

## **Chloramine-T Clinical Field Trials - INAD 9321**

### **Year 2010 Annual Summary Report on the Use of Chloramine-T in Clinical Field Efficacy Trials**

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#### **Summary**

Chloramine-T has been used effectively in the U. S. under compassionate INAD Exemption #9321 to control mortality in a variety of fish caused by common fish bacterial pathogens. In calendar year 2010 (CY10), the efficacy of chloramine-T (CLT) was evaluated in 294 disease trials involving approximately 25.1 million fish to control mortality in a variety of fish species caused by a variety of infectious fish pathogens. Trials were conducted at 56 fish culture facilities, including nine U.S. Fish and Wildlife Service National Fish Hatcheries (NFH), 38 state fish hatcheries, four private fish hatcheries, and five tribal hatcheries. The compassionate study protocol under which treatments were administered allowed the investigator to use chloramine-T on either three consecutive or alternate days for 1h at dosages ranging from 10 - 20 mg/L; or one day a week for 1 h at 15mg/L. Overall, results of trials conducted in CY10 indicated that treatments appeared efficacious in approximately 78% of the trials, ineffective in 5% of the trials, and were characterized as inconclusive in 4% of the trials. In the remaining 13% of the trials, the Investigators were not required to report efficacy data because the

effectiveness technical section for the specific claim has been completed and accepted by CVM.

## Introduction

Bacterial gill disease (BGD) is one of the most common diseases of hatchery reared salmonids (Bullock 1990) and causes more fish losses than any other bacterial disease (Bills et al. 1988). Fish mortality is generally not a direct result of the infection, but is a consequence of the infection. Mortality is most likely the result of asphyxiation from lack of adequate oxygen exchange in severely congested gills. Stressors associated with intense fish culture may predispose fish to infection. Although *Flavobacterium branchiophilum* is the bacteria responsible for causing most outbreaks of BGD (Wakabayashi, et al., 1989; Ferguson et al., 1991), other gram-negative bacteria have also been implicated. These "other" bacteria include *F. aquatile*, *F. psychrophilus*, *F. columnaris*, as well as other flavobacters and aeromonads and pseudomonads. Clinical signs of BGD have been well documented, and it is widely known that this disease can cause the rapid proliferation of gill epithelium and the production of excess mucus as the host responds defensively to the infection. This response can "smother" gills and cause severe losses if prompt measures are not taken. If BGD, which is horizontally transmitted, is not diagnosed and treated early, an epizootic may occur within a 24-h period (Bullock et al. 1990).

Historically, several chemicals including benzalkonium chloride (available as Hyamine 1622 and 3500), diquat, and chloramine-T have been used to control mortality

caused by BGD (Bullock et al. 1990). However, none of these chemicals have been approved by the FDA to control mortality in freshwater fish caused by BGD. Because chloramine-T appears to be the most effective therapeutant when salmonids have BGD (From 1980; Bullock et al. 1990; Bowker et al, in press) it has become the prime candidate for approval with the U.S. Food and Drug Administration (FDA) as a bath treatment. Chl-T has been characterized as a non-selective sanitizing agent and has been shown to clean up gills infested with bacteria and coated with excess mucus.

### **Purpose of Report**

The purpose of this report is to summarize the results of CY10 supplemental chloramine-T field efficacy data. Similar data have been submitted by the Service in previous years. We anticipate that CY10 data will be used to enhance the existing chloramine-T database established from previous years, and will be considered in the “body of evidence” for the purpose of developing an appropriate label claim for the use of chloramine-T in aquaculture.

### **Facilities, Materials, Treatment Procedures**

#### **1. Facilities**

A total of 294 field efficacy trials were conducted at 56 fish culture facilities, including nine U.S. Fish and Wildlife Service NFH's, 38 state fish hatcheries, four private fish hatcheries, and five tribal hatcheries. Water temperature during

treatments at the various testing facilities ranged from 35.6 - 78.0 °F, with a mean treatment temperature of 55.3°F.

## **2. Chemical material**

Chloramine-T (CAS No. 127-65-1) is a pure white crystal powder. All facilities used designated lots of chloramine-T provided by one of the following two manufactures: (1) Axcentive SARL/International Specialty Chemicals, Inc., Tarrytown, NY; or (2) B.L. Mitchell, Inc., Greenville, MS.

