Rulemaking to List Black Carp Under the Lacey Act

Economic Analysis

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EXECUTIVE SUMMARY

The U.S. Fish and Wildlife Service published a final rule to add live black carp (*Mylopharyngodon piceus*) to the list of injurious wildlife under the Lacey Act. An injurious wildlife listing will prohibit the importation and interstate transport of all black carp (diploid and triploid black carp, gametes, and viable eggs). This document analyzes the economic impacts of three alternatives: No Action Alternative (Baseline); Alternative 1 – Add diploid black carp to the list of injurious wildlife; and Alternative 2 (Preferred Alternative) – Add diploid and triploid black carp to the list of injurious wildlife.

Black carp are not marketed as a foodfish nor are they exported by U.S. farmers. However, they are used by the aquaculture industry to control digenetic trematodes in aquaculture ponds. Because domestic black carp broodstock are adequate, the aquaculture industry does not currently import black carp from sources outside the United States and most likely will not resume imports. An injurious wildlife listing will not prohibit intrastate transport or any use of black carp within State lines. Any regulations adhering to the use of black carp within individual States are the responsibility of each State.

As noted by Tucker et al (2004), "economic losses resulting from infectious diseases are difficult to quantify because record keeping varies among farmers and many diseases go unreported." Estimating the potential impacts associated with adding black carp to the list of injurious species required a number of assumptions for the catfish, hybrid striped bass, and baitfish industries due to the uncertainties related to trematode outbreaks and the use of black carp to control those outbreaks. To account for these uncertainties, this analysis presents a variety of potential scenarios that may occur.

The Baseline (No Action Alternative) is the status quo. Under the Baseline, the aquaculture industry will not incur any additional economic impacts. Trematode infestations and associated losses will not change. The potential threat to freshwater mussels will continue. If one black carp enters the rivers and tributaries, the estimated annual cost over 10 years ranges from $209,636 to $279,515 discounted at 7 percent and range from $245,087 to $326,783 discounted at 3 percent. This estimate represents the freshwater mussel replacement costs and does not quantify ecological, commercial, recreational, and non-use values of freshwater mussels. Therefore, this impact is likely underestimated.

If Alternative 1 is implemented, the interstate transport of triploid black carp will continue. As a result, the aquaculture industry would continue to use black carp to manage snail-borne parasites. However, farmers inadvertently shipping diploid black carp could face penalties for Lacey Act violations. The penalty for a Lacey Act violation is not more than six months in prison and not more than a $5,000 fine for an individual, and not more than a $10,000 fine for an organization. Under Alternative 1, the probability of black carp establishing a population in the wild may decrease compared to the baseline. The change in probability is unknown. If just one black carp escapes, impacts are estimated to range from $209,636 to $326,783 over 10 years.

Under Alternative 2, the interstate transport of all black carp will be prohibited. Thus, for those facilities in states with no in-state source of black carp, they will no longer be able to import black carp to manage snail-borne parasites. The 10-year net revenue losses for Alternative 2 (Preferred Alternative) is estimated to range from $3.2 million to $25.8 million discounted at 3 percent or range from $2.7 million to $21.0 million discounted at 7 percent. Table ES-1 shows the net revenue losses discounted at 3 percent. The cost estimate represents the loss of net revenue to catfish farms and hybrid striped bass farms that use black carp and do not have an in-state source for black carp. These cost estimates present the various potential scenarios that were considered. The scenarios show the possible outcomes based on the future rate of black carp demand and which States produce or prohibit black carp. In Scenario 1, Alabama and Arkansas are excluded from potential impacts because Alabama prohibits the use of black carp and Arkansas produces black carp. In Scenario 2, Mississippi is also excluded because it may have the potential to produce black carp in the future. If the Missouri Department of Conservation is successful in promoting a cross of redear/green sunfish hybrid as an alternative to black carp by 2007, these estimated impacts would be reduced. Due to limited data availability, the hybrid striped bass analysis assumes all States will be affected. Therefore, the impacts are likely overestimated. Detailed data regarding the impact of the yellow grub on the baitfish industry were unavailable when this report was prepared. Therefore, the cost estimate may underestimate the impact of this rulemaking.

Under Alternative 2 (Preferred Alternative), the potential 10-year benefits per prevented black carp entering the rivers and tributaries are estimated to range from $209,636 to $279,515 discounted at 7 percent and range from $245,087 to $326,783 discounted at 3 percent. This estimate represents the potentially avoided freshwater mussel replacement costs. While not eliminating black carp as a threat, this Alternative could reduce the possibility of black carp escapement, compared to the Baseline and Alternative 1. It is unknown what the new probability of escapement will be under Alternative 2. This benefit estimate does not quantify ecological, commercial, recreational, and non-use values of freshwater mussels, and does not take into account values of endangered mussels at risk. The benefits from these unused factors are unknown, but are certainly not zero. Therefore, the overall benefits estimated for preventing the escape of a single black carp are underestimated.

A summary of the potential economic effects for each alternative shown in Table ES-1.

Table ES-1. Summary of Economic Impacts by Alternative

	Baseline	Alternative 1	Alternative 2
Costs	If one black carp escapes, freshwater mussel replacement costs could range between $209,636 and $326,733. Impacts would be greater if an established black carp population results.	Aquaculture farms would face the potential risk of violating the Lacey Act ($5,000). Freshwater mussel populations would still be at risk.	The aquaculture industry would incur costs ranging from $3.2 million to $25.8 million. Aquaculture farms would face the potential risk of violating the Lacey Act ($5,000).
Benefits	No change.	The risk to freshwater mussel populations would be reduced because it would be less likely that a black carp population would become established.	The risk to freshwater mussel populations would be greatly reduced. Benefits ranging from $209,636 to $326,733 represent the avoided costs of freshwater mussel replacement.

INTRODUCTION

Background

In February 2000, the U.S. Fish and Wildlife Service received a petition from the Mississippi Interstate Cooperative Resources Association to list the black carp (*Mylopharyngodon piceus*) under the injurious wildlife provision of the Lacey Act. The petition was based on Mississippi River Basin State concerns about the potential impacts of black carp on native freshwater mussels and snails. On October 23, 2002, the U.S. Fish and Wildlife Service received a petition signed by 25 members of Congress representing the Great Lakes region to add bighead carp, silver carp and black carp to the list of injurious wildlife under the Lacey Act; a follow-up letter identified seven additional Legislators that support the petition.

The Service has the responsibility of prohibiting the importation and interstate movement of those species found to be injurious under the Lacey Act. The regulations contained in 50 CFR part 16 implement the Lacey Act (18 U.S.C. § 42) as amended. Under the terms of the law, the Secretary of the Interior is authorized to prescribe by regulation those wild mammals, wild birds, fish (including mollusks and crustaceans), amphibians, reptiles, and the offspring or eggs of any of the aforementioned, which are injurious to human beings, to the interests of agriculture, horticulture, or forestry, or to the wildlife or wildlife resources of the United States. Wild mammals, wild birds, fish, mollusks, crustaceans, amphibians, and reptiles are the only organisms that can be added to the injurious wildlife list. The lists of injurious wildlife species are at 50 CFR 16.11-15.

If black carp are determined to be injurious, then as with all listed injurious animals, their importation into, or transportation between, States, the District of Columbia, the Commonwealth of Puerto Rico, or any territory or possession of the United States by any means whatsoever will be prohibited, except by permit for zoological, educational, medical, or scientific purposes (in accordance with permit regulations at 50 CFR 16.22), or by Federal agencies without a permit solely for their own use, upon filing a written declaration with the District Director of Customs and the U.S. Fish and Wildlife Service Inspector at the port of entry. In addition, no live black carp, gametes or eggs imported or transported under permit could be sold, donated, traded, loaned, or transferred to any other person or institution unless such person or institution has a permit issued by the Director of the U.S. Fish and Wildlife Service. The interstate transportation of any live black carp, gametes or eggs currently held in the United States for any purposes not permitted will be prohibited. The rule will not prohibit intrastate transport or possession of black carp within States, where not prohibited by the State. Any regulation pertaining to the use of black carp within States will continue to be the responsibility of each State.

The Service published a Notice/Review of Information in the Federal Register on June 2, 2000 as the first step in the rulemaking process. The Service received 124 responses during the public comment period that closed August 1, 2000. A Proposed Rule to add black carp to the list of injurious fishes under the Lacey Act was published in the Federal Register on July 30, 2002 (Volume 67, pages 49280-49284). The Service received 81 comments on the Proposed Rule. In an effort to gather additional economic and ecological information, a notice was published in the Federal Register reopening the public comment period on the proposed rule and the draft Risk Assessment for black carp prepared by the U.S. Geological Survey (USGS) on June 4, 2003 (Volume 68, pages 33431-33432). The Service received 22 responses during the comment period that closed August 4, 2003. On August 30, 2005 (70 FR 51326) the Service published a Federal Register announcement regarding the availability of the draft environmental assessment and draft economic analysis, including the initial regulatory flexibility analysis, for the proposed rule and sought comments on alternatively listing only the diploid (fertile) form of black carp; this comment period was extended to December 16, 2005 (70 FR 61933, October 27, 2005). The Service received 89 responses during this comment period.

Disease problems are the highest cause of loss in aquaculture (Meyer 1991). The aquaculture industry uses a variety of chemical and biological methods to protect farm raised fish from disease. In regard to disease, black carp are used as a biological control for digenetic trematodes (flukes), such as the yellow grub (*Clinostomum spp*.) and white grub (*Posthodiplostomum minimum*) in the baitfish and hybrid striped bass industries and *Bolbophorus*[1] in the catfish industry.

The lifecycle of the white and yellow grubs includes the great blue heron, the snail *Physella sp*., and a fish host (Cooke et al 2002). The grubs infect baitfish and hybrid striped bass by infecting the muscle of the fish. As a result, the fish are more susceptible to disease, may have lower growth rates, and mortality may possibly occur if they are severely infected (Gray 2004). Black carp aid in controlling grubs by feeding on snails in aquaculture ponds, thus interrupting the grub's lifecycle.

Black carp are also used as a biological control for *Bolbophorus* in the catfish aquaculture industry. Documented cases of *Bolbophorus* are relatively recent with the first cases documented in the late 1990s. Since 1999, several cases have been documented where the parasitic flatworm *Bolbophorus* has infected farm raised catfish. (Henceforth, *Bolbophorus* and "trematode" will be used interchangeably.) No cure has yet been found, and the disease is controlled only by disrupting the trematode's lifecycle (American white pelican to Ram's horn snail to catfish to American white pelican). Within the United States, the American white pelican winters along the southern coast, including the States of California, Arizona, Louisiana, Mississippi, Alabama, Florida, and the southern border of Georgia. The pelican's breeding range includes California, Oregon, Montana, Wyoming, Colorado, North Dakota, and South Dakota (Evans and Knopf 1993). Because the American white pelican is a protected bird, the parasite can only be controlled by restricting the snail population using a mixture of chemical and

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[1] In the past, trematodes in catfish ponds were referred to as *Bolbophorus confusus*. Research has determined that "…previous reports of *B. confusus* in North America…were probably not *B. confusus* but rather *B. damnificus,* the cryptic *Bolbophorus* sp., or some combination of the 2 species" (Flowers et al 2005). This report refers to the trematode as *Bolbophorus*.

biological methods. The primary biological control is the use of black carp in the aquaculture ponds.

If catfish are infected with *Bolbophorus*, growth rate is reduced, susceptibility to other diseases is increased, and mortality may occur if smaller fish are severely infected (Avery et al 2001 and Tucker et al 2004). Once the fish is infected, the trematode will not affect human health because cooking will eliminate the flatworm. Furthermore, skinning of the fish removes most of the cyst (Jeff Terhune, pers. comm. 6/10/03). While the actual sale of the fish may possibly not be impacted, the farmer's net revenue may decrease due to smaller sized fish raised and increased costs for pond treatment.

Structure of This Report

The remainder of this report is structured as follows:

- **Overview:** This section presents an overview of the aquaculture industry, current practices to control snail populations, trematode impacts to aquaculture, and State regulations pertaining to black carp.

- **Baseline (Status Quo) – The No Action Alternative:** This section analyzes the current impact of trematodes in the catfish, hybrid striped bass, and baitfish industries. In addition, it analyzes the impact to freshwater mussels if the No Action Alternative is implemented.

