water from the Sandusky River, 1996 and 1997 (N=number of net days sampled).

Fish Species		April (N=1.6)	May (N=3.8)	June (N=6.5)
Black bullhead	(*Amieurus melas*)	--	0.5	0.3
Black crappie	(*Pomoxis nigromaculatus*)	10.0	7.9	0.8
Bluegill	(*Lepomis macrochirus*)	--	5.5	--
Bowfin	(*Amia calva*)	3.8	5.0	0.2
Brown bullhead	(*Amieurus nebulosus*)	0.6	--	1.8
Common carp	(*Cyrinus carpio*)	0.6	0.8	9.8
Green sunfish	(*Lepomis cyanellus*)	--	0.3	--
Logperch darter	(*Percina caprodes*)	0.6	--	--
White crappie	(*Pomoxis annularis*)	1.9	0.3	0.3
Yellow bullhead	(*Amieurus natalis*)	--	--	0.2

List of Figures

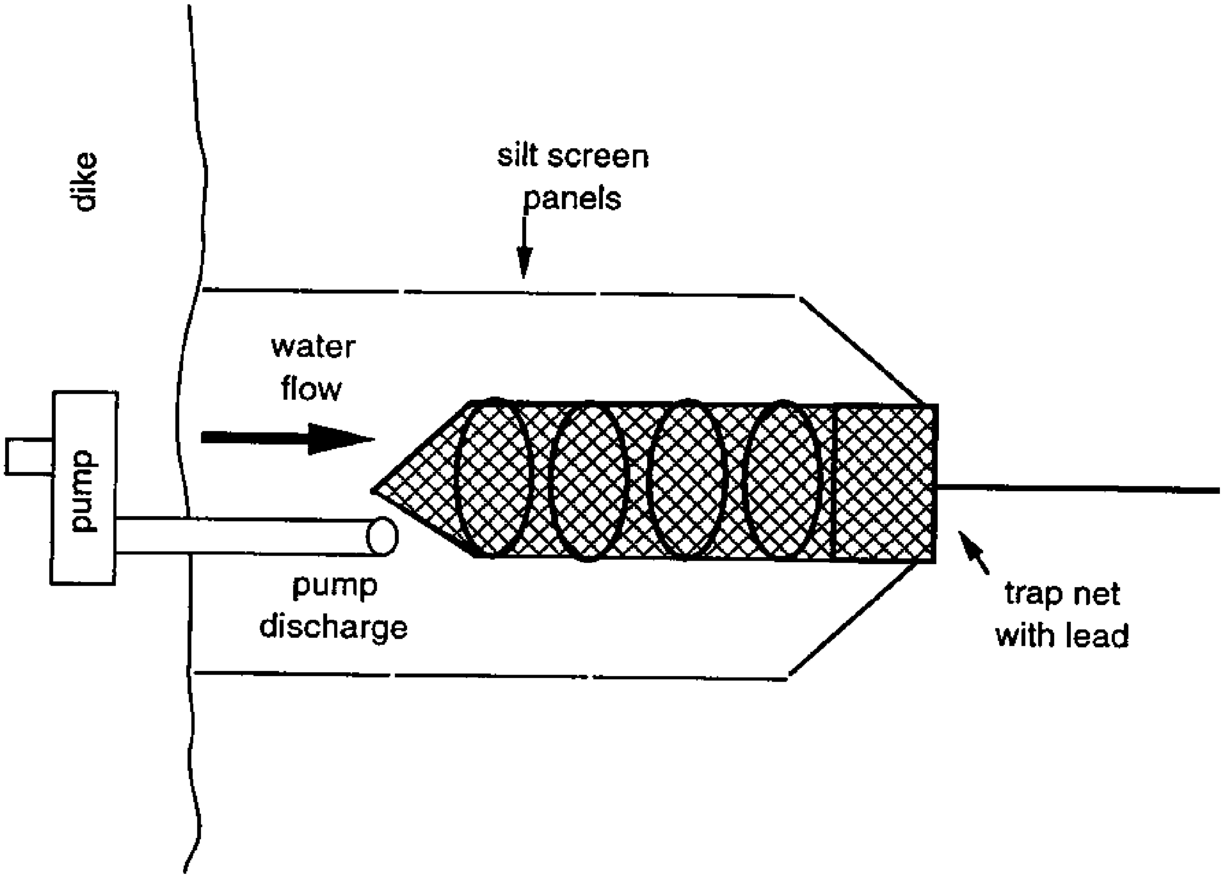
dike
silt screen panels
water flow
pump
pump discharge
trap net with lead

