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DEPARTMENT OF
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BEFORE THE DIRECTOR
OF THE DEPARTMENT OF WATER RESOURCES
OF THE STATE OF IDAHO

IN THE MATTER OF DISTRIBUTION FOR WATER TO WATER RIGHT NOS. 36-02551 AND 36-07694 (RANGEN, INC.)	**SPRONK WATER ENGINEERS, INC. EXPERT REBUTTAL REPORT DATED FEBRUARY 7, 2013 PREPARED FOR THE CITY OF POCATELLO**

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Expert Rebuttal Report
Dated February 7, 2013
Prepared for the
City of Pocatello

On December 13, 2011, Rangen, Inc. ("Rangen") filed a Petition for Delivery Call ("Rangen Petition," or "Rangen Call") with the Idaho Department of Water Resources ("IDWR") seeking curtailment of ground water rights in the Eastern Snake Plain Aquifer ("ESPA") with priority dates junior to Rangen's water right nos. 36-02551 (July 13, 1962 priority) and 36-07694 (April 12, 1977 priority).

On December 21, 2012, expert reports were filed on behalf of various parties to the Rangen Call, including the following two reports filed on behalf of Rangen:

- Brockway, C.E., Colvin, D., and Brannon, J., 2012. Expert Report in the Matter of Rangen Inc. – Availability of Spring Flow and Injury to Water Rights ("Brockway Report").
- Smith, Charlie E., 2012. Expert Report in Matter of Distribution of Water to Rangen, Inc's Water Right Nos. 36-02551 and 36-07694 ("Smith Report").

This rebuttal report was prepared to respond to certain information and opinions contained in the Brockway and Smith Reports. The opinions described herein are based on our review of the Rangen expert reports, our work since the early 1990s in Idaho, our experience in the review and analysis of water use and other data, and our experience in conjunctive management and administration of ground water and surface water supplies and water rights. This rebuttal report supplements the December 21, 2012 expert report by Spronk Water Engineers, Inc. ("SWE"), and is styled to describe or quote the opinion contained in the Rangen report (in italics), followed by the rebuttal response.

1.0 Rebuttal to Brockway Report

1.1 Source of Water for Rangen Water Rights

Rangen Opinion (p. 6)

Rangen owns five (5) water rights with the designated point of diversion as the Rangen Spring or Martin-Curren tunnel which issues from the Eastern Snake Plain Aquifer (ESPA).

Response

The source of water listed in the Snake River Basin Adjudication partial decrees for the water rights that are the subject of the Rangen Call (36-02551 and 36-07694) and the other Rangen water rights (36-00134B, 36-00135A, and 36-15501) is the Martin-Curren Tunnel.

1.2 Prior Injury Findings

Rangen Opinion (p. 7)

In response to Rangen's first delivery call on September 23, 2003, former Director Karl Dreher issued an order finding material injury to Range water rights 36-02551 (priority July 13, 1962) and 36-07694 (priority April 12, 1977).

Response

Former Director Karl Dreher's first order in response to Rangen's 2003 delivery call was issued on February 25, 2004. In that order, Director Dreher found material injury to Rangen's water right no. 36-02551 (FOF 70; COL 18, 20). However, he found that water was not available to water right no. 36-07694 at the time of its appropriation or anytime thereafter (FOF 53, 54, and 63), and that Order contained no finding of injury to this water right.

The Second Amended Order issued by the Director on May 19, 2005 revised the prior orders concerning water right no. 36-02551 and found there was no material injury to the Rangen based on determination that curtailment of ground water rights junior to July 13, 1962, the priority date for water right no. 36-02551, will not at any time result in a meaningful increase in the quantity of water discharging from springs in the Thousand Springs to Malad Gorge spring reach; which includes the Curran Spring from which Rangen diverts (FOF 84). As a result of this finding, the Director determined the Rangen Call was futile (COL 25) and that Rangen's delivery call should be denied (COL 28).

1.3 Conditions at Time of Site Visits

Rangen Opinion (p. 8)

At the time of the site visits by the Rangen experts, there was not enough flow to operate the small raceways, leaving them dry.

