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DEPARTMENT OF
WATER RESOURCES

Expert Rebuttal Report

By John D. Woodling
Fisheries Biologist
Prepared on behalf of
the City of Pocatello

In the Matter of Distribution of Water to
Water Right Nos. 36-02551 and 36-07694

I. INTRODUCTION

Experience

I have worked as a fishery biologist since 1968. I am currently retired and work as an independent consultant. I was employed by the Colorado Water Quality Control Division (WQCD) from 1973–1977 and the Colorado Division of Wildlife (DOW) from 1978–2003, in a variety of positions including research biologist and aquatic planner. My duties with the WQCD and DOW included working with the NPDES system. My duties with the DOW included working with fish production units to improve and implement fish culture techniques at warm water and cold water facilities. I was responsible for developing an annual budget for the Division's aquaculture units for a series of years in the 1980's. While performing these duties I became knowledgeable in all phases of hatchery operations, planning and development. My work with both WQCD and DOW required me to answer many questions as to how water quality and other factors influenced both hatcheries and aquatic systems. I designed, implemented and completed a multitude of research projects in hatcheries, rivers and laboratories to answer these various questions. The DOW hatcheries were managed in a decentralized manner when I joined the DOW. I performed an analysis of the decentralized hatchery operations and production costs and wrote a report that resulted in the hatcheries being centralized and managed out of the DOW's main office. This policy change resulted in a decreased cost of production of catchable sized fish and operational costs. I have experience testifying as an expert witness in a variety of forums in Colorado regarding water quality impacts on fisheries and hatcheries.

Publications.
See attached CV for publication list.

Compensation
I charge $150/hour plus expenses for my work on this project and $300/hour for depositions and court testimony.

Information reviewed
I utilized the following while preparing this document:

1. Research reports and documents provided by Rangen and procured from the Rangen Hatchery by White and Jankowski.
2. Research Index created by Rangen Research Hatchery personnel, provided by Rangen.
3. Inventories created by Rangen Research Hatchery personnel, provided by Rangen.
4. Raceway Experiment Reviews as of July, 2002 (N0102, N0004, N0003, N9905), provided by Rangen on October 9, 2012.
5. Smith, Charles, 2013. Expert Witness Report. Rangen Research Hatchery. Water right Nos. 36-02551 and 36-07694.
6. Brock, David. Expert Witness Report. Rangen Research Hatchery. Water Right Nos. 36-02551 and 36-07694.
7. Spronk Water Engineers, Inc. Expert Report. December 21, 2012. Prepared for the City of Pocatello.
8. Piper, R.G., et al. 1982. Fish Hatchery Management. U.S. Fish and Wildlife Service, Washington. D.C.

9. Final Deposition Transcript of Doug Ramsey Volume I, September 12, 2012.
10. Final Deposition Transcript of Doug Ramsey Volume II, November 13, 2012.
11. Final Deposition Transcript of Lonny Tate, September 11, 2012.
12. Final Deposition Transcript of David Loring Brock, January 22, 2013.
13. Banks, L. and L.G. Fowler. 1982. The effects of population weight loads and crowding on fall Chinook fingerlings reared in circular tanks. U.S. Fish and Wildlife Service, Abernathy Salmon Cultural Development Center. Technology Transfer Series No. 82-3. 12 pages.
14. Rogers, Thomas. 2012. Expert witness report. Idaho Ground Waters Appropriators, Inc. Water Right Nos. 36-02551 and 36-07694.
15. Rikardsen, A.H., M. Woodgate, and D. Thompson. 2002. A comparison of floy and soft VIalpha tags on hatchery arctic charr, with emphasis on tag retention, growth and survival. Environmental biology of fishes. 64:269-273.
16. McAllister, K.W., P.E. McAllister, R.C. Smith and J.K. Werner. 1992. Performance of nine external tags on hatchery-reared rainbow trout. Transactions of the American Fisheries Society. 121:192-198.
17. Carson National Fish Hatchery and Coleman National Fish Hatchery personnel. Telephone conversations.
18. Brignon B. U.S. Fish and Wildlife Service, Vancouver, Washington. Telephone conversation.

II. OPINIONS REQUESTED.

I have been asked to prepare opinions in this matter for the following two issues:

A. Are the existing seasonal flows inhibiting or restricting research projects at the Rangen Research Hatchery?
B. Do the existing fish production levels inhibit or restrict research projects at the Rangen Research Hatchery?

III. SUMMARY OF OPINIONS.

Mr. Charlie Smith's report suggests that the Rangen Research Facility ("Rangen Research Hatchery") is incapable of rearing more fish or performing more research based on existing water flows. This assertion is incorrect. Rangen has the ability to produce additional trout with the current water flows and flow regime. Further, Rangen records demonstrate that research performed in the Greenhouse and Hatch House locations routinely result in statistically significant results; by contrast, Rangen records demonstrate that past raceway studies seldom resulted in statistically significant results that proved one treatment or feed was better than another. The problem with Rangen's raceway studies is a lack of precision of data collection and measurement, not water flows. Measurement precision could be increased by using fish tags. At current water flow and fish production levels, Rangen has the ability to perform all types and forms of research that were historically performed at the Rangen Research Hatchery.

IV. METHODS UTILIZED TO DEVELOP OPINIONS REFLECTED IN THIS REPORT.

This report was developed in part through a review of records produced by Rangen. These records were supplied in an electronic format. Files concerning fish research projects were in a PDF format while Rangen Fish inventory records for 2005 through 2010 were in an Excel file format. To date Rangen has produced an index listing 392 research records. These records range from written proposals that were never approved or completed, to incomplete records of various report sections such as methods or data, to draft and final reports. Rangen cannot identify which projects of the 392 projects were completed or which projects remained in just a proposal stage. Final or draft reports are not available for all 392 projects. Final or draft reports were provided for 71 studies, including 59 at the Rangen Research Hatchery. Final or draft reports appear to be available for only 11 raceway studies at this time. The fish inventory records were taken from the computer of the Hatchery Administrative Assistant. The numbers of research projects performed by Rangen were developed in concert with Spronk Water Engineers. Tom Rogers provided projections of current potential fish production numbers at the Rangen Research Hatchery. Projections of current fish production numbers at the Rangen Research Hatchery were also taken from Charlie Smith's Expert Report in this matter. Information concerning U.S. Fish and Wildlife tagging operations were obtained through telephone conversations with agency personnel. In addition, White and Jankowski personnel visited the Rangen Hatchery in early October 2012 to locate additional research records.

V. REBUTTAL TO CHARLIE SMITH OPINIONS THAT DECREASED WATER FLOWS CAUSED A REDUCTION IN RESEARCH AT THE RANGEN RESEARCH HATCHERY.

Mr. Smith states at page 10 of his Report that "Rangen could .... conduct more research at the research facility if more water was available." Mr. Smith provides no factual basis for this statement, and in my opinion it is incorrect.

