The Ichthyogram

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LATEST RESULTS OF SURVEY FOR *MYXOBOLUS CEREBRALIS* DISCOVERY OF PARASITE IN PROVO RIVER DRAINAGE?

Myxobolus cerebralis (MC) the causative agent of whirling disease, was first discovered in Utah in 1991. Samples from 1991-1993 were largely collected in areas adjacent to epicenters of infection, or in areas where deformed fish were found by anglers and submitted for analysis. Realizing the need for a more systematic approach to the survey, a meeting was held by the Utah Division of Wildlife Resources in December 1995. Among the decisions reached at that meeting was the need to sample fish from each U.S. Geologic Survey hydrologic unit in Utah that contained salmonids. Fisheries managers helped to provide a list of “priority waters.”

Results of the latest survey segment show the great majority of the samples were negative, but further spread of the parasite within a few areas was noted in the northern and southern wildlife management regions of the state. The positive finding include:

Weber/Provo Canal: The previous finding of MC positive fish in the Weber drainage caused concerns about transfer of the parasite to the Provo drainage via an irrigation canal, terminating near Woodland. Because of limitation of weather and ice, only the portion of the canal at its juncture with the Provo was examined in 1997. Both rainbow and cutthroat trout tested positive for spores consistent with MC from samples obtained on 10/6/97 and 11/17/97. Further testing by the polymerase chain reaction (PCR) assay by Dr. Bob Ellis at Colorado State University verified the presence of MC. However, histopathology has not conclusively confirmed the identity of the parasite. Limited damage to the cranial cartilage in the absence of spores was noted on examination, while spores were detected in the nervous tissue. These findings suggest the likelihood of a dual infection with MC and another unidentified myxosporean, possibly *Myxobolus neurobius* or *Myxobolus*

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Provo River: Similar to the findings in the Weber/Provo Canal, rainbow and cutthroat trout sampled upstream on the Provo River near Woodland showed the presence of two myxosporeans. Some of the spores were the correct size and shape for MC, while others measured slightly larger. Extensive histopathology showed the presence of slight (grade 1 of 4) damage to the cranial cartilage in the absence of accompanying spores. However, spores were again found in the nervous tissue. PCR testing by Dr. Karl Andree at UC Davis demonstrated 1 of 6 fish testing lightly positive for MC. This suggests a dual infection with MC and another myxosporean.

South Fork Provo River: Further upstream above the confluence of the Little South Fork, both rainbow trout and cutthroat showed the presence of spores. The rainbow spores were consistent with MC. Histopathogic examination showed widespread cartilagenous damage (grade 2 of 4), but no concurrent myxospores for confirmation. Spores in cutthroat trout were slightly larger and inconsistent with MC. Results suggest a mixed infection in these species, although a final confirmation of MC by histopathology is needed. Other species (brook, brown) were negative for spores.

Little South Fork of the Provo: One pool of cutthroat trout showed the presence of a light (*n*=3) spores slightly larger than the dimensions of MC. No spores consistent with MC were seen. Due to the low number of spores seen, neither histopathology or PCR testing was done. This site is classified as *questionable*.

Little Bear River above Porcupine: This previously positive site was electroshocked during the spawning run of kokanee in September of 1996 and 1997. Sixty fish were collected and individually evaluated for deformities and presence of spores. Results show a **dramatic** increase of cranial deformities, prevalence of infection and levels of infection (see *Ichthyogram*, Vol. 8, #3.)

Weber River at Petersen: This area was tested in 1996 and spores were found in brown trout. The area above the power plant in Weber Canyon was tested in 1997 and spores consistent with MC were found in brown and cutthroat trout as well as whitefish. (This is the first detection of MC in whitefish in Utah). Histopathologic confirmation of the disease was made on cutthroat, and whirling disease is officially confirmed for the first time in the Weber drainage. The evidence suggests that the area around Petersen is a focal epicenter of infection.

Rockport Reservoir: Rainbow trout collected from Rockport reservoir in 1996 showed a small number of spores consistent with MC. Due to the low number of spores detected, it was felt that histopathology was not adequate for confirmation. The polymerase chain reaction procedure was performed by Dr. Robert Ellis at Colorado State University and tested positive for MC. Although verified by another method, official designation of the presence of "whirling disease" cannot be made until histopathologic confirmation.