Response

Based on information provided by Rangen after the reports were filed, the following is a list of the site visits that were made by the Rangen experts:

Date of Visit	Expert Attending	Total Rangen Flow (cfs)
June 21, 2012	Dave Colvin	12.3
July 24, 2012	Charlie Smith	11.6
September 18, 2012	Chuck Brockway	15.2
October 1, 2012	Chuck Brockway	16.6
October 4, 2012	Charlie Smith	16.6
October 29, 2012	Chuck Brockway	20.1

Figure 1-1 is an illustrative depiction of when the various raceways contained fish during 2012 and are projected to contain fish in 2013 for the three primary fish production cycles that presently occur at the Rangen Hatchery. These egg cycles are designed to provide adult fish under the Idaho Power contracts for the early spring and fall plants in the Snake River, and the late spring plant in American Falls Reservoir. Rangen has not provided Monthly Fish Inventory reports for 2012, and therefore the raceway content information shown in **Figure 1-1** is based on typical historical practices for prior years. The raceway content information for the spring and

fall production cycles are consistent with the Idaho Power Hatchery Production Summaries for 2012.

Also plotted in **Figure 1-1** are the dates when the Rangen experts made site visits to the Rangen Hatchery in 2012. The site visits in June, July, September, and early October occurred at times when the Small Raceways typically do not contain fish pursuant to the fish production cycles that Rangen uses to satisfy the delivery requirements under the Idaho Power contracts. Under the current fish production schedule, the only outdoor raceways that typically contain fish between June and early October are the Large Raceways that contain fish for the fall plant in the Snake River.

While the Brockway Report indicated there were no fish in the Small Raceways during the site visits of the experts, Dr. Brockway's photographs from his October 29, 2012 site visit clearly show water and fish in the Small Raceways. Furthermore, Deposition Exhibit 80 shows that Rangen had fish in two sets (of 5 ponds) of the small raceways on October 27. This information is consistent with an October 22, 2012 entry in the research notebook maintained by Doug Ramsey, Rangen's Research Scientist, that indicates there were two sets of Small Raceways in operation. The fish in the Small Raceways on October 29, 2012 would have been for the spring production cycle for Idaho Power as illustrated in **Figure 1-1** and were also involved in an ongoing Rangen research study. (Ramsey, 259-260)

Figure 1-1 also includes a line graph depicting the flow hydrograph for 2012. Rangen typically has fish in the Small Raceways for approximately one month starting in early January, mid-May, and late-October. The flow available to Rangen at these times spans the range of flows that are currently available to Rangen.

To summarize, the Small Raceways were not in operation during the site visits of the Rangen experts that occurred between mid-June and early October, because of the production cycles that Rangen uses to satisfy its contracts with Idaho Power. However, based on review of the flows that are have been utilized in the past to operate the Small Raceways, there was sufficient flow available during the site visits of the Rangen experts to operate the Small Raceways had Rangen chosen to do so.

1.4 Accuracy of Rangen Flow Measurements

Rangen Opinion (p. 9)

During site visits LRE and Brockway Engineering observed Rangen employees collecting flow measurements. The discharge table used by Rangen employees appears to match most closely with a standard rectangular contracted weir formula with a coefficient of 3.09 rather than the typical 3.33 coefficient. This would account for the fact that the 2-inch boards over which the water flows are not sharp crested, as is assumed in the standard rectangular contracted weir formula. The use of a modified weir coefficient of 3.09 applied to board overflow is consistent with standard practice on aquaculture facilities

Simplified weir flow calculations and a plot of the comparison of the Rangen discharge table and a standard rectangular contracted weir are presented in Appendix A along with the look up table that Rangen staff use. Review of the measurements indicates that the Rangen staff lookup tables are likely to be more accurate than the flow calculations presented in Appendix A. The standard rectangular weir discharge using a USBR weir flow calculations were within 8% of the Rangen staff reported flows. Additionally, Frank Erwin indicated that he has checked the Rangen staff measurements and that they are accurate. Furthermore, he has stated that Rangen measurements are more accurate than his own. (Deposition of Frank Erwin, Sept. 13, 2012).

Response

The rate of flow available for use by Rangen is determined by summing the flow measured in the CTR Raceways and the flow measured over the Lodge Dam in Billingsley Creek. Rangen also measures the flow in the Small Raceways and Large Raceways for its internal use. After reviewing the procedures used by the Rangen staff to measure the flow, it is likely that there are significant flow measurement errors that result in Rangen significantly under-measuring the flow that is actually present in the raceways and passing over the Lodge Dam. The two largest sources of error are (a) the rating tables that Rangen uses to convert the measured depth of flow to a discharge rate are likely inappropriate for the measuring devices at the Rangen Hatchery, and (b) the location that the Rangen staff measures the flow does not conform with industry standards for flow measurement.

The following rebuttal concerning Rangen's flow measurement practices begins with discussion of how Rangen measures the flows through the Raceways and at the Lodge Dam. This is followed by discussion of the standard weir devices for measuring water flow, and how the Rangen devices do not conform to the standard devices. Next is a discussion and analysis of the Rangen measurement procedures, including the nature of the measurement errors and quantification the potential magnitude of the measurement errors.