- **Alternative 1 – Add Diploid Black Carp to the List of Injurious Wildlife:** This section analyzes the impacts to the catfish, hybrid striped bass, and baitfish industries and freshwater mussels that would be incurred if diploid black carp are listed as an injurious species.

- **Alternative 2 – Add Diploid and Triploid Black Carp to the List of Injurious Wildlife:** This section analyzes the impacts to the catfish, hybrid striped bass, and baitfish industries and freshwater mussels that would be incurred if diploid and triploid black carp are listed as an injurious species.

OVERVIEW

Aquaculture Industry

This section provides an overview of current production of catfish, hybrid striped bass, and baitfish in the United States.

Catfish Aquaculture Industry

Catfish is the leading aquaculture industry in the United States and represents over 40 percent of total aquaculture sales. In 2005, there were 1,158 operators with sales of over $482 million (Table 1). Over the last decade, the number of catfish farms has varied by about 10 percent, ranging from 1,319 farms in 1997 to 1,147 farms in 2004. Since 2002, water acreage used for production has steadily declined from 196,760 acres to 173,590 acres.

Table 1. U.S. Catfish Production 1996 to 2005 (2005 dollars)

YEAR	Number of Operations (Farms)	Water Surface Acres Used for Production	Total Sales (1,000 dollars)
1996	1,328	167,340	$570,767
1997	1,319	177,460	$533,474
1998	1,243	171,130	$577,532
1999	1,279	180,865	$570,540
2000	1,252	187,330	$563,411
2001	1,277	195,820	$517,628
2002	1,236	196,760	$478,978
2003	1,161	187,200	$484,436
2004	1,147	177,790	$518,114
2005	1,158	173,590	$482,125
10-year average	1,240	181,529	$529,700

Source: National Agricultural Statistics Service, USDA, 1995-2005.

Catfish production is not distributed evenly across the United States (Table 2). Instead, production is concentrated in four states: Alabama, Arkansas, Louisiana, and Mississippi. These four States have consistently represented about 95 percent of the U.S. aquaculture production since 1995 (National Agricultural Statistics Service 1995-2003). Together, these four major catfish producing States represent 71 percent of catfish operations, 95 percent of water surface acreage, and 95 percent of total sales. Mississippi accounted for the largest percentage of operations (35 percent), water surface acres (58 percent), and total sales (56 percent) in 2005.

Table 2. 2005 Catfish Production, by State (2005 dollars)

State	Number of Operations	Water Surface Acres	Total Sales (1,000 dollars)
Alabama	230	25,100	$97,602
Arkansas	153	31,500	$77,556
California	31	1,700	$7,308
Florida	46	650	$1,120
Georgia	55	1,090	$2,066
Kentucky	60	600	$887
Louisiana	38	7,600	$14,936
Mississippi	410	101,000	$268,303
Missouri	24	1,320	$1,723
North Carolina	49	2,000	$6,077
Texas	62	1,030	$4,547
United States	1,158	173,590	$482,125

Source: National Agricultural Statistics Service, USDA, 2006.

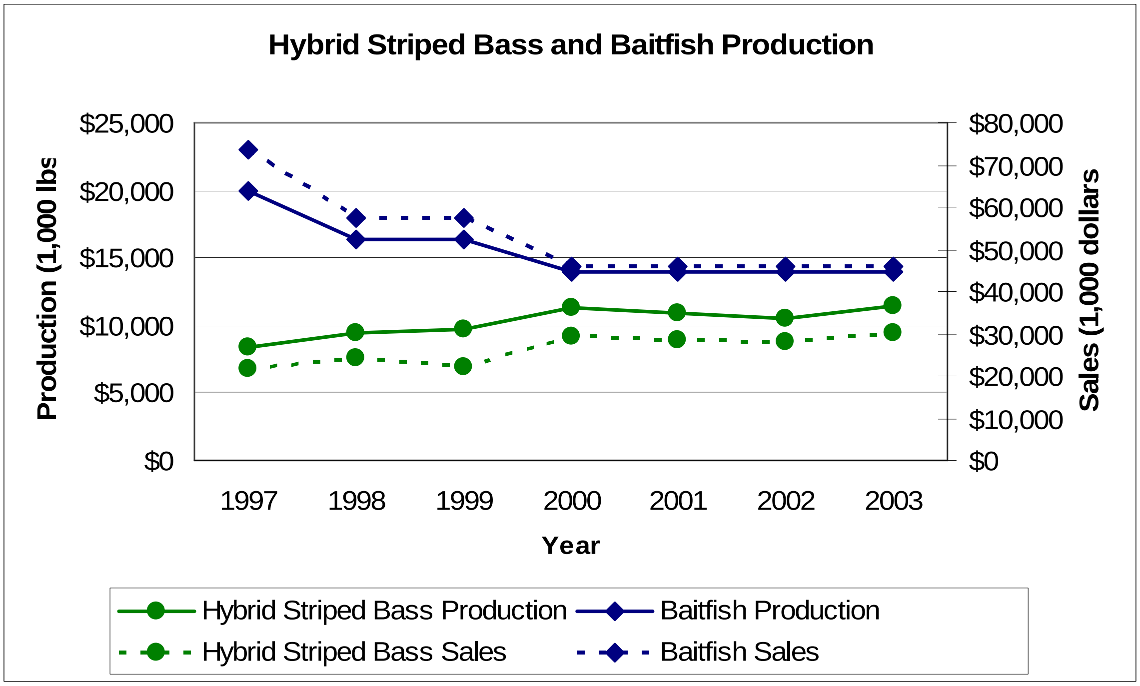
Baitfish and Hybrid Striped Bass Aquaculture Industry

Figure 1 shows hybrid striped bass and baitfish production in the United States from 1997 to 2003. During this time period, hybrid striped bass production increased 36 percent from 8.4 million pounds to 11.4 million pounds. While total hybrid striped bass sales have increased over the last 5 years, price received per pound has decreased as supply increased. During the same time, baitfish production decreased 30 percent from 19.9 million pounds to 14.0 million pounds.

Geographically, baitfish sales are concentrated in the Southern Region with $28.86 million (Table 3). However, the number of baitfish farms are nearly equally distributed across both the Southern Region and the North Central Region. Hybrid striped bass farms are focused in the Southern Region, where there were 43 farms and $13.25 million in sales in 1998.

The most recent detailed State data for the hybrid striped bass and baitfish industries are from the 1998 Census of Aquaculture. Since there has been so much change in these industries during this time period, those data are not presented. Between 1998 and 2003, the hybrid striped bass industry has increased 26 percent. Therefore, the table using Census of Aquaculture data represent a general nationwide distribution of hybrid striped bass farms.

Figure 1. Hybrid Striped Bass and Baitfish Production, 1997 - 2003



Source: National Marine Fisheries Service 2005.

Table 3. Regional Distribution of Baitfish & Hybrid Striped Bass Aquaculture Farms (2003 dollars)

Region	Baitfish		Hybrid Striped Bass	
	Farms	Sales ($1,000)	Farms	Sales ($1,000)
Northeastern Region	62	(1)	27	$7,756
Southern Region	104	$28,864	43	$13,246
North Central Region	92	$6,845	15	(1)
Western Region	16	$2,726	3	(1)
United States	275	$39,955	88	$30,031

Source: USDA, 1998 Census of Aquaculture. States denoted by (1) are not included to avoid disclosure.

Snail Control and Prevention of Trematode Infestations

Preventing and controlling the trematode infestations is directed toward disrupting the trematode life cycle by eliminating snails in aquaculture ponds. Depending upon State regulations, pond treatment includes the use of chemical treatments and/or biological control species.

Chemical pond treatments include the application of either hydrated lime or copper sulfate (Avery et al 2001). The effectiveness of these chemical treatments depends on water alkalinity and temperature, wind speed, fish size, and pond size (Avery et al 2001 and Core 2002a). If pond conditions are not conducive, fish mortality could result and/or treatments may not be effective.

Hydrated lime is applied to ponds with alkalinity with less that 50 ppm (Avery et al 2001), and copper sulfate is used for ponds with more than 150 ppm alkalinity and larger than 7 acres (Avery et al 2001 and Terhune et al 2003). When a mixture of copper sulfate and citric acid are applied, "…95 to 100 percent of snails were killed in studies when the water temperature was between 73.4 °F and 86 °F" (Core 2002a). This mixture is approved by the EPA and is widely used in the Mississippi Delta area (Core 2002b). While copper sulfate is extremely effective, the correct pond conditions must exist, as noted above. Otherwise, severe oxygen depletion in the ponds could cause fish mortality (Avery et al 2001).

The costs for chemical pond treatments are as follows. For hydrated lime, shoreline treatment for one 10-acre pond is approximately $1,890, while whole pond treatments would cost approximately $4,420 (Randall Evans, public comment 10/18/05). For copper sulfate, shoreline treatments cost approximately $1,500 to treat one 10-acre pond, while whole-pond treatments cost approximately $2,270 (Randall Evans, public comment 10/18/05).

While these chemical treatments can control algae and weeds along the pond margin, they are not an effective choice for the deeper sections of the pond. To control the snail after chemical treatments and in the deeper areas, about 10 black carp per acre may be stocked (Avery et al 2001). Black carp assist in keeping infections under control in high risk areas (David Wise, pers. communication, 18 October 2005). When the pond is harvested, the black carp are destroyed (Mike Freeze, pers. communication, 18 October 2005). Therefore, black carp would need to be continually purchased to restock the aquaculture ponds. The approximate costs for black carp are detailed in Table 4 below.

Black carp are the most commonly used biological snail control for aquaculture farms. However, there are ongoing studies investigating the potential for alternative options. The Blind Pony Hatchery in Missouri determined that hybrid redear/green sunfish provided excellent control for snails (John D. Hoskins, public comment 10/24/05). Studies, partially funded by the Service, are ongoing, but the Missouri Department of Conservation expects that a program could provide sunfish as an alternative to black carp by 2007 (John D. Hoskins, public comment 10/24/05).

Table 4. Wholesale Price of Black Carp

Fish Size	Price per fish[1]	Avg. Price Per 11 acre pond
4 – 6 inches	$1.50	$165.00
6 – 8 inches	$2.50	$275.00
8 – 10 inches	$3.50	$385.00
10 – 12 inches	$4.00	$440.00

Source[1]: Mike Freeze, pers. communication, 18 October 2005.

When ponds are so highly infected that they are no longer profitable, it may be necessary to completely renovate the pond. Renovating a pond is very costly. For a whole pond treatment, molluscicide is applied (Avery et al 2001). In addition to the costs associated with draining and cleaning the pond itself, it takes two years before fish reach market size (Carole Engle, 25 October 2005, pers. communication). Thus, two years of potential net revenues for that pond are lost.

Status of Trematode Infestations and the Use of Black Carp

There are varying reports regarding the incidence of trematodes in aquaculture facilities. The following section summarizes information from public comments, academic journal articles, and the 2003 USDA sponsored survey of catfish farms.

In fry and fingerling catfish operations, the most common diseases were ESC (52.9 percent), unknown causes (46.2 percent), and columnaris (45.2 percent) (USDA 2003a). Trematodes accounted for 1.9 percent of disease outbreaks in these operations. For fry and fingerling catfish operations, trematode outbreaks accounted for 0.9 percent of all stocked fry that did not survive until harvest (USDA 2003a).

For foodsize catfish operations in 2002, the most widespread diseases were enteric septicemia of catfish (ESC) (60.6 percent), columnaris (50.4 percent), and winter kill (32.9 percent) (USDA 2003b). Trematodes accounted for a small percentage of disease outbreaks in foodsize operations (4.3 percent) (USDA 2003b). Large operations (150 or more surface acres) experienced the most trematode outbreaks (11.6 percent of large operations). Of all foodsize operations, 1.3 percent of ponds experienced trematode outbreaks (USDA 2003b).

Examples for Selected States

Alabama. As of 2003, there were no documented cases of *B. confusus* (now identified as *B. damnificus*) in Alabama aquaculture ponds (Alabama Catfish Producers, pers. comm. 6/10/03). Black carp are prohibited in Alabama (Jernigan 2001).