A. Background Information.

The Rangen Research Hatchery can be used to perform research on any life stage of trout from egg to market or stocking size. The Hatch House, Greenhouse, small raceways and large raceways can and have been utilized for research for the last few decades. However, the Idaho Power Contract (IPC) currently governs all aspects of production and research at the Rangen Research Hatchery. Rangen now only brings three egg lots onto the unit each year and raises two lots of fish utilizing density indices and flow indices that are different from most commercial fish hatcheries and rearing units. According to Mr. Smith's report, Rangen hatched and reared seven lots of eggs per year prior to the IPC. Thus, up to seven research studies could have been performed at the Rangen Research Hatchery prior to the IPC. The timing of the IPC fish lots may interfere with the hatching and rearing of seven lots of fish a year in the Hatch House but the capability to do this level of research still exists. However, Rangen does not presently appear to have a commercial use for additional lots of 2.8 inch fish from the Hatch House that would result from any additional studies due to the existing IPC.

In general five different types of trials have been performed at the Rangen Research Hatchery. Throughout the last decades Rangen has performed tests in small containers such as five-gallon buckets, in the Hatch House troughs, in the small and large raceways, in cages in the raceways and in the Greenhouse.

1. Small container tests

Smaller trout were studied in trials performed using small containers such as five gallon buckets. Fish were placed in these small buckets and fed over a period of time to measure growth. Many tests were performed using this exposure mechanism including 27-019-82, 111-077-83, N89-08, N97-09, N04-02 and N84-04.[1] Rangen for the most part phased out small container tests after the Greenhouse was constructed in 1991.

2. Hatch House tests

The Hatch House is utilized for testing feed and feed additives while rearing fry to 2.8 inch fingerling size. Rangen has performed many test trials in the Hatch House including 048-83, 130-83, N89-01 and N91-05. The 12 hatchery troughs allow for multiple replicates increasing the chance of finding statistically significant differences in the test results. Up to three different feeds could be compared at one time with four replicates. The maximum flow rate through the troughs usually reported by Rangen is 26 gpm (Rangen Records for the triploid spring and fall IPC fish) or a total of 312 gpm through all 12 troughs. Doug Ramsey stated that current seasonal flow levels are high enough to allow the Hatch House to operate on a year round basis (Ramsey Dep. vol. II, 213:4–22, 316:6–17).

A maximum flow of 35 gpm was utilized in the six troughs during one research trial (N01-07). About 288,000 eggs were hatched into each trough for research study N01-07, numbers much higher than in other Hatch House studies. Rangen personnel realized the troughs were overloaded and increased flow. The flow index was 1.85 and the density index 3.6 for this study, numbers higher than those normally resulting from lower flows and egg loads. Increased flow indices and density indices both negatively impact growth of salmon fingerlings (Banks and Fowler 1982). Higher density and flow indices likely led to the less than adequate results in study N01-07.

3. Raceway tests

Rangen performed research in both the small and large raceways. In some instances tests and trials were performed through the entire rearing cycle from hatchery troughs to the small raceways to the large raceways (N89-01). Rangen however, does not emphasize raceway trials. Reports have been located for only 11 raceway studies known to have been undertaken at the Rangen Research Hatchery (Table 1). Incomplete records for other studies include data that may prove useful at some level including 130-83 and N9105.

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[1] These identifiers correspond to research projects listed on the Rangen Research Index (No. 2 in list of information reviewed).

Table 1. List of Raceway tests performed at the Rangen Research Hatchery. List includes all studies for which some record was found. * = One result of all four to these tests was that test needed to be done in small controlled tank facility (Greenhouse). NS = results not significant.

Study	Study dates	Outcome from report	Report status or comments
271 - 82	9/82 – 1/83	NS[2]	Report found, sample size too small
130 - 83			No report found, only some data
N84 - 03	8/83 – 10/83	Significant and NS	Report found
N84 - 05		Significant	Report found
N85 - 17	10/84 – 2/85	NS	Report found, problems with design precluded data analysis
N88 - 67	3/88 – 8/88	Significant and NS	Report found, not between feeds but between top/mid/bottom
N89 - 01	4/89 – 12/89	Significant results	Report found, included significant difference between control raceways
N91 - 05			No report, some usable data
N97 - 05		Significant and NS	Only two raceways, tested individual fish
N99 - 05*		NS	Report recommends nutritional tests in greenhouse.
N00 - 03*	11/99 – 4/00	NS	Report recommends nutritional tests in greenhouse.
N01 - 02*	10/00 – 2/01	NS	Report recommends nutritional tests in greenhouse.
N00 - 04*	10/00 – 3/01	NS	Report recommends nutritional tests in greenhouse.

Regardless of flow levels, raceway studies have rarely proven to be an effective way of performing tests at the Rangen Research Hatchery. Statistically significant results were provided in only 2 of the 11 tests for which reports are to-date available. Three of reports reported both significant results and results that were not significant. In the other 6 raceway trials no claim can be made that one treatment (a specific feed for example) was better than the other treatment or control after lengthy study periods. At least two of the trials with significant results were contract projects for other entities (N8901 and N9705). Rangen feeds were not tested in these two studies, products for the outside entities were the test treatments. At least half of the Rangen raceway studies have resulted in expenditure of funds without definitive results. In my opinion the procedures and methods utilized by Rangen to complete raceway studies are not likely to consistently produce statistically significant results without study design modifications.

Rangen questioned use of raceway studies to the point that a document (Raceway Experiment Reviews as of July, 2002) was produced summarizing difficulties encountered during raceway

[2] "NS" means "not significant". The data collected during Rangen research projects are assessed using statistics. Rangen appears to incorporate or adopt research project findings when outputs of these statistical tests are significant. The word significant is applied when the output of any specific statistical test indicates the probability of the outcome is less than a pre-specified maximum acceptable risk of rejecting a true hypothesis. Rangen accepts a 5% chance (Brock Dep., 67:1–5) of rejecting a true hypothesis. Rangen like most researchers using statistical analyses accepts a risk of being in error in one of 20 projects.

studies. This Rangen review summarized issues raised in four studies, N0102, N0004, N0003 and N9905). One study (N0003) included the statement,

> *Tests utilizing rearing ponds are difficult to manage and obtain reliable data. Initial numbers of fish are at best, an estimate as are weights. Termination data is often questionable since larger weights are involved and sampling of larger fish is prone to more variation within a sample. More replicates per treatment, a better system of randomization and distribution of fish at the start, and more accuracy in final weighs are necessary to get significantly valid results.* ***For this reason, studies which involve small tanks where numbers and weights of fish can be determined accurately at both the beginning and ending of the experiment and where increased numbers of replications are used remains the method of choice for nutritional studies*** (emphasis added).

All the four studies included in the summary contained the observation that utilization of small controlled tanks such as those found in the Greenhouse is preferred over the raceway exposures.

A final conclusion in one of the summarized studies was,

> "Do not test further raceway tests because of lack of sensitivity" (N0102).

Raceway studies have not been particularly successful in the past at the Rangen Research Hatchery. Rangen appears to be hesitant to utilize this method of experimentation especially since tests in the small circular tanks in the Greenhouse have proven successful. For example, raceway test N0003 failed to detect significant differences between treatments that had previously been found in a Greenhouse test (N9904).

Rangen reports included many statements describing the reasons that raceway studies did not result in significant findings including difficulties in determining accurate counts of fish, accurate measurements for length, and accurate measurement of weight and production constraints. However, Rangen reports never mentioned study restrictions due to limited hatchery flows although some noted the benefit of additional replicates. As suggested in various Rangen research documents, Rangen needs to implement more precise methods to count and measure the fish used in research projects to improve data precision. The addition of more replicates alone will not improve results and data precision.

