Controlled Harvest and Overfishing

U.S. ARMY CORPS OF ENGINEERS **Building Strong®**

ANS Control: Controlled Harvest and Overfishing

Targeted Species: Fish and crayfish are managed through controlled harvest and overfishing. Specific ANS of Concern – CAWS[1] that may be controlled by this technology include blueback herring *(Alosa aestivalis),* skipjack herring (*A. chrysochloris),* alewife (*A. psuedoharengus),* northern snakehead (*Channa argus),* silver carp (*Hypophthalmichthys molitrix),* bighead carp (*H. nobilis),* and black carp (*Mylopharyngodon piceus)*.

Nets are commonly used to commercially harvest fish in the effort to reduce Asian carp populations in the Upper Illinois River downstream of the Electric Fish Barrier; commercial fishermen contracted by IDNR unload fish caught near Morris, IL.

Selectivity: This Control was designed to control fish and crustaceans and is non-selective.

Developer/Manufacturer/Researcher: There are various state and Federal natural resource agencies, as well as private entities, developing and researching the effectiveness of this Control.

Brief Description: Controlled harvest involves the removal of an organism to a level where it can no longer maintain a viable population. Controlled harvest implies that the captured organisms are consumed or used for some purpose other than disposal. Overfishing is similar to controlled harvest; however, the captured organisms are discarded and not necessarily used beneficially. This technique requires an intense capture effort over a long period of time. A variety of nets and traps have been designed to catch targeted species in order to reduce the by-catch of non-targeted species. It is difficult to overharvest a river system because the harvested areas quickly repopulate with fish that migrate from other parts of the river.

Attraction could be used as a capture method. Target species could be lured into backwater lakes using food, pheromones, water temperature, and similar techniques, and “corralling” them by closing off the entrance pathway with a net, gate, temporary dam or levee. The backwater lake would then be pumped down to a point where fish could be efficiently harvested and native fish sorted out and released. This method would have beneficial effects on the backwater by exposing and consolidating sediments and promoting vegetative growth (habitat), which would enhance native fish populations when the backwater naturally refills post-harvest.

[1] For a complete list of the 39 specific ANS of Concern – CAWS, please see Table 1 of the main report.

Prior Applications: In an attempt to control harvest invasive species, the State of Illinois is currently working with commercial fishers and processors, under contract with a Chinese manufacturer, to catch and export 30 million processed pounds of Asian carp from Illinois waterways (Asian Carp Regional Coordinating Committee 2011). The population dynamics of Asian carp are not understood well enough to predict the required harvest to control these species and there is insufficient data to determine whether or this level of harvest will deter upstream migrations. Controlled harvest has also been used to manage invasive crayfish populations in lakes (Hein et al. 2007).

General Effectiveness: Some species have specialized life cycle requirements that make them especially susceptible to human-induced factors, such as habitat destruction and controlled harvests (Nehlsen et al. 1991); however, many invasive species have highly adaptive life cycle requirements making them far less susceptible to targeted control actions. Long-lived, late-maturing species with infrequent and specialized reproductive requirements, called *K*-selected species, are susceptible to anthropogenic impacts (including harvest), whereas short-lived, fast-maturing species with frequent and generalized reproductive requirements, called *r*-selected species, are less susceptible (MacArthur & Wilson 1967; Sakai et al. 2001). Characteristics common to successful colonists across taxa include *r*-selected life histories (use of pioneer habit, short generation time, high fecundity, and high growth rates), the ability to shift between *r*- and *K*-selected strategies, the number of released individuals, and the number of release events (Kolar & Lodge 2001). Because many ANS of Concern – CAWS are successful colonists, controlled harvest and overfishing may be useful as suppression measures but ultimately ineffective as eradication measures. Both controlled harvest and overfishing may require either continual capture over a long period of time, or intensive harvest during critical periods of concentration and reproduction (e.g., migration and spawning season).

Population models indicate that if population density is lowered by harvesting, the net effect will be to increase resources available to survivors. This can either cause no impact on net recruitment, or have the adverse effect of causing a rapid increase in recruitment, growth rate, and fecundity of the invasive species (Zipkin et al 2009). The latter can progress to a point where population recovery to pre-harvest conditions occurs rapidly despite best efforts (Smith et al. 1997), or even cause an increase in overall population abundance (Zipkin et al 2008).

