Supply Response of Commercial Fishermen and Implications for Management of Invasive Asian Carp

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Introduction

Asian carp are two invasive species of fish that first appeared in Illinois waters in the early 1990's[1]. Asian carp were first imported into the United States in the early 1970's to improve water quality in aquaculture ponds in Arkansas and Mississippi. It is believed that that a few fish escaped during occasional periods of high water over the next decade (Rasmussen, 2002). Since that time the species have spread rapidly to become the dominant fish in many parts of the Mississippi and Illinois River systems. Between 1988 and 1992, commercial fishermen in Illinois harvested a total of less than 1300 pounds of bighead and silver carp. By 1994 the total had increased to 5.5 tons and after 1997 the catch exceed 55 tons per year (Chick and Pegg, 2001). In 2003 the Asian carp commercial catch was over 446 tons (Maher, 2005).

Fishermen and some biologists believe that Asian carp are doing significant ecological and economic damage to the rivers. There is also great concern over the possibility that Asian carp will spread into the Great Lakes and disrupt the trophic structure there. Asian carp are large fish (many grow to over 50 pounds), voracious feeders and highly prolific spawners. Because Asian carp feed on plankton, it is thought that they could directly compete for food with species such as buffalo, gizzard shad, paddlefish, mussels and juvenile salmon and trout. A temporary electrical barrier to prevent Asian carp from entering Lake Michigan through the Chicago Sanitary and Ship Canal currently exists. A new barrier, with a construction cost of over $9 million, is currently nearing completion. Such barriers are believed to be highly effective, although

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[1] The two species are bighead carp, *Hypothalmichthys nobilis*, and silver carp, *Hypothalmichthys molitrix*. The two species are reported collectively as Asian carp in catch statistics.

they may not prevent all fish from moving through the canal. Alternative control strategies are needed.

One possible control strategy is to pay a subsidy to commercial fisherman to harvest Asian carp. Already, without a subsidy, Asian carp make up a large portion of the commercial catch on the Illinois River. However, fishermen do not target Asian carp because prices are much lower than other species, especially buffalo fishes, and Asian carp tend to cause significant damage to fishing gear.

Fishery managers and commercial processors believe that fishermen would target Asian carp and could harvest large amounts of the fish if the price were higher. However, very little economic analysis of the commercial fishing industry in Illinois has been done to date. The present study aims to determine harvesters' response to changes in the price of Asian carp and to determine how the increased harvest of Asian carp might affect other fish species. Supply functions for five types of fish are estimated. These functions are used to test for jointness-in-inputs between species and obtain input-compensated supply elasticities to describe how fishermen respond to changes in price.

Jointness-in-inputs means that all inputs are required to produce all outputs and that production decisions about one output affect the production of other outputs. If such jointness exists, then policies designed to affect the harvest of a single species will significantly affect the harvest of other, technologically related species. Determining whether this type of joint production relationship exists is important for Asian carp management. If a subsidy designed to increase harvest of Asian carp is implemented, it is important to know which other fish species will be affected. Cross-price elasticities further describe the joint production relationship. Positive cross-price elasticities would indicate that production of two types of fish is joint, either with one species as bycatch or with both species as targeted catch. Negative cross-price elasticities would indicate nonjoint production processes and that effort is allocated among target species based on relative prices (Thunberg, Bresnyan and Adams, 1995). The own-price elasticity will suggest whether or not a subsidy is likely to be an effective means of increasing harvest.

We find that fish harvest is relatively insensitive to changes in the price of fish. We also find no evidence that increased production of Asian carp will affect the harvest of other species.

Description of the Fishery

In 2003, the most recent year for which data is available, the commercial fishing industry in Illinois produced over 6.3 million pounds of fish worth approximately $1.33 million. The majority of fish, 59 percent, were harvested in the Mississippi River and 25 percent were harvested in the Illinois River. The remainder was harvested in lakes, smaller rivers and privately held waters. The fishery has historically been comprised mainly of buffalo, catfish and common carp. Buffalo fishes are clearly the most important commercial fish on the river. In 2003 they accounted for 45 percent of the total landings (2.9 million pounds) and 48 percent of the dockside value in the fishery ($637,000). Since the late 1990’s, however, Asian carp have become an increasingly large component of the overall landings and value of the fishery. Asian carp harvest increased 124 percent in 2003 while buffalo declined by 18 percent (Maher 2005). Figures 1 and 2 show the composition of the fishery by species in terms of harvest and value. Table 1 shows the average statewide price by species in 2003.