Arkansas. From 2000 to 2003, five Arkansas catfish farms reported the presence of *B. confusus* that contributed to fish mortality (Dorman 2003). No cases were reported in 2000 and 2001, while 1,473 acres and 2,973 acres were infected in 2002 and 2003, respectively (Dorman 2003). These reported cases do not include potential incidences where fish health was not affected. This estimate represents a conservative estimate that may be higher because catfish producers may be able to identify the trematode themselves, and thus, treat the problem without notifying the Cooperative Extension Program at the University of Arkansas Pine Bluff. Furthermore, "Catfish farms in Arkansas that have stocked triploid black carp have not had problems with trematodes" (Randall Evans, public comment 10/18/05). Catfish producers in Arkansas can apply for a permit to use black carp. As of 2001, 11 black carp permits were issued.

Georgia. Georgia aquaculture does not use black carp. (public comment 12/16/05)

Illinois. There have been no reports of trematodes in Illinois (public comment 10/24/05)

Iowa. There have been no reports of trematodes in Iowa (public comment 10/21/05)

Mississippi. Mississippi is the leading catfish producer with 405 farms and over $243 million in sales (National Agricultural Statistics Service 2006). In 2003, it was estimated that "…more than half of Mississippi's 113,500 acres of catfish ponds are threatened by the parasite [*Bolbophorus confusus*]" (Delta Farm Press 2003). These farms have the option of using chemical and/or biological controls to manage trematode infestations in catfish. To date, about 20 Mississippi producers are permitted to use black carp to control snails (Brent Baily, public comment 09/27/05 and Gene Robertson, pers communication 10/21/05). These producers represent 5 percent of the catfish farms in Mississippi.

While Mississippi allows the importation of certified triploid black carp, black carp are not currently commercially produced in Mississippi (APHIS 2000; Brent Baily, public comment 09/27/05). No state hatcheries or universities have black carp broodstock (Gene Robertson, pers. communication, 10/21/05). However, one Mississippi hatchery maintains a diploid population of about 20 black carp (Louie Thompson, pers. communication, 10/21/05). If the need arises, this hatchery could potentially produce triploid black carp (Louie Thompson, pers. communication, 10/21/05). Depending on future state regulations, it is possible that triploid black carp could be produced in-state in the future.

Missouri. Approximately 20 percent of Missouri fish farmers reported snails or grubs as a problem (John D. Hoskins, public comment 10/24/05). At present, the Missouri Department of Conservation is importing triploid black carp to distribute to fish farms for snail management. Table 5 shows the farms stocking triploid black carp. The demand for black carp has decreased from 4 farms in 2001 to 2 farms in 2005.

Missouri is planning to phase out the use and possession of black carp by July 1, 2009 (John D. Hoskins, public comment 10/24/05). If the use and possession of black carp is prohibited in the future, fish farms in Missouri would be impacted by this rule only until 2009.

Table 5. Triploid Black Carp in Missouri

Year	Number of Triploid Black Carp	Approximate Acreage with Black Carp (10 black carp per acre)	Number of Farms Stocking Triploid Black Carp
2001	820	82	4
2002	606	61	4
2003	400	40	2
2004	200	20	1
2005	300	30	2

Source: John D. Hoskins, public comment 10/24/05

North Carolina. Since 1993, North Carolina reported losses of up to $2 million annually in hybrid striped bass ponds and tanks due to trematode outbreaks (Frinsko public comment 2005). Cook et al reports hybrid striped bass losses of $1 million annually due to grub infestations in North Carolina (2002). Four hatcheries had the most severe infestations. North Carolina inspects and imports triploid black carp from Arkansas. Only two catfish ponds (out of ~45-46) in last 13 years were heavily infested (Frinsko pers. communication 10/19/05).

Tennessee. Tennessee aquaculture does not use black carp (public comment 12/8/05).

Additional Data

In addition to the information noted above, there are a few studies that analyze the impact of trematodes and the prevalence of black carp on aquaculture farms. A summary of the studies follows.

- In 2002, the National Animal Health Monitoring System of the U.S. Department of Agriculture surveyed catfish operations in Alabama, Arkansas, Louisiana, and Mississippi. While this survey was voluntary, there were 739 survey respondents (Alabama – 223, Arkansas – 157, Louisiana – 67, and Mississippi – 292) with a response rate of 79 percent (USDA 2003a & USDA 2003b). As of 2005, these four States represented 71 percent of U.S. catfish operations, 96 percent of national catfish sales, and 96 percent of water surface acres used (National Agricultural Statistics Service, 2006). Nationwide, this survey represented 64 percent of all catfish producers. The Survey reported that 4.1 percent of catfish farms stock black carp and 1.8 percent of ponds use black carp to control snails. The Survey also reported 4.3 percent of farms (1.3 percent of ponds) experienced trematode outbreaks.

- Between July 1999 and August 2000, Terhune et al surveyed 821 ponds from 32 catfish farms in northwest Mississippi (2002). From this sample, 262 of 821 ponds (32 percent) yielded at least one fish with the *Bolbophorus confusus* infection. While this study shows the prevalence of *Bolbophorus* *confusus* at these particular farms, the study does not necessarily represent the prevalence of the trematode nationwide. As Terhune et al noted, "…the farms sampled were not randomly selected from all farms throughout the sampling area. Rather, they were sampled at the request of owners who submitted fish testing positive for *B. confusus* to TCNWAC's fish diagnostic laboratory (and who were concerned about infection rates in other ponds) or those who had observed pelicans on or around their ponds and were experiencing unexplained production losses" (2002).

- In 2001, Mitchell reported that 7,500 acres of water were stocked with black carp annually, which represented 3.8 percent of water acreage used for catfish production. This estimate is comparable with the 2003 USDA Catfish Survey estimate that 4.1 percent of farms stock black carp.

- In Mississippi, about 20 catfish farmers are permitted to use black carp (Brent Baily, public comment & Gene Robertson, pers. communication). Twenty farmers represent 5 percent of Mississippi catfish farmers. This number of 5 percent is comparable to both the 2003 USDA Catfish Survey estimate of 4.1 percent of farms and the Mitchell estimate of 3.8 percent of water acreage.

- Hanson and Wise studied the financial effects of trematode infestations on 40 ponds from one catfish farm in Mississippi (2005 and Terry Hanson public comment 28 Oct. 2005). This analysis directly correlated the level of trematode infestation with the average feed per acre and the number of pounds of catfish produced, and attributed all pond losses to trematode infestation levels. This farm used only chemical treatments and did not use black carp to mitigate the effects of trematode infestations although black carp are an option in Mississippi (Terry Hanson, public comment, 28 Oct. 2005). The study found that 60 percent of water acreage (58 percent of ponds) at this farm were infested with trematodes at varying degrees. This case study considerably differs with the 32 percent estimate from Terhune and Wise (2002), the 4.1 estimate from the 2003 USDA Catfish Survey, the 7,500 acres estimate (3.8 percent of surface water acreage) from Mitchell (2001), and the 5 percent estimate of Mississippi catfish farmers. This case study represents one farm that would be categorized as "severe" in the 2003 USDA Catfish Survey.

As summarized above, the only study that analyzes a large percentage of catfish farms is the 2003 USDA Catfish Survey. The remaining studies focus on a small subset of catfish farms or case studies. While these case studies depict the possible varying impacts of trematodes to localized areas, they do not depict the nationwide impacts. Furthermore, the 2003 USDA Catfish Survey is comparable to black carp estimates from Mitchell (2001) and the number of catfish farmers using black carp in Mississippi. Therefore, the 2003 USDA Catfish Survey is used as a benchmark for this analysis.

State Regulations and Production of Black Carp

Between 1993 and 1999, the U.S. Fish and Wildlife Service conducted a program to certify the production of triploid black carp. During this time, the Service certified triploid black carp in Arkansas, Florida, Louisiana, Mississippi, North Carolina, Oklahoma, and Wisconsin. Furthermore, Florida, Iowa, Illinois, Louisiana, North Carolina, Oklahoma, and Wisconsin received shipments of triploid black carp while Arkansas, Mississippi, Missouri, and Texas received shipments of diploid black carp (Nico et al. 2005). Because an injurious wildlife listing does not prevent the intrastate transport of black carp, we assume that States that are capable of producing black carp will not be impacted by the rule. Only Arkansas is producing triploid black carp. One farm in Mississippi (Louie Thompson Fisheries) possesses diploid black carp and may be capable of producing triploid black carp in the future, depending on future State regulations (Louie Thompson, pers. communication 10/05).

Table 6 details individual State regulations concerning the use of black carp.

Table 6. Selected State Regulations Regarding the Use of Black Carp as of 2003

State	Regulation	Black Carp Prohibited
Alabama	Current Alabama regulations do not allow black carp to be imported, possessed, or released. (Jernigan 2001)	×
Arizona	Currently attempting to add black carp to the list of Restricted Live Wildlife. Transfer through the state would still be permitted.	
Arkansas	Requires a permit for the use of triploid black carp for aquaculture use and a permit for diploid black carp as broodstock for production of triploids. As of 2001, there were about 11 black carp permits.	
Florida	The Florida Fish & Wildlife Conservation Commission controls black carp through the use of permits.	
Georgia	The State of Georgia requires a wild animal license to possess, import, transport, transfer, sale, or purchase black carp.	
Illinois	The State of Illinois lists black carp as injurious. Permits are available for educational, medical, research or exhibition purposes. No applications for such permits have been received.	×
Indiana	The State of Indiana prohibits the possession, propagation, purchase, sale, trade, transfer or loan of live black carp, their eggs, or their genetic material.	×

State	Regulation	Black Carp Prohibited
Iowa	The State of Iowa does not include black carp as an approved aquaculture species. A permit is required for use, but no applications have been received.	
Kentucky	Import, possession and sale of black carp allowed by permit.	
Louisiana	The State of Louisiana prohibits the possession of diploid black carp.	
Minnesota	The State of Minnesota lists black carp as a prohibited invasive species. Permits are required for import, possession or transport. None have been issued.	
Mississippi	Mississippi Department of Wildlife, Fisheries, and Parks– allows the importation of certified triploid black carp by permit. (source: APHIS Aquaculture Industry Report, USDA, Animal and Plant Health Inspection Service, July 2000)	
Missouri	The State of Missouri currently permits the possession of black carp. However, black carp should be eliminated by 2009. The Missouri Department of Conservation currently possesses diploid black carp broodstock.	
Montana	The State of Montana prohibits the possession, sale, and transport of black carp. Permits are available for educational, medical, research or exhibition purposes.	×
New York	The State of New York prohibits the possession of black carp.	×
North Carolina	Black carp permits are required from the North Carolina Wildlife Resources Commission. Currently, there are 6 permits for black carp (1 catfish farm and 5 hybrid striped bass farms).	
Ohio	The State of Ohio prohibits the possession of all Asian Carp.	×
Oklahoma	The State of Oklahoma requires a permit for the importation and possession of black carp.	
South Carolina	Permits are required for the importation, possession, or transport of black carp. There are currently no permits for black carp.	
Tennessee	Diploid and triploid black carp are prohibited	×
Texas	Diploid black carp are prohibited. Triploid black carp are allowed with a permit.	
Wisconsin	Permits are required for the possession of black carp. Currently, there are no permits.	

Source: State regulation information is compiled from Nico et al. 2005 and public comments.

BASELINE (STATUS QUO) – THE NO ACTION ALTERNATIVE

Aquaculture Industry

This section quantifies the overall present impact of trematodes on the aquaculture industry. These impacts would continue to occur whether or not diploid and/or triploid black carp are listed as an injurious species. While decreased revenue would indirectly affect jobs, employment earnings, and other aspects of the economy, this section does not quantify these effects.

Catfish Industry

As noted previously, the 2003 USDA Catfish survey will be used as a benchmark for this analysis. A summary of the survey data follows.

Within a four State area, 12.7 percent of foodsize operations and 11.6 percent of fry and fingerling operations[2] for catfish production reported problems with snails in 2002 (USDA 2003a, USDA 2003b). For foodsize operations, snail problems were more prevalent for operations located in the Arkansas, Louisiana, and western Mississippi (19.0 percent) than those operations located in Alabama and eastern Mississippi (7.2 percent) (USDA 2003b). Snail problems were not substantially different for fry and fingerling operations by region. Because the USDA survey does not detail the various types of snail problems, this estimate would represent the maximum number of operations that reported Ram's horn snail problems.

