The Ichthyogram

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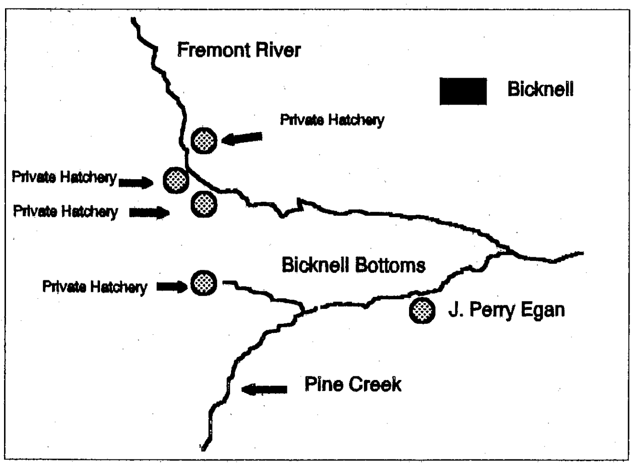
Whirling Disease Control Enters Second Year

As the summer of 1992 comes to an end, UDWR workers have entered their second year of attempts to eradicate whirling disease from the two contaminated drainages in southern Utah. The parasite was discovered for the first time at **any** location in Utah in June 1991 at a private aquaculture facility in the area. Eradication efforts have been focused on attempting to break the life cycle of the parasite by eliminating the salmonid host. In August, biologists repeated the rotenone treatment of Otter Creek between Koosharem and Otter Creek Reservoirs, previously treated in November 1991. In early September, the Bicknell Bottoms region of the Fremont River was also treated for the second time, along with Pine Creek. A few weeks later, fish in UM Creek above Forsyth Reservoir were chemically removed for the first time.

With data now available from two years of sampling, results have been a mixture of good and bad news. In the Great Basin drainage, brook trout in Otter Creek sampled from the vicinity of the contaminated private hatchery tested positive for the parasite. These small fish were young of the year class and apparently hatched subsequent to the rotenone treatment in 1991. These fish were the first wild fish to test positive in this drainage. Rainbow trout sampled downstream at Otter Creek Reservoir (largely dewatered) have continued to test negative for the parasite, however. Biologists are still optimistic that the several miles of fishless water will act as a buffer to prevent further downstream spread of the parasite.



In the adjacent Colorado River drainage, results have been much more encouraging. Fish in middle Bicknell Bottoms area still test positive, however spore counts in these fish are greatly reduced from samples in 1991. In contrast to last year, fish in the lower portion of the Fremont have tested negative in 1992, as well as all areas in Pine Creek drainage. The J. Perry Egan and Loa state hatcheries continue to test negative. See accompanying figure.

Fish in the upper portions of the Fremont River drainage at UM Creek have tested positive all the way up to the Left Fork. During the course of the rotenone treatment, an estimated 20% of young brook and rainbow trout were observed with gross cranial and skeletal deformities. In contrast, fish in the Right Fork of UM Creek, isolated by beaver dams, have continued to test negative. These findings have caused fish pathologists to speculate the disease has spread upstream to this area and is a relatively recent introduction.

Encouraged by these results, UDWR biologists are continuing their efforts to eradicate the parasite from the two drainages. Plans are underway to treat Mill Meadow and Forsyth Reservoirs in October as the irrigation season comes to an end. Large amounts of data from these studies have been assembled in a computer database and are being analyzed. Results of testing will continue to be a major factor in directing eradication efforts.
Chris Wilson

Fin Erosion Survey at Utah's Ten State Fish Hatcheries

Fin erosion is a common malady of hatchery-raised salmonids and is often used as an indicator in the field to identify recently stocked fish. Although many studies have been conducted on the effects of fin removal, the results remains unclear, some concluding detrimental effects, while others reported no significant differences from fish with unclipped fins. Even if the effect of some fin loss is minimal, active fin erosion of hatchery fish is often accompanied by microbial infection and hemorrhage which could comprise survivability when the fish is finally released into the wild. Furthermore, hatchery-raised trout with complete, uninfected fins, represent quality production which is more aesthetically pleasing to the angler and consumer.