[Figure 1. Illinois Statewide Annual Harvest by Species – 2003]

[Figure 2. Value of Illinois Statewide Annual Harvest by Species - 2003]

[Table 1. Illinois Statewide Average Prices – 2003]

Commercial fishermen in Illinois are self-employed and work in small boats. The Illinois Department of Natural Resources counted 47 full-time and 273 part-time fishermen in 2003. Other individuals purchase commercial licenses but do not sell more than 1,000 pounds and so are classified as recreational fishermen. Fishermen often hold other part-time or full-time jobs.

Conceptual Model

A system of five supply equations, one equation per harvested group of fish, is modeled. The five groups are buffalo, catfish, common carp, Asian carp, and all other species. The supply equations are derived from revenue functions, in accordance with the standard theory of production.

The analysis assumes that fishermen maximize revenue over the year given a single, fixed level of effort. Once a fisherman has decided to license his gear for the season he does not alter the amount of gear applied to fishing and thus the gear level can be thought of as a sunk cost. It has been demonstrated that with such a fixed composite input, as well as the additional assumption of a competitive output market, revenue maximization is equivalent to profit maximization (McFadden, 1978, Diewert, 1974). Therefore, a theoretically consistent supply function can be derived from a revenue function.

The assumption of a fixed composite input is not strictly correct in the present study because the period of observation, one year, is so long. Over the course of the year, fishermen can select the level of inputs including fuel, bait and labor. Unfortunately, data on these variable inputs are not available. The single fixed input assumption is defensible, however, based on discussions with fishery managers. Fishermen can be thought of as selecting the amount of gear to be used before the season and then selecting an optimal product (species) mix during the season based on the amount of gear available to them.

Each fisherman's annual revenue is a function of fish prices and the level of a fixed input – gear.

$$(1) \qquad R(G,P) = \sum_i \sum_j \beta_{ij} (P_j / P_i)^{1/2} G + \sum_i \beta_i P_i G^2$$

In the revenue function in equation 1, *i* and *j* subscripts denote types of fish, *P's* are output prices and *G* is the amount of gear applied. Supply equations can be derived from the revenue function (equation 1) using Hotelling's Lemma, that is, by finding the derivatives of the revenue function with respect to prices:

$$(2) \qquad \frac{\partial R(G,P)}{\partial P_i} = Q_i (P_i, P_j, G)$$

Supply elasticities can be generated from these supply equations in order to examine how fishermen change their species mix in response to changes in prices.

Several alternative functional forms for the revenue function are available. The translog and Leontief functional forms are most commonly applied in the fisheries literature. The revenue function presented in equation 1 is a generalized Leontief function. The Leontief functional form is used here because it generates supply functions in terms of output or harvest levels (the translog functional form generates a system of share equations). Estimation in terms of output levels makes the supply functions available for use in future simulations and makes the results more easily explained to policy makers.

Previous Studies

The technical and economic relationships between fishes in multi-species fisheries are of considerable interest to policy makers. As a result, there are several good examples of models of supply systems in the fisheries economics literature. Kirkley and Strand (1988) first outlined the dual revenue conceptual framework described above. That study developed estimated supply elasticities for the New England trawl fishery using the Leontief functional form. Kirkley and Strand rejected input-output seperability and nonjointness-in-inputs and used those results to argue against the managment of New England groundfish stocks as a single biomass and against management of a single key species (yellowtail flounder). These two policies were in use at the time of the analysis.

Diop and Kazmierczak (1996) performed a similar analysis with the Mauritanian cephalopod fishery. Their results indicated a high degree of output substitutability between octopus, squid and cuttlefish. Diop and Kasmierczak use these results to argue that the policy of managing only octopus harvest would lead to overfishing of the other two cephalopod species.

Pradham, Sharma and Leung (2003) performed a similar analysis with the Hawaiian longline fishery. They reject nonjointness-in-inputs and conclude that single species regulation (e.g., regulating only tuna harvest) would not be effective and may lead to overharvest of other species. They do not reject input-output seperability and thus conclude that managing the fishery for total biomass may be effective. These results support historical management practices in the Hawaiian fishery.

Thunberg, Bresnyan and Adams (1995) follow the same conceptual framework, but estimate a supply system derived from a translog (rather than Leontief) revenue function for the in-shore fishery in Florida. They find a high degree of economic and technical interrelationship between species, with most species production being positively affected by the price of mullet. They use these results to argue that management of a single species, mullet, may be a simple, effective way to manage the entire multi-species fishery.