These affected operations used a variety of measures to control snails, as shown in Table 7. In foodsize and fry/fingerling operations, 19.9 percent and 26.8 percent (respectively) used measures to control snail populations. For fry/fingerling and foodsize operations, the primary control measures are lime, copper, and weed control. Biological control (which may include black carp) accounts for 3.8 percent of fry/fingerling operations and 1.8 percent of foodsize operations. While survey respondents reported that 1.8 percent of foodsize operations use biological control to control trematodes, survey respondents also reported that 4.1 percent of foodsize operations stock black carp in general.

[2] The *Catfish 2003* study defines fry as "newly hatched fish less than 1-inch long", fingerling are "1- to 8-inch fish, generally larger than fry but smaller than foodsize fish" and foodsize fish are "fish of marketable size, generally more than 10-inches long and up to 3 pounds in weight." Hatcheries tend to harvest their foodsize fish up to 3 pounds in weight. Catfish larger than 3 pounds in weight tend to be used as broodstock.

Table 7. Snail Control Measures in Catfish Ponds

Snail Control Measure	Percent of Operations	
	Fry and Fingerling	Foodsize
Lime	8.6	11.1
Copper	14.5	13.0
Weed Control	7.7	4.6
Biological Control	3.8	1.8
Other Measures	2.3	0.7
*Total**	*26.8*	*19.9*

*The total does not sum because operations may use more than one type of snail control measure.
Source: USDA 2003a and USDA 2003b

According to the 2003 USDA Catfish Survey, 4.3 percent of foodsize catfish operations experienced trematode outbreaks. However, not all ponds on each operation were impacted. Instead, 1.3 percent of all foodsize ponds experienced trematode outbreaks. For foodsize catfish operations, the severity of the trematode outbreak varied across operations. Table 8 depicts the impact of a trematode outbreak in foodsize ponds. As Table 8 shows, 98.7 percent of ponds were not affected by trematodes. Table 9 shows the distribution of average loss if farms experience trematode outbreaks.

Table 8. Average Impact for Foodsize Ponds due to Trematode Outbreaks

Percentage of Ponds			
None	*Light* (less than 200 lbs)	*Moderate* (200 – 2,000 lbs)	*Severe* (more than 2,000 lbs)
98.7	0.5	0.7	0.1

Source: USDA 2003b.

Table 9. Average Loss per Trematode Outbreak for 4.3 percent of Catfish Farms

Percentage of Ponds		
Light (less than 200 lbs)	*Moderate* (200 – 2,000 lbs)	*Severe* (more than 2,000 lbs)
38.5	53.8	7.7

Source: USDA 2003b.

<u>Current Losses to the Catfish Industry</u>

The current trematode impacts to the catfish industry are estimated for two scenarios: (1) 1.3 percent of ponds are impacted by trematodes and (2) 4.3 percent of farms are impacted by trematodes. Because the number of ponds is not available, the average number of ponds is estimated by dividing statewide water surface acreage by the average pond size (11 acres) for foodsize catfish[3]. The current loss due to trematode outbreaks is estimated by applying the data in Table 8 and Table 9 to Equations 1 to 4. Minimum and maximum losses were estimated by applying the range of loss for light (0 to 200 pounds), moderate (200 to 2,000 pounds), and severe (2,000 to 55,000 pounds). The upper limit for severe losses assumes that the entire pond is lost[4].

Scenario 1: 1.3 percent of ponds:
Eq.1 Min. Loss (lbs) = (Avg # of Ponds) *(0.005*0 + 0.007*200 + 0.001*2,000)
Eq.2 Max. Loss (lbs) = (Avg # of Ponds) *(0.005*200 + 0.007*2,000 + 0.001*55,000)

Scenario 2: 4.3 percent of farms:
Eq3 Min. Loss (lbs) = (4.3% of farms) *(0.414*0 + 0.400*200 + 0.186*2,000)
Eq.4 Max. Loss (lbs) = (4.3% of farms) *(0.414*200 + 0.400*2,000 + 0.186*55,000)

By extrapolating the 2003 USDA Catfish Survey data nationwide, the impact of trematodes on the industry sales for catfish can be estimated, as shown by Table 10. Because the majority of catfish is sold to processors, the estimated revenue loss is approximated by the average price per pound ($0.70/lb). If 1.3 percent of ponds are currently impacted, the current trematode impact to farmed catfish ranges between 57,563 pounds and 1.8 million pounds, with revenue ranging between $40,294 and $829,529 annually. If 4.3 percent of farms are currently impacted, the impact to farmed catfish ranging between 434,479 pounds and 10.7 million pounds with revenue ranges between $304,135 and $7.5 million annually. This impact represents between less than 0.01 percent and 1.6 percent of the nation's total catfish sales. This may be an underestimate because over 40 percent of catfish farmers were unfamiliar with trematodes (USDA 2003b).

Table 10. Estimated Annual Sales Losses at Catfish Operations due to Trematode Outbreaks

	Scenario 1 *1.3% of ponds*		**Scenario 2** *4.3% of operations*	
	Low Estimate	**High Estimate**	**Low Estimate**	**High Estimate**
Acreage Impacted	2,421	2,421	10,574	10,574
Ponds Impacted	220	220	961	961
Pounds Decrease	57,563	1,185,113	434,479	10,682,024
Sales Decrease	$40,294	$829,579	$304,135	$7,477,417

[3] Foodsize catfish represent 93.9 percent of total catfish sales in the United States (USDA 2005). This analysis applies trematode rates for foodsize catfish to the entire industry.
[4] The 2003 USDA Catfish Survey defined "severe" as "more than 2,000 pounds." This analysis assumes that a severe outbreak would cause the entire pond to be destroyed. The average commercial harvest ranges between 4,000 and 6,000 pounds per acre annually (Aquaculture in North Carolina Catfish). Average pond size (11 acres) multiplied by the average harvest (5,000 pounds) yields 55,000 pounds lost per pond for the upper limit of a severe outbreak.

Hybrid Striped Bass Industry

Data detailing the use of black carp and trematode impacts on hybrid striped bass farms are limited. Thus, the hybrid striped bass analysis depends on a limited number of publications and public comments received during the rulemaking process.

To control the yellow grub and white grub, hybrid striped bass farms have stocked black carp since the early 1980s (Wui and Engle 2005). Stocking 10 black carp per acre has resulted in nearly no incidence of snails in hybrid striped bass ponds and tanks (Wui and Engle 2005, Frinsko public comment 2005). The number of hybrid striped bass farms using black carp to control snails in the United States is unknown. However, there is limited statewide information. Black carp were initially brought into North Carolina for a one-year trial period in 1995 (Frinsko public comment 2005). Protocol was established in 2001, and 6 farms (5 hybrid striped bass and 1 catfish farm) in North Carolina used black carp to manage snail populations in approximately 350 water acres for the first time (Frinsko public comment 2005). Black carp have been nearly 100 percent effective in North Carolina and as of December, 2005 only one other black carp importation has been planned into the State (Frinsko public comment 2005).

Cook et al investigated strategies to minimize snail populations and trematode outbreaks in fry hybrid striped bass ponds in North Carolina (2002). None of the hybrid striped bass farms in the study sample demonstrated signs of grub disease. This disease rate is not applied in this analysis because the study sample only represents a subset of the industry.

The nationwide rate of trematode outbreaks in hybrid striped bass farms is unknown. Since 1993, North Carolina reported losses of up to $2 million annually in fry and foodsize hybrid striped bass ponds and tanks due to trematode outbreaks (Frinsko public comment 2005). Cook et al reports hybrid striped bass losses of $1 million annually due to grub infestations in North Carolina (2002). In 2001, 22 hybrid striped bass farms in North Carolina had farm gate value of approximately $5.7 million (North Carolina Aquaculture Statistics 2006). Thus, $1 to $2 million impacts from trematode outbreaks resulted in 18 to 26 percent decrease in North Carolina farm gate value when no black carp were used to control snails. If this estimate is extrapolated nationwide, then current annual trematode impacts to hybrid striped bass sales would range from $5.5 million to $11.0 million in 2004 (Table 11).

Table 11. Estimated Current Annual Sales Losses at Hybrid Striped Bass Farms due to Trematode Outbreaks

2004 Hybrid Striped Bass Sales	18% Sales Loss	26% Sales Loss
$31.3 million	$5.5 million	$11.0 million

Baitfish Industry

There is no data regarding trematode outbreaks and the use of black carp in the baitfish industry. Trematodes are known to infect baitfish, and it is expected that some losses associated with trematode outbreaks occur in the baitfish industry. However, without the necessary data, we are unable to estimate the current impacts.

Freshwater Mussels

The Risk Assessment for black carp that was conducted by the U.S. Geological Survey concluded that black carp is high risk for escape from aquaculture facilities, establishment of populations, and environmental impact (Nico and Williams 2003). If the No Action Alternative is taken, then there would continue to be a high risk of escape from aquaculture facilities across the United States. This estimate attempts to establish a baseline that quantifies the damage a single black carp could cause if released. The focus of the damage estimates will be on freshwater mussels, as they may be impacted to the greatest extent if black carp escape into the wild. While other mollusks would be at risk, specific losses for them will not be modeled due to a lack of relevant data. This section discusses freshwater mussels in terms of ecological, commercial, and replacement values.

Background

The black carp is recognized as a molluscivore. It has been shown to grow up to lengths of 1.5 meters, with a length range of 0.1 to 1.31 meters reported for a sample of 1,090 fish taken from China (Nichols 1943:90, IHAS 1976). That same sample showed common weights ranging from 15 to 40 kg though certain individuals weighed up to 70 kg.

Black carp begin preying on mollusks when their fixed teeth emerge, usually 26+ days after hatching (Nico and Williams 2003). Four year old black carp have been shown to eat three to four pounds of zebra mussels per day (Evtushenko et al. 1994 and references). It should not be assumed, however, that the introduction of black carp would be an effective method for reducing zebra mussels. More than likely the black carp would be unable to break apart the large clumps that zebra mussels tend to form (Nico and Williams 2003).

Studies by Nico and Williams (2003) and Shelton et al (1995) determined that black carp 1 to 1.5 meters long would have gape widths of approximately 49 to 55 mm and 72 to 82 mm respectively. Nico and Williams concluded that black carp would likely be able to consume all but the largest mollusks.

“In North America, it is estimated that 43 percent of the 300 species of freshwater mussels are in danger of extinction” (USGS 2003). Causes for freshwater mussel declines include habitat loss and the introduction of invasive species. To combat these problems, many private, State, and Federal funds support freshwater mussel propagation and restoration. Figure 1 shows watersheds with threatened or endangered freshwater mussel and snails populations in the United States.

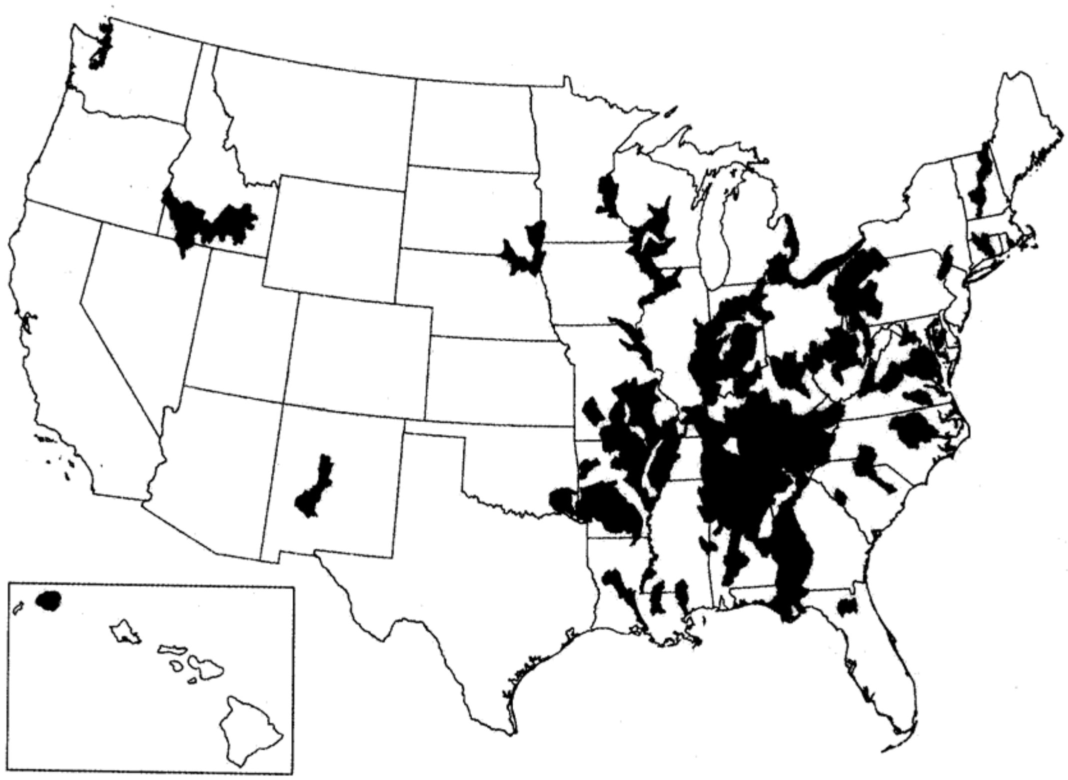


Figure 2. Watersheds of the U.S. with one or more endangered or threatened (Federal list) aquatic mollusks. Drainages shown at the Hydrologic Unit Code (HUC) 8 level. Coverage is based on a total of 54 freshwater mussels and 17 aquatic snails (Nature Serve, Arlington, VA). (Note: map does not include experimental populations (reintroductions) that are not protected as threatened or endangered species). From Nico and Williams 2003.