## **3. Treatment Methods**

Chloramine-T treatments were administered using either a flow-through or standing bath treatment method. Both procedures called for accurately weighed amounts of dry chemical dissolved in an appropriate amount of non-chlorinated water. When using a flow-through system, dissolved chemical was metered into rearing units at a rate to achieve the desired treatment concentration during a 1 h period. When using a standing bath method, water flow to the rearing unit was turned off and dissolved chemical added to the rearing unit and mixed thoroughly to ensure uniform chloramine-T concentration throughout the tank. Thorough mixing was essential to ensure there were no chloramine-T "hot spots." After the 1 h treatment, water flow was turned on again to flush the chemical out of the rearing unit.

#### 4. Drug dosages

During CY10, various chloramine-T doses were used. Listed below are the doses and the number of trials conducted with each dose:

1.	10 mg/L	68 trials
2.	12 mg/L	5 trials
3.	15 mg/L	103 trials
4.	15 & 20 mg/L	2 trials
5.	20 mg/L	116 trials
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	Total	294 trials

#### 5. Number of treatments per disease outbreak

According to the Study Protocol, Investigators were allowed to administer chloramine-T on three consecutive/alternate days when used to control mortality caused by BGD or once/week when used to prevent mortality. During CY10, the most common treatment regimen was to administered CLT on three consecutive days to control mortality in fish caused by BGD.

**Study Protocol Deviation:** Treatment regimen administered in 3 trials

(approximately 1% of trials) deviated from the protocol. In these trials, fish were treated with CLT at 10 mg/L for 4 - 26 days. Fingerling muskellunge were treated 21 - 26 times within a 3 month period. This facility has a history of BGD issues

during the culture of northern muskellunge and CLT treatments have been beneficial in previous years. Fingerling rainbow trout were treated 4 - 5 times during a 10 day period to control BGD.

## **Fish Species Treated and Fish Diseases Involved in CY10 Trials**

### **1. Species and size of fish treated**

Twenty-nine fish species, including 15 species of salmonids and 14 non-salmonids fish species, were treated during CY10. Treated fish ranged in length from 0.55 - 38.0 in. and the average length of all treated fish was 5.0 in. Species treated included:

**Salmonids:** (1) landlocked Atlantic salmon *Salmo salar*; (2) brown trout *S. trutta*; (3) arctic grayling *Thymallus arcticus*; (4) apache trout *Oncorhynchus apache*; (5) chinook salmon *O. tshawytscha*; (6) chum salmon *O. keta*; (7) coho salmon *O. kisutch*; (8) sockeye salmon *O. nerka*; (9) kokanee salmon *O. Nerka*; (10) cutthroat trout *O. clarki*; (11) rainbow trout *O. mykiss*; (12) steelhead trout *O. mykiss*; (13) brook trout *Salvelinus fontinalis*; (14) lake trout *S. namaycush*; and (15) splake *Salvelinus fontinalis* x *S. namaycush*.

**Non-salmonids:** (1) black crappie *Pomoxis nigromaculatus*; (2) channel catfish *Ictalurus punctatus*; (3) fathead minnow *Pimephales promelas*; (4) freshwater drum *Aplodinotus grunniens*; (5) golden shiner *Notemingonus crysoleucas*; (6) hybrid striped bass *Morone saxatilis* x *M. chrysops*; (7) lake sturgeon *Acipenser fulvescens*; (8) largemouth bass *Micropterus salmoides*; (9) smallmouth bass *M. dolomieu*; (10) longnose sucker *Catostomus catostomus*; (11) muskellunge *Esox masquinongy*; (12) northern pike *E. lucius*; (13) walleye *Sander vitreus*; and (14) yellow perch *Perca flavescens*.

## **2. Diseases treated**

The disease treated most frequently was characterized as BGD (89% of the trials). Other diagnosed diseases included external columnaris, external bacterial coldwater disease, and external flavobacteriosis.