4. Cage tests

Rangen also performed trials in cages suspended in raceways. The advantage of a cage study is that multiple cages can be suspended in one raceway. Up to 16 cages have been placed in one raceway (N9103, N8903). In that manner, all exposures can be performed in the same raceway including controls and test organisms reducing the chance of random differences among raceways influencing results. Rangen does not appear to emphasize this type of study. Seasonal water flows are not an issue in performing this type of exposure test. All fish from different diets or additives can be fed in the same raceway reducing the chance of random differences.

5. Greenhouse tests

The Greenhouse is another research facility at the Rangen Unit built in the early 1990s resulting in more control of study variables such as number of fish in a test container and more precise measurements of growth. The facility has circular tanks that can be utilized for performing research trials. Rangen has performed many test trials in the Greenhouse including N9105, N9602, N0302, N0405, N0601 N0803, N1001, among others. The typical research study in the Greenhouse utilizes up to 20 circular tanks with a 200 gallon volume and flow rates of 8 gpm per tank. A total flow of 160 gpm is needed for all tanks to be utilized at one time. The number of studies in the Greenhouse is mostly constrained by study design and not flow. Circular tank research projects can be designed to study fish from egg to fish large enough to fulfill IPC requirements (1.2/lb to 2/lb). An egg to a fish of 1.2 per pound requires about eight months to rear at the Rangen Research Hatchery. Thus, study objectives and study duration are the parameters that limit the annual number of raceway studies.

The Greenhouse circular tanks appear to be the study method of choice for Rangen. These exposures can be more tightly controlled along with more precise measurements of fish. Rangen research has noted that Greenhouse tests are preferable compared to raceway studies (N0102, N0004, N0003 and N9905).

B. Mr. Smith's apparent conclusion that current flows limit the number of research projects is inconsistent with the facts.

Charlie Smith claimed that research at the Rangen Research Hatchery is limited or perhaps not possible due to existing flow levels. Mr. Smith's opinions appear to be based on his two 2012 visits to the Rangen Research Facility and not previous experience at the unit. Mr. Smith visited the hatchery twice in the summer and fall (July 23-25 and October 3-4) 2012 and on "*both instances it was clearly evident that there was insufficient water flow at the facility to conduct research testing, egg hatching or early fry rearing* (Smith Expert Report at 10). Mr. Smith indicated that low flows limit the number of egg lots that could be incubated through the year in the Hatch House by writing that "*historically* [eggs] *were purchased...7 times each year*" (Smith Expert Report at 5), but currently "*Because of the extremely low water flows ordering of eggs occurs*" three times a year. Such is not the case. Doug Ramsey declared that current flows are adequate to operate both the Hatch House and the Greenhouse at full capacity throughout the entire year except during the month of June. Either the Hatch House or the Greenhouse could be operated at a reduced level during the month of June while the other facility could be operated at full capacity (Ramsey Dep. vol. II, 213:4–22, 316:6–17, 348:8–349:24). Furthermore, Rangen was conducting research in the small raceways during October of 2012 (Ramsey Dep. vol II, 259–60, Exh. 80).

Mr. Smith was not correct in asserting that existing flow rates limit the use of the Hatch House as a research (or production) facility. Rangen hatched and reared seven lots of eggs per year prior to the IPC, but now hatches and rears only three lots of eggs. Rangen could have performed research projects on any or all of those seven lots each year. The Hatch House currently sits idle up to 30 weeks a year. Water is not a limiting factor in planning or conducting research in the Hatch House. The number of Hatch House research studies are limited only by need and not flow.

Mr. Smith discussed the design of the Rangen Research Hatchery in relation to the research program at the unit. The construction and planning of a fish hatchery influence the final production of a unit to the same degree as other major parameters such as water flows, temperature and water quality. Several statements in Mr. Smith's expert report concerning the design of the Rangen Research Hatchery were not supported with specific data or information:

1. Mr. Smith stated that the Rangen Research Hatchery was constructed in 1963 and "based on an abundant water supply of excellent quality it was designed to raise fish under typical production conditions similar to those of other hatcheries in the area" (Smith Expert Report at 4).

In my opinion the Rangen Research Hatchery was not designed to raise fish "*under typical production conditions.*" Rangen water supply lines were constructed so that much of the first use water is not available for use in the Hatch House or Greenhouse or the small raceways. Much of the water used for fish rearing is taken from Billingsley Creek downstream of the Hatch House, Greenhouse and small raceways. Fish units are almost all constructed so that all available water can be used in all raceways and ponds. The water sources are available to all unit facilities. Additional water could be used in the small raceways by installing a redundant pump system as discussed in Thomas Rogers (Table 2.4) expert report in this matter.

In addition, Rangen currently rears rainbow trout using a lower density index and flow index than those utilized at many other hatcheries in the area that utilize feeds manufactured and sold by the Rangen Mill. Rangen rears fish at lower densities than found at most commercial fish hatcheries that purchase Rangen feed. The response of fish at the Rangen Research Hatchery to different types and formulations could be different than fish being reared at higher densities on commercial fish hatcheries, reducing the applicability of Rangen research findings to commercial fish rearing units. Rangen has not informed customers that purchase feed that raceway tests likely are not be an accurate reflection of how fish growth is related to different feeds at higher densities (Ramsey Dep. vol. II, 264:10–265:8).

2. The statement was also included that Rangen Unit is unusual in that "due to the small amount of drop in elevation at the Rangen Hatchery there is little to no replenishment of oxygen between the series of raceways using the same water flow" (Smith Expert Report at 8).

Almost all hatcheries are constructed so that aeration occurs between raceways series (or strings). The Rangen Research Hatchery was designed and constructed in a manner that apparently limits aeration between raceway strings. That decision may constrain production in lower raceways if Rangen were to rear substantially more fish in the future. Any such production constraints would be the result of the hatchery design and not connected to any changes in flow or other aspect of the unit operations. Rangen personnel measure dissolved oxygen in raceways. These dissolved oxygen concentrations never appeared to be less than 6 mg/l or 7 mg/l (Tate Dep., 91:22–24). Trout rearing is not restricted by dissolved oxygen concentrations of 6 mg/l. Doug Ramsey indicated that dissolved oxygen was a parameter that was "not measured on a routine basis at all" (Ramsey Dep. vol. I, 36:21–22), an indication that dissolved oxygen has never been a problem at the Rangen Research Hatchery that limited production. Dissolved oxygen is not limiting research or production at the unit.

Charlie Smith asserted that low dissolved oxygen can limit production through disease mortality and stress (Smith Expert Report at 9). However, dissolved oxygen does not appear to be an issue at the Rangen Research Hatchery (Tate Dep., 91:22–24) and would not appear to be an issue at the current flow regime, production schedule and by connection any research programs. Rangen however, could address any potential dissolved oxygen limitation by installing an aeration system, like many other hatcheries in North America. Raceway research would not be impaired if an aeration system were installed. Many hatcheries in North America have aerations systems.

3. One aspect of research at the Rangen Research Hatchery claimed by Mr. Smith was that "*Feed tests can also be done in first, second and third use water to determine how well they perform under each condition*" (Smith Expert Report at 5).