Rangen Measurement Procedures

Rangen estimates the flow in the raceways by measuring the depth of water flowing over check boards located in the raceways and converting the depth to a flow rate in cubic feet per second ("cfs") based on certain rating tables. The rating tables that are used by Rangen to determine the raceway flows are included in **Appendix A** ("Rangen Tables") and consist of a separate rating table for each raceway type and for the Lodge Dam. The information used to derive the figures in the rating table has not been provided by Rangen. There is a note at the bottom of the tables stating, "table adjusted for measurement over 2" boards," however the basis for the adjustment has also not been provided.

Background on Weir Measuring Devices

Appendix A of the Brockway Report includes a comparison of the Rangen rating table for the CTR Raceways to rating tables computed using standard weir equations for (a) a rectangular suppressed weir, and (b) a rectangular contracted weir, each with a standard discharge coefficient of 3.33, and a modified discharge coefficient of 3.09. The following is the standard equation for computing the flow over a weir:

$$Q = C \times L \times H^{1.5}$$

where

Q = Discharge (cfs)
C =Discharge coefficient (varies by weir type)
L = Weir length (ft) (subtract 0.2 x H for contracted weir)
H = Measured head (ft)

The standard weir equation shown above with a coefficient of 3.09 is also used as the standard broad-crested weir equation (King 1976).

Illustrations of the three standard weir types and the associated flow equations are provided in **Figure 1-2a and 1-2b**. Descriptions of the standard weir types are provided below.

- Suppressed Rectangular Weir – A sharp-crested weir that spans the width of the flow channel such that the sides of the weir are coincident with the sides of the channel. As a result, the jet of water that flows over the weir (a.k.a. flow nappe) does not contract laterally (i.e., the side contractions are suppressed). The sharp crest of the weir results in the flow nappe springing upward vertically from the upstream face of the crest. The underside of the nappe must be fully aerated so that there is atmospheric pressure above and below the nappe. The vertical sidewalls continue downstream from the weir so that there is no lateral expansion of the overflow jet.

- Contracted Rectangular Weir – A sharp-crested weir with side contractions at least twice the maximum measurement head that result in the nappe fully contracting laterally at the ends and vertically at the upstream face of the crest. The jet of water that flows over the weir is narrower than the weir opening. Because of the lateral contraction, the nappe is fully aerated.

- Broad-Crested Weir – A weir that spans the channel with a broad crest in the direction of flow that supports the flow so that the nappe does not spring free from the upstream face as for a sharp-crested weir. The crest is sufficiently broad to exceed twice the measured flow depth above the weir crest. The flow across a broad-crested weir will transition through critical depth and become uniform along a portion of the crest.

Differences Between Rangen Measuring Devices and Standard Weirs

Photographs of the Lodge Dam and the check dams in the Small Raceways, Large Raceways, and CTR Raceways taken by the Rangen experts are included in **Appendix B**. Rangen has not indicated whether the photographs are of the actual check dams where the measurements occur, however it is believed that the configuration of the check dams where the flows are measured are similar to the check dams shown in the photographs. Comparison of the photographs in **Appendix B** to the diagrams in **Figures 1-2a and 1-2b** indicates that the raceway check dams do not match any of the standard weir configurations. The following are among the deviations of the Rangen check dams from the standard weir configurations:

- The Rangen check dams do not conform to specifications of sharp-crested weirs because there are not sharp crests on the overflow dam boards or the concrete side walls of the area through which the flow leaves the raceways. The check boards reportedly are two-inch wide boards that may be worn and irregular.
- The Rangen check dams do not conform to the specifications of a rectangular suppressed weir because there are lateral contractions so that the crest widths are less than the width of the raceways (approach channel).
- The Rangen check dams do not conform to the specifications of a contracted weir because the lateral contractions are less than twice the maximum measured head and the flow nappe does not spring clear from the side walls of the weir.
- The Rangen check dams do not conform to the specifications of broad-crested weirs because the 2-inch crest width is less than twice the measured head (except when measured heads are less than 1 inch).

Because the Rangen check dams do not conform to the standard weir configurations, use of the standard weir equations to compute the flow from the measured head most likely would not result in accurate determination of the raceway discharges or the discharge over the Lodge Dam. In these circumstances, it is appropriate to calibrate the weirs based on flow measurements to establish empirical rating tables that describe the relationship between discharge and measured head.