East Canyon Drainage: The East Canyon tributary to the Weber was tested in several locations in 1997. Both brown and cutthroat trout tested from the creek below the reservoir tested positive for MC spores

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and confirmation of whirling disease was made by histopathology. Extensive sampling of rainbow trout from the reservoir has failed to show the presence of the parasite. The detection of spores in fish sampled near Kimball Junction above the reservoir suggests an even wider distribution of the parasite. Histopathology has confirmed the presence of whirling disease at this location.

Lost Creek Drainage: The Lost Creek tributary to the Weber River was tested at two locations for the first time in 1997. Both brown and cutthroat trout tested positive for MC spores at the downstream location (close to the Weber River) and confirmation was made through histopathology. Further upstream, fish immediately below Lost Creek Dam at the gauging station tested negative for the parasite. These findings suggest an upstream transfer of the parasite from the Weber River.

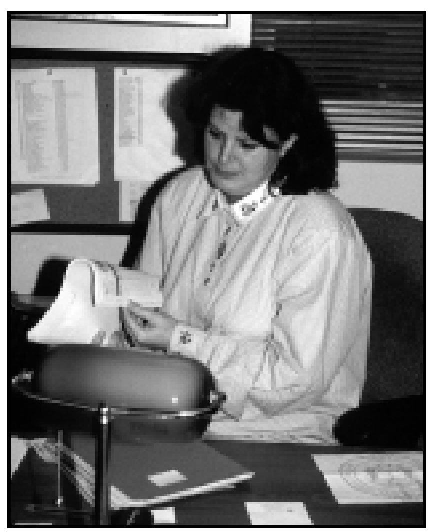
Smith & Morehouse Canyon: This drainage was considered at risk after the discovery of a transfer of infected fish to a reportedly enclosed pond from a contaminated private hatchery in 1992. The discovery of apparent infection in Rockport Reservoir downstream increased the suspicion. Low numbers of spores were found at one site below Smith-Morehouse Reservoir, but tested negative by PCR. This site is considered a questionable positive. Fish from Smith-Morehouse Reservoir and in the stream above the reservoir tested negative.

Upper Weber River below Diversion near : Although a small sample of fish were obtained, a subsample of two rainbow trout showed the presence of a large number of spores compatible with MC.

Histopathology showed multifocal lesions consistent with whirling disease, but no spores were observed in the sections to confirm whirling disease. This site should be considered as highly suspect.

New Faces at Fisheries Experiment Station

The newest addition to the Fisheries Experiment Station is Janet Baker, who fills the role of office manager. She is a native of Portage, Utah and lives in Logan with her husband, Scott and three children.



Janet has previously worked as a legal secretary . Her interests include hiking, country music and playing with her grand-daughter (not necessarily in that order)!

Janet has had her work cut out for her, as the position was vacant for several weeks prior to her arrival. A special thanks to Nelma Gates for helping out in the interim.

Fry Survival Study at Strawberry Reservoir

Predation losses of fingerling cutthroat stocked in the fall have been very high during the last couple of years. Three trials were conducted in 1997 to study the feasibility of stocking fry in mid summer. Bear Lake cutthroat fry (CTBL) from the Glenwood hatchery were stocked in the Meadows area on August 4, August 18 and September 4. The fry were loaded into our barge and scatter stocked in two areas. Half of the lot (300 lb. @ 130-200/lb.) were stocked near shore by the mouth of Indian Creek. The other half were stocked 500-100m offshore from the Renegade boat ramp. At the time of stocking, lots of 100 fry were counted out and placed in cages in four locations: Indian Creek (control with ideal temperature, oxygen and pH), Meadows onshore stocking site, Meadows offshore stocking site surface, and Meadows offshore stocking site 8m (just above the thermocline). Temperature, dissolved oxygen, pH and survival of fry were monitored at each cage site for 96 hr following the three stocking trials. Incidence of acute predation was monitored by setting gillnets (horizontal onshore and vertical offshore) overnight following stocking and examining stomach contents of captured fish.