Mr. Smith's opinion was not based on Rangen research results. Only two research reports (N8867 and N0003) were found that reported results and analyses based on a study design where fish were fed in first, second and third use water in raceways. Results were not statistically significant between feeds for either study. However, statistical differences were once found among first, second and third use water (N8867). Fish growth decreased significantly from first use to second use water and second to third use water, respectively for the control and test groups (N8867). Raceway studies do not appear to have determined how well different feeds perform in first, second and third use water in a raceway string.

The written report for N0003 included the statement that,

> *Studies which involve small tanks where numbers and weights of fish can be determined accurately at both the beginning and ending of the experiment and where increased numbers of replications are used remains the method of choice for nutritional studies.*

Mr. Smith's conjecture that the Rangen raceway study design demonstrates how different feeds perform in first, second and third use water is not supported by available Rangen research records. A different research design will likely aid in providing significant results in the production rates in first, second and third use waters. Additional replicates may not provide such aid due to the imprecision associated with Rangen's methods for counting fish, weighing fish and measuring lengths of test fish in raceway studies. Rangen's problems with raceway studies are attributable to a lack of precision in measurements not water supplies.

4. Mr. Smith referred a second time to testing reused water by noting how "This (hatchery design) allowed replicate testing of different feeds and feed ingredients under typical pond loadings as well as water reused down through a series of ponds similar to those used in other hatcheries" (Smith Expert Report at 4).

Rangen does not utilize "*typical pond loadings*" in their current raceway production scheme due to obligations under the current IPC. Currently, Rangen rears trout at lower densities than most commercial hatcheries. Rangen has not reared trout since 2004 under "typical pond loadings."

These lower densities likely produce research results not comparable to commercial trout hatcheries and rearing stations.

Past Rangen feed trials did not result in significant results when two feeds were compared "*down*" a series of ponds (N8867 and N0003), as noted in the previous section. Increasing the number of replicates is unlikely to resolve difficulties that are in fact associated with counting fish, weighing fish and measuring lengths of fish that have historically occurred in past raceway studies where water is "*reused down through a series of ponds.*" Rangen would most likely improve the outcome of raceway studies by altering the study designs utilized at the unit.

5. Mr. Smith also claimed that "Design of the Research Hatchery allows side by side testing of different diets" (Smith Expert Report at 4)."

As previously discussed, past Rangen raceway studies detected significant differences between different diets were found in only five of 11of the studies for which reports have been located. Greenhouse studies "*remain[s] the method of choice for nutritional studies*" (N0003) at the Rangen Research Hatchery. Rangen performs side by side tests to compare diets in the Greenhouse. Greenhouse studies have resulted in significant differences among different diets.

6. "Since Rangen is one of the major producers of fish feeds it is in their best interest to continually test new ingredients that may be replacements for fish meal and other costly ingredients as they become available" (Smith Expert Report at 4, 5).

Rangen has performed many tests in the Hatch House and Greenhouse that provided significant data utilized to improve Rangen feeds and other aspects of fish culture. By far, the majority of the significant data were the results of tests performed in the Hatch House on fry and small fingerlings and the Greenhouse on larger fish ranging up in size to those ready for sale to Idaho Power. Rangen recommends that fish larger than one pound not be used in Greenhouse studies (N0002), so all fish reared to sale size for the IPC can be utilized in Greenhouse trials. Raceway tests have not proven as successful. As noted in Section IV above, significant results resulted in only 5 of 11 projects for which reports have been located and two of the studies with significant results were performed for outside entities not on Rangen products.

Rangen research needs have been achieved through Greenhouse studies not raceway trials. Research reports have acknowledged this difference by concluding that "*studies which involve small tanks where numbers and weights of fish can be determined accurately at both the beginning and ending of the experiment and where increased numbers of replications are used remains the method of choice for nutritional studies*" (N0003). One suggestion advanced was not to perform any other raceway studies due to a lack of "*lack of sensitivity*" (N0102).

Rangen's "best interest(s)" concerning research would seem to be to produce the tightest most precise data sets possible. The raceway studies performed at Rangen seem to have two different objectives. Rangen wants to do "very good" studies with valid results (Brock Dep., 63:17–24). However, Rangen also uses raceway studies to influence customers who purchase fish feeds from the Rangen feed mills. Rangen asserts that feed customers are more likely to accept substantial modifications to feeds where results of a field test (read raceway test) are "backed up" with a raceway study (Brock Dep., 63:10–14). These field tests are an effort to duplicate a Greenhouse study that had previously provided statistically significant results proving a feed additive of perhaps a different, cheaper protein source improves or maintains acceptable growth. The raceway study will not provide any more technical support for the results of the Greenhouse trial. However, raceway test results appear to cater to the perception of feed customers that results of a Greenhouse trial are somehow inferior.

Brock asserts that many of Rangen Feed customers are "fish meal oriented" (Brock Dep., 63:1–2) and may not support the addition of cheaper protein sources to various Rangen feeds. As such, the results of some Rangen research proving cheaper protein substitutes may never be released or "aired to the customers" (Brock Dep., 62:16–18). A Greenhouse study (N0405) resulted in a finding that cull beans provided a cheap substitute for fish meal in Rangen feeds. Cull beans have been incorporated into Rangen feeds when available but that research finding was not verified with a raceway study. Culled beans now make up to 5% of Rangen feeds (Brock Dep., 60:2–3). Feed customers may not support the use of cull beans in place of fishmeal. Thus, the use of raceway studies is selective and is used to communicate findings to feed customers in certain circumstances but not all circumstances. Rangen appears to want to use raceway feed trial for purposes other than the actual research and has altered feed components based solely on Greenhouse trials.

The raceway studies are not always used to obtain valid research results but are at least in-part infused with a public relations component. Although a stated goal of raceway studies was to create "very good" studies, another aspect appeared to be to influence costumers by finding significant results using raceway studies and that did not happen often. Six of 11 raceway studies for which reports are available did not produce significant results.

Still study designs need to be as precise as possible to produce usable results. The lack of precision in raceway studies were attributed to difficulties in determining accurate counts of fish, accurate measurements for length, accurate measurement of weight and production constraints. Precision of raceway study data could be improved by changing the study design of those tests.

7. Mr. Smith included an assertion that "The design of the Research Hatchery allows replicate testing in both small & large ponds which improves the reliability of the data collected" (Smith Expert Report at 5). Available data does not support that this claim is true for studies performed in the raceways.

Replicate testing in the Hatch House and Greenhouse results in statistically significant data in most tests. Historically, replicate raceway tests resulted in significant results in only five of the 11 tests for which reports are available (Table 1). Rangen written reports note the lack of precision in counting and measuring fish as main reasons that raceway studies not the number of replicates (N0102, N0004, N0003 and N9905). Final weights at the end of an experiment have been determined by water displacement (N0004), not a precise means of determining weight. Additional replicates were mentioned as one way of increasing precision (N0003). Increasing replicates will not improve the precision of measurements and counts required for reliable raceway studies. For example, Rangen found a significant difference between two control groups in one study (N8901). A significant difference between control groups is not an expected outcome of any experiment. Control groups are compared to determine any systematic error. One probable cause of systematic error in a raceway study is the admitted lack of precision inherent in raceway studies at the Rangen Research Hatchery. Increasing measurement precision will better serve the needs of Rangen raceway projects more than the addition of additional replicates.