Potential Errors in Rangen Flow Measurements

Review of the scientific literature on weirs, comparison of the data in the Rangen Tables to discharge relationships for various weir types, and consideration of the method that Rangen uses to measure the depth of flow over the weir crests indicate that Rangen's flow measurements are most likely substantially in error, and most likely understate the actual raceway flows and the flow over the Lodge Dam. A discussion of the nature of the measurement errors follows:

Rangen Stage-Discharge Table Irregularities

The Brockway report indicates the stage-discharge relationship reflected in the Rangen discharge tables closely matches that of a contracted weir with coefficient of 3.09, which essentially is the equation for a broad-crested weir. However, except at very low flows, the Rangen check dams do not conform to the standards of a broad-crested weir. As described above, a weir will function as broad-crested when the width (aka breadth) exceeds twice the measured head. The flow across a broad-crested weir transitions to horizontal and uniform across the weir crest. If the weir is not broad enough, then the flow will continually contract across the weir, and the discharge will be different than would be computed using the standard broad-crested weir equation with a 3.09 discharge coefficient. Review of flow measurement data provided by Rangen for the period from June 2011 – April 2012 indicate that the typical maximum measured depths in the Small Raceways, Large Raceways, and CTR Raceways are 2 inches, 10 inches, and 6 inches, respectively. At these depths, the measurement weirs would have to be at least 4 inches, 20 inches, and 6 inches wide, respectively, to operate hydraulically as broad-crested.

When the measured head exceeds 1 to 2 times the width of the crest, the nappe will ordinarily spring clear and the weir will hydraulically operate as sharp-crested (Chow 1964, King 1976). For the 2-inch Rangen weirs this would occur when the measured head exceeds 2 to 4 inches. Experiments on the relationship between head, crest width, and discharge show that the discharge coefficient in the weir equation increases with the ratio of the head to crest width (H/B) (King 1976). As shown in **Table 1-1**, the discharge coefficient increases from about 2.7 to 3.3 as H/B increases up to 2.0. The relationship in **Table 1-1** indicates that the steepness of the slope of the discharge coefficient increases as the crest width narrows.

I developed stage-discharge tables for the Rangen check dams using the discharge coefficient relationship between head and breadth shown in **Table 1-1** for a 6 inch weir, which is the narrowest weir for which data were available, and the geometry of the Rangen dams (King 1976). The results are shown in **Tables 1-2 to 1-5** for the check dams in the Small Raceways, the Large Raceways, the CTR Raceways, and the Lodge Dam, respectively. These discharge relationships are referred to herein as "Hybrid Weirs" based on their function as broad-crested weirs at low heads and sharp-crested weirs at higher flows. Also contained in **Tables 1-2 to 1-5** are the corresponding discharges from the Rangen Tables shown in column (1).

For comparison purposes, I derived the discharge coefficients that are implicit in the Rangen Tables by solving for the discharge coefficient using the standard weir equations. Because the geometry of the Rangen check dams is somewhere in between the geometries of a suppressed weir and a contracted weir, the discharge coefficients implicit in the Range Tables were derived using the equations for both weir types. The results of these analyses are shown in column (5) for the suppressed weir equation and column (6) for the contracted weir equation. The difference between the discharge coefficients derived for the two standard weir equations are relatively small, and neither sets of coefficients match the 3.09 discharge coefficient that the Brockway Report asserts is most closely appropriate for the Rangen check dams. Graphs of the computed discharge coefficients from the Rangen Tables are shown in **Figures 1-3 to 1-6**.

As was noted by the Rangen experts in Appendix A of their report, there are two unexplained abrupt changes in the stage-discharge relationship for the Rangen Tables. These abrupt changes are reflected in the abrupt changes in the discharge coefficients for the Rangen Tables shown in **Figures 1-3 to 1-6**. In addition to the abrupt changes, the discharge coefficients derived from the Rangen Tables reflect an unexplained gradual declining slope as the head increases. Notwithstanding these unexplained changes, the discharge coefficients for the Hybrid Weirs are of similar magnitude to the discharge coefficients implicit in the Rangen Tables for the raceways for heads less than approximately three inches. For heads greater than three inches, the discharge coefficients for the Hybrid Weirs diverge from the Rangen Table discharge coefficients as the function of the Rangen check dams transitions to that of a sharp-crested weir.

Discharges computed using the Hybrid Weir relationships are shown in column (9) of **Tables 1-2 to 1-5**, and are plotted with the discharges from the Rangen Tables in the middle graphs in **Figures 1-3 to 1-6**. The differences between the Hybrid Weir discharges and the discharges in the Rangen Tables are shown in columns (10) and (11) of **Tables 1-2 to 1-5**. The percentage differences are plotted in the lower graphs in **Figures 1-3 to 1-6**. The following is a summary of the range of differences between the Hybrid Weir discharges and the Rangen Table discharges under average conditions, and the range of difference reflected in the stage-discharge tables.