In this survey, fins from 600 trout raised at all ten Utah state hatcheries and from two wild populations of rainbow trout were examined for comparison. At each of the 10 hatcheries, two to four samples of 20 fish (4-12 inches) were taken from raceways or ponds containing different species, strains, ages, lots, or bottom substrates. Fish were temporarily immobilized with MS-222, weighed, and measured for total length and maximum fin length (Figure 1). Each fin was also scored with the fin index developed by Ron Goede and Bruce Barton with a modification that a fin need not necessarily show signs of active infection/hemorrhage at the time of examination. 0 = no erosion, 1 = mild erosion, 2 = severe erosion. Fin scores were summed for each fish and then the sum of scores for each group of 20 fish was tabulated. This quantity, called hereafter 'fin index sum', could yield a maximum range of 0-320, with zero representing perfect fins for all twenty fish and 320 representing severe erosion of all fins for all 20 fish.

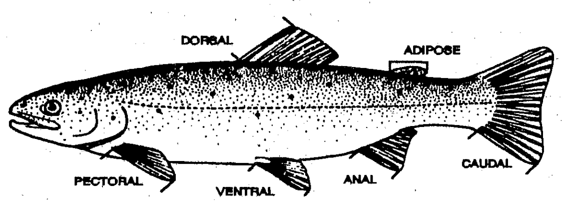


Figure 1. Exterior view of trout showing where maximum fin length measurements were obtained.

A total of 600 hatchery trout were examined from 30 different groups (n=20/group). These included 22 groups of rainbow trout, 4 groups of cutthroat trout, 2 groups of albino rainbow trout, and one group each of brook trout and brown trout. Considering the type of bottom substrate, trout raised in steel raceways (n=2 groups) had a mean fin index sum of 69.5, concrete raceways (n=23) averaged 54.7, and gravel or dirt substrates (n=5) averaged the lowest group sum of 18.2. Statistical comparison of concrete versus gravel/dirt produced a highly significant difference. This is evidence that natural bottoms do not cause as much fin erosion as concrete or steel.

Overall, the mean fin index sum averaged 22 for albino rainbow trout, 46 for rainbow trout, 55 for brown trout, 57 for brook trout, and 80.5 for cutthroat trout. Although statistical tests showed that rainbow trout fin condition was significantly better than cutthroat trout, other species comparisons were not possible because of small sample size. There was also a large degree of variation within hatcheries. For example, albinos at Midway and Kamas were actually no better than normal rainbow trout at their respective hatcheries, and both brook and brown trout were significantly better than rainbow trout at the Egan Hatchery.

We analyzed the pattern of erosion with regard to individual fins. Species differences were apparent, with rainbow and brown trout showing greatest erosion on dorsal fins, followed by pectoral fins. Cutthroat and brook trout showed greatest erosion of ventral fins, followed by dorsal fins. To demonstrate variability between hatcheries, data for rainbow trout were tabulated for eight hatcheries where two or more groups

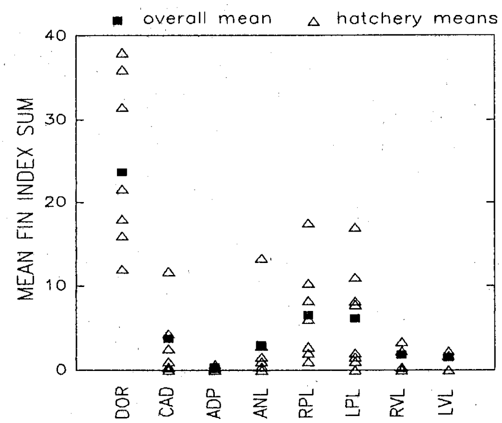


Figure 2. Hatchery means of fin scores for rainbow trout groups (Higher scores indicate greater fin erosion).

of rainbow trout were sampled. The results of this analysis (Figure 2) demonstrated that there was substantial variation in fin erosion between hatcheries within a single species, but clearly the dorsal fin was most affected.

We also wanted to compare the hatchery rainbow with its wild counterpart to fully quantify the extent of erosion on each fin. In this part of the study, we measured the fins of wild rainbows that were electro-shocked from Farmington and Summit Creeks. Similar to the results of the fin score index, results showed that the dorsal fin of hatchery rainbows was most severely afflicted, followed again by pectorals (Figure 3). In juvenile steelhead trout, researchers at Simon Fraser University, British Columbia, found that fin nipping was directed mainly at the dorsal fin which is consistent with our results for the fin with the greatest damage.