C. Options to improve research studies at the Rangen Research Hatchery.

The total Rangen operations are such that research project costs are less than those incurred at many academic fish research facilities throughout the United States. The trout used in Greenhouse and Hatch House experiments are moved to raceways after the experiment and reared to market size and sold. Fish used in raceway experiments are then sold to either IPC or on the spot market. Selling test organisms at a profit is an unusual opportunity by any standard. The different diets fed to test fish are often manufactured at the Rangen Mill. The feeds are available for just the cost of manufacturing. No profit must be paid to a second party. Labor costs are minimized for research since the test organisms are part of fish lots eventually sold for profit. Much of the labor required for each research project is time that is required to rear the fish to market size in any event. Services provided by the Rangen pathologist or any water sampling analyses are available at costs less than those incurred by commercial units to rear fish. The lower costs of current studies likely will allow Rangen to utilize additional funds to improve the raceway study design to improve data precision.

Future research at the Rangen Unit is not constrained by current flow levels based on the frequency and magnitude of past research programs. Most future research will probably be performed in the Greenhouse, the Hatch House or occasionally in the small and large raceways, based on past activity patterns at Rangen. Any future projects utilizing small buckets or cages suspended in raceways would not be constrained by current water levels in any case.
Hatch House research projects are not constrained by flow in any manner. Rangen personnel (Ramsey Dep. vol. II, 213:4–22, 316:6–17) agree that current water levels from the Curren Tunnel are adequate to operate the Hatch House 12 months a year. Charlie Smith's claim that only three egg lots can be moved through the Hatch House (Smith Expert Report ¶¶ B.i, at 5) is incorrect based on the testimony of Doug Ramsey. Rangen could perform up to seven Hatch House research projects a year. The limit of sevens studies is based on the amount of time required to rear eyed eggs to a 2.8 inch size in the Hatch House not any flow issue. Rangen can perform additional Hatch House studies at any time of the year.

Rangen raceway studies have not proven consistently successful at any flow. Only 5 of the 11 raceway studies for which reports have been located resulted in significant findings. However, three of those five tests also resulted in analyses that were not significant. A lack of precision in counting and measuring fish was consistently mentioned as reasons for lack of significant data. Raceway studies appear to be more important to the reputation of the Rangen Company than the business of the company. Customers could be more influenced by results from "field" tests in raceways even though test results from the Greenhouse studies are those that actually resulted in the significant differences between treatments.

Greenhouse studies are more precise and able to detect differences in treatments. Rangen has incorporated results from Greenhouse research projects into standard fish rearing procedures without raceway validation. Culled beans were found to decrease feed costs when used as replacement for fish meal in a Greenhouse research project (N0405). Rangen now incorporates 5% culled beans into fish food when culled beans are available (Brock Dep., 6:2–3). The Greenhouse can be used to hatch and rear rainbow trout from egg to the size mandated by the IPC, so any type of research study performed in the past at the Rangen Research Hatchery can be performed in the circular tanks of the Greenhouse.

Performing raceway studies would be a viable research alternative if significant findings are routinely produced. Increasing data precision collected during raceway tests appears to be the best way to create significant results. Increasing the number of replicates will not lead to increased precision in data since data collection would utilize the same inadequate methods currently utilized in Rangen raceway studies.

Data precision could be increased by measuring changes in fish and not in raceways. Individual fish could be tagged and followed through the rearing process. The test replicates become the individual fish and not the raceway. Precise information can be collected measuring changes in length and weight for each tagged fish at different time intervals. The result would be a beautiful data set that could answer a variety of questions.

D. Precision of raceway data can be improved by incorporation of fish tags into the study design.

Two and a half inch long rainbow trout can be tagged using several methods, including Floy tags and PIT tags among others. Price of a Floy Tag is 61 cents each when 10,000 or more are purchased (Floy Tag Company Jan 2013 personal communication). Fish could be tagged and marked when moved from hatchery troughs to the small raceways. Tagged fish could be sorted and measured a second time when moved from the small raceways to the large raceways and measure again when moved out of the large raceways and then stocked for the IPC. One raceway per treatment is adequate.

The use of tagging programs in hatchery operations is an accepted practice. Salmon are routinely tagged in hatcheries to determine how many fish return from the sea (Carson National Fish Hatchery and Coleman National Fish Hatchery web pages). Coded wire tags are planted in small salmon, reared for several months and then released to migrate to the sea at units such as the Carson National Fish Hatchery. The effect of different types of tags on raceway reared trout in raceways has been studied (McAllister et al. 1992). Growth of salmonids in raceways has been studied using tagged fish (Rikardsen, et al, 2002). Growth of bull trout in raceways is currently being studied using PIT tagged fish (Bill Brignon US Fish and Wildlife Service, personal communication). Rangen has made limited use of fish tags. IPC fish have been marked with jaw tags prior to stocking so that creel data could be collected to determine success of the IPC stocking program.

Rangen has not incorporated use of tagged fish into raceway studies. Research costs would increase for each study using tagged fish. Current research costs are low and tagging fish would require more effort from Rangen personnel. However, Rangen has performed tests where individual fish were the replicates much as they are in fish experiments using fish tags. Changes in individual fish were measured in N85-17, when individual trout were killed for analyses at specific times. Statistical analyses were not performed measuring change between raceways because the study design did not include replicate exposures, only one raceway was used for each diet (N85-17). Given this study design, a statistical comparison could have been done to measure changes in growth had the fish been tagged at the beginning of the experiment. Rangen has previously done very detailed research work involving a lot of time for a small amount of data such as histological examinations of fish tissues. Adding a tagging program would not be a major change in research policy at the Rangen Research Hatchery, but would increase research data precision from raceway trials.

These tagged fish could be used to answer a variety of questions, in addition to determining differences between different diets. Based on my experience in a state game agency, I imagine the Idaho Power and the Idaho Game and Fish Department would be interested in partnering in some of these tag studies. These entities could assess success of these fish plants through intensive creel studies after fish are planted. Both entities may well provide personnel time to help with sorting and measuring the fish.

The research program at the Rangen Research Hatchery is not constrained by the current seasonal flow regime. All research and fish production at the Rangen Unit is governed by the IPC contract. Mr. Smith alluded to these limitations by stating "*the contract does require that fish are reared at lower fish loadings and fish densities*" (Smith Expert Report at 5). Mr. Smith's words mean that Rangen raises fewer fish per raceway for the IPC than would be reared for sale to processors. These lower densities may produce different results during feeding trials. Rangen may also not be able to utilize the Hatch House for a maximum number of studies since the IPC requires delivery of fish in specific months. The IPC delivery sequence may reduce the number of fish lots that could be reared in a sequential manner one immediately following the other.

E. Conclusions about Smith's opinion that more water would allow for more research at the Rangen Hatchery.

Rangen's policy concerning research is not clear. Rangen expresses a need to perform research yet has not utilized the Greenhouse in recent years despite available water flows and the fact that Greenhouse studies have routinely resulted in statistically valid results. Rangen also asserts that raceway studies are not performed due to a lack of water yet raceway studies do not dependably produce statistically valid results, and no documentation supports the concept that Rangen believed (prior to this delivery call) that the lack of statistically significant results was due to inadequate water supplies. In addition, documentation supports the fact that a principle use of raceway studies is to convince feed customers that results of a Greenhouse study also apply to a raceway environment. In such instances, the function of raceway tests is not research or feed improvement, but marketing. The Greenhouse was the actual research tool that produced statistically valid study results yet Rangen has not utilized that tool in the last several years. Perhaps Rangen actually has not had a need to perform research projects in the last few years.

