



# Aquaculture Overview: Private and Public Sector Statistics, including Drug-use Estimations

presented  
by

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# Domestic Aquaculture Production (2002)



Species	Farms	Sales (\$1M)
catfish	1,370	450.7
salmon (food)	47	103.9
trout	561	72.5
tropical fish	192	57.1
clams	360	50.1
oysters	205	36.0
hybrid striped bass	88	28.2
tilapia	148	24.3
golden shiners	123	18.1
shrimp	42	12.2
softshell crabs	218	10.3
feeder goldfish	34	9.3
fathead minnow	164	7.4
goldfish	65	6.7
turtles	56	4.8
largemouth bass (sport)	136	4.5
koi	115	3.9
other mollusks	66	3.6
clam seed	31	3.4
carp	76	3.3
mussels	29	3.2
other food fish	31	3.0

Species	Farms	Sales (\$1M) or pounds (million)
other baitfish	62	2.7
oyster seed	21	2.0
bluegills (sport)	129	1.8
salmon eggs	22	1.3
walleye (food)	38	1.2
other ornamental	48	1.1
sunfish (sport)	28	0.5
crappie (sport)	39	0.3
other sport fish	23	0.3
<b>TOTAL</b>	<b>6,344</b>	<b>\$927.7</b>
yellow perch	75	
sturgeon	12	
crayfish	563	17.4
trout eggs	24	
salmon (restoration)	244	2,142.0
catfish (restoration)	113	11.0
bass (restoration)	119	71.3
trout (restoration)	362	177.6
walleye (restoration)	107	642.6
other fish (restoration)	158	98.8
<b>TOTAL</b>	<b>1,777</b>	<b>3,160.7 lb</b>



# USFWS Hatchery Production (2004)



Species	Number of Fish	Fish Weight (lb)
chinook salmon	44,131,265	862,794
walleye	23,180,034	9,282
rainbow trout	11,017,255	2,138,537
Atlantic salmon	10,895,312	182,895
coho salmon	6,354,661	318,450
lake trout	5,801,862	369,907
striped bass	5,750,795	50,035
steelhead	4,186,118	800,132
northern pike	4,075,247	1,626
fathead minnow	3,432,840	8,781
bluegill	3,198,831	5,863
cutthroat trout	2,415,241	101,821
largemouth bass	2,137,986	3,207
American shad	1,842,849	6
razorback sucker	1,711,473	26,263
redbreast sunfish	1,699,556	2,998
yellow perch	1,221,868	1,244
paddlefish	820,140	7,520
red drum	806,065	192
brown trout	735,075	74,634
chum salmon	733,585	1,814
channel catfish	614,233	54,878
brook trout	473,116	54,842
bonytail	370,021	5,230

Species	Number of Fish	Fish Weight (lb)
black crappie	326,278	261
pallid sturgeon	209,571	3,819
Colorado pikeminnow	187,053	553
smallmouth bass	176,161	205
landlocked Atlantic salmon	163,398	12,181
striped bass / hybrid	153,543	84
Apache trout	111,752	23,650
Rio Grande silvery minnow	96,108	511
lake sturgeon	81,471	1,343
redeer sunfish	44,500	26
robust redhorse sucker	37,670	2
Chihuahua chub	4,667	81
woundfin	4,479	11
Gila trout	2,145	109
Barrens topminnow	1,564	15
Arctic grayling	1,055	226
bull trout	300	0
fountain darter	82	0
shortnose sturgeon	46	81
Devils River minnow	11	0
beautiful shiner	10	0
desert pupfish	10	0
Gila topminnow	10	0
Leon Springs pupfish	10	0
<b>FISH TOTALS (48 spp)</b>	<b>139,207,322</b>	<b>5,126,106</b>