Survival of all lots of fry was 97-100%, and with the exception of the 8m offshore cage that was lost in the second trial, there were no significant differences (chi squared $p<.05$) in survival of in-reservoir fish compared to the Indian Creek controls (Table 1). Eric Wagner (The *Ichthyogram*, Sept 1997) observed critical thermal maximum temperatures of 23-25C for CTBL acclimated to 13C (approximate Glenwood Hatchery temperature) and lethal dissolved oxygen of 2.2-2.5 ppm). Stocking mortality was observed at Strawberry when pH was 9.4, and stocking into waters with pH >9.5 is not advised (Wagner, The *Ichthyogram* November 1993). Environmental parameters in the Meadows were not lethal to cutthroat fry during the trials. Surface temperatures reached 22C at the inshore cage during trial 1, with maximum pH of 8.9. Minimum dissolved oxygen was 3 ppm at the 8m offshore site in trial 3. Blue-green algae blooms which elevate pH above 9 generally don't occur at Strawberry until mid to late September.

Piscivory on the stocked CTBL fry was variable between the three trials and between offshore and onshore netted fish. No piscivory was observed during trial 1(4-7 August). In trial 2 (Aug 18-22), 16% (2 of 12) large cutthroat captured inshore consumed an average of 1 fry per piscivore, and 2 of 3 large offshore cutthroat consumed an average of 9 fry per predator. In trial 3 (4-7 Sept) 35% of large inshore cutthroat and 100% of inshore medium cutthroat and rainbow trout, consumed 4.5, 1 and 1 fry per piscivore, respectively. No fry were eaten by the 3 cutthroat captured in the offshore nets in trial 3.

Stocking of CTBL fry in the shallows in August may be a viable strategy for improving survival of small fish. The incidences of predation inshore in trials 1 and 2 were low, and the number of predators captured at the Meadows inshore site may have been higher than most of the reservoir because of the proximity to the inflow from Indian Creek. Biologists plan to evaluate predation in other inshore stocking sites in August 1998. They will use electronics to find weedbed areas with low density of large fish. Offshore predation in trial 2 was high, in terms of percent of predators consuming fry and number of fry consumed per predator.

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Even with relatively warm surface temperatures, cutthroat in offshore areas may be able to find thermal refuge at depth and then prey upon stocked fry.
As temperatures cooled in the fall, piscivory increased substantially. USU student Casey Baldwin sampled offshore 1 and 2 days following offshore stocking of cutthroat fry on October 22 and found 30-60% piscivory, with 6 fry consumed per predator, and one individual cutthroat consumed 40 fry.

Chronic piscivory may occur on summer stocked fry during the fall as water temperatures cool and large cutthroat move back into the shallows. During the October 1997 survey gillnetting, 10% by wet weight of the diet of 57 large cutthroat captured in inshore nets (sites not necessarily associated with recent stocking of fingerlings) was cutthroat and unidentified salmonid prey. The remainder of the diet was 22% daphnia, 1% utah chub, 38% benthos, 12% terrestrial insects, 13% chironomids). The total percentage of summer stocked fry is unknown. It is intuitive that if weedbeds, which have been

Table 1. Summary of 96 hour survival for CTBL fry placed in cages at the time of onshore and offshore stocking, Strawberry Reservoir fry survival trials, August-September 1997.

Trial Dates		Fish Truck	Indian Creek Control	Meadows Onshore	Meadows Surface	8m
8/4-8/7	Temp oC	14.4	8.3-14.8	18.6-22.0	18.1-19.8	15.1-18.8
	pH	7.5	7.9-8.5	7.6-7-8.9	7.9-8.8	7.5-8.5
	O2 ppm	7.9	5.2-7.6	6.4-8.2	6.6-8.3	4.1-7.5
	96hr %		100	100	99	99
	Chi-square			0(nsd)	0.01(nsd)	0.01(nsd)
8 / 1 8 -	Temp oC		8.2-14.7	16.6-19.3	17.7-19.6	16.9-17.7
	pH		7.5-8.4	8.6-8.9	8.7-9.0	8.3-8.8
	O2 ppm		5.5-8.5	7.4-12.6	7.7-9.0	5.6-7.8
	96hr %		100	100	94	cage lost
	Chi-square			0(nsd)	0.36(nsd)	100.00
9/4-9/7	Temp oC		7-14	12-18	16-17	11-19
	pH		7.1-8.0	7.9-8.6	8.0-8.6	7.3-8.5
	O2 ppm		4.0-8.0	5.0-10.0	5.0-10.0	3-6.5
	96hr %		99	99	97	96
	Chi-square			0(nsd)	0.04(nsd)	0.09(nsd)