## **Data Collected**

### **1. Pathologist's report**

In CY10 a pathologist's report was submitted for 27% of the studies. Pathology reports are important for accurate interpretation of study results because they typically contain the following information:

1. A description of how the identity of disease agent(s) was verified,

2. Disease identification records that confirm the presence of the disease agent,
3. The name and title of the individual performing the diagnosis.

Additionally, evidence would typically be provided to document that there were no secondary infections or infestations caused by unrelated disease agents in the population of test fish.

## **2. Treatment response and drug accountability data**

Drug receipt reports, drug use reports, diagnosis, treatment, and mortality reports (including adverse effects/toxicity observations), and fish disposition reports were prepared by study Investigators. Such reports were routed through the Study Monitor for review, and then sent to the AADAP Office for review, data analysis and report writing, entering data into a database, and archiving in permanent files.

Based on correspondence with FDA, the following efficacy and safety technical sections have been completed:

1. Effectiveness of chloramine-T at a concentration of 12 ppm administered as a 60 min bath once per day every other day for a total of three treatments to control mortality associated with bacterial gill disease in

freshwater-reared salmonids (we refer to your file number INAD 4000 H-0071 dated July 11, 2000).

2. Safety of chloramine-T at a concentration of 20 ppm administered as a 60 min bath on three consecutive or alternate days for the control of mortality associated with bacterial gill disease in freshwater-reared salmonids (we refer to your file number INAD 4000 P-0093 dated September 13, 2002).

As a result of the completed technical sections, mortality data are no longer required when Investigators administer chloramine-T at a dosage of 12 - 20 ppm on three alternate or consecutive days for 60 min to control mortality associated with bacterial gill disease in freshwater-reared salmonids. In all other cases, collection of mortality data is still required and efforts were made to collect all such data. However, for a variety of reasons, mortality data were not always collected for the entire required data collection period. Reasons for incomplete mortality data included: splitting fish into additional rearing units and stocking early life stage fish shortly after final treatment.

## **Discussion of Study Results**

### **1. Relevance of study to a proposed label claim for chloramine-T**

Results of CY10 trials conducted under Compassionate INAD exemption #9321 are similar to results detailed in reports previously submitted to FDA under INAD's #9321 and #4000.

### **2. General observations on the efficacy of CLT for the control of bacterial diseases in salmonid and non-salmonid fish** (Note: Table 1 provides a list of all trials in which treatment appeared efficacious; Table 2 provides a list of all trials in which treatment appeared ineffective; Table 3 provides a list of all inconclusive trials; Table 4 provides a list of all trials where efficacy data was not required; Table 5 provides summary data for all trials; and Table 6 provides a brief description of all trials conducted during CY10 under INAD #9321).

#### **A. Efficacy at 10 mg/L chloramine-T**

Brook trout, brown trout, coho salmon, rainbow trout, steelhead trout, splake, longnose sucker, and muskellunge were treated with 10 mg/L chloramine-T for 1 - 26 days in 68 trials (Tables 1 - 3). Investigators used CLT to control mortality caused by BGD, external bacterial coldwater disease, or external flavobacteriosis. CLT treatments appeared effective in 52 trials, ineffective in 11 trials, and were characterized as inconclusive in five trials.

### **B. Efficacy at 12 mg/L chloramine-T**

Rainbow trout were treated with 12 mg/L chloramine-T for 1 day in five trials (Table 1). Investigators used CLT to control mortality caused by BGD. CLT treatments appeared effective in all trials.

### **C. Efficacy at 15 mg/L chloramine-T**

Apache trout, brook trout, brown trout, chinook salmon, chum salmon, coho salmon, cutthroat trout, kokanee salmon, lake trout, rainbow trout, sockeye salmon, steelhead trout, lake sturgeon, and walleye were treated with 15 mg/L chloramine-T for 1 - 20 days in 103 trials (Tables 1 - 3). Investigators used CLT to control mortality caused by BGD, external coldwater disease, external flavobacteriosis, or external columnaris. CLT treatments appeared effective in 96 trials, ineffective in three trials, and inconclusive in four trials.

### **D. Efficacy at 15 & 20 mg/L chloramine-T**

Two trials were conducted using 15 & 20 mg/L chloramine-T for 2 - 3 days (Table 1). Investigators used CLT to control mortality caused by BGD in walleye. CLT treatments appeared effective in both of these trials.