Ecological Benefits

Freshwater mussels are an ecologically important family. Mussels act as natural water filters for sedimentation and contaminants, cleaning as much as several gallons of water per day (USFWS 2003). The *Investigation and Monetary Values of Fish and Freshwater Mussel Kills* publication by the American Fisheries Society in 2003 states:

> "This service benefits all species of flora and fauna within an aquatic ecosystem. Loss of mussels may result in degradation of water quality, leading to negative impacts on the overall health and productivity of the ecosystem, including all human recreational and commercial uses. Other ecological benefits include providing food for wildlife, nutrient recycling, streambed stabilization, fish spawning habitat, habitat structure for invertebrates, and more. These values, though not quantified at the time of this publications release, may be substantial."

For these reasons, the American Fisheries Society recommends replacing lost mussels to regain the lost ecological services provided by mussels. The complete effects of a mussel kill on its ecosystem are unknown and have not been quantified. Therefore, this analysis will not attempt to estimate specific ecological damages.

Commercial Benefits

Commercial wholesale values can be estimated, but to truly assess the lost commercial value of killed mussels, only the profits would need to be considered. Data regarding the average costs to harvesters, which would be necessary for such an estimate, is lacking. Therefore, lost wholesale values will be estimated and discussed, but effective commercial benefits will not be included in the overall assessment.

Historically, freshwater mussels have been harvested commercially since the early 1900s. While they were originally harvested to manufacture buttons, freshwater mussels are currently harvested for the cultured pearl industry.

The Economic Census conducted by the U.S. Census Bureau does not have detailed data for mussel production (NAICS 112512) or mussel fishing (NAICS 114112). Furthermore, the highest level of detail collected by NASS includes Fishing, Hunting, and Trapping (NAICS 114) by State. The National Native Mussel Conservation Committee has reported that the U.S. mussel shell industry is valued at approximately $40 to $50 million (National Native Mussel Conservation Committee 1998). The mussel shells are used in the cultured pearl and jewelry industries, and the shell harvest provides employment to about 10,000 residents, primarily in the Mississippi River basin (National Native Mussel Conservation Committee 1998).

The States of Kansas, Wisconsin, Illinois, Indiana, and Iowa report past mussel harvests averaging between $400,000 and $3 million dollars per year (Table 12). These harvests have since been shut down due to declining mussel populations. The purposeful or accidental introduction of black carp could eliminate the possibility of these States resuming commercial harvest in the future. Iowa reported only their peak year in 1995; an average value for their harvest is not given. These values are averages reported in nominal terms.

Table 12. Discontinued Commercial Mussel Harvests

State	Average Past Annual Mussel Harvest Revenue
Illinois	$630,000
Indiana	$3,000,000
Iowa	Peaked at $1,000,000
Kansas	$400,000
Wisconsin	$440,000

Source: Public Comments from States of Illinois, Indiana, Iowa, Kansas, and Wisconsin.

The harvests shown in the table above have been shut down due to declining mussel populations. However, mussel harvests are still active in some states, most notably Tennessee. According to the Tennessee Wildlife Resources Agency, the commercial mussel harvest in Tennessee is expected to remain between 1,000 and 2,000 tons per year for the next 15 years. Total U.S. shell exports are expected to remain between 2,000 and 3,000 tons for the next 5 years. Olson (2002) states that Tennessee currently represents 96 percent of the U.S. shell exports. Of that, greater than 99 percent come from the Kentucky Reservoir, part of the Mississippi River system (Hubbs 2004). Table 13 illustrates the freshwater mussel industry in Tennessee in 2005 dollars.

Table 13. Tennessee Commercial Freshwater Mussel Shell Industry

Year	Harvesters	Dealers	Tonnage	Revenue (Millions $)	Average Price per Pound
1996	1,188	23	2,362	$6.60	$1.39
1997	641	25	1,061	$3.10	$1.50
1998	351	19	601	$0.80	$0.67
1999	260	15	1,335	$3.40	$1.26
2000	421	24	1,717	$2.90	$0.83
2001	416	17	2,144	$3.10	$0.73
2002	144	11	714	$0.79	$0.56
2003	215	13	1,439	$1.60	$0.56
2004	247	14	1,267	$1.30	$0.54
2005	264	15	1,693	$2.40	$0.71

Source: Tennessee Wildlife Resources Agency.

In 2005, the weighted average wholesale price per pound paid to mussel harvesters in Tennessee was $0.71. Historically, $0.71 per pound is a low price for mussels, which peaked at $1.89 per pound in 1995 (TWRA 2002). The wholesale price averaged close to $1.00 per pound for the period from 1992 through 2005 (Hubbs 2006). The decline in price since 1995 has been attributed to oyster die-offs in Japan which have decreased their demand for shells. These die-offs began in 1996 (TWRA 2006). Since no long term price trend emerges, $0.71 per pound will be used in the estimate for wholesale values.

Tennessee additionally reported nominal shell tax revenues of $31,786 in 2004 (TWRA 2006). This represents an average approximately $0.0125 per pound harvested. While license sales bring additional revenue into the State, it is unclear how much the introduction of black carp would affect licenses. Therefore, Table 14 uses the wholesale value of $0.71 per pound, tax revenues of $0.0125 per pound, but does not include effects on license revenue.

Table 14. Potential Commercial Cost per Year per Black Carp

Range of Freshwater Mussel Consumption per Black Carp	Pounds of Freshwater Mussels per Year	Wholesale Value Lost	Tax Revenue Lost	Cost per Year
Low (3 lb/day)	1095	$777	$14	$791
Medium (3.5 lb/day)	1278	$907	$16	$923
High (4 lb/day)	14608	$1,037	$18	$1,055

As shown in the table, an escaped black carp could cause the loss of $1,037 of wholesale value per year. However, to correctly value a fishery's worth to society, economists use producer surplus. Producer surplus is defined as the net return to harvesters after the costs of production have been accounted for. Important factors include wholesale price, maintenance costs, fuel costs, etc. Due to the recent unstable nature of mussel wholesale prices and the possibly large variability in costs, particularly fuel, producer surplus is not known.

However, subjectively, producer surplus for mussel harvesters is likely low. The reduction in harvesters in Tennessee since 1996 (Table 16) indicates that profit margins for mussels may have declined. The reduction of mussel populations due to habitat loss and the invasion of zebra mussels would make the average cost per pound of mussels harvested rise, while demand for those mussels has fallen due to Japan's oyster kills. The higher costs of harvesting and lower prices received would reduce producer surplus considerably. Using the results from Table 17 and assuming an average profit margin of 10 percent, a black carp would cause a loss of between $80 and $100 of producer surplus per year. This value is uncertain, but represents less than 1 percent of the total damage per year that could be caused by a black carp as shown in following sections. Therefore, due to its uncertain nature and small effect, potential losses to the commercial mussel industry are not quantified further.

Replacement Costs

The replacement costs for freshwater mussels are outlined by the American Fisheries Society. They repeatedly stress that the values are meant as a general guide, and are conservative in several ways. They suggest using data from the specific affected area instead if it is available. However, since these data are not available, the averages given by *Investigation and Monetary Values of Fish and Freshwater Mussel Kills* will be used (2003).

It is important to note that calculating the replacement costs for mussels does not fully value their benefits to the ecosystem, use, and non-use values. It simply attempts to show the lost value of the mussels through their estimated replacement costs. Only replacement costs are estimated. These ecosystem benefits are not factored into this section of the assessment.

The replacement costs outlined by the American Fisheries Society are composed of production costs, restocking costs, and administration costs. These relate to the costs of mussel propagation facilities to produce the mussels, transportation costs for the replacement mussels, and administrative costs to determine the extent of the mussel kill. In this assessment, only production costs will be considered. The reason is that since the mussels are not being replaced, there will be no transportation costs. Administrative and investigational costs relate to specific mussel kills. While they are likely to be incurred in the event of a large mussel kill, the number and cost of the investigations cannot be estimated.

Mussels produced at propagation facilities are raised until they are 2 months old. The authors of the American Fisheries Society publication assume a 9.5 percent survival rate for juvenile mussels to reach sexual maturity at age 5, but they note that from research conducted so far, survival rates are actually closer to 5 percent. They recommend that if the exact ages of the killed mussels are not known it should be assumed that all of the affected mussels were at sexual maturity. Therefore, the number of juvenile mussels that need to be stocked to replace the lost sexually mature mussels is equal to the number of mussels killed divided by the survival rate of 9.5 percent[5].

Since the age of the lost mussels is by definition unknown due to the nature of a forward looking analysis, all of the mussels killed are assumed to be at sexual maturity. Therefore, a logarithmic estimate of the survival of mussels based on their age group is not conducted in this assessment.

Once the number of mussels that need to be stocked is determined, it must be multiplied by the cost of production for a single juvenile mussel. Production costs of juvenile freshwater mussels depend on the ease of their propagation. Three categories: "Easy," "Average," and "Difficult" have costs in 2005 dollars of $0.53, $0.88, and $11.56 respectively per mussel, though it is noted that for threatened or endangered species significantly higher rates will apply (American Fisheries Society 2003).

Information from the States of Alabama, Illinois, and Tennessee indicate that *Megalonaias nervosa*, *Amblema plicata*, *Fusconaia ebena, Quadrula apiculata, Quadrula quadrula*, and *Fusconaia flava* are major components of their harvest. All of these species are listed in the "Average" production cost category. For simplicity, this analysis assumes that these most commonly harvested species are the most abundant in those states. It therefore assumes that an introduced black carp would be feeding mostly on these or similar species of mollusks. Table 15 represents data for these six species taken from the Ohio River since 1995.

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[5] The equation to estimate the number of stocked mussels is:

$$N = K / (0.095)$$

Where

N = number of juvenile mussels that must be stocked.

K = number of mussels killed.

Table 15. Average Weight of Freshwater Mussels

Species	Number Counted	Average Weight (lb)	Mussels per Pound
Amblema plicata	514	0.44	2.27
Megalonaias nervosa	46	0.80	1.25
Fusconaia ebena	595	0.28	3.57
Quadrula apiculata	No data	No data	No data
Quadrula quadrula	65	0.25	4.00
Fusconaia flava	9	0.12	8.33
Weighted Average	**1229**	**0.36**	**2.75**

Source: Fish and Wildlife Service Data Provided by Patricia Morrison

The average weight of 0.36 pounds per mussel lies between the weights of the two most commonly found species, *Amblema plicata* and *Fusconaia ebena*, so that is the value that will be used for future calculations. Low, medium and high values will be used for consumption, corresponding to a black carp eating 3, 3.5, and 4 pounds per day respectively. The average mussel weight translates to 2.75 mussels per pound. Table 16 shows the cost per year estimate for the damage caused by a single black carp.