Estimation and Data

Empirical Model

Differentiating equation 1 with respect to the price of each of fish gives a system of five supply equations. Dummy variables are added to account for differences in fishing location and which year the observation occurred. The resultant supply equations take the form in equation 3:

$$(3) \qquad Q_i = \alpha_i + \sum_{i \neq j} \beta_{ij} (P_j / P_i)^{\frac{1}{2}} G + \beta_{ii} G + \beta_i G^2 + \sum_{l=1}^{14} \gamma_l D_l + \sum_{y=2002}^{2004} \gamma_y D_y + FT$$

In equation 3, α's, β's, δ's, and γ's are parameters to be estimated. The subscripts i and j represent types of fish. The subscripts l and y on the dummy variables identify the location and year, respectively, for each observation. FT is a dummy variable indicating whether each individual fisherman self-reported as full-time.

Differentiating equation 3 with respect to the price of each fish gives price elasticities. Own-price elasticities are given in equation 4:

$$(4) \qquad \eta_{ii} = \frac{\partial Q_i}{\partial P_i} = -\frac{1}{2Q_i}\left[\sum_{i \neq j} \beta_{ij} (P_j / P_i)^{1/2} G\right]$$

Cross-price elasticities are given in equation 5:

$$(5) \qquad \eta_{ij} = \frac{\partial Q_i}{\partial P_j} = \frac{1}{2Q_i} \beta_{ij} (P_j / P_i)^{1/2} G$$

Estimation Method

The system of supply equations described in equation (3) is estimated using Seemingly Unrelated Regression (SUR) in Stata[2]. The data set is a four year panel and we transform the data to account for unobserved differences between individual fishermen, including differences in fishing ability and intensity of fishing effort. Previous studies have used pooled regressions to estimate supply elasticities. For example, Thunberg, Bresnyan and Adams (1995) are forced to pool data on daily fishing trips from 1986 to 1989 because confidentiality agreements prevented the identification of data points by individual. Pradhan, Sharma and Leung (2003) apparently pool data from 1991 to 1998 without explanation.

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[2] SUR in Stata is performed using the sureg command.

It is likely that there are unobserved, time invariant differences between individual fishermen in the sample. Such differences might be due to fishing ability, experience, or age. Panel data methods, particularly fixed effects and random effects models, allow for estimation of consistent and efficient estimators when data contain unobserved, time invariant effects (see Wooldridge, 2002, chapter 10 for a textbook exposition on panel data models). The fixed effect estimator is consistent, but is not efficient if the unobserved effect is uncorrelated with the explanatory variables. The random effects estimator is consistent and efficient if the unobserved effect is uncorrelated with the explanatory variables, but is biased if the unobserved effect is correlated with the explanatory variables. We perform the familiar Hausman specification test for endogeneity to determine which model is most appropriate for our data set.

We use the approach suggested by Hausman and Taylor (1981) to perform the specification test. We estimate the random effects model with the individual means of the variables that vary over time included as explanatory variables. We then test the null hypothesis that the coefficients on the individual mean variables are all equal to 0. If the null hypothesis is rejected, then the unobserved effects are endogenous and the random effects estimator is biased. We fail to reject the null hypothesis and conclude that the random effects estimator is a consistent and efficient estimator for our data set.

Data

Data on prices and harvest are obtained from reports by individual fishermen. Each person who is issued a commercial fishing license is required by the Illinois

Department of Natural Resources (IDNR) to fill out an Illinois Annual Commercial Fisherman Report. The report includes the location fished, annual harvest levels by species and gear type, the average price received by species, the amount of gear owned and licensed, and the name of fish markets that purchased any portion of the catch. There is one observation per fisherman per year. Fisherman who fish more than one location must submit a report for each one. Responses for the years 2001 through 2004 are used. The data represent an unbalanced panel with 487 observations; 138 in 2001, 122 in 2002, 130 in 2003, and 95 in 2004.

IDNR classifies fishermen as full-time, part-time or recreational. Full-time fishermen are those that identify themselves as full-time, *i.e.*, those who presumably derive all or a large portion of their income from commercial fishing. Part-time fishermen are those that classify themselves as part-time or those that do not sell fish but report more than 1,000 pounds of harvest. Recreational fishermen report no sales and less than 1,000 pounds of harvest.