### **E. Efficacy at 20 mg/L chloramine-T**

Arctic grayling, brook trout, brown trout, cutthroat trout, landlocked Atlantic salmon, rainbow trout, black crappie, channel catfish, fathead minnow,

freshwater drum, golden shiner, largemouth bass, lake sturgeon, muskellunge, northern pike, hybrid striped bass, smallmouth bass, walleye, and yellow perch were treated with 20 mg/L chloramine-T for 1 - 3 days in 116 trials (Tables 1 - 4). Investigators used CLT to control mortality caused by BGD, external columnaris, or external coldwater disease. CLT treatments appeared effective in 73 trials, not report in 39 trials (due to the efficacy packet being complete), ineffective in one trial, and were characterized as inconclusive in three trials.

### **3. Observed Toxicity**

No toxicity or adverse effects relating to CLT treatment were reported in any of the trials.

### **4. Observed Withdrawal Period**

No withdrawal time is needed for fish treated with CLT under the current Food-Use Authorization dated December 22, 2009.

### **Current Study Protocol for CLT INAD #9321**

Please see the attached current study protocol for CLT INAD #9321 . Please note no changes have occurred to this study protocol.

## Facility Sign-up List

Please see “Table 7. Facilities and Names of Investigators” for facilities that signed-up to participate in the CLT INAD #9321 during CY10. Facilities not listed in Appendix III-a of the current CLT INAD #9321 during CY10 study protocol have been highlighted.

Please note all of these facilities are in compliance with their reporting requirements to the NPDES authority. It should also be noted that 287 trials were either 1) in compliance with their reporting requirements to their NPDES authority for a CLT discharge higher than 0.1 ppm; or 2) met the discharge level set by CVM. In the remaining seven trials the CLT discharge ranged between 0.14 - 1.03 ppm. The investigator was contacted in these trials and reminded of the discharge limit set by CVM.

The following facilities had chloramine-T on-hand during CY10 but never used the drug:

- |                               |                       |
|-------------------------------|-----------------------|
| 1. Texas Freshwater Fisheries | 2. Erwin SFH          |
| 3. Lyons Ferry SFH            | 4. Crystal Lake       |
| 5. Darrah Springs SFH         | 6. Durango SFH        |
| 7. Ed Weed SFH                | 8. Pequest SFH        |
| 9. Salisbury FCS              | 10. Story SFH         |
| 11. Whitman Lake              | 12. Limestone Springs |
| 13. Manchester SFH            | 14. Warm Springs NFH  |

15. Ford SFH

16. Gavin's Point NFH

17. Fort Richardson SFH

18. Fort Peck SFH

19. Page Springs SFH

### **Correspondence sent to CLT INAD #9321 Participants**

Please see the attached correspondence that was sent to all chloramine-T participants after the AADAP Office received their sign-up form for CY10.

### **Number of Treated Fish under Treatment Use Authorization**

Total number of fish treated during CY10 was 25,139,141. The total number of treated fish to count against the treatment use authorization dated December 22, 2009 is 25,292,467.

### **Summary of Study Results**

Chloramine-T was used at doses ranging from 10 - 20 mg/L in 294 treatment trials in which fish were treated one, two, or three times to control mortality, or once per week when used to prevent mortality. Twenty-nine different fish species were treated and trials involved approximately 25.1 million fish. Treated fish ranged in size from 0.55 - 38.0 in. Water temperature during treatment ranged from 35.6 - 78.0°F, with a mean treatment temperature of 55.3°F. Overall, results showed that treatment appeared effective in approximately 78% of trials, ineffective in 5% of the trials, and characterized as inconclusive 4% of the trials. In the remaining 13% of the trials, mortality data

collection and reporting were not required. There was no evidence of toxicity or adverse effects related to CLT treatment reported in any of the trials. Data from the CY10 trials support the results of previous Annual Report submissions under INAD #9321 and INAD #4000 that indicate that the chloramine-T treatment regimen recommended in INAD Protocol #9321 is safe and effective to control/prevent mortality in a variety of fish species caused by external bacterial infections such as BGD. As a result of the lack of quality criteria, such as dose verification, use of controls, replicates, and randomization, it is understood that these data will be considered as ancillary data, and that pivotal efficacy studies are needed to definitively demonstrate chloramine-T efficacy for the treatment of BGD. However, the ancillary data described above should provide useful, corroborative data to help support a label claim for the use of chloramine-T to control mortality associated with BGD in a variety of fish species. Although it is anticipated that the majority of future efficacy data collected under INAD #9321 will also be ancillary data, efforts will be directed towards the continued generation of high quality data.