When evaluating Table 16 it is important to remember that one juvenile mussel does not equal one adult mussel. With the assumed survival rate of 9.5 percent, only 1 in approximately 10.5 juvenile mussels ever reaches sexual maturity. So, as shown in the table, if a black carp eats 3,513 sexually mature mussels per year, it would be destroying the survivors of approximately 36,982 juvenile mussels from the same generation. Therefore, to replace that number of surviving mature mussels, the full number of juveniles would need to be produced.

Table 16. Mussel Replacement Cost per Black Carp per Year

Range of Mussel Consumption	Pounds per Year	Mussels Killed per Year (2.758/lb)	Juvenile Mussels Needed/Year	Production Cost per Juvenile Mussel	Cost per Year[6]
Low (3 lb/day)	1,095	3,011	31,699	$0.88	**$27,895**
Medium (3.5 lb/day)	1,278	3,513	36,982	$0.88	**$32,544**
High (4 lb/day)	1,460	4,015	42,265	$0.88	**$37,193**

The results shown in Table 16 are subject to several uncertainties. According to the American Fisheries Association's guidance for kills of mussels that have an unknown age, the table assumes that the black carp would eat only mussels that are 5 years old or older. This is unlikely, especially with the larger mussels such as *Megalonaias nervosa* that could become too large for black carp consumption after a certain age. If the black carp consumed mussels that were younger, the number of juvenile mussels required to restore the lost mussels would be fewer. Therefore, this uncertainty causes the calculation to tend toward over estimation.

In contrast, though, the table assumes a survival rate of 9.5 percent from the juvenile stage until sexual maturity, which is nearly twice the observed survival rate of 5 percent (AFS 2003). A lower survival rate would require more juvenile mussels to be stocked per lost mature mussel. Additionally, the table assumes that black carp would consume only fairly common mussel species. While it would likely consume species with lower production costs, it is reasonable to assume that it would also consume species with far higher production costs. Species in the "Difficult" category of propagation have a cost of $11.56 per juvenile mussel. The costs of threatened and endangered species are not quantified but are likely to be far higher (AFS 2003). Seventy species of the 297 mussels native to the United States are federally listed as endangered or threatened, and many other species have declined in abundance and distribution. Most of these are native to the eastern half of the United States. These uncertainties would cause the calculation to tend toward under estimation.

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6 To calculate the number of juvenile mussels that would be needed to replace the sexually mature ones lost, the amount of mussels a black carp would consume per year is divided by 9.5 percent as shown in the equation below. The number of juvenile mussels is then multiplied by $0.88 to determine the cost of black carp consumption per year per fish.

$$N = K / (0.095)$$
$$C = N * (0.88)$$

Where

K = number of mussels killed per year
N = number of juvenile mussels that would need to be stocked per year
C = cost per year

The exact proportion of threatened and endangered mussels that would be present in the black carp diet is impossible to estimate. Additionally, predicting damages assuming that its diet is entirely composed of threatened and endangered mussels would be irrelevant. Therefore, no specific yearly assessment will be made to predict damages to threatened or endangered mussel species. For reference, however, the Fish and Wildlife Service reported that State and Federal funds spent a nominal amount of $7,276,873 combined on mollusk recovery programs in 2004 (USFWS 2006). The number applies to all programs nationwide. While some mussel populations are included that would likely not be affected by this rule, most populations are located in an area at risk (Refer to Figure 2). Additionally, this value only accounts for spending voluntarily reported by agencies, which implies that it underestimates total spending. The assumption that black carp will not consume threatened or endangered mussels underestimates the economic impact.

Finally, the model assumes that the diet of the escaped black carp would consist entirely of freshwater mussels. In reality, it would consume snails and other mollusks as well. Similar methods for assessing damages to these other animals have not been published, so the effects of this uncertainty are unknown.

Summary

To calculate the present value for a 10 year time period from 2007 to 2016, the social discount rates of 3 percent and 7 percent are applied per OMB guidance. The potential impacts of the No Action Alternative, as shown in Table 17, range from $209,636 to $326,783 per fish depending on the rate of consumption and the discount rate. These values ignore ecological, commercial, recreational, and non-use values of freshwater mussels, and do not take into account values of endangered mussels at risk. The benefits from these unused factors are unknown, but are certainly not zero. Therefore, the overall benefits estimated for preventing the introduction of a single black carp are underestimated.

Table 17. 10-Year Present Value Benefits for Freshwater Mussels if One Black Carp Escapes

	Low Estimate	Moderate Estimate	High Estimate
7% discount rate	$209,636	$244,576	$279,515
3% discount rate	$245,087	$285,935	$326,783

This estimate assumes that the escaped black carp will live for 10 years. Black carp have been shown to live up to 15 years (Biro 1999). While there are too many variables to possibly predict whether an escaped black carp would continue to cause damages for ten years, they would face no natural predators in the Mississippi Basin

(Nico and Williams 2003). The fish could survive for more or less than ten years. Therefore, the uncertainty of this variable cannot be assessed.

The American Fisheries Society states that its recommendations for calculating replacement costs as shown in the previous section do not include ecological, use, or non-use values of the mussels, and that these values should be included if known. Ecological, recreational and non-use values have not been studied, and are not included in the total benefits. The data for the commercial value of mussels does not address profit margins, and is inadequate for this estimate. Therefore, the discounted benefits consist solely of the replacement costs as calculated in the previous section.

This analysis has not dealt with the potential impacts associated from preventing established populations of black carp. Calculating exact damages for such a scenario is beyond the scope of this analysis. However, the total value of the species and industries at risk can be discussed. The total freshwater mussel industry was valued between $40 and $50 million per year across the country in 1998. From voluntary reports, restoration of threatened and endangered freshwater mollusk populations cost over $7 million in 2004. Research suggests that black carp, if introduced, could become established in the Great Lakes (Nico and Williams 2003). Possible effects of black carp to the ecosystem and industry there are unknown. For reference, the 2006 annual cost for sea lamprey control in the Great Lakes is $16.0 million. These annual control costs have steadily increased since the initial sea lamprey management budget in 1958 with $1.3 million. Over the past decade, the annual sea lamprey control costs increased nearly 60 percent from $10.0 million in 1994 to $16.0 million in 2006 (Great Lakes Fishery Commission 2005).

The Risk Assessment for black carp that was conducted by the U.S. Geological Survey concluded that black carp is high risk for escape from aquaculture facilities (Nico and Williams 2003). This designation, however, does not assist in calculating a percentage chance of escape. The risk of escape must be evaluated on a subjective basis, and so total impacts for this alternative are unknown.

ALTERNATIVE 1 – ADD DIPLOID BLACK CARP TO THE LIST OF INJURIOUS WILDLIFE

Under Alternative 1, the Service would list only diploid black carp as injurious wildlife under the Lacey Act, which would prohibit importation and interstate transport of live diploid black carp, gametes, or eggs. This alternative would not prohibit intrastate transport or any use of diploid black carp within a State, where permitted by the State. Listing only diploid black carp as injurious would mean that triploid black carp could still be imported into the United States and transported across State lines for use.

Aquaculture Industry

Catfish Industry

The implementation of Alternative 1 would not affect the use of black carp or impacts from trematode outbreaks in the catfish industry, compared to the Baseline (No Action Alternative). It is assumed that the same percentage of catfish farms would continue to use black carp to control snail populations as needed. Thus, it is assumed that 1.8 percent of ponds experiencing trematode outbreaks would continue to lose between $40,294 and $829,579 in annual sales, or 4.3 percent of operations experiencing trematode outbreaks would continue to lose between $304,135 and $7,477,417 in annual sales. It is further assumed that 4.1 percent of catfish farms would continue to stock black carp.

This Alternative would prohibit the interstate transport of live diploid black carp, gametes, and eggs. Therefore, only States that currently have broodstock would be capable of producing triploid black carp in the future. Thus, Alternative 1 would limit future production to States that currently have broodstock.

In addition to the baseline losses associated with trematode outbreaks noted above, catfish farmers will also face the risk of fines or prison if caught transporting diploid black carp across State lines. This would be a potential risk for hatcheries shipping black carp across State lines and for catfish farms shipping catfish across State lines for processing. When North Carolina imported triploid black carp in 2001, it was discovered that approximately 40 percent of the pre-inspected/pre-certified lot was diploid; only triploid black carp were transported to North Carolina. (Frinsko public comment 12/12/05). It is not known what the average rate of triploidy is for producers of triploid black carp.

When catfish are shipped live to processing plants, it is possible that black carp could be unintentionally included in the shipment. This risk would be especially likely for farmers in Arkansas because catfish are shipped from Arkansas to Mississippi, Louisiana, and Texas for processing (Randall Evans public comment 10/18/05). Farmers inadvertently shipping diploid black carp could face penalties for Lacey Act violations. The penalty for a Lacey Act violation is not more than six months in prison and not more than a $5,000 fine for an individual and not more than a $10,000 fine for an organization.

Because the average rate of triploidy is unknown and data are limited, this analysis does not quantify this potential impact.

Hybrid Striped Bass Industry

The implementation of Alternative 1 would not affect the use of black carp or impacts from trematode outbreaks in the hybrid striped bass industry, compared to the Baseline (No Action Alternative). It is assumed that the same percentage of hybrid striped bass farms would continue to use black carp to control snail populations as needed. It is further assumed that hybrid striped bass sales losses due to trematode outbreaks would continue at $5.5 million to $11.0 million annually.

In addition to the baseline losses associated with trematode outbreaks noted above, hybrid striped bass farmers will also face the risk of fines or prison if caught transporting diploid black carp across State lines. Farmers inadvertently shipping diploid black carp could face penalties for Lacey Act violations. The penalty for a Lacey Act violation is not more than six months in prison and not more than a $5,000 fine for an individual and not more than a $10,000 fine for an organization. This analysis does not quantify this potential impact because the average rate of triploidy is unknown and data are limited.

Baitfish Industry

The implementation of Alternative 1 would not affect the use of black carp or impacts from trematode outbreaks in the baitfish industry, compared to the Baseline (No Action Alternative). It is assumed that the same percentage of baitfish farms would continue to use black carp to control snail populations as needed. It is further assumed that any baitfish sales losses due to trematode outbreaks would continue.

In addition to any baseline losses associated with trematode outbreaks, baitfish farmers will also face the risk of fines or prison if caught transporting diploid black carp across state lines. Farmers inadvertently shipping diploid black carp could face penalties for Lacey Act violations. The penalty for a Lacey Act violation is not more than six months in prison and not more than a $5,000 fine for an individual and not more than a $10,000 fine for an organization. This analysis does not quantify this potential impact because the average rate of triploidy is unknown and data are limited.

Freshwater Mussels

Under Alternative 1, freshwater mussels would continue to be susceptible to the potential escapement of black carp. Listing diploid black carp as injurious will help protect biota in large river systems and tributaries, but these systems will still likely be at risk from triploid introductions. While triploidy may impede breeding of black carp in the natural environment, non-breeding populations are still likely to have substantial negative impacts on native snail and mussel populations through predation. Though they cannot reproduce, even triploid fish are likely to cause ecological impacts if they survive in the wild. Triploid black carp, which can live to be 15+ years old, can compete with native fish for food and prey on threatened and endangered mollusks.

Flooding of aquaculture facilities is the most likely pathway into the wild, but black carp could also be inadvertently sold as bait, escape from bait buckets, intentionally introduced, be released due to a transportation accident, or moved through wildlife predation. While there are no confirmed escapements of black carp, black carp have been captured in the wild. The first specimen reported captured from the wild was in March 2003 from Horseshoe Lake Illinois. Since then, specimens were captured in the lower Red River, Louisiana in April 2004, and in June 2004 in the Mississippi River near Lock and Dam 24 near Clarksville, Missouri (USGS website). On April 5, 2005 a black carp was found in the White River, just north of DeVall's Bluff, Arkansas (USGS website).

Listing only diploid black carp as injurious will result in the continued risk of introduction of triploids. Interstate transport of triploids may still occur with the potential for accidental release even in states that do not permit their possession or use (i.e. highway accident on a bridge over a waterway). This analysis has not dealt with the potential impacts associated from preventing established populations of black carp. Calculating exact impacts for such a scenario is beyond the scope of this analysis. In addition, this analysis has not incorporated the probability of escapement because the probability is unknown. In general, listing diploid black carp should decrease the probability of escapement compared to the baseline. However, if just one black carp is introduced, the estimated total impacts range from $209,636 to $326,783 over 10 years.