Structure	Head for Average Condition (inches)	Difference in Discharge at Under Typical Operation	Range of Differences in Discharges
Small Raceways	2	-3.8%	+3.7% to -10.2%
Large Raceways	5	-7.3%	+0.8% to -10.2%
CTR Raceways	5	-8.0%	+1.1% to -10.9%
Lodge Dam	4	-15.1%	-6.4% to -20.2%

The Rangen check dams appear to operate as in between suppressed rectangular weirs and contracted rectangular weirs. As described above, a contracted weir has side contractions that exceed twice the measured head. Based on the typical measured head of 5 inches, the side contractions for the Rangen check dams would need to exceed 10 inches. However, the photographs in **Appendix B** indicate the side contractions are likely less than 3 inches. Further, in a standard contracted weir, the flow springs from the vertical walls of the flow opening resulting in a contracted flow jet. The photographs in **Appendix B** show the flow does not contract, but rather adheres to the concrete side walls. The difference in the flow equations for the suppressed and contracted rectangular weirs is the reduction in the effective weir length (L) to account for the laterally contracting flow through a contracted weir. The reduction to the weir length is 0.2 x the head over the weir. Based on a typical flow depth of 5 inches, the flow through a 44-inch contracted weir would be 2.3% less than through a comparable suppressed weir.

Location of Head Measurements

According to information provided by Rangen, the head behind the check dams is improperly measured by the Rangen staff. The head measurement used in a standard weir equation is the difference between the crest elevation and the water surface measured at least four times the maximum head on the crest (King 1976). Based on review of the recent measurement records provided by Rangen, the maximum head on the crest of the dams in the Large Raceways and the CTR Raceways is approximately 6 to 10 inches, and therefore the flow should be measured at least 24 to 40 inches upstream from the dam. According to deposition testimony, the head measurements at the Rangen check dams are made at the upstream face of the dams, and this is shown in photo B-11 in **Appendix B**. (Erwin, 56:17-23; Tate, 127:24 – 128:4). The purpose of measuring the head upstream of the weir is that the measurement should represent the total energy contained in the flow. Upstream of the dam, where the flow velocity is relatively small, the measured head approximately measures the total energy of the flow (as potential energy) (King 1976). As the flow approaches the check dams, the velocity increases and a portion of the flow energy is transformed into the kinetic energy of the velocity head ($V^2/2g$), and there is a corresponding drop in the elevation head. The difference between the water surface elevation at the dam and upstream of the dam is illustrated in **Figure 1-2b**.

According to the Bureau of Reclamation, if the head on is measured too close to the weir, the head measurement can be up to 0.1 feet too small. For a head of 0.45 feet, a measurement error of 0.1 feet would translate into under-measurement of the flow by 35 percent (BOR 2001). The data in **Tables 1-2 to 1-5** were reviewed to assess the likely under-measurement of the Rangen discharge that results from measuring the head at the check dams rather than further upstream. If the head measurement at the dam was 0.1 feet (1.2 inches) less than the head measured at the correct location further upstream, this would translate into under-measurement of the flow by 28 percent to 33 percent at the average head condition for the Large Raceways, the CTR Raceways, and the Lodge Dam using the Hybrid Weir discharge tables. The small raceways are typically operated with less head over the check dams. If the head in the small raceways was under-measured by 0.5 feet, this would translate into an under-measurement of the discharge by 31 percent at the average operating condition of 2 inches of head at the check dam.

Other Potential Measurement Errors

It is unclear whether the space under the flow nappe for the Rangen check dams and the Lodge Dam would be fully aerated at all discharges. If there is no aeration, then a partial vacuum can occur under the nappe that pulls the water surface downward. To the extent that this occurs, the water surface elevation over the dam will be less than it would be if the nappe was vented, and the discharge will be greater for the same measured head (King 1966).

The condition of the check dam boards may also lead to under-measurement of the raceway and Lodge Dam flows for at two reasons. First, the effect of rounding of the upstream corner of a broad-crested weir is to increase the discharge for a given head (King 1976). To the extent that the wooden check dam boards in the Rangen structures are significantly worn, the result could be rounded edges on the upstream face. Another reason for flow under-measurement would be flow that passes between check dam boards rather than over the top of the check dam. Photo B-10 in **Appendix B** appears to show this occurring in the middle section at the lower check dam in a CTR Raceway with the presence of "whitewater" part way down the flow nappe.