## References

- Bills, T.D., L.L. Marking, V.K. Dawson, and J.J. Rach. 1988. Effects of environmental factors on the toxicity of chloramine-T to fish. U.S. Fish and Wildlife Service, Investigations in Fish Control 96, Upper Mississippi Science Center, P.O. Box 818, LaCrosse, Wisconsin.
- Bowker, J. D., L. Telles, B. David, D. Oviedo, and D. Carty. In press. Efficacy studies conducted to support a chloramine-T new animal drug approval claim for freshwater-reared salmonids. *Journal of North American Aquaculture*.
- Bullock, G.L. 1990, Bacterial gill disease of freshwater fishes, Fish Disease Leaflet 84, U.S. Dept. of the Interior, Fish and Wildlife Service, Washington DC.
- Ferguson, H.W., V.E. Ostland, P. Byrne, and J.S. Lumsden. 1991. Experimental production of bacterial gill disease in trout by horizontal transmission and bath challenge. *Journal of Aquatic Animal Health* 3:118-123.
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- Wakabayashi, H, G.J. Huh and N. Kimura. 1989. Flavobacterium branchiophila sp. nov., a causative agent of bacterial gill disease of freshwater fishes. *International Journal of Systematic Bacteriology* 39:213-216.

**Table 1. Year 2010 Chloramine-T Efficacy Results - Efficacious Studies**

# of Studies	Hatchery	Fish Species	Fish Size (in.)	Number of Fish	Disease	Dose (mg/L)	Number of treatment days	Temp. (°F)
4	Alchesay-Williams Creek NFH	APT	1.4 - 1.9	91,459	BGD	15	3	50.0 - 51.0
2	Dubois SFH	ARG	0.6 - 8.1	48,000	BGD	20	3	55.0
1	Bennington FCS	BKT	8.50	21,000	BGD	15	3	46.0
1	Bridgeport Hatchery	BKT	3.80	118,000	BGD	15	3	56.0
5	Coursey Springs FCS	BKT	4.4 - 9.0	190,000	BGD	15	3	52.0 - 56.0
4	Dubois SFH	BKT	0.8 - 3.0	95,895	BGD	20	3	52.0 - 58.0
1	Genoa NFH	BKT	1.00	50,000	BGD	20	3	53.0
1	Jordan River NFH	BKT	2.08	2,400	BGD	15	2	48.0
1	Marion FCS	BKT	4.60	12,800	BGD	20	3	59.0
2	Marquette SFH	BKT	4.1 - 6.8	116,000	BGD	10	3	41.0 - 50.0
1	Roxbury FCS	BKT	1.00	60,000	BGD	20	3	46.0
1	Wray SFH	BLC	1.40	17,200	External Columnaris	20	3	68.0
1	Bellvue-Watson SFH	BNT	1.00	180,000	BGD	20	3	53.0
1	Dubois SFH	BNT	1.03	20,204	BGD	20	3	52.0
1	Garrison Dam NFH	BNT	1.00	38,609	BGD	20	3	53.1
1	Harrietta SFH	BNT	2.11	218,597	External CWD	10	3	46.4
1	Wytheville FCS	BNT	2.00	24,000	BGD	15	3	56.0
1	Genoa NFH	CCF	2.00	1,000	External Columnaris	20	3	69.0
1	Genoa NFH	CCF	7.70	270	BGD	20	3	60.0