Figure 1

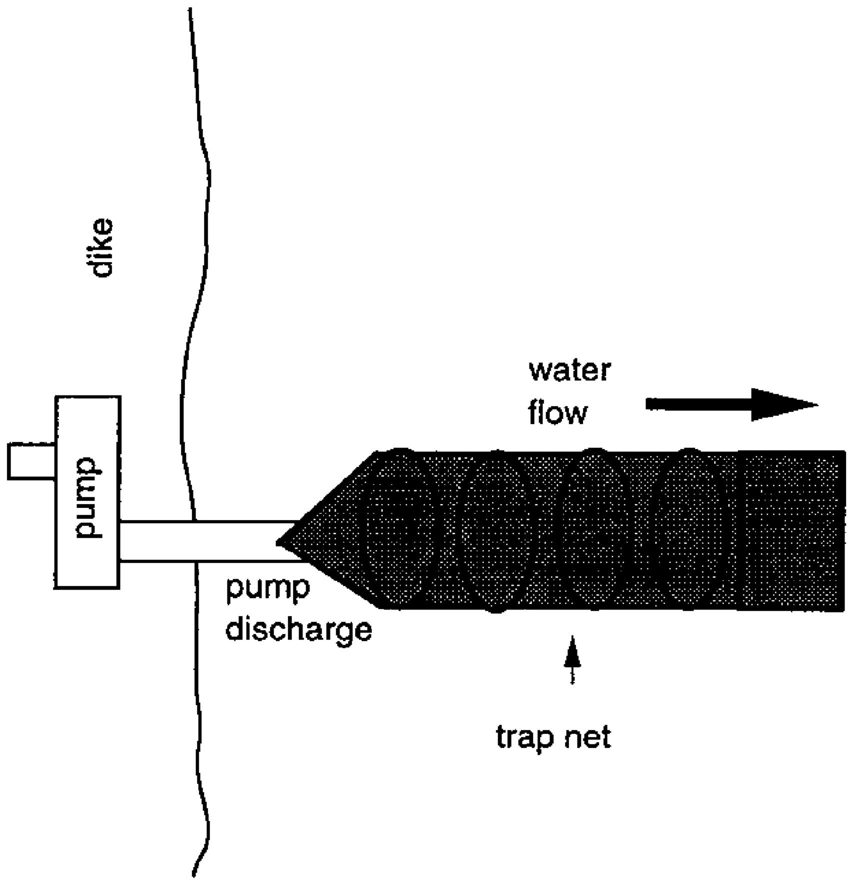

Figure 2

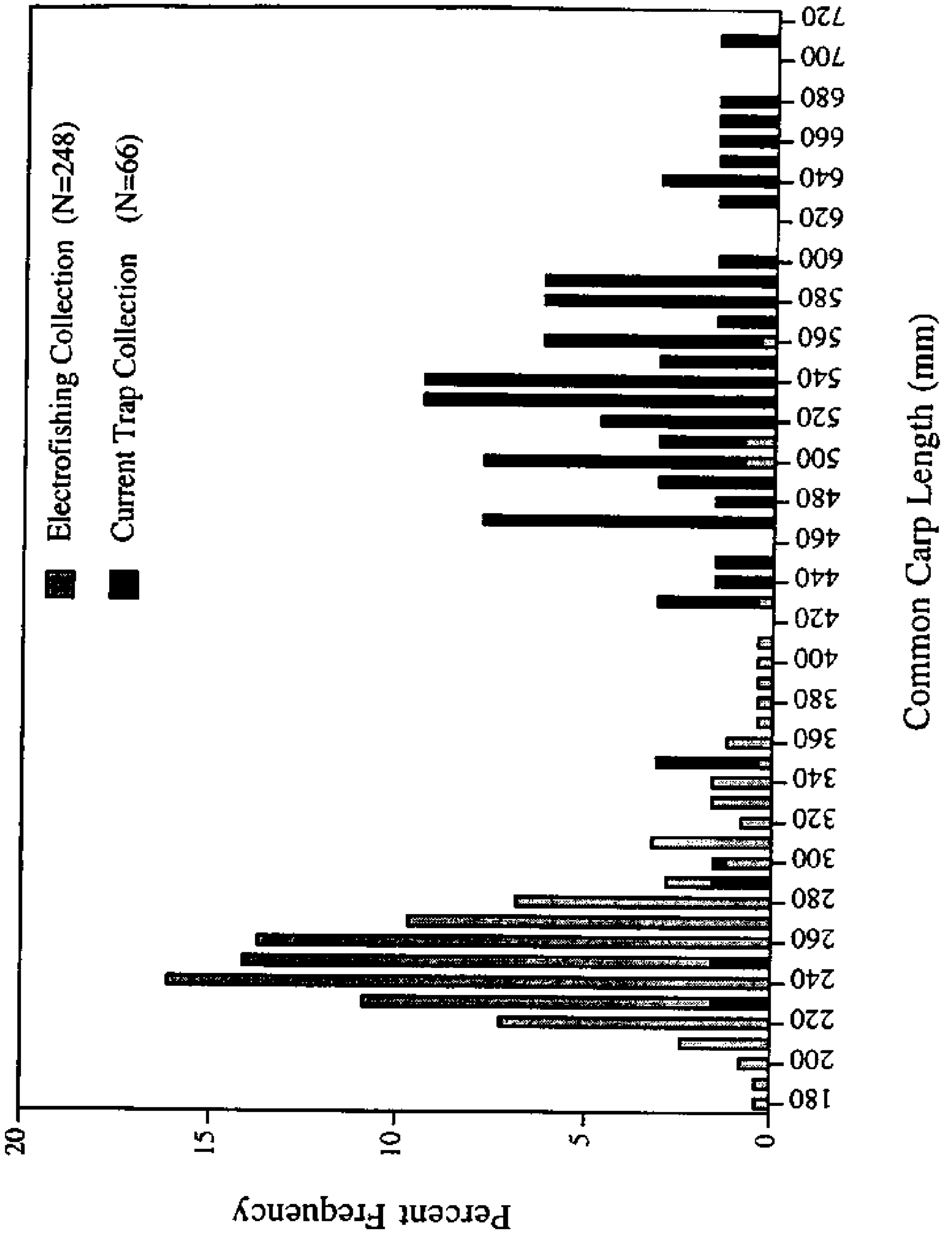
Electrofishing Collection (N=248)
Current Trap Collection (N=66)
Percent Frequency
0
5
10
15
20
Common Carp Length (mm)
180
200
220
240
260
280
300
320
340
360
380
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700
720

Figure 3