# State Hatchery Production (2001)



State	Number of Species	Number of Fish	Fish Weight (lb)
Alabama	8	8,354,554	19,106
Arizona	5	1,230,142	39,427
Arkansas	19	7,815,747	1,644,887
California	9	53,435,500	3,656,043
Colorado	25	82,499,486	1,566,981
Florida	9	4,495,543	120,253
Georgia	10	33,140,634	534,889
Hawaii	5	237,000	4,921
Idaho	8	49,371,357	2,058,999
Illinois	18	72,339,257	203,310
Indiana	19	22,748,705	160,255
Iowa	11	139,700,700	262,810
Kansas	15	65,140,938	138,725
Kentucky	9	15,498,111	139,827
Louisiana	8	546,930,258	723,175
Maine	6	1,204,722	261,100
Maryland	16	17,169,274	307,467
Massachusetts	6	1,792,872	485,035
Michigan	11	48,919,610	681,054
Minnesota	15	260,912,263	437,674
Mississippi	7	1,836,555	30,355
Missouri	18	40,935,956	1,905,032

State	Number of Species	Number of Fish	Fish Weight (lb)
Montana	14	41,848,428	341,878
Nevada	5	2,183,927	434,889
New Hampshire	6	2,804,623	417,710
New Jersey	18	3,253,934	335,383
New York	16	206,428,448	936,903
North Carolina	13	4,722,141	381,351
North Dakota	8	12,134,775	103,768
Ohio	15	71,986,522	243,708
Oklahoma	13	27,735,858	64,951
Oregon	10	48,649,676	4,244,862
Pennsylvania	27	112,675,092	3,023,779
South Carolina	10	8,944,851	149,245
South Dakota	8	54,022,695	82,533
Tennessee	15	8,980,740	309,267
Texas	12	63,624,000	193,734
Utah	13	11,484,200	770,203
Vermont	8	10,274,071	210,415
Virginia	13	20,724,401	787,283
Washington	20	191,470,003	7,733,910
Wisconsin	14	74,793,629	618,648
Wyoming	8	5,315,977	338,324
<b>TOTALS</b>		<b>2,487,911,270</b>	<b>37,875,716</b>



# Value of Recreational Fishing



- ▶ FWS NFHs produced **11 million RBT** weighing **2.1 million pounds** which were stocked in over 20 states with AR, CO and TN receiving the most
- ▶ **Angler days** associated with RBT stocking = **3.6 million**
- ▶ Associated **retail sales** = **\$165.9 million** (aggregated state impacts)
- ▶ **Total economic output** (the "multiplier" effect) = **\$319.8 million**
- ▶ The number of **associated jobs** = **3,387**
- ▶ Associated **jobs generated over \$79 million** in wage and salary income
- ▶ **Social benefits** (as measured by net consumer surplus) = **\$198.4 million**
- ▶ Sales and **motor fuel taxes** = **\$9.5 million**
- ▶ **State income tax** generated = **\$3.1 million**
- ▶ **Federal income tax** generated = **\$10.9 million**
- ▶ **Total economic value** (retail sales plus social benefits) = **\$364.3 million**
- ▶ Each FWS **dollar spent** on RBT rearing **yields \$68 of total economic value**



# Domestic Aquaculture Systems



Characteristics	Culture System				
	Raceways	Intensive Net pens	Tanks	Semi-intensive Ponds	Extensive Ponds
density	high to very high			moderate	low
feeding	High levels, no natural productivity			Moderate, some natural productivity	Low to none, high natural productivity
aeration	yes	not normally	yes	yes	not normally
monitoring	yes	yes	yes	sometimes	usually not
example species	rainbow trout, muskellunge	Atlantic salmon, tuna, cobia	hybrid striped bass, tilapia	penaeid shrimp, channel catfish	subsistence aquaculture

Fish Category	Example Species
coldwater (<12°C)	salmonids (salmon, trout, charr), although optimum for rainbows is 15°C
coolwater (12-18°C)	walleye, yellow perch, hybrid striped bass, largemouth bass, baitfish
warmwater (>18°C)	channel catfish, tilapia, penaeid shrimp, tropical ornamentals