VI. MR. SMITH'S BROAD CONCLUSION THAT ADDITIONAL WATER IS NEEDED TO PRODUCE MORE FISH IS NOT SUPPORTED BY AVAILABLE INFORMATION.

A. A statement was included in Mr. Smith's expert report (page 3) that "*There is no doubt that Rangen could utilize more water at the research hatchery.*" Mr. Smith seemed to imply that additional water is needed for research at the Rangen Research Hatchery. In my opinion additional water is not needed for the type and magnitude of research historically performed at the Rangen Research Hatchery.

Mr. Smith's report suggests visits on two occasions (July 23–24, 2012 and October 3–4, 2012) form the basis for his observation that more water could be used to rear fish and by extension perform research. However, as described above, current water supplies are adequate to perform research or rear trout in both the Hatch House and Greenhouse simultaneously throughout the year except in the month of June (Ramsey Dep. vol. II, 213:4–22, 316:6–17). Either the Hatch House or Greenhouse could be operated at full capacity during the month of June, while the other could be utilized at less than a full capacity. For example, the Greenhouse could be operated at full capacity in the month of June while hatching eggs and feeding the resulting fry in a reduced number of Hatch House troughs. Rangen has performed Hatch House research projects using only six troughs (N0203) rather than a full complement of 12 troughs.

The Hatch House is not currently utilized in the month of June because the timing for the IPC fish does not require that eggs be either hatched or reared in troughs during the month of June. Rangen only rears three lots of eggs per year to meet the requirements of the IPC. Rangen could rear additional lots of eggs, if desired, for research purposes at any time of the year. Rangen has performed few research projects in the last several years, but both the Hatch House and Greenhouse could be used for additional research and production throughout the year. Water levels do not limit research capabilities in either the Hatch House or the Greenhouse.

Mr. Smith appeared to calculate current fish production limits at the Rangen Research Hatchery using a constant flow regime. Mr. Smith's report determined fish production at the Rangen Research Hatchery based on a constant minimum low flow of 15 cfs. Flows vary in a seasonal manner with low flows in the late spring and early summer. Flow rates increase through the remaining months of the year. Actual production rates (and thus the number of fish available for research purposes) would thus exceed levels predicted by Mr. Smith in his expert testimony.

Water flows through the Rangen Research Hatchery did not limit the numbers of fish on the unit on the days of Mr. Smith's visits days (July 23–24, 2012 and October 3–4, 2012). The obligations of the IPC were the reason many of the raceways were empty at the Rangen Research Unit on the days of Mr. Smith's 2012 visits. The presence or absence of fish from any portion of the Rangen Research hatchery on any given date is dependent on IPC requirements, not available water flows. Trout are moved out of the Rangen Research Hatchery hatcheries on three occasions each year to meet requirements of the IPC (note that fish are present in the CTR raceways throughout the year and are sold on the spot market). Trout are stocked out in March, May and October. Thus, the March and May IPC trout are removed from the unit by July of each year. The fish for the upcoming October plant are in the large raceways and of course some are in CTR raceways in July. Eggs for the March plant of the next year (2013 in this case) are brought onto the unit in August of each year. The Hatch House and small raceways were empty on July 23 and 24 because Rangen does not bring eggs onto the unit for rearing except for the three IPC lots. The only fish on the unit on July 23 and 24, 2012 were for the October fish plant so the Hatch House, the Greenhouse and the small raceways were empty. Rangen could have been rearing fry in the Hatch House and/or performing a research study in the Greenhouse on July 23 and 24, 2012 if so desired. Doug Ramsey (Ramsey Dep. vol. II, 213:4–22, 316:6–17) has acknowledged that water flows are adequate to operate both the Hatch House and Greenhouse in all months except June.

A similar situation existed at the time of Mr. Smith's second visit on October 3 and 4, 2012. Fish for the upcoming March plant were being reared in the large raceways. Trout were not in the small raceways because Rangen only rears three lots of eggs per year and those fish are reared to meet precise stocking dates in March, May and October of each year. However, trout for the upcoming May 2013 plant were in the Hatch House in October 3 and 4, 2012. These fish were stocked into the small raceways a few days after Mr. Smith's visit. Trout for the May 2013 plant had been placed into the small raceways by Oct 8, 2012 (Tom Rogers, personal communication). Had Mr. Smith visited the Rangen Research Hatchery on October 8, 2012 he would have found fish in the small raceways, large raceways and the CTR raceways. In addition another lot of eggs could have been moved into the Hatch House in October for either routine rearing or a research study. Thus trout would have been found in the Hatch House, small raceways, large raceways and the CTR raceways. Water levels in October were not limiting use of any facility at the Rangen Research Hatchery at the time of Mr. Smith's visit. Rangen simply did not need any more fish on the unit to meet requirements of the IPC on October of 2012.

B. Mr. Smith's opinions appear to be based on solely on flow conditions in the raceways at the time of his visits.

Counting dry raceways on four days throughout the year is not an appropriate manner of judging fish production or research water limits. For example, the small raceways and the large raceways were all empty of fish at the beginning of November 2008 (Rangen Administrative Assistant computer records). Fish were only present in the CTR raceways at the start of November 2008. Absence of fish from both the small and large raceways in the beginning of November 2008 did not mean fish could not be reared and fed in those facilities. The absence was due to Rangen obligations under the IPC. Rangen rears only three fish lots per year under the obligations of the IPC. The IPC schedule does not require that trout be present in the small and large raceways at all times of the year including the early part of November.

The design of research projects does not appear to be limited by the number of fish/lot Rangen can rear. Rangen appears to believe that a maximum number of 188,000 eggs/lot (N0203) can be hatched and reared in the Hatch House (Table 2), in close agreement with Tom Roger's prediction of 168,000 eggs/lot. Mr. Smith's prediction of 300,000 is much higher, perhaps due to his use of a larger trough volume in his calculations than actually is found at the Rangen Hatch House. Nonetheless, Rangen can hatch and rear more eggs/lot in the Hatch House than current records for the IPC contract indicate.

Table 2. Comparison of maximum number of rainbow trout/lot that can be reared in different parts of the Rangen Research Hatchery as reflected in Rangen records and predicted by Tom Rogers, Charlie Smith. Mr. Rogers and Mr. Smith's numbers were in or derived from expert reports.

Rearing facility	Tom Rogers	Rangen records	Charlie Smith
Hatch house	168,000	188,000[A]	300,000
Small raceways	156,458[B]	125,048[C]	135,872 [D]
Large raceways	98,416	81,691[E]	129,232 [F]
CTR			61,600[G]

[A] = Rangen research report N0203. [B] = calculation at a more restrictive flow index of 0.5. [C] = maximum number actually removed from small raceways, Administrative Assistant computer records, inventory folder. [D] = 8,492 pounds at 16/lb at five inches in length. Mr. Smith indicated 6 inch fish would be moved from the small raceways, however Rangen usually moves fish from small raceways at less than 5 inches in length. [E] = Maximum produced for IPC, Rangen fish sale receipts, table value from 2011 sales data. [F] = 53,847 pounds at 2.4 fish/lb. [G] = 28,031 pounds at 2.2 fish/lb.