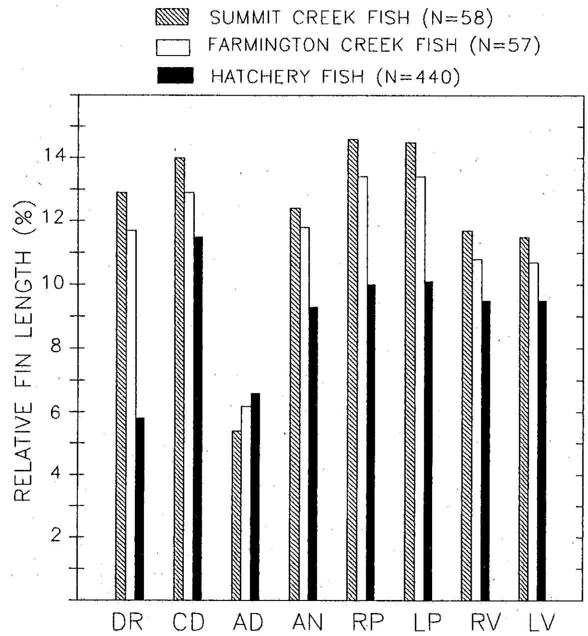


Figure 3. Comparison of relative fin length (fin length/total length*100) for each fin of wild and hatchery rainbow trout.

On the other hand, damage to pectorals may be due to abrasive injuries on concrete walls and floors of raceways since we found lower overall fin scores in gravel/dirt ponds. At this time we are also looking at the effects of water quality and rearing conditions in trying to produce a multiple regression model which could explain the relative importance of the multiple factors involved in fin erosion.

Thomas Bosakowski

National Aquatic Animal Health Task Force to Meet with U.S. Trout Farmers

The National Aquatic Animal Health Task Force was established by the Congressional Joint Subcommittee on Aquaculture. Their purpose is to examine the issue of fish health management on a nationwide basis and to develop specific programs and recommendations for a consistent national approach toward managing fish health in both cultured and wild populations. The next scheduled meeting of the task force is October 13th and 14th in conjunction with the U.S.Trout Farmers Association convention in Copper Mountain, Colorado. Having the task force meeting at the Trout Farmer's meeting will allow a much greater opportunity for trout farmers to give direct input to the committee about their concerns over the management of trout diseases.

The task force was set up with representatives from private aquaculture, public aquaculture, natural resource agencies, agricultural agencies and academic institutions to develop a comprehensive perspective of aquatic animal health management on national level. Bruce Schmidt, Chief of Fisheries, Utah Division of Wildlife Resources, is one of two state agency representatives on the ten member core group of the task force. Other members of the core group included: co-chairs, Meryl Broussard, U.S. Department of Agriculture and Jim Warren, U.S. Fish & Wildlife Service; Kevin Amos, Washington Department of Fisheries; Phil Mackay, Mount Lassen Trout Farms; Joe McCraren, U.S. Trout Farmers/National Aquaculture Assoc.; John Fryer, Oregon State University; Ken Johnson, Texas A&M University; John Pitts, Washington Department of Agriculture; and John Plumb, Auburn University. The task force will be actively involved in a number of aspects of fish health management, including improved methods of managing diseases, a review of which specific diseases merit control through regulation and development of model state regulations which could be applied consistently across the country. The fundamental concept behind the task force is to have all of the entities involved in the culture of aquatic animals work together to develop consensus recommendations.

Having the task force meet with the annual Trout Farmer's meeting adds an extra value to those considering attending the convention. This will be an excellent opportunity for fish growers in the private sector to voice their concerns over how fish health is managed and regulated across the country.

Bruce Schmidt

WHIRLING DISEASE - SHOULD WE TURN IT LOOSE?

Whirling disease (WD) of salmonids, induced by *Myxobolus cerebralis* is broadly prohibited or regulated throughout the world. There have been attempts in recent years to downlist this pathogen or even to remove regulation entirely. In spite of these efforts most regulating agencies still restrict or prohibit importation of fish from sources known to be contaminated with this organism.

There are attempts in some jurisdictions to permit movement into areas in which the parasite exists but not into those free of same. If this compromise is based upon belief that the disease is of no consequence in either cultured or free ranging fish, one must wonder why they wish to regulate it at all. If, in fact, it is of no consequence it can make no difference. There may be some lingering doubt. The logic is, at best, inconsistent. The purpose of this effort is to discuss rationale for conservative action.

It has been established that WD can be managed in hatcheries as long as they hold the young fish in spore-free water in cement raceways until they are old enough to be beyond significant impact. This is because cartilage is targeted by the parasite and as the fish get older much or most of the cartilage is converted to bone after which time the fish is out of "harms way." If one purchases spore-free fish old enough, they will likely develop few if any of the clinical signs of the disease, even though they will be invaded by the water borne actinosporean spores in contaminated water throughout their life and continue to produce the resistant and secure myxosporean spores.