Summary

The Brockway Report states that use of contracted weir equation with a modified coefficient of 3.09 applied to board overflow is "standard practice" on aquaculture facilities, however there is no explanation of this characterization of standard practice. In any event, even if use of a 3.09 coefficient is standard practice, the discharge coefficients implicit in the Rangen Tables that are shown in columns (5) and (6) of **Tables 1-2 to 1-5** and plotted in the upper graph in **Figures 1-3 to 1-6** are significantly different than 3.09.

Based on the foregoing discussion, it is most likely that Rangen is significantly under-measuring the flows through the raceways and at the Lodge Dam. The extent of the under-measurement could range from 30 percent to 40 percent or more. The actual amount of any under-measurement of flow can be determined by conducting discharge measurements in the raceways and in Billingsley Creek using a current meter at various discharges to establish a calibrated rating table for each structure. The discharges determined using the calibrated rating table can be compared to the discharges determined by the procedures that the Rangen staff members have been using (measured stage at the upstream face of the check dams and converted to discharge using the Rangen Tables).

To the extent that the available flow for the raceways has limited the amount of fish that Rangen has produced in the past and is currently producing (e.g., because of the flow index criteria in Rangen's contracts with the Idaho Power Company; see the December 2012 SWE Expert Report for discussion of the flow index limits on Rangen's fish production), then Rangen could be raising more fish if it actually had more flow than its measurements indicated. This would indicate that Rangen has been wasting water by not fully utilizing the available flow.

In addition, because the Rangen flow measurements were used as a calibration target in the calibration of the ESPAM 2.1, significant under-measurement of the flows during the calibration period calls into question the model calibration to the Curren Spring flows, and would likely require that the model be re-calibrated.

1.5 Feasibility of Recirculation System

Rangen Opinion (p. 11)

Alternative 6 presents the idea of pumping back used water from below the Rangen Research Hatchery back up to the research buildings and raceways. This would require significant treatment of the water, redundant power systems, and could injure downstream senior water rights. Rangen's use of water had historically been non-consumptive and a sustainable pumpback system with sufficient water treatment would likely be an expensive system with some amount of water consumption.

Response

The Rangen experts have provided no evidence of the amount of water treatment that would be required in developing a pump-back system. In depositions, Rangen staff testified that there were limitations on fish production resulting from dissolved oxygen levels, ammonia levels, or other constituents. (Ramsey Vol. I, 27:4 – 6; Kinyon, 19:2-4; Tate 37:8-9). Based on this testimony, there would likely be some additional production capacity left in the Rangen water supply through a pump-back system.

Water consumption in the fish facilities at the Rangen Hatchery occurs primarily through evaporation from the exposed water surface area of the troughs, tanks, and raceways. The only additional consumption that would occur in the raceways with a pump-back system would be the evaporation from the additional raceways that could be operated. Rangen has not provided information on the consumptive use that would occur through any necessary water treatment. Any additional water consumption that would occur through the operation of a pump-back system through additional evaporation or water treatment would likely be within the scope of the water uses permitted under Rangen's water rights.

The Rangen experts presented and rejected six alternatives for increasing the water supply to the Rangen Hatchery. None of these alternatives included the most promising and logical alternative that is pumping water up to the Small Raceways (and Hatch House or Greenhouse if necessary) from the collection area behind the diversion dam for the Large Raceways. This "pump-up" alternative would alleviate the limited flow that is currently available to the Small Raceways from the Curren Tunnel, which is the most significant limitation on the production of additional fish according to the Rangen staff.

1.6 Recommendation of ESPAM by the ESHMC

Rangen Opinion (p. 12)

ESPAM 2.0 was recommended by the ESHMC and adopted by IDWR in July 2012. The ESHMC recognized the improvements to the prior model and recommended that IDWR begin using ESPAM 2.0 instead of ESPAM 1.1.

Response

The ESHMC did not provide an unqualified recommendation of the ESPAM 2.0 in July 2012. The qualified recommendation of the ESHMC meeting was described in a July 16, 2012 email from Rick Raymondi to Gary Spackman. In that email, the following recommendation from the ESHMC members was provided:

> "The Eastern Snake Hydrologic Modeling Committee recommends that the Department begin using ESPAM version 2 rather than ESPAM version 1.1 for ground water modeling."

The following qualification to the above recommendation was added by Greg Sullivan and Chuck Brendecke:

> "…..although other tools or models may be more appropriate in certain circumstances."

A longer qualification to the committee recommendation was added by Bryce Contor.