Variables

Harvest

Harvest is the amount (in pounds) of each type of fish caught in the reporting year. The Annual Commercial Fisherman Reports contain harvest numbers for each of 18 species of fish[3]. For use in this study, these 18 species are aggregated into five groups – buffalo, catfish, common carp, Asian carp and other. The first four groups represent

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[3] Common carp, buffalo, white perch/freshwater drum, channel catfish, flathead catfish, blue catfish, bullheads, shovelnose sturgeon, paddlefish, carpsuckers, suckers, gar, bowfin, toothed herring, eel, grass carp, Asian carp (bighead and silver combined).

the four most valuable fisheries in Illinois. "Other" aggregates all other fish species. The catfish variable includes channel, flathead and blue catfish species.

Price

Price is the average price received for fish over the course of the reporting year. For use in this study, species are aggregated as described above for the harvest variable. When aggregating in the other and catfish categories, the price is the weighted average of the prices of the reported fish included in the category. If a fisherman reports a harvest but no price, then it is assumed that the fish were caught and discarded, *i.e,* that the fisherman received a price of zero. When constructing the terms required for the estimation of the supply functions (see equation 2), a price of zero is unacceptable because it creates a denominator of zero in the cross-price ratio term. Therefore, when fish are discarded, a price of $0.001 is entered in the data. Biologists and managers have reported that some fishermen who catch Asian carp dispose of the fish by throwing them on the river bank because, as discussed above, Asian carp are considered a nuisance. Also, several fishermen commented on their annual harvest reports that they discarded the reported amount of Asian carp. The treatment of no reported price as a near-zero price captures this behavior in the model. Also, many fishermen keep some fish for personal use. The near zero price also captures this behavior. Out of 487 observations for each species, there are 7 reports of zero price for buffalo, 12 reports for catfish, 19 for common carp, 48 for Asian carp, and 31 for other fish.

If a fisherman reports no catch for a particular species, this is entered as a quantity of zero and a price equal to the sample median price. This reflects an assumption that fishermen can allocate effort toward or away from particular species in response to price.

If the price is too low for a particular species, some fishermen may choose to target other species.

Gear

Effort is measured as the amount of gear used. It is expressed using a gear index created for use in the present study. Fishermen use six types of gear: seines, trammel nets, gill nets, basket traps, hoop nets and trotlines. Most fishermen use more than one type. To create a single composite gear variable, gear index coefficients were derived by dividing the total pounds of fish caught statewide by the units of gear licensed statewide and dividing by 100. The gear index coefficient for each gear type is then multiplied by the amount of each gear type licensed by each fisherman and these products are summed.

Fishermen are required to report the amount of gear owned and the amount of gear licensed. The amount of gear licensed is used to construct the gear variable since the fisherman chooses the amount to license each year and because the amount of gear legally licensed should better reflect what is actually fished.

Fishing Location

Fishing location is included in the model through the use of dummy variables. The upper Mississippi River is managed for barge transportation using a series of 27 locks and dams. The most downstream lock and dam is located near St. Louis, Missouri. This system creates a series of 26 navigation pools. Fishermen are required to report their catch by pool. Most fishermen fish on only one pool. Those who fish on more than one pool must submit a catch report for each pool fished. The Illinois portion of the Mississippi stretches from approximately pool 11 to the open water section below St. Louis. The Illinois River is similarly divided into navigation pools. Dummy variables are included for 16 pools on the Mississippi River, 3 pools on the Illinois River, and several smaller rivers for which there is catch reported. To avoid multicollinearity, the dummy variable for pool 23 on the Mississippi River is dropped.

Year Dummies

To account for the variation in fishing conditions from year to year, dummy variables for the reporting year are included in the model. Such variation could be due to weather conditions, for example. The variable for 2001 is dropped to avoid multicollinearity.

Full Time Variable

IDNR classifies fishermen as full-time, part-time or recreational. This model includes fishermen who self-identify as full-time or part-time fishermen and report receiving income for fishing. A dummy variable is included to account for the fact that full-time fishermen spend more time fishing.

Summary Statistics

Summary statistics for the data used in the empirical model are given in Table 2.