Rangen could currently increase production in the small and large raceways based on the expert reports of Charlie Smith, Spronk Water Engineers and Tom Rogers. Available Rangen records indicate a maximum harvest of 125,048 trout from the small raceways, while Mr. Smith and Mr. Rogers determined that from 10,000 to 30,000 additional five-inch rainbow could be reared per lot in the small raceways for IPC fish plants. Rangen's expert Mr. Smith determined that large raceway production is limited to 129,232 fish (Table 2) while the recent maximum harvested for the IPC was 81,691. Rangen appears to be able to rear approximately 47,000 additional rainbow trout/lot at 2.2/lb (Smith Expert Report, numbers taken from Exh. 3 at 1).

Rangen appears also to be able to rear at least 61,000 rainbow trout (2.2/lb) in one CTR raceway (Smith Expert Report Exh. 3, at 4). Rangen records indicate that only from about 7,000 to 35,000 trout were present in a CTR raceway at the end of any given month from October 2008 through June 2010 (Administrative Assistant computer records, inventory folder). Rangen could rear and hold far more fish in each CTR raceway than have been present in the last several years. Flow levels have not been the cause of low numbers of fish in a CTR raceway.
More fish could be reared for the May IPC plant of 8,000 pounds of rainbow trout than for the March and October IPC deliveries. A density index of 0.3 and a flow index of 0.8 do not apply to the May fish. Rangen can rear more fish in the large and small raceways for the May fish plant than for the March and October fish plants. Rangen appeared to bring 60,000 eggs into the Hatch House in the fall of 2011 for the May 2012 IPC plant which required the production of 8,000 pounds at 2 fish/lb. Prior to 2011 Rangen produced 8,000 pounds of fish for the May IPC plant at seven fish to the pound, or 56,000 fish. Data are not available at this date for the number of eggs brought onto the unit to produce these 56,000 IPC fish.

However, from about 88,650 to 104,776 fingerlings were transferred to the small raceways in January or February of 2007 to 2009 to produce the 56,000 fish for May of 2008 through May of 2010. Rangen appeared to have brought a minimum of 104,776 eggs onto the unit from 2007 to

2009 to fill an order of 56,000 fish at seven to the pound (Table 3). Rangen brought about twice as many eggs into the Hatch House from 2007 through 2010 for the May plant as were brought onto the unit in the fall of 2011 for the May 2012 plant. Rangen could still hatch and rear the same number of fish for the May plant that were reared from 2007 through 2010 for the May plant. Rangen has excess capacity for the May IPC plant and could rear tens of thousands of additional trout. Yet Rangen has not done so.

Table 3. Number of fish moved to small raceways from 2007 through 2010 to meet IPC requirements for fish in May. In = fish placed into small raceways. Out = fish removed from small raceways. End = fish in small raceways at the end of the month.

Date		Number of fish
February 2007	In	88,650
	Out	0
	End	88,364
February 2008	In	95,966
	Out	0
	End	95,711
January 2009	In	99,439
	Out	0
	End	99,055
January 2010	In	104,776
	Out	0
	End	104,707

The fish reared for the May IPC plant result in something of a contradiction. More fish appear to be present on the Rangen Unit in the months of May and perhaps June than any other time of the year (Table 4). At the same time May and June are the months of low flow at the Rangen Research facility. Trout were present in the small raceways, the large raceways and the CTR raceways in May and June of 2009 and 2010. Mr. Smith stated that the small raceways were empty in July of 2012; in his opinion a sign that more water was needed. Mr. Smith would have seen many more fish and many more raceways filled with water had he visited the unit in early May prior to fish being stocked for the IPC and other fish moved to the large raceways.

Table 4. Movement and holding of trout on the Rangen Unit in May and June of 2009 and 2010. Data from Administrative Assistant computer files, folder = Inventory. In = fish moved into the raceways. Out = fish moved out of the raceways. End = those fish left in the raceways at the end of the month.

Date		Small raceways	Large raceways	CTR raceways
April 2009	In	0	0	1,680
	Out	0	2,046	17,393
	End	0	77,209	14,284
May 2009	In	123,759	84,287	0
	Out		137,247	904
	End	123,554	26,631	9,695
June 2009	In		199,909	31,005
	Out	104,341	126,573	4,684
	End	0	95,689	30,102
April 2010	In	0	0	0
	Out	0	1,791	61
	End	0	95,283	25,056
May 2010	In	109,150	79,348	0
	Out	0	132,106	50
	End	108,639	31,617	23,691
June 2010	In		103,649	36,005
	Out	102,649	31,683	19,324
	End	0	103,466	35,271

Fish production at the Rangen Unit has decreased over time in a manner unrelated to water flows. In the 1980's Rangen produced about 20,000 pounds of trout per cfs (Spronk Water Engineers Expert Report at 16 & Fig. 4.2). Since 2005 production has decreased by 50% to a level of about 10,000 pounds of trout per cfs. Overall production decreased from about 184,000 pounds per year in 2007 to about 142,000 pounds in 2011 (Spronk Water Engineers Expert Report at 18). Part of this decrease is due to requirements of the IPC. However, total production at the Rangen Research Hatchery would increase if the number of pounds produced per cfs was increased to pre-2005 levels (Spronk Water Engineers Expert Report at 16–17).

In summary, expert reports in this matter (Charlie Smith, Spronk Water Engineers and Tom Rogers) and Rangen Records (Administrative Assistant computer records, Inventory) indicate that current rainbow trout production levels are less than what is actually possible at the current flow levels in the Hatch House, small raceways and large raceways. Rangen can hatch and rear more eggs to fingerling size/lot in the Hatch House than is currently done even with the existing seasonal flow regime. Rangen can produce more fish/lot in the small raceways than currently done with the existing seasonal flow regime. Rangen can produce more fish/lot in the large raceways and a CTR raceway than currently done with the seasonal flow regime. Rangen production and thus research is limited more by the IPC that results in only three lots of fish per year than any flow limitations. The inability to perform additional research projects is thus limited more by the IPC than any other factor such as flow.

CURRICULUM VITAE

John Woodling, Ph.D. 970-361-7004
Aquatic Biologist
2180 1/2 K 1/2 Road, Grand Junction, Colorado 81505 woodling@colorado.edu

EDUCATION

Ph.D., Biology Major, University of Colorado, Boulder, Colorado, 1993.

Title of Doctoral Dissertation: "Factors Effecting Toxicity of Metals To Brown Trout, An In Situ study of the Arkansas River"

M.S., Biology Major, Chemistry Minor, University of Louisville, Louisville, Kentucky, 1971.

Masters Thesis: "Biological, Chemical, and Physical Characteristics of Brashears Creek, Spencer and Shelby Counties"

B.S., Biology Major, Mathematics Minor, Southern Colorado State College, Pueblo, Colorado, 1968.

PROFESSIONAL EXPERIENCE

Jan 2007
Present

College Instructor
Mesa State College, Grand Junction, Colorado. Scientific Writing, Aquatic Entomology and Fish Biology (Undergraduate)

Jan. 2004
Present

Consultant, Woodling Aquatics, LLC.
Clients include Colorado Trout Unlimited, Colorado State Land Board, Colorado Division of Hazardous Materials and Waste Management, West Slope Water Network, Sierra Club, Western Resource Advocates, Eagle River Watershed Council and Eagle Mine Limited. Prepare technical assessments of environmental issues in aquatic systems. Represent organizations at Colorado Water Quality Control rulemaking hearings and testify as expert witness in US District Court.