For physical removal to cause a shift to a relatively stable (but probably still temporary) alternative population density, the total population would have to be harvested to a low enough level to limit the number of available reproductive adults. Where this point lies with invasive species such as the common carp is not known, but it is most likely at a value less than 10% of original biomass (Thresher 1997), however, some models suggest that carp populations respond differently as harvest increases. One study found that common carp abundance declined 28-56% at low levels of harvest (0-20%), but at high levels of harvest (90%), abundance was only reduced 49-79% due to several factors, including increased egg production in the surviving individuals (Weber et al. 2011).

Policymakers must consider whether encouraging the harvest of a harmful invasive species is wise. In the case of Asian carp, once harvesters, processors, and communities become dependent on these fish, pressure to manage a sustainable population of Asian carp may conflict with the original purpose of removing these organisms from the environment (Speir & Brozović 2006).

Operating Constraints: Controlled harvest of fish species would require the development of an infrastructure to support a large commercial fishing industry (fleet and processing plants) and the development of a market to sustain the viability of the industry over time. The effectiveness of controlled harvest decreases where there is a high probability of reintroduction. The impact of controlled harvest on non-target organisms should be evaluated prior to implementation to minimize unintended consequences.

Cost Considerations:

Implementation: Implementation costs would include the cost to harvest, or overfish and dispose of fish.

Planning and design activities in the implementation phase may include research and development of this Control, modeling, site selection, site-specific regulatory approval, plans and specifications, and real estate acquisition. Design will also include analysis of this Control's impact to existing waterway uses including, but not limited to, flood risk management, natural resources, navigation, recreation, water users and dischargers, and required mitigation measures.

Operations and Maintenance: The effectiveness of harvesting/overfishing can only be determined through routine monitoring of fish populations.

Mitigation: Design and cost for mitigation measures required to address impacts as a result of implementation of this Control cannot be determined at this time. Mitigation factors will be based on site-specific and project-specific requirements that will be addressed in subsequent, more detailed, evaluations.

Citations:

Asian Carp Regional Coordinating Committee. 2011. 2011 Asian carp control strategy framework. Council on Environmental Quality. Washington, D.C.

Hein, C.L., M.J. VanderZanden, & J.J. Mangnuson. 2007 Intensive trapping and increased fish predation cause massive population decline of an invasive crayfish. *Freshwater Biology,* vol. 52, pp. 1134–1146

Kolar C.S. & Lodge D.M. 2001. Progress in invasion biology: predicting invaders. *Trends in Ecology and Evolution,* vol. 16(4), pp. 199-204

MacArthur, R.H. & E.O. Wilson. 1967. The Theory of Island Biogeography. Princeton University Press. Princeton, NJ. 203 pp

Sakai A.K., F.W. Allendorf, J.S. Holt, D.M. Lodge, J. Molofsky, & K.A. with S. Baughman, R.J. Cabin, J.E. Cohen, N.C. Ellstrand, D.E. McCauley, P. O'Neil, I.M. Parker, J.N. Thompson, & S.G. Welle. 2001. The Population Biology of Invasive Species. *Annual Review of Ecology and Systematics,* vol. 32, pp. 305-332

Smith, Philip A, R.T. Leath, & J.W. Eaton, 1997. “Removal as an Option for Management of an Introduced Piscivorous Fish – the Zander.” Pp 74-86 in *Controlling Carp: Exploring the Options for Australia,* Jane Roberts & Richard Tilzey (eds.)

Speir, C. & N.E. Brozović. 2006. Supply response of commercial fishermen and implications for management of invasive Asian carp. Proceedings of the American Agricultural Economics Association Annual Meeting, Long Beach, CA. July 23-26, 2006

Thresher, Ronald E. 1997. “Physical Removal as an Option for the Control of Feral Carp Populations.” Pp 58-73 in *Controlling Carp: Exploring the Options for Australia,* Jane Roberts & Richard Tilzey (eds.)

Weber, M.J., M.J. Hennen, & M.L. Brown. 2011. Simulated population responses of common carp to commercial exploitation. *North American Journal of Fisheries Management*. vol. 31(2), pp. 269-279

Williams, J.E., W. Nehlsen, & J.A. Lichatowich. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. *Fisheries,* vol. 16(2), pp. 2-21

Zipkin, E.F., C.E. Kraft, E.G. Cooch, & P.J. Sullivan. 2009. When can efforts to control nuisance and invasive species backfire? *Ecological Applications,* vol. 19(6), pp. 1585-1595

Zipkin, E.F., P.J. Sullivan, E.G. Cooch, C.E. Kraft, B.J. Shuter, & B.C. Weidel. 2008. Overcompensatory response of smallmouth bass (*Micropterus dolomieu*) population to harvest: release from competition? *Canadian Journal of Fisheries and Aquatic Sciences,* vol. 65(10), pp. 2279-2292