[Table 2. Sample Summary Statistics]

Results

Parameter Estimates

We model a system of five equations – one equation for each type of fish harvested (buffalo, catfish, common carp, Asian carp, and other fish). The equations are of the form presented in equation 3 and are estimated by performing SUR on data that has been transformed to the random effects model specification. We estimate 31 parameters in each equation: coefficients for normalized cross-prices, gear, gear^2, dummy variables representing fishing location (primarily by navigation pool), dummy variables for the year of each observation (2001 – 2004), and a dummy variable indicating whether the fisherman self-reported as full-time. Note that, by themselves, the estimated coefficients for normalized cross-price terms do not have a clear interpretation. These are used for testing for nonjointness-in-inputs and obtaining price elasticities. Also note that own-price coefficients are not estimated. In the Leontief form, the output supply is a function of prices normalized by the own price. Preliminary regressions indicate that the symmetry condition required of theoretically consistent supply functions ($\beta_{ij} = \beta_{ji}$, for all i, j – see Diewert, 1974) is not satisfied. Symmetry is therefore imposed in the subsequent regressions reported here.

Regression results are presented in Table 3. Out of 155 estimated parameters in the system (not all are reported in Table 3), 33 are significant at the 10 percent level or better. Note that in Table 3 the column headings give the name of each the harvest equation and the labels on the left side of the table give the name of the variables included in the regression.

[Table 3. Estimated Parameters – Output Supply Functions]

As noted above, the normalized price coefficients in Table 3 have no easy interpretation, but are used to test for jointness-in-inputs and to derive price elasticities.

The remaining reported coefficients (gear, year dummies, status as a full-time fisherman) may provide some information on the determinants of fish supply. That the gear coefficient (β_{ii} in equation 3) is negative and significant in the Asian carp equation is a surprising result. One might expect that more gear catches more fish. The negative gear coefficient in the Asian carp equation may indicate that larger scale fishermen are able to effectively target their catch and avoid Asian carp. It may also indicate some measurement error in the data if smaller fishermen, who may not keep detailed records, over-estimate the amount of Asian carp they have discarded.

The year dummy representing 2004 harvest is positive, large, and significant in the Asian carp equation. This could indicate either that Asian carp were very abundant in 2004 or that fishermen began finding a market for Asian carp in 2004. There is anecdotal evidence of both. Conversations with managers and fishermen indicate that the population of Asian carp continues to explode. Perhaps more importantly, a limited number of processors began to find new markets for Asian carp on the west coast around 2004.

Hypothesis Tests for Non-joint Production Technology

Testing for nonjointness-in-inputs consists of testing the null hypothesis that the price coefficients in equation 3, βij, are all zero, *i.e.*, that cross prices have no effect on production. If nonjointness is not rejected then the production of each type of fish could be characterized by a unique production function.

The results of the test for nonjointness-in-inputs using the estimated normalized cross-price coefficients from Table 3 are given in Table 4.

[Table 4. Hypothesis Test for Joint Production Technology]

We reject the null hypothesis that fish production exhibits nonjointness-in-inputs for the overall system. This indicates that there is some degree of joint production in the fishery. Analysis of the harvest equations for each species gives somewhat ambiguous results. The buffalo, catfish, and other fish equations do not exhibit signs of joint production technology. Production of buffalo, catfish, and other fish species does not result in the production of other fish species as by-catch. The common carp and Asian carp equations do exhibit joint production. Production of common carp and Asian carp does entail the production of other fishes as by-catch.

Price elasticities

Point estimates of the own- and cross-price supply elasticities were constructed using the parameter estimates in Tables 3 as shown in equations 4 and 5. Elasticities are evaluated at the median sample values except for Asian carp. The median harvest of Asian carp is 0, so we estimated elasticities using Asian carp harvest of 1,000 pounds. Standard errors and confidence intervals are generated through bootstrapping at 1000 repetitions.

The estimated own-price elasticities are presented in Table 5.

[Table 5. Own-price elasticities]

Economic theory predicts that own-price elasticities should be positive. When price increases, production should increase. The own-price supply elasticity of common carp is negative and significant. A negative own-price elasticity may indicate that the price of common carp declined over the four years in the panel at the same time that the population of common carp increased. In fact, the price of common carp has declined steadily and the harvest of common carp has fluctuated widely over approximately the last ten years (Wright, 2006). It is likely that the negative own-price elasticity reflects changes in the population levels for common carp rather than oddly-behaving producers. Own-price elasticities for other fish are not significant. This is consistent with previous empirical studies. Diop and Kazmerczak (1996) reported four out of five own-price elasticities were not significant and small in magnitude. Pradhan, Sharma and Leung (2003) reported 11 out of 12 own-price elasticities were not significant. That fish production is insensitive to changes in price may indicate that harvest is determined more by the abundance and location of fish than by targeted effort by fishermen.