Jan. 1994
Present.

University Instructor
University of Denver, Community College, Environmental Policy Management
Instructor , Wetland Ecology, General Ecology, Aquatic Toxicology, Research Writing, Endangered Species and Introduction to Water Quality (Graduate level classes) and capstone student advisor.

Jan 1998
Present

Research Associate
University of Colorado Boulder, Colorado. Awarded US EPA grant in 2003 to study impacts of estrogenic compounds on Colorado fish populations.

Jan. 1997
2003

University Instructor
University of Colorado, EPO Biology. Stream Biology.

July 2002 -
Retired
May 2003

Cost Center Supervisor
Colorado Division of Wildlife (DOW), Denver Colorado

- Principal duty was to manage and supervise water unit of the habitat section, including water quality and Water Quantity aspects of agency goals and objectives.
- Develop budget and work objectives used by DOW to respond to water resource issues.
- Supervised and directed water unit employees to achieve program goals

Designed and developed web-based model to analyze fishery and habitat data for DOW use.

- Participated in state and federal Superfund and CERCLA by development and writing of and/or review of remedial investigation documents, feasibility studies and remedial action plans; negotiate for the state in settlement actions, testify in water quality related hearings and court cases.

July 1987 -
June 2002.

Program Specialist
Colorado Division of Wildlife (DOW), Denver Colorado

- Principal duty was to represent the DOW in all matters pertaining to water quality issues.

Exhibit A

• Developed policy and programs used by DOW to respond to water quality issues.
• Designed and performed laboratory and field research studies of rivers throughout Colorado to define and quantify impacts of pollutants to aquatic ecosystems. Projects included efforts to create biological stream standard proposals for Colorado's eastern plains warm water streams and rivers and mountain trout streams. Potential biological stream standards were developed using results from genetic analysis of trout and aquatic macroinvertebrates, fish community structure modeling and stress hormone response studies on a variety of fish species. Ancillary studies included a multi-year monitoring program of the Eagle River, Arkansas River and Clear Creek to assess efficacy of remediation programs and systematic studies of the fish genera *Phoxinus* and *Cottus* in Colorado.
• Wrote and submitted successful grant applications to receive funding from US EPA, Colorado Department of Public Health and private enterprise for field and laboratory studies.
• Participated in state and federal Superfund and CERCLA by review and/or development of remedial investigation documents, feasibility studies and remedial action plans; negotiated for the state in settlement actions involving fish kills and CERCLA actions.
• Created DOW position in rulemaking hearings for the Colorado Water Quality Control Commission (WQCC) through which stream standards and use classifications are adopted.
• Member Colorado 319 Nonpoint Pollution Task Force.
• Appointed by WQCC to rewrite Colorado Stream Standards for nitrogen compounds.
• Testified as expert witness in court proceedings and rulemaking hearing of the WQCC.

April 1984 - July 1987 — **Coldwater Program Specialist**, DOW

• Developed, implemented and monitored statewide DOW coldwater fishery program.
• Developed annual budgets for DOW–fish hatcheries, aquatics section and aquatic research–$6 million/year.
• Developed statewide DOW fish program budget, including hatcheries.
• Assisted DOW fish hatcheries in increasing production and efficiency.
• Co-authored report that resulted in the reorganization of the DOW fish hatchery system.
• Provided WQCC with technical information regarding water quality issues such as mine drainage.

July 1979 - April 1984 — **Warmwater Program Specialist**, DOW

• Developed, implemented and monitored statewide DOW warmwater fishery program.
• Prepared DOW response to legislative queries regarding annual budget.
• Worked with fish hatcheries to increase production and efficiency.
• Provided WQCC and Colorado Wildlife Commission with technical information regarding water quality issues such as nutrient enrichment and acid rain.

Sept. 1978 - July 1979 — **Project Manager**
Camp, Dresser and McKee, Denver, Colorado.

• Prepared bids, planned and directed interdisciplinary studies. Wrote final reports for these studies.
• Represented power companies, coal mining and other underground mining corporations.

Sept. 1973 - Sept. 1978 — **Research Biologist**
Colorado Water Quality Control Division, Denver, Colorado

• Planned and performed stream and river basin studies concerning impacts of mining, milling, agricultural, domestic and industrial effluents on water quality.
• Monitored and analyzed biological, chemical and physical components of aquatic ecosystems to determine impacts from effluents on these systems.
• Performed in situ assays to determine toxicity of pollutants to resident fish populations.
• Served as expert witness at public hearings and adjudicatory hearings.
• Served as member of subcommittee to develop Colorado water quality standards and use classifications.

Jan. 1971- May 1971 — **College Instructor**

• Taught Human Anatomy and Physiology, University of Southern Colorado.

Sept. 1971- June, 1972 — **High School Teacher**
Cathedral High School, Denver, Colorado.

• Taught high school biology and coached football and wrestling.

July 1968- Dec, 1970 — **Research Assistant**
University of Louisville, Louisville, Kentucky

• Implemented a pre-impoundment study of the Salt River in central Kentucky. Collected and analyzed water quality samples, collected and identified aquatic macroinvertebrate and fish samples.
• Collected and analyzed samples measuring the movement of radioactive nucleotides through a spring-fed system, Doe Run in Kentucky.

Sept. 1966- Dec. 1967. **Laboratory Assistant**
Southern Colorado State College, Pueblo, Colorado.
• Taught laboratory sections in zoology, botany, plant physiology and ecology

PUBLIC SERVICE

Colorado 319 Nonpoint Pollution Council. Voting member 1989-2001.

Cherry Creek Basin Authority. Voting member 2001-2005. Appointed by Governor of Colorado.

PAPERS PRESENTED AT PROFESSIONAL MEETINGS

Woodling, J. 1984. Acid precipitation impacts in the upper Colorado River Basin, a long-term situation . Upper Basin Subtechnical Committee. Western Association of Fish and Wildlife Agencies. Las Vegas, Nevada.

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Woodling, J. 1984. Biologic recovery of Coal Creek: A Colorado stream impacted by mine drainage. 114th Annual Meeting of the American Fisheries Society. Ithaca, New York.

Woodling, J. 1994. The South Platte River from Denver to Nebraska: Water quality monitoring is not a simple process. The South Platte River Forum. Greeley, Colorado.

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Nykerk, S. and J. Woodling. 1996. Nutrient patterns in the mainstem South Platte River, Denver to Julesburg, Colorado: Seasonal and temporal variations, a long-term Tom Sawyer monitoring program. Platte River Basin Ecosystem Symposium. Kearney, Nebraska.

Woodling, J. 1996. What if anything is a redbelly dace in Colorado. 45th annual workshop. Great Plains Fisheries Workers Workshop. Great Plains Fisheries Workers Association. Fort Collins, Colorado.

Woodling, J. 1996. Physiological and weight changes of wild brown trout inhabiting waters with acutely toxic cadmium and zinc concentrations: an *in situ* study. International Congress on the biology of fishes. San Francisco State University. San Francisco, California.

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