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# of Studies	Hatchery	Fish Species	Fish Size (in.)	Number of Fish	Disease	Dose (mg/L)	Number of treatment days	Temp. (°F)
4	Keta Creek Hatchery	CHS	1.0 - 2.4	3,197,250	BGD	15	2 - 3	44.0 - 52.0
2	Dworshak NFH	COS	2.6 - 5.9	391,100	External CWD	10	3	42.0 - 43.9
2	Keta Creek Hatchery	COS	1.00	100,000	BGD	15	1	44.0
4	Platte River SFH	COS	3.66	965,271	BGD	10	3	54.5
1	Solomon Gulch Hatchery	COS	1.80	264,000	BGD	15	3	46.0
2	Mixsawbah SFH	CSA	2.9 - 3.2	238,100	BGD	15	3	48.0 - 49.0
1	Dan Speas FRS	CUT	6.90	31,000	BGD	15	3	59.4
1	Dubois SFH	CUT	0.83	25,152	BGD	15	3	51.0
10	Dubois SFH	CUT	0.8 - 6.8	256,337	BGD	20	3	54.0 - 67.0
1	Eastbank SFH	CUT	6.20	50,000	BGD	15	3	49.9
1	Wigwam FRS	CUT	16.50	2,075	BGD	15	3	49.0
5	Wigwam FRS	CUT	3.8 - 14.0	82,742	BGD	20	3	49.0
1	Nez Perce Tribal Hatchery	FCS	2.42	300,000	BGD	15	3	52.0
1	Genoa NFH	FHM	1.70	270,000	External Columnaris	20	3	60.0
1	Genoa NFH	FRD	4.50	2,200	External Columnaris	20	3	60.0
1	Genoa NFH	GOS	3.70	175	External Columnaris	20	3	53.0
1	Chelan SFH	KOE	2.50	91,000	BGD	15	3	56.0
1	Bald Hill FCS	LAS	5.00	35,000	External Columnaris	20	3	71.0

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# of Studies	Hatchery	Fish Species	Fish Size (in.)	Number of Fish	Disease	Dose (mg/L)	Number of treatment days	Temp. (°F)
1	Jordan River NFH	LAT	2.08	3,590,000	BGD	15	2	48.0
1	Genoa NFH	LMB	4.50	7,000	External Columnaris	20	3	53.0
1	Manning SFH	LMB	1.75	40,000	External Columnaris	20	3	68.0
1	University of Wyoming	LNS	10.20	42	BGD	10	3	44.7
2	Genoa NFH	LST	0.8 - 1.0	72,755	External Columnaris	15	4 - 20	58.0 - 66.4
1	Genoa NFH	LST	0.80	20,000	External Columnaris	20	3	58.0
1	Hackettstown SFH	MUE	3.90	21,000	BGD	20	3	70.0
1	Wolf Lake SFH	MUE	2.00	409,568	BGD	10	21 - 26	70.0
1	Hackettstown SFH	NOP	2.50	66,000	BGD	20	3	68.0
7	Albert Powell Trout SFH	RBT	2.5 - 8.8	692,000	BGD	15	3	54.0
1	Alchesay-Williams Creek NFH	RBT	1.28	77,198	BGD	10	3	51.0
5	Alchesay-Williams Creek NFH	RBT	1.3 - 2.5	296,282	BGD	15	3	50.0 - 51.0
2	Alsea SFH	RBT	4.00	259,563	BGD	20	1	55.0
4	Bennington FCS	RBT	1.0 - 6.1	67,000	BGD	15	3	46.0 - 68.0
1	Bennington FCS	RBT	4.75	15,000	BGD	20	3	50.0
3	Boulder FRS	RBT	5.0 - 7.0	85,950	BGD	20	3	52.0
1	Bridgeport Hatchery	RBT	12.00	1,100	BGD	15	3	48.6
1	Buller FCS	RBT	8.55	25,000	BGD	15	3	68.0