Correction of an error in ESPAM 2.0 resulted in IDWR producing a revised model identified as ESPAM 2.1. The revised model received the same qualified recommendation from the ESHMC members, except for a change in the qualification from Bryce Contor.

1.7 Timing of Curren Spring Response to Curtailment

Rangen Opinion (p. 13)

The evaluation of the depletive impact to the springs relied upon Rangen, utilizing the above IDWR procedure and the ESPAM 2.1 ground water model, shows an impact from curtailment of ground water pumping with the area of the model under water rights junior to July 13, 1962 of 17.9 cfs at steady state. It is estimated using the transient ESPAM 2.0 model that a recovery to 90% of the steady state value (16 cfs) will occur within approximately 15 years.

Response

The Rangen experts state that results from the ESPAM 2.1 show that 17.9 cfs will accrue to the spring relied upon by Rangen at steady-state following curtailment of water junior to July 13, 1962. This statement should not be interpreted to mean that the model shows that the flow of the Curran Spring will increase by a flat rate of 17.9 cfs year around. Instead, the model results indicate there will be seasonable variability in the increase in flow at the Curran Spring as a result of curtailment.

1.8 Benefit to Rangen from Curtailment

Rangen Opinion (p. 21)

Utilization of the increased spring discharge within the Rangen Research Hatchery will allow increased fish production as well as rehabilitation of research facilities and historical fish propagation research.

Response

No data or analyses were provided to support the opinion that Rangen would increase fish production with the additional flow. As described in my December 2012 Expert Report, the available evidence shows that Rangen has sufficient flow to meet the delivery obligations that are set forth in its contracts with the Idaho Power Company. As shown in Figure 4-2 of the 2012 SWE Expert Report, Rangen's current annual fish production is approximately 10,000 pounds per cfs of average annual total Curren Spring flow. In the past, Rangen routinely produced 15,000 to 20,000 pounds per cfs. This indicates that Rangen could be producing more fish but for whatever reason has chosen not to do so. Further, Rangen has submitted no specific plan or information describing whether and how it would produce more fish if it had more water.

No data or analyses were provided to support the opinion that Rangen could rehabilitate its research facilities. It would appear that Rangen could rehabilitate the physical condition of the research facilities without regard to the available flow.

No data or analyses were provided to support the opinion that Rangen could rehabilitate its historical fish propagation research. As described in the December 2012 SWE Expert Report, the available evidence shows that there currently is sufficient flow from the Curren Tunnel to support the research studies that have been conducted in the past in Rangen's indoor research facilities and most of the studies in the Small Raceways. It is only during the low flow portion of the Curren Tunnel hydrograph when there may not be sufficient flow to run some of the studies that have historically been performed in the Small Raceways.

An overarching implication in the Brockway Report is that depletions predicted by the ESPAM 2.1 model from junior ground water users equals injury. This is not how the prior versions of the ESPAM have been used in delivery calls. Only after it has been proven that a senior water user is suffering material impacts due to water shortages caused by junior ground water users has the Department used the ESPAM to assess the magnitude of the shortage resulting from junior ground water use that was causing the injury.

1.9 Benefits to Others from Curtailment

Rangen Opinion (pp. 21-22)

Additional benefits from curtailment of junior ground water users would occur as follows:

- *Increased flow for the benefit of hundreds of water rights in the Billingsley Creek system.*
- *Increased discharges at other developed springs for irrigation and other uses.*
- *Increases in Upper Snake River reach-gains for the benefit of irrigators with senior water rights. fish producers using spring water, for stabilizing existing water supplies for irrigation and for in-stream uses, including hydropower production.*
- *Enhancement of water quality and fisheries.*
- *Increased ground water levels in the ESPA.*

Response

The incidental benefits to other water users that would result from curtailment of junior ground water users are not relevant to the Rangen Call. To the extent that these other water users believe they are injured by the use of ground water by holders of junior priority ground water rights, these other users are free to make their own delivery calls. In addition, there have been other delivery calls, and in some instances, mitigation water is being provided to offset the impact of junior ground water uses. In these instances, the senior users are already being mitigated and aren't entitled to the windfall that would occur from widespread curtailment of pumping.

2.0 Rebuttal to Smith Report

2.1 Conditions at Time of Site Visits

Rangen Opinion (pp. 1-2)

I visited the Research Hatchery on July 23-25, 2012 where I reviewed the hatchery water system, the hatchery configuration, determined where pipelines originated and if all water was put to beneficial use. Based on the empty tanks in the Research Hatchery and hatch/house/early rearing building, as well as the majority of empty outside raceways where most of the fish production occurs, it was clear that insufficient water flow was a major limiting factor at the hatchery.