ALTERNATIVE 2 – ADD DIPLOID AND TRIPLOID BLACK CARP TO THE LIST OF INJURIOUS WILDLIFE

Under Alternative 2, the Service would list live diploid and triploid black carp as an injurious species under the Lacey Act. This designation would prohibit the importation and interstate transport of diploid and triploid black carp, gametes, and eggs. This alternative would not prohibit intrastate transport or any use of black carp within a State, where permitted by the State.

Aquaculture Industry

To quantify the costs of listing diploid and triploid black carp as an injurious species on the aquaculture industry, the impacts on net revenue are evaluated. Net revenue is the difference between the amount that farmers receive for their product and the costs incurred to produce that product. To estimate the impacts to net returns, an economic model for each industry is employed.

Catfish Industry

Under Alternative 2, catfish farmers without an in-State source of triploid black carp will no longer have the option to use black carp to manage snail populations. The use of chemicals or other snail eating fish or some combination of chemical and biological control would still be available to catfish farmers to help control losses. Therefore, the implementation of this Alternative will affect the use of black carp and increase impacts from trematode outbreaks in the catfish industry, compared to the Baseline (No Action Alternative).

The following assumptions apply to the analysis of catfish industry impacts associated with Alternative 2.

<u>Catfish Industry Assumptions</u>:

1. *Affected States* – States that permit black carp and do not have an in-State source for triploid black carp may incur costs. These costs are incurred because that State's aquaculture producers that were using black carp are now susceptible to trematode outbreaks. Based on the information below, this analysis will present scenarios where (1) Alabama and Arkansas are not impacted and (2) Alabama, Arkansas, and Mississippi are not impacted. Furthermore, the analysis removes Missouri from the impacted population in 2010.
    - Alabama prohibits the possession of black carp.
    - Missouri is planning to phase out the use and possession of all black carp by July 1, 2009 (John D. Hoskins, public comment 10/24/05).
    - Only Arkansas produces triploid black carp.
    - One farm in Mississippi possesses diploid black carp and may potentially produce triploid black carp in the future for use in Mississippi.

2. *Affected Catfish Operations* – The 2003 USDA Catfish Survey found that 4.1 percent of foodsize catfish operations stock black carp. This estimate is consistent with both the Mitchell estimate of 3.8 percent of water acreage (7,500 acres) stocking black carp and the 5 percent of Mississippi catfish farmers using black carp. While the 2003 USDA Catfish Survey reports that 4.1 percent of catfish farms stock black carp, it also reports that only 1.8 percent of foodsize farms use biological measures to control snails. Although there is this discrepancy, the estimate of 4.1 percent will be employed because it is comparable with the two other data sources.

3. *Future Demand for Black Carp in the Catfish Industry* – It is difficult to estimate the future rate of demand for black carp because this disease is relatively new. If demand for black carp continues at the current rate and producers have the capacity to meet increased demand, demand could increase by 20 percent annually for the foreseeable future. The potential 20 percent annual increase would account for the 45 percent of catfish farmers who are currently unfamiliar with trematode impacts. More likely, trematode outbreaks and demand for black carp will stabilize at some point. The reason for the stabilization is that not all ponds are at the same degree of risk because some ponds are not located near the white pelican range, and some ponds are conducive to chemical treatments that help mitigate any snail populations. The future demand for black carp probably lies between the current demand for black carp (4.1 percent) and the 20 percent annual increase. This analysis presents both potential scenarios.

4. *Severity of Trematode Outbreaks in the Catfish Industry* – We assume that black carp used to control snails wholly prevented trematode outbreaks that would have occurred otherwise. If black carp use discontinues, then these operations would be more susceptible to trematode outbreaks. It is unknown what the severity of trematode outbreaks will be on farms that no longer use black carp. In some areas, farms will be unable to use chemical treatments because pond conditions (alkalinity, size, etc.) may not be compatible with hydrated lime or copper sulfate.

   Infected ponds could experience trematode outbreaks along any range of impacts, including the range depicted in Tables 8 and 9. Impacts from trematodes may be higher than Survey respondents reported. This is because fish infected with the trematode are more susceptible to other diseases (Komar et al 2004). Therefore, secondary impacts from trematode outbreaks may not be accounted for in the Survey estimate. This analysis will present two possible scenarios to detail the potential impacts from trematodes if black carp are not used. Minimum and maximum losses will be estimated by applying the range of loss for light (0 to 200 pounds), moderate (200 to 2,000 pounds), and severe (2,000 to 55,000 pounds) (USDA 2003b). The upper limit for severe losses assumes that the entire pond is lost.

This analysis employs a 10-year average for the catfish industry with 1,240 producers and 181,529 water surface acres. The average price per pound is $0.70. There are 4.1 percent of catfish farms that currently use black carp to manage snail populations, which correlates to 7,442 acres (about 677 ponds). These farms produce about 38 million pounds with sales of $21.7 million. These catfish producers that operate in affected States would be susceptible to trematode outbreaks because they would no longer have the option to use black carp to control snail populations.

To estimate the impacts to net returns earned by catfish farmers, an economic model for a 450 acre catfish farm was adapted (Hanson, public comment 10/28/05; Hanson and Wise 2005). The model was adjusted to assume an 11 acre pond produces 5,500 pounds of catfish.

Table 18. Annual Costs and Returns on a 452 acre Commercial Catfish Farm

Revenue	
Fish Produced, lb	5,500
Selling price, $/lb	$0.70
Fish Sales, $	$38,500
Variable Costs	
Feed fed, ton	61.875
Feed price, $/ton	$230
Feed cost, $	$14,231
Chemical cost of Trematode treatments	$1,584
Other Variable Costs, $	$14,231
Total Variable Costs	$30,047
Income Above Variable Costs	$8,454
Fixed Cost, $ per 11 acre pond	$5,500
Net Return per 11 acre pond	**$2,954**

Sources: Hanson and Wise 2005; Hanson public comment October 2005.
All cost assumptions are from Hanson and Wise (2005): 2.25 pounds of feed to produce 1 pound of catfish, and other variable costs are 50 percent of total variable costs.

The range of potential trematode impacts (Assumption 4) were applied to the economic model above. These impacts included losses of between 0 and 55,000 pounds per impacted pond. Modeling the change in pounds produced due to the increase in trematode outbreaks resulted in decreased net return per 11 acre pond. Table 19 shows the estimated annualized losses to the catfish industry for the 4.1 percent of impacted catfish farms in terms of pounds decrease, sales decrease, and lost net returns. Scenario 1 shows the estimated annualized impacts if Arkansas continues producing triploid black carp and Alabama continues to prohibit black carp. Scenario 2 shows the estimated annualized impacts if Arkansas continues producing triploid black carp, Alabama continues to prohibit black carp, and Mississippi begins producing triploid black carp. For Scenario 1, estimated annual lost net revenues range between $22,061 and $454,201. For Scenario 2, estimated annual lost net revenues range between $4,093 and $84,262.

Table 19. Estimated Annualized Losses to the Catfish Industry

Scenario 1: Excluding Arkansas and Alabama		
	Low Estimate	**High Estimate**
Water Acreage Impacted[1]	5,122	5,122
Ponds Impacted	466	466
Pounds Decrease	121,784	121,784
Sales Decrease	$84,618	$1,742,140
Lost Net Returns	$22,061	$454,201

Scenario 2: Excluding Arkansas, Alabama, and Mississippi		
	Low Estimate	**High Estimate**
Water Acreage Impacted[2]	981	981
Ponds Impacted	89	89
Pounds Decrease	23,327	23,327
Sales Decrease	$15,698	$323,196
Lost Net Returns	$4,093	$84,262

[1]For Scenario 1, Water Acreage Impacted = (181,529 acres – AR acres – AL acres)*4.1%
[2]For Scenario 2, Water Acreage Impacted = (181,529 acres – AR acres – AL acres – MS acres)*4.1%

As noted in the Assumption 3 above, it is possible for the use of black carp to remain constant or for the use of black carp to continue increasing at a rate of 20 percent per year. If the assumption that black carp demand will increase in the future holds true, then impacted acreage will increase from 5,122 acres in 2007 to 26,428 acres in 2016 for Scenario 1. For Scenario 2, impacted acreage will increase from 981 acres in 2007 to 5,062 acres in 2016.

The present value of catfish sales losses and catfish net revenue losses are shown in Table 20 and Table 21, respectively. To calculate the present value for a 10 year time period, the social discount rates of 3 percent and 7 percent are applied per OMB guidance. These discount rates are applied to two rates of demand, 0 percent increase in use of black carp and 20 percent annual increase in use of black carp as producers become more aware of potential trematode problems. In addition to these losses, multiplier effects could increase the potential impact. These effects would be greatest in areas that are less diversified and dependent upon the catfish industry.

In addition to the losses associated with trematode outbreaks shown in the tables below, catfish farmers will also face the risk of fines if caught transporting black carp across state lines. This risk would be especially likely for farmers in Arkansas because catfish is shipped from Arkansas to Mississippi, Louisiana, and Texas for processing. Farmers inadvertently shipping black carp could face penalties for Lacey Act violations. The penalty for a Lacey Act violation is not more than six months in prison and not more than a $5,000 fine for an individual and not more than a $10,000 fine for an organization.

Table 20. 10-Year Present Value of Total Catfish Sales Loss

Scenario 1 : Excluding Arkansas and Alabama	**Low Estimate**	**High Estimate**
7 percent discount rate		
0% Annual Increase in Use of Black Carp	$636,423	$13,102,850
20% Annual Increase in Use of Black Carp	$1,483,345	$30,539,588
3 percent discount rate		
0% Annual Increase in Use of Black Carp	$743,714	$15,311,780
20% Annual Increase in Use of Black Carp	$1,832,263	$37,723,237

Scenario 2: Excluding Arkansas, Alabama, and Mississippi	**Low Estimate**	**High Estimate**
7 percent discount rate		
0% Annual Increase in Use of Black Carp	$118,472	$2,439,156
20% Annual Increase in Use of Black Carp	$281,172	$5,788,873
3 percent discount rate		
0% Annual Increase in Use of Black Carp	$138,174	$2,844,783
20% Annual Increase in Use of Black Carp	$347,312	$7,150,601

Table 21. 10-Year Present Value of Total Catfish Net Revenue Loss

Scenario 1: Excluding Arkansas and Alabama	**Low Estimate**	**High Estimate**
7 percent discount rate		
0% Annual Increase in Use of Black Carp	$165,925	$3,416,101
20% Annual Increase in Use of Black Carp	$390,530	$8,040,325
3 percent discount rate		
0% Annual Increase in Use of Black Carp	$193,897	$3,992,000
20% Annual Increase in Use of Black Carp	$482,763	$9,939,241

Scenario 2: Excluding Arkansas, Alabama, and Mississippi	**Low Estimate**	**High Estimate**
7 percent discount rate		
0% Annual Increase in Use of Black Carp	$30,888	$635,923
20% Annual Increase in Use of Black Carp	$72,917	$1,501,242
3 percent discount rate		
0% Annual Increase in Use of Black Carp	$36,024	$741,676
20% Annual Increase in Use of Black Carp	$90,052	$1,854,006

Hybrid Striped Bass Industry

The implementation of Alternative 2 would affect the use of black carp and increase impacts from trematode outbreaks in the hybrid striped bass industry, compared to the Baseline (No Action Alternative). Hybrid striped bass farmers without an in-State source of black carp would no longer have the option to use black carp to manage snail-borne parasites.

As noted earlier, data detailing hybrid striped bass production, and the use of black carp and the impact of trematodes on hybrid striped bass farms are limited. The most recent Aquaculture Census was in 1998. While the National Marine Fisheries Service reports annual national hybrid striped bass data for pounds produced and total sales (2005), the number of acres and producers is not reported. In addition, current industry statistics by State, with the exception of North Carolina, are unavailable (Jimmy Avery pers. communication 08/06 and Nathan Stone pers. communication 08/06).