Estimated cross-price elasticities are presented in Table 6. Note that the column headings in Table 6 indicate which harvest equation generated an elasticity estimate. The labels on each row indicate which normalized cross-price coefficient generated an elasticity estimate.

[Table 6. Cross-price elasticities]

Cross-price elasticities can reveal complementary or substitution production relationships between outputs. Both buffalo-catfish cross-price elasticities are negative and significant, indicating that buffalo and catfish are substitute products. Buffalo and catfish are the two highest-value species in the fishery. This means that they are the two groups of fish that are targeted. Buffalo are harvested mainly with trammel nets and gill nets, while catfish are caught with trotlines and hoop nets. The differences in gear means that fishermen are able to differentially target buffalo and catfish depending on the relative price.

Both common carp-Asian carp elasticities are also negative, indicating that common carp and Asian carp are substitute products. Common carp and Asian carp are the two lowest-value species in the fishery. Any harvest of these fish is likely by-catch while fishing for other species. Fishermen in this fishery work in small boats with limited capacity. When a boat's capacity is constrained, a rational fisherman would discard low-value fish when high-value fish (buffalo or catfish) are brought aboard. Common carp and Asian carp are the two species most likely to be discarded in this case. Our results indicate that the price of these two fish determined which species is discarded.

The Asian carp-catfish cross-price elasticity is large and positive. This result is puzzling and there is no readily apparent explanation.

Note that in most cases, even when the cross-price elasticity is significant it is inelastic. The lack of significance of the elasticities suggests that fisherman have limited ability to control their product mix. Instead, it appears that what species is caught depends more on relative abundance and the location of fish (Segerson and Squires, 1993). An alternative explanation is that fishermen may be unable, or unwilling, to expend more effort to catch fish when price increases. They may be constrained in the amount of gear they have available, for instance, or in the amount of time available to spend fishing.

Discussion

There are two main results from this paper. First, the supply of fish is relatively insensitive to the price of fish. Estimated own-price elasticities are insignificant and estimated cross-price elasticities are small in magnitude. This lack of price response seems to indicate either that fish harvest depends on the abundance of fish or that fishermen are unable (or unwilling) to change the amount of effort applied to the fishery.

Second, there is no evidence that increasing the harvest of Asian carp will affect the harvest of other species. Analysis of the cross-price supply elasticities shows that Asian carp production is not related to production of other fish species except for common carp. Policies to encourage the commercial harvest of Asian carp are being considered to control the population. One concern about such polices is that increased Asian carp harvest might increase fishing mortality of commercially and ecologically valuable species such as buffalo and paddlefish. Our results indicate that buffalo production is not related to Asian carp production, i.e., that fishermen can target Asian carp effectively enough to avoid buffalo.

This model should be interpreted with caution because of a lack of information on the size of fish stocks. There is some stock assessment data available for locations on the upper Mississippi River system, but the data are limited to a few locations. Fish stocks represent an omitted variable in our model.

Policy makers are considering raising the price of Asian carp, either through a direct subsidy to fishermen or through increased marketing of the fish. A large (non-marginal) price increase would likely stimulate the investment in sturdier gear and larger boats needed for large-scale production of Asian carp. Given the huge and rapidly expanding Asian carp population, these new investments would likely make Asian carp much easier to catch. However, policy makers must also consider whether encouraging the harvest of a harmful invasive species is wise. Once harvesters and processors (and communities) become dependent on Asian carp, pressure may grow to manage a sustainable population of Asian carp. This could have harmful ecological consequences, such as increasing the probability of Asian carp invading the Great Lakes. Research into the political economy of Asian carp seems warranted.