*nsd- no significant difference in survival

Sterile Rainbows for Strawberry

Earlier this year the Utah Division of Wildlife Resources obtained sterile rainbow trout eggs from a private hatchery in California. The eggs were destined to be grown out by the Kamas and Springville state hatcheries and once they reached a suitable size, stocked into Utah's Strawberry Reservoir. Strawberry has historically been a valued rainbow trout fishery and the Division of Wildlife Resources had, up until several years ago, stocked the lake with rainbows that had been sterilized by hormone treatment. The sterile rainbow were required to prevent hybridization between the cutthroat trout currently in the lake with the rainbows to be stocked. For various reasons the hormone sterilization method was no longer possible so an alternate source of sterile fish was needed.

The eyed eggs obtained by the state from the private hatchery were the result of the fertilization of eggs obtained from a normal female, and sperm obtained from females that had been sex-reversed to males. So, the males were genetically females, but phenotypically males. This means the males could produce sperm, but the sperm would contain female chromosomes. The results of the fertilization process are all female fish. After fertilization the eggs were heat shocked to induce triploidy. Triploid refers to fish which have three sets of chromosomes as opposed to a normal diploid (two sets of chromosomes) fish. Triploidy interferes with the reproductive process which results in sterile fish.

Results from the analysis of blood sampled from the Kamas and Springville fish confirmed that greater than **90%** were triploid. Of 108 blood samples collected from fish at Kamas, 98 of them proved to be triploid (**91%**). Of the blood collected from 102 fish at Springville, 97 of them were triploid (**95%**).

In order to confirm the sterile status of the fish, blood samples were tested by flow cytometry to determine triploidy. Several steps must be taken in order to analyze blood cells for ploidy. For large fish, blood can be collected in a non-lethal manner by drawing it out of the caudal vasculature with a syringe. For smaller fish, including the fish destined for Strawberry, a lethal sample is necessary in order to get an adequate sample of blood. After the blood is collected it is washed in a saline solution to remove the plasma and it is prepared for the actual analysis of the red blood cells. The next step involves dying the red blood cells with a fluorescing dye that stains the nuclear DNA.

When the samples are run through the flow cytometer individual cells are fed through an opening that guides a stream of cells perpendicular to a beam of laser light. When the cells are hit with the laser, the fluorescent dye is excited and the machine is able to determine the size of the DNA by the degree of light emitted. By running an accompanying set of chicken blood and diploid blood samples with the test blood, you can differentiate between diploid and triploid fish.

This work would not be possible without the help of the crews at Kamas and Springville who are raising the fish, Roger Burger at Utah State University for assisting with the analysis, and Ernie Dean at the FES for humoring the author occasionally by providing blood from one of his prized chickens.

USU Begins Whirling Disease Research

Research on whirling disease has begun at Utah State University, Logan. It is a cooperative effort between the Fisheries Experiment Station (FES)and the Biology Department, and funded by the federal Sport Fish Restoration program. Three main foci of research will be pursued
1) development of monoclonal antibodies for detection of the disease,
2) development of techniques for tissue culture of the parasite, and
3) evaluation of additional oligochaete alternate hosts and production of the triactinomyxon stage for research.

The antibody work will eventually provide a quick diagnostic assay for detection of the disease that is capable of detecting the parasite in all its life stages. The assay will be quicker than the nested PCR assay and detection will be not be limited to the spore stage as with the current pepsin-trypsin or plankton-centrifuge methods. Protein components of the parasite (used to develop the antibody) and their derivatives could also be useful as immunogens, i.e., a 'vaccine'. Dr. Tom Grover, lab director of the Biotechnology Center, and Chris Heck, also at the Center, will work on this project.
The tissue culture work would provide a means for completing the life cycle of the parasite in vitro. This would provide all stages of the parasite for supporting the antibody development research. A culture system would also provide a means for screening drugs and chemicals for use in control of the parasite. Dr. Nabil Yousef and Joyce Knoblett will work on this project.