# Treatment Estimations



## ▶ Assumptions:

- ▶ The 2002 aquaculture census values are reasonable estimates for 2005
- ▶ Of the total number of farms listed, each rears an average of 2 different species; therefore there are  $8,121 \div 2$  or approximately 4,060 farms
- ▶ The average number of fish produced per farm can be represented by the average number of fish reared per FWS hatchery; 1.9 million
- ▶ The fish numbers cited, include fish “out the door,” and hence, could be fry, fingerlings, adults and/or broodfish, but they are not counted twice



# Treatment Estimations



- ▶ Assumptions (con't):
  - ▶ Although a fish will not be counted twice for production, it may be treated during more than one life-stage
  - ▶ The average number of farms potentially using a particular drug will be extrapolated from the proportion of FWS INAD facilities using that drug
  - ▶ All farms working under FWS INADs used approximately the same amount of drug that a farm administering the approved drug would use
  - ▶ Values indicated represent the **best estimates** based on the **best available information**



# Fish Treated Under FWS INADs



Drug	Average # per Year	Disease or Condition (for CY 2004)	# of species	# <2.0"	# 2.0 – 7.9"	# >8.0"
AQUI-S®	2.2 million	<i>Aeromonas hydrophila</i>	3	647,000	411,000	12
Calcein	1.9 million	anesthesia	7	0	4,500,000	52,000
Crude Carp Pituitary	3,300	coldwater disease - systemic	5	5,896,000	3,821,000	44,000
Chloramine-T	16.1 million	bacterial gill disease	15	5,739,000	6,350,000	1,450,000
Diquat	4.6 million	bacterial kidney disease	1	0	3,500,000	0
Florfenicol	11.3 million	columnaris - systemic	9	687,000	5,545,000	111,000
LHRHa - injection	800	enteric septicemia of catfish	1	1,104,000	33,000	0
LHRHa - implant	3,700	coldwater disease - external	3	0	848,000	0
17-α methyltestosterone	12.2 million	columnaris - external	5	15,000	620,000	44,000
Oxytetracycline - feed	25 million	furunculosis	5	0	5,484,000	505,000
Oxytetracycline - immersion	0.85 million	general bacterial - systemic	5	1,840,000	135,000	17,000
Oxytetracycline - injection	220	bacterial enteritis – Gram negative	1	3,129,000	0	0
Oxytetracycline - marking	26 million	marking	13	2,992,000	1,040,000	0
<b>TOTAL</b>	<b>100.1 million</b>	motile aeromonas	2	0	180,000	0
		streptococcal septicemia	2	0	3,356,000	132,000
		gender manipulation	1	2,976,000	0	0
		spawning	16	0	0	5,000
		<b>TOTAL (for CY 2004)</b>		<b>25,025,000</b>	<b>35,823,000</b>	<b>2,360,000</b>



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

## ▶ **AQUI-S<sup>®</sup> - anesthetic**

### ▶ Considering the previous assumptions:

- ▶ Average amount used by each INAD participant =  $9.0 \text{ L} \div 15 \text{ farms} = 0.6 \text{ L}$
- ▶ Proportion of domestic farms potentially treating =  $15 \div 232 = 6.5\%$
- ▶ Total number of domestic farms treating fish:  $4,060 \times 6.5\% = 263$
- ▶ **Total amount of AQUI-S<sup>®</sup> potentially used nationwide: = 158 L**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

## ▶ Chloramine-T - microbicide

### ▶ Considering the previous assumptions:

▶ Ave. amount used per INAD participant =  $3,300 \text{ kg} \div 27 = 122 \text{ kg}$

▶ Proportion of domestic farms potentially treating =  $27 \div 232 = 11.6\%$

▶ Total number of domestic farms treating fish:  $4,060 \times 11.6\% = 473$

▶ **Total amount of Chloramine-T potentially used nationwide = 57,600 kg**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