The options described above for the culture application are not available in management of wild populations. Fish naturally produced are subject to invasion by the spores throughout their life. Those infected by enough spores at an early enough age will likely perish or be deformed. The others will become carriers. This is central to the argument. There is not always sufficient concern for the wild free-ranging fishes. These include some very valuable and irreplaceable remnant populations of fishes containing important gene pools capable of providing much needed genetic diversity.

Proponents of deregulation of WD suggest there are reports that WD is of no consequence in the wild or more specifically, that it does not induce significant mortality in the wild populations. This information is misleading. What they are actually reporting is that no obvious effects were observed. There have been, in fact, no controlled studies to determine this. That same statement could be made about most all of the known fish pathogens in the world. Very few studies have been done relative to impact in the wild. Most fish disease control work is conducted within the context of the cultured fish.

The questions to be answered are many. Will this parasite compromise the fish in any significant way? Will the infected fish deal with environmental stressors as well as the uninfected fish? There is a considerable body of evidence to indicate that a persistent level of a wide variety of parasites does, in fact compromise the fishes ability to deal with stressors. Will the infested fish be more susceptible to the many infectious agents that may challenge them? There is documentation of the increased susceptibility to infectious agents when there are chronic infections or infestations with parasites. These parasites may in fact serve as stressors.

Are fish with persistent levels of these parasites more susceptible to toxicants or a wide range of pollutants or xenobiotics? Here as above, there is evidence relative to many different parasites that do work in this way.

Is there an impact on biotic potential, fecundity, growth, etc.? There is documentation to show that many parasites have been shown to impact these factors. Most of these impacts are not evident to the casual observer. It may be expressed as slower growth, reduced fat reserves, poor condition, lower survival to maturity, etc.

All of these effects could lead to a diminished ability of the contaminated populations to survive environmental episodes. The fish may survive until challenged by a significant environmental perturbation. The fewer factors that are compromising the health and condition of the individual fish in a population, the more likely it is that the population will survive these episodes.

That there will be compromising environmental episodes goes without saying in this day and age and particularly in the fragile western environs. Consider the fierce competition for water in the arid west. Streams are diverted for agricultural, industrial, culinary or domestic use. It is used to generate power, irrigate crops and supply water for a wide range of domestic uses. Many or most of the streams in Utah suffer severe restrictions of flow. Total dewatering by intent or accident is not at all uncommon.

The quality of water is altered when detained in reservoirs. Reservoirs generally are subject to severe draw-down leaving the fish to endure shallow, warm, stratified, anoxic waters lacking adequate ecological support for fish populations. Much of the flood-irrigation surplus returns to the streams warmed and carrying leached salts and all manner of agricultural fertilizers, pesticides, herbicides and feedlot wastes. The riparian vegetation is often grazed to extinction. This eliminates cover and a source of terrestrial insects to feed fish. The lack of cover will result in increased temperatures, increased sedimentation and changes in aquatic communities. Heavy equipment is used in the streams to channel and redirect the water in the interests of flood control thus destroying habitat for fish.

The streams are used as receiving and conducting systems for a wide variety of waste. Domestic sewage, industrial waste and agricultural waste are common and not likely to be controlled. The public will to deal with these problems is rarely sufficient.

All of the above are samples of possible environmental insults that will probably occur as episodes. Environmental episodes are inevitable and we must therefore be aware of the quality of the fish which must exist in such a world. Any additional compromising factor placed in the fish population either singly or in combinations will compromise the fishes ability to survive these environmental episodes. In the case of naturally sustained populations this diminished capability could prove fatal. In the case of severely restricted wild, remnant populations such as the Lahontan cutthroat and Bonneville cutthroat or in the case of threatened species on the brink of extinction, this could be tragic.

It is possible or even likely that WD may be one of the factors that adversely affect fish populations. No one has demonstrated that WD is not such a factor. The resistance and environmental persistence of this organism should also result in caution when determining the disposition of stocks contaminated with it. The myxosporean spore stage of this organism once released into the environment can survive for many years in the mud until ingested by a tubificid worm. Once introduced into the environment the organism can easily establish and is there to stay and available to mitigate the general quality and survivability of the salmonid fishes present.