**Table 1. Year 2010 Chloramine-T Efficacy Results - Efficacious Studies**

# of Studies	Hatchery	Fish Species	Fish Size (in.)	Number of Fish	Disease	Dose (mg/L)	Number of treatment days	Temp. (°F)
2	Chalk Cliffs SFH	RBT	6.0 - 9.1	149,000	BGD	20	3	58.0
7	Coursey Springs FCS	RBT	3.0 - 10.0	286,800	BGD	15	3	56.0
1	Coursey Springs FCS	RBT	9.75	69,000	BGD	20	3	56.0
2	Dan Speas FRS	RBT	7.4 - 8.3	689,632	BGD	15	3	59.4 - 60.0
5	Decorah SFH	RBT	3.3 - 10.8	120,042	BGD	10	3	52.0 - 56.0
1	Dubois SFH	RBT	1.10	20,463	BGD	10	3	54.0
14	Dubois SFH	RBT	0.9 - 6.9	541,467	BGD	20	3	43.0 - 64.0
30	Hotchkiss NFH	RBT	1.2 - 9.5	944,457	BGD	10	1 - 4	56.0
1	Marion FCS	RBT	5.00	78,000	BGD	20	3	59.0
1	Mason Valley SFH	RBT	1.16	99,239	BGD	10	3	58.0
2	Monte Vista SFH	RBT	9.00	30,000	BGD	20	3	65.0 - 68.0
1	Mt. Shavano SFH	RBT	9.21	15,400	BGD	15	1	53.0
2	Paint Bank FCS	RBT	1.5 - 8.0	164,000	BGD	15	3	21.0 - 54.0
5	Rifle Falls SFH	RBT	5.0 - 8.2	372,000	BGD	12	1	59.0
6	Spokane Tribal Hatchery	RBT	4.60	84,000	BGD	15	3	53.0
7	Willow Beach NFH	RBT	0.9 - 2.3	546,000	BGD	15	3	54.0 - 64.0
2	Wolf Lake SFH	RBT	3.04	344,162	External CWD	10	3	54.2
1	Wytheville FCS	RBT	4.00	120,000	BGD	15	3	56.0

**Table 1. Year 2010 Chloramine-T Efficacy Results - Efficacious Studies**

# of Studies	Hatchery	Fish Species	Fish Size (in.)	Number of Fish	Disease	Dose (mg/L)	Number of treatment days	Temp. (°F)
4	Susquehanna Aquaculture/ Brunner Island Fish Farm	SBH	3.0 - 4.0	279,000	BGD	20	3	70.0 - 78.0
1	Eastbank SFH	SCS	38.00	178	External Columnaris	15	10	54.7
1	Genoa NFH	SMB	4.20	7,150	External Columnaris	20	3	53.0
1	Wray SFH	SMB	1.89	66,454	External Columnaris	20	3	68.0
1	Eastbank SFH	SOS	20.00	130	External Columnaris	15	3	53.4
1	Marquette SFH	SPL	6.50	243,000	BGD	10	3	44.0
6	Bodine SFH	STT	3.1 - 5.1	326,434	BGD	15	3	54.0
1	Chelan SFH	STT	1.25	66,000	External CWD	15	1	58.0
2	Hagerman NFH	STT	6.50	94,193	External Columnaris	15	3	59.0
5	Mixsawbah SFH	STT	2.3 - 3.3	688,446	BGD	15	3	50.0
2	Thompson SFH	STT	6.6 - 7.5	393,000	BGD	15	3	50.0
1	Bonaparte Pond	SUS	5.00	185,000	BGD	15	10	38.0
1	Eastbank SFH	SUS	38.00	1,048	External Columnaris	15	13 - 14	54.7
1	Similkameen Rearing Pond	SUS	5.00	45,219	BGD	15	3	40.0
2	Genoa NFH	WAE	6.7 - 8.0	1,900	External Columnaris	20	3	52.0 - 53.0
2	Rathbun SFH/Research Facility	WAE	4.00	108,500	BGD	15 & 20	2 - 3	75.8

**Table 2. Year 2010 Chloramine-T Efficacy Results - Ineffective Studies**

<b># of Studies</b>	<b>Hatchery</b>	<b>Fish Species</b>	<b>Fish Size (in.)</b>	<b>Number of Fish</b>	<b>Disease</b>	<b>Dose (mg/L)</b>	<b>Number of treatment days</b>	<b>Temp. (°F)</b>
11	Hotchkiss NFH	RBT	0.8 - 5.7	383,676	BGD	10	1 - 5	56.0
1	Monte Vista SFH	RBT	3.00	80,000	BGD	20	3	64.0
1	Sterling Springs SFH	RBT	2.75	156,000	External CWD	15	3	50.0
2	Trail Lakes/Eklutna Hatchery	SOS	0.75	512,000	External Flavobacteriosis	15	3	38.0