The worm culture effort is being spearheaded by Dr. Don Roberts, professor emeritus from Cornell University, where he was an invertebrate pathologist. His current work would supply the triactinomyxon for antibody development and FES research on chemical toxicity. The researchers will also test other worm species for their ability to complete the life cycle of the parasite. Once a clear picture of which worm species may act as alternate hosts is developed, further study of the ecology of aquatic worms and the variables that alter their abundance may lead to control measures through manipulation of the

Coming Soon to a Web Site Near You!

Construction is underway for a world wide web site for the Fisheries Experiment Station. The final address for the site has not been determined, but should be found by accessing the Utah Division of Wildlife Resources' site at "www.nr.state.ut.us/dwr/!homeypg.htm"

Plans for the site include personnel profiles, electronic versions of the *Ichthyogram* in Adobe Acrobat format, research publication abstracts, results of the latest research trials as well the latest results of the whirling disease survey.

Barring unforeseen delays, the site should be available after August 1st. See you on the Web!

A Comparison of Relative Abundance of Salmonids Before and After Discovery of *Myxobolus cerebralis* in the East Fork of the Little Bear River, Cache Valley, Utah

In Utah, *Myxobolus cerebralis*, the parasite causing whirling disease, was first discovered in 1991 in the Fremont River drainage and in some commercial hatcheries in that area. The parasite was discovered in Cache Valley for the first time in January 1993 at commercial fish hatchery on the Little Bear River. This prompted further testing of wild fish to determine the extent of the distribution of *M. cerebralis.* At that time, a few infected fish were found above the hatchery, but none below. Since that time, infected fish have been found upstream as far as tributaries to Porcupine Reservoir and downstream as far as Hyrum Reservoir.

The impact of *M. cerebralis* on wild populations has not been adequately documented in Utah. This evaluation is an effort to collect some recent information about salmonid populations in infected areas such as the East Fork of the Little Bear River and compare it to historical data.

The East Fork of the Little Bear River is a tributary to the Bear River which flows into the Great Salt Lake. Sampling was conducted in three 100-m reaches by 2-pass electrofishing on September 8 and 9, 1998. Lengths, weights and stream widths were recorded and these data were used to calculate population and biomass estimates. The data was compared to historical data in the archives of the Utah Division of Wildlife Resources.

There were significant differences in species composition among years. The difference was primarily for 1965, in which cutthroat trout were a significantly greater proportion of the sample and brown trout significantly less (Table 1). When percentages before and after discovery of *M. cerebralis* were compared, the only significant difference in composition was for rainbow trout (8.25% before, 1.8% after). This difference is biased by the annual stocking of about 2,000-3,000 rainbow trout which ceased in 1994.

T-tests comparing trout abundance (fish per km) or biomass (kg/ha) before and after discovery of *M. cerebralis* indicated no significant differences in either variable for brown, cutthroat, and rainbow trout (Figs. 1 and 2). Total fish per km or total biomass similarly showed no significant differences before and after discovery of *M. cerebralis* or among years. Among-year differences in total abundance or biomass were not significant. Differences between altered (habitat improvement work) and unaltered sites were notable, yet could not be statistically analyzed due to lack of replication. No deformities other than obvious catch-and-release hooking

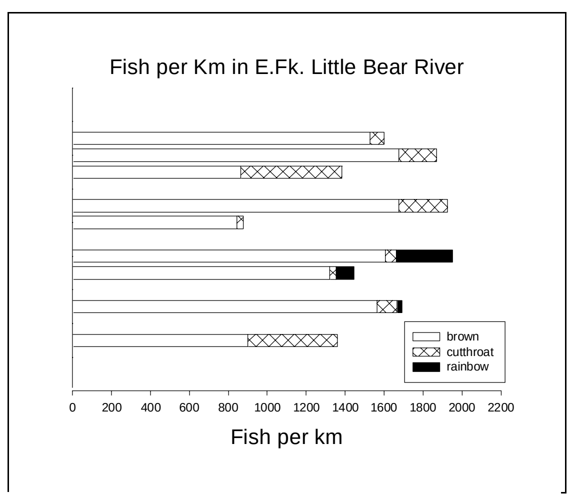

Figure 1. Number of fish/km in East Fork Little Bear River.