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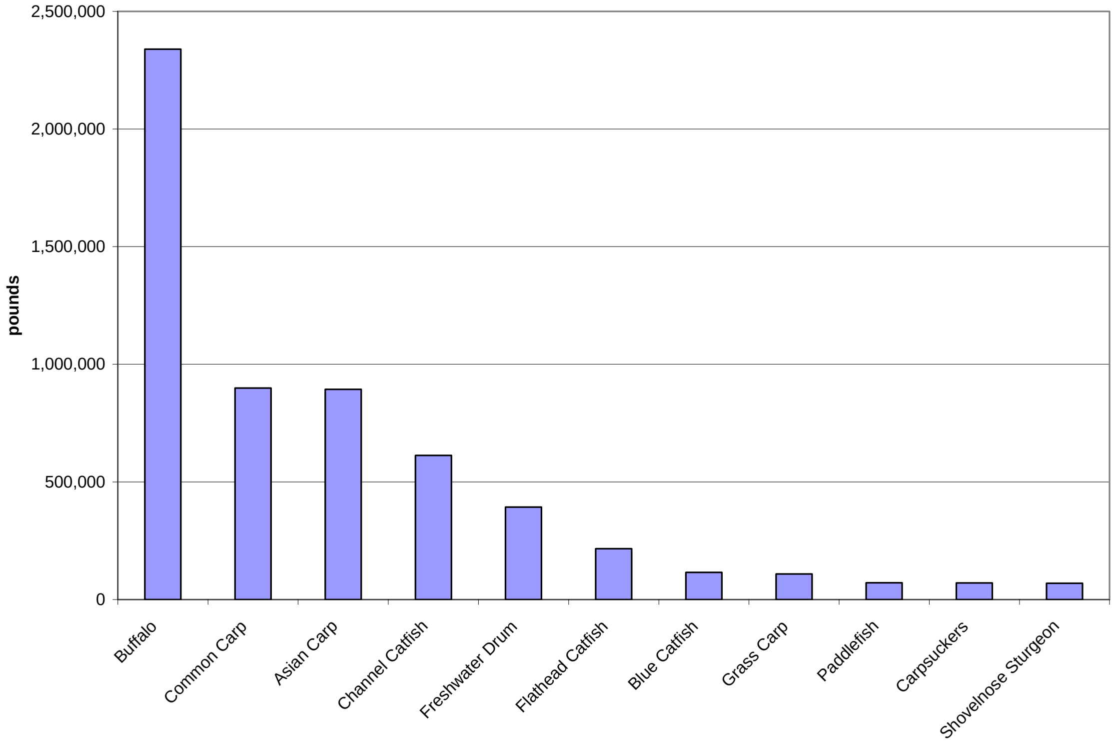