Hybrid striped bass production is highly concentrated. "Three producers produced over 60 percent of the total national hybrid striped bass production in 2002: Kent Sea Tech of California, Natures Catch of Mississippi, and Silver Streak Bass company of Texas" (Lougheed and Nelson). It is unknown whether these operations use black carp. In North Carolina, about 26 percent of hybrid striped bass farms use black carp to control snail populations (Frinsko public comment 2005). Even with limited use of black carp in North Carolina, the number of hybrid striped bass farms has increased from 10 farms in 1998 to 19 farms in 2005 (NASS 1998 and Losordo et al 2006).

Wui and Engle is the sole study that examines the economic impact of alternative snail control on hybrid striped bass farms (2005). The Wui and Engle (2005) model used survey data from hybrid striped bass farms and assumed that black carp were used for snail control at all farms. Wui and Engle modeled that without the option to use black carp on 1,937 acres in 2001, "…losses would range from $0.7 million/yr to $2.94 million/yr in the short run and $4.7 million/yr to $5.6 million/yr in the long run" depending on the alternative treatment used (2005). This estimate is likely an overestimate because it is not likely that all hybrid striped bass production experience trematode outbreaks nor do all farmers choose to use black carp. In addition, farms in States that prohibit or produce black carp will not be affected by Alternative 2. As noted earlier, even without the rule, most hybrid striped bass farms (74 percent in North Carolina) do not use black carp.

The following assumptions apply to the analysis of hybrid striped bass industry impacts associated with Alternative 2.

<u>Hybrid Striped Bass Industry Assumptions</u>:

1. *Affected States* – States that permit black carp and do not have an in-State source for black carp may incur costs. Thus, the State's hybrid striped bass production that was using black carp is now susceptible to trematode outbreaks.

- Alabama prohibits the possession of black carp.
- Missouri is planning to phase out the use and possession of black carp by July 1, 2009 (John D. Hoskins, public comment 10/24/05). If the use and possession of black carp is prohibited in the future, fish farms in Missouri would be impacted by this rule only until 2009.
- Only Arkansas produces triploid black carp.
- One farm in Mississippi possesses diploid black carp and may potentially produce black carp in the future if necessary for use in Mississippi.
- The hybrid striped bass production in Alabama and Arkansas should not be included in the affected population. Since State data are unavailable, this assumption is not carried through this analysis. Therefore, the impacts to the hybrid striped bass industry are likely overestimated.

2. *Affected Hybrid Striped Bass Operations* – The nationwide use of black carp in hybrid striped bass and baitfish farms is unknown. The only information available is that 26 percent of North Carolina hybrid striped bass producers use black carp to control snails. To account for this uncertainty, the hybrid striped bass and baitfish analysis will present a range of potentially affected acreage: 10 percent, 26 percent, and 50 percent.

3. *Future Demand for Black carp in the Hybrid Striped Bass Industry* – It is difficult to estimate the future rate of demand for black carp in hybrid striped bass ponds. Since hybrid striped bass farms have stocked black carp since the early 1980s, we assume the majority of farmers are aware of problems with yellow grubs and white grubs. Therefore, the analysis will assume there will be no change in the demand for black carp.

4. *Severity of Trematode Outbreaks in the Hybrid Striped Bass Industry* – Wui and Engle (2005) assumes that all hybrid striped bass farms experience trematode outbreaks. Due to the lack of other data, this analysis will use the estimates from Wui and Engle (2005). Depending on pond or tank conditions, it is assumed that operators will choose to treat their ponds with hydrated lime, redear sunfish, or copper sulfate.

To estimate the impact of Alternative 2 on the net revenue earned by hybrid striped bass farmers, the estimates from Wui and Engle (2005) are employed (Table 22).

Table 22. Estimated Net Revenue Loss per Acre

Treatment	Estimated Net Revenue Loss per Acre If Black Carp is not used		
	Small Farm (20 acres)	Medium Farm (70 Acres)	Large Farm (300 acres)
Short Run			
Black Carp	$0	$0	$0
Hydrated Lime	$1,019	$1,019	$1,019
Redear Sunfish	$1,520	$1,519	$1,519
Copper Sulfate	$360	$360	$360
Long Run			
Black Carp	$0	$0	$0
Hydrated Lime	$3,389	$2,199	$2,205
Redear Sunfish	$3,438	$2,684	$2,779
Copper Sulfate	$4,349	$2,755	$2,403

Source: Wui and Engle (2005)

If farmers cannot use black carp, they will use the most cost-efficient treatment that is suitable to their pond conditions. Therefore, it is unknown which treatment operators will choose. This analysis assumes that snail treatments will be distributed evenly across the impacted acreage. It is estimated that there were 2,043 water acres[7] in hybrid striped bass production in 2004. This acreage was distributed among small (17 percent), medium (12 percent), and large farms (71 percent) in the same percentages as the Wui and Engle paper. The timeline for the long run in the Wui and Engle paper is not stated. Therefore, this analysis uses the short run impacts for years 2007-2011 and the long run impacts for years 2012-2016. Equation 5 shows how impact estimates for the long run were developed.

Eq. 5. Long Run Impact = (Percentage of Farms Using Black Carp)*
[(⅓)*(345 small farm acres)*($3,389 + $3,438 + $4,349) +
(⅓)*(238 medium farm acres)*($2,199+ $2,684 + $2,755) +
(⅓)*(1,460 large farm acres)*($2,205 + $2,779 + $2,403)]

To calculate the present value for a 10 year time period, the social discount rates of 3 percent and 7 percent are applied per OMB guidance. These discount rates are applied to three estimates for the percentage of hybrid striped bass farms using black carp, 10 percent, 26 percent, and 50 percent. Based on these assumptions, the present value of hybrid striped bass net revenue loss with a listing of diploid and triploid black carp will range from $2.6 million to $15.8 million (Table 23).

[7] As noted earlier, data regarding the total acreage for hybrid striped bass farms is unavailable. By creating a ratio between acreage and pounds produced, the 5.5 percent increase in pounds produced between 2001 and 2004 was applied to yield a 5.5 percent increase in acreage between 2001 and 2004. This analysis extrapolated the 1,937 acres in 2001 from Wui and Engle to 2,043 acres in 2004.

Table 23. 10-Year Present Value of Total Hybrid Striped Bass Net Revenue Loss

	Estimated Hybrid Striped Bass Farms Using Black Carp		
	10 percent	**26 percent**	**50 percent**
7 percent discount rate	$2,581,999	$6,713,196	$12,909,993
3 percent discount rate	$3,163,346	$8,224,699	$15,816,728

In addition to the losses associated with trematode outbreaks shown in the tables above, hybrid striped bass farmers will also face the risk of fines if caught transporting black carp across State lines. Farmers inadvertently shipping black carp could face penalties for Lacey Act violations. The penalty for a Lacey Act violation is not more than six months in prison and not more than a $5,000 fine for an individual and not more than a $10,000 fine for an organization.

Baitfish Industry

The implementation of Alternative 2 will affect the use of black carp and increase impacts from trematode outbreaks in the baitfish industry, compared to the Baseline (No Action Alternative). Due to the lack of available data, we do not estimate the potential impacts to the baitfish industry.

In addition to any increased losses associated with trematode outbreaks, baitfish farmers will also face the risk of fines or prison if caught transporting diploid black carp across state lines. Farmers inadvertently shipping black carp could face penalties for Lacey Act violations. The penalty for a Lacey Act violation is not more than six months in prison and not more than a $5,000 fine for an individual and not more than a $10,000 fine for an organization.

Freshwater Mussels

Alternative 2 would likely be effective in preventing the interstate shipment and use of all black carp in several states that currently use them as a biological control but don't produce them in-state. While not eliminating black carp as a threat, this preferred alternative could reduce the pathways and chances for black carp being introduced into the Mississippi River Basin and other U.S. waterways.

Under Alternative 2, freshwater mussels will continue to be susceptible to the impacts of introduced black carp. Listing diploid and triploid black carp as injurious will help protect biota in large river systems and tributaries, but these systems will still likely be at risk from introductions.

Listing diploid and triploid black carp as injurious will decrease the risk of introduction of diploids and triploids. This analysis has not dealt with the potential impacts associated with preventing established populations of black carp. Calculating exact impacts for such a scenario is beyond the scope of this analysis. In addition, this analysis has not incorporated the probability of unintentional introduction because the probability is unknown. In general, listing diploid and triploid black carp should decrease the probability of unintentional introduction compared to the Baseline (No Action Alternative) and Alternative 1. However, if this rulemaking prevents just one black carp from being introduced there will be benefits ranging from $209,636 to $326,783 over 10 years.

Summary Impacts for Alternative 2

Alternative 2 would prohibit the importation and interstate transport of diploid and triploid black carp, gametes, and eggs. If Alternative 2 is implemented, the use of black carp in the aquaculture industry and the potential risk of black carp unintentional introduction would be impacted.

Potential Costs

Table 24 shows the 10-year present value of net revenue losses are estimated to range between $3.0 million and $25.8 million if Arkansas and Alabama are not impacted and black carp demand continues to increase 20 percent annually for the foreseeable future. Table 25 shows the 10-year present value of net revenue losses are estimated to range between $2.7 million and $17.7 million if the hatchery in Mississippi begins to produce black carp and black carp demand continues to increase annually. Due to the limit of detailed data for the hybrid striped bass industry, this analysis did not account for farms in Arkansas and Alabama not being impacted which would cause the estimate to be overestimated. Furthermore, data for the baitfish industry were unavailable so the potential impacts were not quantified, and the estimate may be underestimated.

Table 24. Alternative 2: 10-Year Present Value of Net Revenue Losses with 20 percent annual increase in black carp demand

	Low Estimate*	High Estimate**
7 percent discount rate		
Catfish Farmers	$390,530	$8,040,325
Hybrid Striped Bass	$2,581,999	$12,909,993
Total	**$2,972,529**	**$20,950,318**
3 percent discount rate		
Catfish Farmers	$482,763	$9,939,241
Hybrid Striped Bass	$3,163,346	$15,816,728
Total	**$3,646,109**	**$25,755,969**

*Low Estimate Assumptions: (1) Arkansas and Alabama catfish farmers will not be impacted, (2) the demand for black carp in the catfish industry will increase 20 percent per year if there is no listing, and (3) 10 percent of hybrid striped bass farmers will no longer have the option to use black carp.
**High Estimate Assumptions: (1) Arkansas and Alabama catfish farmers will not be impacted, (2) the demand for black carp in the catfish industry will increase 20 percent per year if there is no listing, and (3) 50 percent of hybrid striped bass farmers will no longer have the option to use black carp.

Table 25. Alternative 2: 10-Year Present Value of Net Revenue Losses with 20 percent annual increase if Mississippi Hatchery Produces Black Carp

	Low Estimate*	High Estimate**
7 percent discount rate		
Catfish Farmers	$72,917	$1,501,242
Hybrid Striped Bass	$2,581,999	$12,909,993
Total	**$2,654,916**	**$14,411,235**
3 percent discount rate		
Catfish Farmers	$90,052	$1,854,006
Hybrid Striped Bass	$3,163,346	$15,816,728
Total	**$3,253,397**	**$17,670,734**

*Low Estimate Assumptions: (1) Arkansas, Alabama, and Mississippi catfish farmers will not be impacted, (2) the demand for black carp in the catfish industry will increase 20 percent per year if there is no listing, and (3) 10 percent of hybrid striped bass farmers will no longer have the option to use black carp.
**High Estimate Assumptions: (1) Arkansas and Alabama catfish farmers will not be impacted, (2) the demand for black carp in the catfish industry will increase 20 percent per year if there is no listing, and (3) 50 percent of hybrid striped bass farmers will no longer have the option to use black carp.

Potential Benefits

Under Alternative 2 the interstate shipment of black carp would be prevented; intrastate shipment and use would continue for those States that produce and allow black carp. While not eliminating black carp as a threat, Alternative 2 could reduce the pathways and chances for black carp being unintentionally introduced into river systems and tributaries. This analysis does not estimate the decreased probability of unintentional introduction nor the decreased probability of black carp population becoming established. Table 26 shows the benefits if only one triploid black carp is prevented from unintentional introduction.

Table 26. 10-year Present Value Benefits if One Black Carp Escapement is Prevented

	Low Estimate	Moderate Estimate	High Estimate
7 percent discount rate	$209,636	$244,576	$279,515
3 percent discount rate	$245,087	$285,935	$326,783

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