**Table 3. Year 2010 Chloramine-T Efficacy Results - Inconclusive Studies**

# of Studies	Hatchery	Fish Species	Fish Size (in.)	Number of Fish	Disease	Dose (mg/L)	Number of treatment days	Temp. (°F)
1	Odgen SFH	BNT	3.35	395,679	External Flavobacteriosis	10	3	45.7
1	Eastbank SFH	CUT	8.00	48,997	BGD	15	1	49.9
1	Bellvue-Watson SFH	RBT	1.75	77,000	BGD	20	1	52.0
2	Hotchkiss NFH	RBT	4.2 - 5.7	40,420	BGD	10	1	56.0
1	Leadville NFH	RBT	4.04	17,000	External CWD	20	3	36.0
1	Mason Valley SFH	RBT	1.16	178,654	BGD	10	3	58.0
1	Bonaparte Pond	SCS	5.00	163,000	BGD	15	3	38.0
1	Dworshak NFH	STT	1.50	10,000	BGD	10	3	53.0
1	Bonaparte Pond	SUS	5.00	200,000	BGD	15	7	35.6
1	Rathbun SFH/Research Facility	WAE	1.00	38,678	BGD	15	1 - 9	65.0
1	Genoa NFH	YEP	1.77	4,029	External Columnaris	20	3	63.3

**Table 4. Year 2010 Chloramine-T Efficacy Results - Studies where efficacy data was not needed**

# of Studies	Hatchery	Fish Species	Fish Size (in.)	Number of Fish	Disease	Dose (mg/L)	Number of treatment days	Temp. (°F)
39	Jones Hatchery	RBT	2.0 - 14.4	2,303,400	BGD	20	3	57.0

**Table 5. Summary Data Regarding Year 2010 Chloramine-T Efficacy Studies**

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<b>Total Number of Fish Treated:</b>	<b>25,139,141</b>
Number of fish treated in efficacious trials	20,530,608
Number of fish treated in non-efficacious trials	1,131,676
Number of fish treated in inconclusive trials	1,173,457
Number of fish where efficacy was not needed	2,303,400

<b>Total Number of Studies:</b>	<b>294</b>
Efficacious trials	228
Non-efficacious trials	15
Inconclusive trials	12
Efficacy was not needed	39

**Treatment Regimens and Frequency Used:**

10 mg/L	68 trials
12 mg/L	5 trials
15 mg/L	103 trials
15 & 20 mg/L	2 trials
20 mg/L	116 trials

**Treatment Water Temperature (°F):**

Temperature Range	35.6 - 78.0
Mean Temperature	55.3

**Size of Treated Fish (in.):**

Size Range	0.55 - 38.0
Mean Length	5.0

## Species Treated:

**Salmonids:** (1) landlocked Atlantic salmon *Salmo salar*; (2) brown trout *S. trutta*; (3) arctic grayling *Thymallus arcticus*; (4) apache trout *Oncorhynchus apache*; (5) chinook salmon *O. tshawytscha*; (6) chum salmon *O. keta*; (7) coho salmon *O. kisutch*; (8) sockeye salmon *O. nerka*; (9) kokanee salmon *O. Nerka*; (10) cutthroat trout *O. clarki*; (11) rainbow trout *O. mykiss*; (12) steelhead trout *O. mykiss*; (13) brook trout *Salvelinus fontinalis*; (14) lake trout *S. namaycush*; and (15) splake *Salvelinus fontinalis* x *S. namaycush*

**Non-salmonids:** (1) black crappie *Pomoxis nigromaculatus*; (2) channel catfish *Ictalurus punctatus*; (3) fathead minnow *Pimephales promelas*; (4) freshwater drum *Aplodinotus grunniens*; (5) golden shiner *Notemingonus crysoleucas*; (6) hybrid striped bass *Morone saxatilis* x *M. chrysops*; (7) lake sturgeon *Acipenser fulvescens*; (8) largemouth bass *Micropterus salmoides*; (9) smallmouth bass *M. dolomieu*; (10) longnose sucker *Catostomus catostomus*; (11) muskellunge *Esox masquinongy*; (12) northern pike *E. lucius*; (13) walleye *Sander vitreus*; and (14) yellow perch *Perca flavescens*

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