Figure 1. Illinois Statewide Annual Harvest by Species – 2003

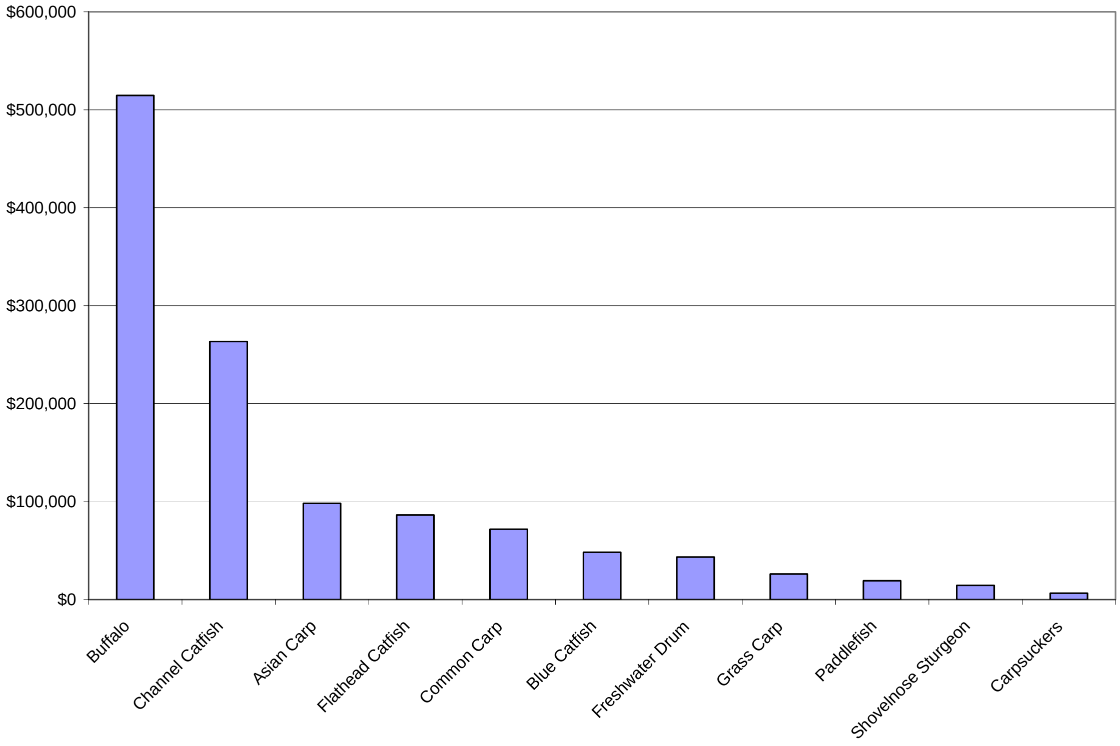

Figure 2. Value of Illinois Statewide Annual Harvest by Species - 2003

Table 1. Illinois Statewide Average Prices – 2003

Species	Price Per Pound
Channel Catfish	$0.43
Blue Catfish	$0.42
Flathead Catfish	$0.40
Bullhead	$0.40
Paddlefish	$0.27
Grass Carp	$0.24
Buffalo	$0.22
Shovelnose Sturgeon	$0.21
Eel	$0.21
Herring	$0.20
Gar	$0.13
Freshwater Drum	$0.11
Asian Carp	$0.11
Carpsuckers	$0.09
Common Carp	$0.08
Bowfin	$0.08
Suckers	$0.07

Table 2. Data Summary Statistics

	Mean	Median	Standard Deviation
Harvest – Buffalo (pounds)	14,865	4,732	28,959
Harvest – Catfish (pounds)	5,245	1,960	7,921
Harvest - Common carp (pounds)	5,379	1,549	11,362
Harvest - Asian carp (pounds)	4,770	0	22,787
Harvest – Other (pounds)	4,543	895	10,432
Price-Buffalo ($/pound)	0.21	0.20	0.054
Price-Catfish ($/pound)	0.43	0.44	0.129
Price-Common Carp ($/pound)	0.09	0.08	0.033
Price-Asian carp ($/pound)	0.08	0.08	0.039
Price-Other ($/pound)	0.15	0.14	0.086
Gear	259.08	196.6	218.01

n = 487, data are an unbalanced panel

Table 3. Regression output

	Harvest-Buffalo	Harvest-Catfish	Harvest-Common carp	Harvest-Asian carp	Harvest-Other
Buffalo	__	2.556*	-1.502	1.914	-1.643
Catfish	2.556*	__	0.373	-5.057**	-0.114
Common carp	-1.502	0.373	__	4.481**	1.358
Asian carp	1.914	-5.057**	4.481**	__	1.853*
Other	-1.643	-0.114	1.358	1.853*	__
Gear	11.375	16.778***	1.460	-58.767**	1.394
Gear2	0.001	-0.008**	-0.005	0.003	0.000
Y2002	1,479.691	30.960	1,844.869*	1,665.179	1053.076*
Y2003	678.296	-244.265	681.746	2,194.304	806.774
Y2004	-2,257.985	-637.023	1,785.806*	6,077.864***	-151.708
FT	2943.003**	3022.983***	354.943	163.950	1040.870*

***significant at the .01 level
**significant at the .05 level
*significant at the .10 level

Table 4. Hypothesis test for technological characteristics: Nonjointness-in-inputs

	χ^2 – value	Degrees of Freedom	p-value (significance)	Decision (α=0.10)
Overall	18.61	10	0.0455	Joint production
Buffalo	6.52	4	0.1636	Non-joint production
Catfish	7.33	4	0.1193	Non-joint production
Common carp	10.12	4	0.0384	Joint production
Asian carp	13.37	4	0.0096	Joint production
Other	4.73	4	0.3158	Non-joint production

Table 5. Own-price elasticities

	Own-price elasticity estimate	Standard Error	95% confidence interval	
Buffalo	-0.056	0.059	-0.235	0.028
Catfish	0.017	0.020	-0.015	0.056
Common carp	-0.303**	0.096	-0.501	-0.094
Asian carp	0.187	0.305	-0.409	0.783
Other	-0.029	0.031	-0.085	0.033

**significant at the .05 level

Table 6. Cross-price Elasticities

	Buffalo	Catfish	Common carp	Asian carp	Other
Buffalo	__	-0.086**	0.151	-0.297	0.216
		(0.051)	(0.196)	(0.510)	(0.195)
Catfish	-0.079**	__	-0.055	1.166**	0.022
	(0.046)		(0.205)	(0.581)	(0.170)
Common carp	0.020	-0.008	__	-0.441**	-0.113
	(0.026)	(0.029)		(0.181)	(0.118)
Asian carp	-0.025	0.108	-0.284**	__	-0.154
	(0.043)	(0.054)	(0.117)		(0.143)
Other	0.029	0.003	-0.114	-0.241	__
	(0.026)	(0.025)	(0.120)	(0.224)	

**significant at the .05 level