- ▶ **Oxytetracycline (OTC) active ingredient (AI) for medicated feed - therapeutic**
  - ▶ Considering the previous assumptions:
    - ▶ Ave. amount of drug used by each INAD participant =  $214 \text{ kg} \div 24 = 8.9 \text{ kg}$
    - ▶ Proportion of domestic farms potentially treating =  $24 \div 232 = 10.3\%$
    - ▶ Total number of domestic farms treating fish:  $4,060 \times 10.3\% = 420$
    - ▶ **Total sales of OTC – AI sold to domestic aquaculture in 2001 = 15,200 kg**
    - ▶ **Total sales of OTC – AI sold to domestic aquaculture in 2002 = 7,134 kg**
    - ▶ **Total amount of OTC - AI potentially used nationwide = 3,738 kg**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

## ▶ Florfenicol AI for medicated feed - therapeutant

### ▶ Considering the previous assumptions:

- ▶ Ave. amount of drug used by each INAD participant =  $44.2 \text{ kg} \div 18 = 2.5 \text{ kg}$
- ▶ Proportion of domestic farms potentially treating =  $18 \div 232 = 7.8\%$
- ▶ Total number of domestic farms treating fish:  $4,060 \times 7.8\% = 315$
- ▶ **Total amount of florfenicol AI potentially used nationwide = 788 kg**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

## ▶ LHRHa – spawning aide

### ▶ Considering the previous assumptions:

- ▶ Ave. amount of drug used by each INAD participant =  $92.7 \text{ g} \div 21 = 4.4 \text{ g}$
- ▶ Proportion of domestic farms potentially treating =  $21 \div 232 = 9.0\%$
- ▶ Total number of domestic farms treating fish:  $4,060 \times 9.0\% = 368$
- ▶ **Total amount of LHRHa potentially used nationwide =  $1,617 \text{ g} = 1.6 \text{ kg}$**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

## ▶ Crude carp pituitary (CCP) – spawning aide

### ▶ Considering the previous assumptions:

- ▶ Ave. amount of drug used by each INAD participant =  $44.9 \text{ g} \div 4 = 11.2 \text{ g}$
- ▶ Proportion of domestic farms potentially treating =  $4 \div 232 = 1.7\%$
- ▶ Total number of domestic farms treating fish:  $4,060 \times 1.7\% = 70$
- ▶ **Total amount of CCP potentially used nationwide = 784 g**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

- ▶ **SE-MARK<sup>®</sup> (calcein) – skeletal marking**
  - ▶ Considering the previous assumptions:
    - ▶ Ave. amount of drug used by each INAD participant =  $137.2 \text{ L} \div 9 = 15.2 \text{ L}$
    - ▶ Total number of farms treating fish:  $1,103 \div 2 \text{ species/farm} \div 2 = 276$
    - ▶ **Total amount of SE-MARK<sup>®</sup> potentially used nationwide = 4,188 L**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

## ▶ **Diquat – microbicide**

### ▶ Considering the previous assumptions:

- ▶ Ave. amount of drug used by each INAD participant =  $552 \text{ L} \div 7 = 78.9 \text{ L}$
- ▶ Proportion of domestic farms potentially treating =  $7 \div 232 = 3.0\%$
- ▶ Total number of domestic farms treating fish:  $4,060 \times 3.0\% = 123$
- ▶ **Total amount of Diquat potentially used nationwide = 9,665 L**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

## ▶ OTC injectable – therapeutant

### ▶ Considering the previous assumptions:

- ▶ Ave. amount of drug used by each INAD participant =  $2.8 \text{ g} \div 3 = 0.9 \text{ g}$
- ▶ Proportion of domestic farms potentially treating =  $3 \div 232 = 1.2\%$
- ▶ Total number of domestic farms treating fish:  $4,060 \times 1.2\% = 53$
- ▶ **Total amount of OTC injectable potentially used nationwide = 47 g**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