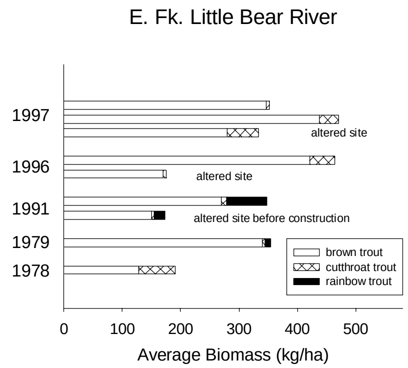

Figure 2. Average biomass of brown, cutthroat and rainbow trout in the East Fork Little Bear River.

injury were noted in the fish sampled in 1997.

Examination of histograms of length frequencies indicated that juvenile brown trout survival was reduced in the last two years (Fig. 3). To analyze this statistically, the percentage of the catch that was less than 160 mm was compared among years using chi-square analysis. Results indicated that this percentage dropped significantly from 32% in 1979 to 4 to 9% in 1996 and 1997 for brown trout (Table 2). The results for cutthroat trout were not as clear cut due to smaller sample sizes, but a significant drop from 71% in 1979 to 3-22% after 1993 was also seen (Table 2).

The differences observed in the analyses above were limited to species composition which differed primarily in 1965 when cutthroat trout were more abundant. These are more susceptible to angling and increasing fishing pressure over time is the

Table 1. A comparison of species composition (%) of samples of salmonids (excluding whitefish) taken from the East Fork of the Little Bear River from 1965 to 1997. Some years had multiple locations that were sampled.

Year	Brown trout	Cutthroat trout	Rainbow trout	Total sample size
1965	29.7	62.2	8.1	37
1965	2.8	83.3	13.9	36
1978	66.2	33.8	0	219
1979	85.5	11.3	3.2	124
1991	89.7	2.6	7.7	194
1991	81.4	2.0	16.6	253
1993	98.8	1.2	0.0	164
1993	90.6	1.4	8.0	149
1993	96.1	0.0	3.9	76
1993	82.2	13.5	4.3	208
1996	92.7	3.8	0.0	133
1996	92.7	7.3	0.0	262
1997	62.3	37.7	0.0	124
1997	89.8	10.2	0.0	179
1997	95.0	5.0	0.0	154

Table 2. A comparison among years of the percentage (sample size in parentheses) of brown and cutthroat trout less than 160 mm in samples from the East Fork Little Bear River, Cache County, Utah. Percentages within a species that were not significantly different among years are followed by a common letter.

Year	Brown trout	Cutthroat trout
	31.9 (213)a	71.4 (14) a
	26.1 (380)ab	20.0 (05) abc
	24.9 (599) b	2.9 (34) c
	9.4 (371) c	21.7 (23) b
	4.2 (525) d	7.8 (64) bc

most likely factor reducing their numbers. There was considerable variation among sites within a year, e.g., cutthroat trout in the altered section were more abundant than in the two unaltered sites in 1997.

It is interesting to compare the E. Fk. Little Bear River where there was no deformity, and the Beaver River, where there was 1-2% deformity in the brown trout and 10-12% in the rainbow trout. Sampling of triactinomyxon stage of the parasite may provide further insight into the differences in the dynamics of the parasite between the streams. Trapping of silt above the stream in Porcupine Reservoir and temperature differences may also play a part in the dynamics of the disease as well.

Despite stocking of rainbow trout, the stream has been principally a brown trout fishery and remains so. There appears to be little or no natural reproduction of rainbow trout and low production of cutthroat trout. *M. cerebralis* does not appear to have had much impact on the brown trout at the population level so far, but signs of reductions in juvenile recruitment are evident. This appears to indicate that fish densities are not limited by recruitment. *M. cerebralis* may be reducing juvenile abundance, but other factors such as predation cannot be ruled out at this time. The impact of *M. cerebralis* on cutthroat and rainbow trout is difficult to discern given the low abundance of both species in the stream.