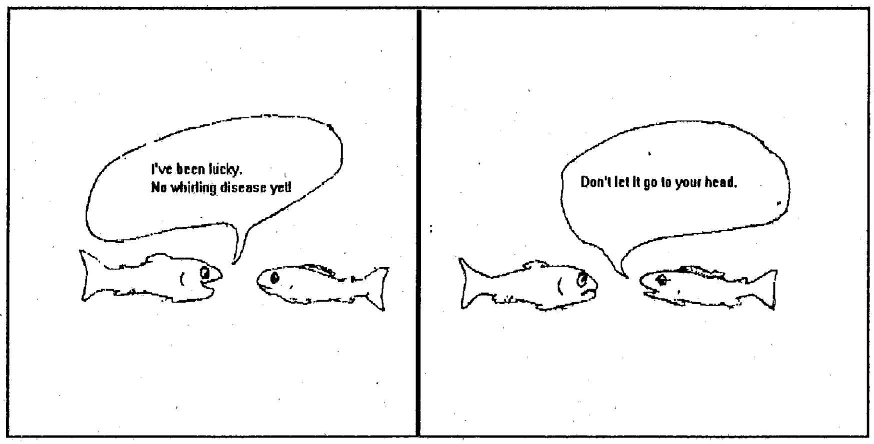
In an arid state such as Utah fish are stranded and killed each time an irrigation canal is shut down or streams are severely restricted or dewatered because of diversion. When this happens the decomposing fish release whirling disease spores. This means that there is an annual, massive infusion of spores in the system which would result in a rapid, significant build up of the organism. This tends to make it more of a problem in Utah than in many other states with less competition and intensive manipulation of water.

It is for all of these reasons that agencies responsible for the management of the natural aquatic resource must be conservative when determining whether to introduce an organism into the natural environment. Efforts to contain or eliminate are difficult, costly and generally unpopular. It is often easier to decide that potential impact is not sufficient to warrant action. All too often when this happens we have lost an "inch" in a "game of inches."

Where exotic chemicals are concerned it is generally necessary to prove no impact before it can be introduced into the environment. Why must we prove that there is an adverse impact before we can prohibit introduction of an exotic parasite?

Let's think before we load the fragile environments with irretrievable problems.

Ron Goede



Effect of *Spirulina* Algae or High Vitamin C Supplemented Diets on Fin Condition, Growth, and General Health of Rainbow Trout.

In an attempt to control fin erosion and produce a fish more acceptable to the angling public, two experimental diets were manufactured for evaluation. One contained 2.5% spirulina and the other was supplemented with vitamin C at 5 to 10 times the minimum amount required for growth. Spirulina is a micro-alga that is high in protein, vitamins, pigments, and growth factors. It is currently popular in the health-food market and is also being investigated for its anti-viral properties in the fight against AIDS.

Rainbow trout were fed the two experimental diets and a control diet for 225 days. Four raceways were used for each replicate. Fish were sampled monthly for determination of mean weight and observation of autopsy-based health and condition parameters.

There was no significant difference in fin condition or mean length between the control, high vitamin C or spirulina diets at the end of the 225 days. (Table 1.) There was a difference in mean weight at theend of the trial, with larger fish in the control treatment. Analysis of the protein and lipid content of the feed indicated that the crumble size of the control diet was higher in protein and fat than the other two diets. To isolate the influence of this factor, the change in mean weight (from the time the crumble sizes were no longer used to the end of the experiment) was compared among diets. There were no significant differences in the change in mean weight. (Table 1.) Mortality and feed conversion among fish from the three treatments did not differ either.

During the 225 day trial period, various parameters of the health condition profile were significantly different: eye, plasma protein, and hematocrit. However, these differences were sporadic and inconsistent. The thymus, bile, fat, fin, and gut index did not differ significantly among diets. Overall, the results indicated no real difference in the performance and health of rainbow trout fed any of the three diets.

Eric Wagner

Table 1. Final mean length and fin condition index after 225 days, and change in mean weight from day 86 to day 225 in rainbow trout fed either a high vitamin-C or Spirulina supplemented diet.

	Control	Vitamin C	Spirulina
Mean length (mm)	167	157	166
Change in Weight (g)	24.9	23.7	24.9
Fin Index	2.0	1.9	1.8

New Diagnostic Test Approved for BKD Detection

Diagxotics, Inc., of Wilton, CT, has announced the approval of two diagnostic test kits for the detection of Bacterial Kidney Disease (BKD) in salmonids by the United States Department of Agriculture. *Renibacterium salmoninarum*, the causative agent of BKD, is one of the major pathogens of salmon and trout throughout the world. The tests are the first and only tests which have been approved by the USDA for the detection of a fish pathogen. Both tests are monoclonal antibody-based enzyme linked immunosorbent assays (ELISA), which represents significant improvement over existing technologies.