## ▶ OTC immersion – therapeutant

### ▶ Considering the previous assumptions:

- ▶ Ave. amount of drug used by each INAD participant =  $7.2 \text{ kg} \div 1 = 7.2 \text{ kg}$
- ▶ Proportion of domestic farms potentially treating =  $1 \div 232 = 0.4\%$
- ▶ Total number of domestic farms treating fish:  $4,060 \times 0.4\% = 18$
- ▶ **Total amount of OTC immersion potentially used nationwide = 126 kg**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

## ▶ OTC bath marking – skeletal marking

### ▶ Considering the previous assumptions:

- ▶ Ave. amount of drug used by each INAD participant =  $6.8 \text{ kg} \div 3 = 2.3 \text{ kg}$
- ▶ Total number of farms treating fish:  $1,103 \div 2 \text{ species/farm} \div 2 = 276$
- ▶ **Total amount of OTC bath marking potentially used nationwide = 635 kg**



# National Estimations: Possible Amount of Various Drugs to be Used (per annum)

## ▶ 17- $\alpha$ methyltestosterone – gender manipulation

### ▶ Considering the previous assumptions:

▶ Ave. amount of AI used by each INAD participant =  $24.2 \text{ g} \div 6 = 4.0 \text{ g}$

▶ Ave. amount of med. feed used by each INAD participant =  $888 \text{ lb} \div 6 = 148 \text{ lb}$

▶ Total number of farms treating fish = **12 farms**

▶ Total amount of AI potentially used nationwide = **48 g**

▶ Total amount of 17MT med. feed potentially used nationwide = **1,776 lb**



# National Estimations: Number of Fish to be Treated

- ▶ Considering the previous assumptions and estimations:
  - ▶ Total number of farms (private & public) rearing fish = 4,060
  - ▶ No. of farms treating fish = sum from drug estimates ÷ 2 drug per farm = 1,608
  - ▶ Average number of fish reared per farm = 1.9 million
  - ▶ **Total number of fish to be treated: 1.9 million x 1,608 farms = 3.1 billion**



# Bacterial Disease Claims: External Bacterial Diseases

- ▶ **Bacterial gill disease on freshwater-reared salmonids:**
  - ▶ external treatments such as potassium permanganate, hydrogen peroxide, or chloramine-T
- ▶ **External columnaris disease on all freshwater-reared fish:**
  - ▶ prevalence is probably pretty high in intensively farmed warmwater fishes such as channel catfish during the late fall and winter
  - ▶ not very prevalent in trout although it certainly does occur



# Bacterial Disease Claims: Systemic Bacterial Diseases

- ▶ **Coldwater disease in freshwater-reared salmonids**
  - ▶ widespread and significant, questionable prevalence
  - ▶ a significant question potentially impacting use is whether OTC works sufficiently to cure coldwater disease, coldwater disease is frequently observed in conjunction with IHNV
- ▶ **Systemic columnaris disease in all freshwater-reared fish**
  - ▶ mostly a problem in warmwater species such as channel catfish
  - ▶ is OTC effective? If so OTC use might significantly increase in cool water months
- ▶ **Furunculosis in freshwater-reared salmonids**
  - ▶ not too much of a problem in Idaho
  - ▶ there is an effective vaccine, although the extent of use is unknown



# Bacterial Disease Claims: Systemic Bacterial Diseases

- ▶ Enteric septicemia in catfish
  - ▶ remains a very significant disease for the channel catfish industry;
  - ▶ MSU recently reported the following losses from disease:
    - ▶ ESC \$13.5 million;
    - ▶ columnaris disease \$10.8 million; and
    - ▶ winter kill \$4.8 million, although the cause of this is unclear
- ▶ Motile aeromonas septicemia (MAS) in coolwater and warmwater fish
  - ▶ MAS is generally an opportunistic infection
  - ▶ while common, the extent of loss is hard to gauge
  - ▶ can occur after exposure to significant stress such as CCV or methemoglobinemia in catfish