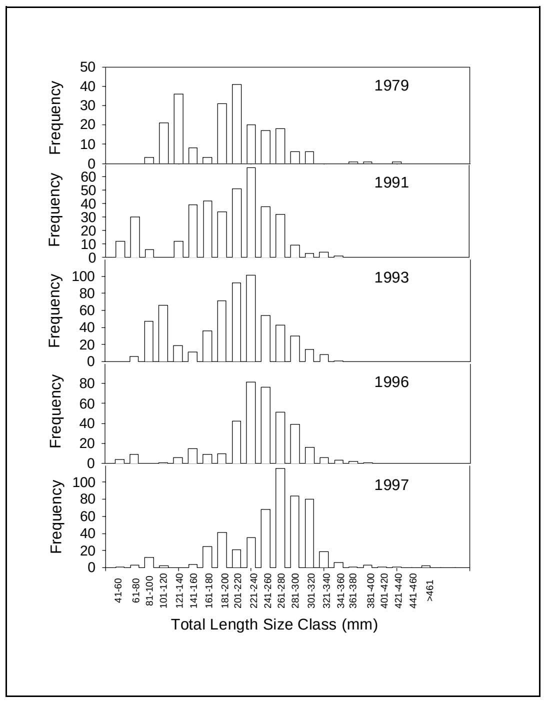

Figure 3. Number of fish in each size class of brown trout in East Fork Little Bear River.

By stocking large fish, cutthroat and rainbow trout may avoid the debilitating effects of whirling disease and provide a fishery. The effect of stocking susceptible fish on brown trout fisheries and the probability of spreading the infection is a question that still needs

Egg Taking and Handling Workshop

On March 16-18, hatchery managers from around the state and some fishery biologists involved with egg takes of wild fish participated in an egg taking workshop. The purpose of the workshop was to review current methods for spawning fish, review the literature concerning environmental effects on egg survival, and better understand disease concerns. Using this information, the group was to develop standard methods to be used statewide and hopefully improve survival to eyeup, hatching, and beyond.

The group was fortunate to have Wes Orr present, the hatchery manager at the Ennis National Fish Hatchery in Montana. His many years of experience with broodstock management, egg taking, shipping, and handling were valuable in our discussion. His presentation of the national perspective and the historical perspective on egg taking were also interesting.

Time was short when it came to the discussion of standard methods, so these still need to be determined. Joe Valentine, director of Utah's hatchery program, will be summarizing this information. Wes Orr will also return to Utah on September 23rd to demonstrate the air spawning technique at the Egan Hatchery. Further discussion of the related techniques will surely be a part of the day as well.

Perhaps the greatest value of the workshop was to expose those involved with egg taking to new ideas and new information which they can apply to their situations. Hopefully record keeping will also improve. As the discussion demonstrated, there are several different ways to go about collecting eggs and sperm and getting healthy fry. There were also different methods of enumerating eggs being used. Hopefully those in the hatchery system will take time to evaluate these techniques and see if they improve survival at your hatchery. Perhaps some friendly competition among the facilities to see who can get the best eyeup would be a fun way to determine which variables affect egg survival and which don't. Hopefully improved egg and broodstock survival will be the outcome.
Eric Wagner

Whirling Disease Education Grant Announced

Recently, the Utah Council of Trout Unlimited was successful in obtaining a $10,000 educational Embrace-A-Stream grant from Trout Unlimited National for whirling disease education. The money was presented to the Division of Wildlife Resources to further educational efforts at a recent Wildlife Board meeting. The money will be used to further work already underway to educate anglers and the general public on the potential dangers of the disease and ways to help prevent its spread. The grant represented a cooperative effort between Trout Unlimited, the Division of Wildlife Resources, tackle manufacturers, private donors and the U.S. Forest Service.

Specifically, the money is planned to produce signs to be placed along lakes and streams, alerting anglers about the disease and ways to prevent its spread. Two similar signs have been designed for both positive and negative waters. (See Figure 1). Trout Unlimited members and other volunteers will help place signs at strategically selected locations.

Other plans include the production and distribution of bumper stickers, reprinting and updating the whirling disease information brochures and purchase or production of informational videos on the disease.

Figure 1. Sign alerting anglers to do's and don'ts of whirling disease

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