The kits will be marketed under the tradenames, K-Dtect® and KwiK-Dtect® and will be manufactured at DiagXotics' laboratory facility in Wilton. K-Dtect is a quantitative test for use in labs producing objective results in under 3 hours utilizing a microtiter plate format. Kwik-Dtect is a rapid, semi-quantitative test which can be used on-site in the field. These test uses coated tubes and can be performed in under two hours.

It is hoped these kits will assist in controlling the spread of the pathogen and disease through rapid diagnosis and management . DiagXotics is presently working on 5 other test kits for different pathogens in salmonids as well as vaccines.

For additional information, please contact Mark Curtis at (203) 762-0279 or (800) 676-2927.

Tips for Improving your Precision with D.O. from Hach Kits

The Fish Farmer's Water Quality Test Kit sold by Hach Company (PO Box 389, Loveland, CO 80539) contains a scaled-down version of the Winkler Method (Azide modification) for determining dissolved oxygen (D.O.). This method prepares a 60 ml sample of test water, but only uses 6 ml (10%) for the final titration and the precision is only $\pm$ 1 mg/l. In order to take advantage of the whole prepared sample, I have devised a fairly simple system to utilize the entire 60 ml sample and improve the titration method.

1. transfer processed 60 ml sample (ready for titration with sodium thiosulfate) to 125 ml flask or beaker.

2. fill a 5 ml pipet to the zero mark with 0.025 N sodium thiosulfate solution using a 3-way safety pipet bulb. Press the "S" button for suction.

3. carefully depress the "E" button on the safety squeeze bulb to dispense sodium thiosulfate drop by drop while gently swirling or stirring the water sample (optional: can use stir plate and magnetic stir bar if available).

4. when the solution clears, immediately stop pipetting and note how many ml were dispensed from the pipet. The volume (ml) of sodium thiosulfate x 3.333 = D.O. in mg/l or ppm. Alternately, one could dilute the 0.025 N sodium thiosulfate solution 3.333 times (add 100 ml to 233.3 ml of distilled water) and the number of ml will equal the D.O. in mg/l or ppm, thus dropping the need for any calculations in the field. (warning: sodium thiosulfate in kits is only 0.0109 N, so one must order the concentration given below).

Adding this system to your kit will require a few cheap, but necessary lab materials including:

* 5 ml disposable serological pipet (Hach Co., 12 for $5.90)
* 3-way safety squeeze bulb (Hach Co., Pipet Filler $10.50)
* 125 ml clear flask or bottle ($2.00)
* sodium thiosulfate (Hach Co., 0.025 N, 946 ml, $8.95)
* magnetic stir plate and magnetic stir bar (optional)

The techniques outlined here will surely improve the precision of your kit results with little additional effort.

-Thomas Bosakowski

HCP UPDATE

The health/condition profile (HCP) has now been presented to about one thousand people. It is in place in numerous agencies and ranges all the way from occasional use to fully applied programs.

At this time, there appears to be three different user groups. The fish culture group is well established. The more recent areas of application have been fisheries management and environmental quality. Use of the HCP in fish culture carries with it the greatest pressure to do something about any departures from normal or desirable HCP. For this reason, they are more likely to require some diagnostic effort. The environmental quality application appears to center more on total number of anomalies and not so much on distribution of normals. The fisheries managers are somewhere in the middle. They are interested in evaluating the relative success of different fish populations with respect to management strategies, etc. in an effort to determine a proper course of action.

The good news is that all three of these areas can use the same system of observation. They will, in some instances, require somewhat different summaries and report structures. These are being developed now.

A tissue normality index has been incorporated into the profile now. It involves a mean departure from normal and allows easier tracking of results and quick comparisons. The rationale in this case centers around the assumption that the more serious any one of the individual departures is the more probable it is that other related departures will show. If, for example, a high fin erosion index is the only departure from normal, it is not likely to be very serious and it will be "buried" to some extent in the tissue normality index.

The tissue normality index is not replacing the HCP but becomes a part of the profile. This addition will be particularly useful to fisheries managers and environmental quality personnel. The system continues to grow and I hear of new applications all of the time.

Utah has been using the fish culture and fisheries management scenarios for some time now. It is planned to hold workshops for the fisheries managers this coming winter to go over the accumulated data bases and discuss questions and plans. When this was done for fish culture, it was very productive and solidified the future role of the HCP in fish culture quality assurance programs.
Ron Goede

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