Response

See the response to Issue No. 1 in Brockway Report. As described in the December 2012 SWE Expert report, Rangen is producing substantially less pounds of fish per cfs of average annual flow than it used to, and is also conducting much less research even though the Rangen staff have testified that the available flow only limits their research in one month out of the year (June).

2.2 Use of Small Raceways

Rangen Opinion (p. 6)

Fingerlings are moved to outside concrete nursery ponds at 2.5 to 3.0 inches in length where they are held for 2.5 to 3.5 months. Currently, the nursery ponds are not being used due to insufficient water flow. Maximum capacity of each nursery pond is 30,000 fish weighing 1100 pounds.

Response

Contrary to the above opinion, Rangen's Monthly Fish Inventory Reports and Idaho Power Hatchery Production Summaries show that fish are present in the Small Raceways for approximately one month during the typical 9-month production cycle. Because Rangen has chosen to limit its current operation to three production cycles per year, the Small Raceways are empty during most of the year. Based on review of the flows that are have been utilized in the past to operate the Small Raceways, there was sufficient flow available during most of the year, including during the site visits of Dr. Smith, to operate the Small Raceways had Rangen chose to do so. See also the response to Issue No. 3 in the Brockway Report.

2.3 Rangen is Using All of the Currently Available Water

Rangen Opinion (p. 9)

I visited the Research Hatchery on two different occasions. Rangen was using all of the water available at those times in a reasonable manner to raise fish. Rangen was not wasting water.

Response

It is unclear whether the conditions in the various raceways that Smith describes were present at both of his visits or only at one of the visits. Smith did not describe the investigation that he undertook to render his opinion that Rangen was not wasting water. It is therefore unknown what factors he considered. For example, he did not state how much water may have been left undiverted in Billingsley Creek and was passing over the Lodge Dam. He did not indicate if he investigated whether Rangen could have raised more fish with the flow that was being diverted. He did not indicate whether he verified that Rangen was accurately measuring the flow that they were using.

Rangen Opinion (p. 9)

Rangen Research Center & Hatch House (incubation & early rearing): There was no water flowing into this building for hatching, early rearing or research projects. Due to insufficient water flow the water was being used in other areas of the facility because with limited flows there was no ability to put another crop of fish through the facility.

Response

The water supply for the Hatch House and Greenhouse comes from the Curren Tunnel. Flow measurements for the Curren Tunnel were discontinued by IDWR on December 31, 2011. Based on records from recent prior years, the Curren Tunnel flow was likely in the range of 2 cfs during Smith's first visit and 6 cfs during his second visit. Since no water was being used in the Small Raceways, all or a portion of the estimated Curren Tunnel flow could have been run through the Hatch House or Greenhouse for research or fish rearing using. According to the Rangen Trout Research Hatchery Outline of Operations (Bates 16795) ("Operations Outline"), 0.80 cfs is used to run all of the troughs in the Hatch House. Data compiled from the Rangen flow records and summarized in Figure 2-9 of the December 2012 SWE Expert Report shows that an average of 0.61 cfs is needed to run all of the research tanks in the Green House. As a result, there was sufficient flow available to operate these facilities.

Rangen Opinion (p. 9)

Small Raceways: All 20 raceways were empty. Due to insufficient water flow the water was being used in other areas of the facility because with limited flows there was no ability to put another crop of fish through the facility.

Response

The water supply for the Small Raceways also comes from the Curren Tunnel. As shown in the updated Figure 2-9, an average of 1.11 cfs is required to run one of the Small Raceway sets (of 4 narrow ponds and 1 wide pond). Therefore, there was sufficient flow available to operate the Small Raceways at the time of the Smith visits.

Figure 2-1 shows the monthly inventory of fish by raceway for the period that such data were provided by Rangen (September 2006 through June 2010). While Rangen leaves the Small Raceways empty for many months during the year because it has chosen to limit its operations to the three production cycles required for its Idaho Power contracts, review of the inventory data shown in **Figure 2-1** indicates there have been months in the past when there were fish in the Small Raceways at times when the Curren Tunnel flow was less than when Smith made his site visits. As described above, during Smith's visit in October 2012 there were approximately 6 cfs flowing from the Curren Tunnel. The data in **Figure 2-1** show that between September 2006 and June 2010 there were nine months when there were fish in the Small Raceways and the Curren Tunnel flows was less than 6 cfs. During Smith's visit in July 2012 there were approximately 2 cfs flowing from the Curren Tunnel. The data in **Figure 2-1** show that between September 2006 and June 2010 there were three months when there were fish in the Small Raceways and the Curren Tunnel flows was less than 2 cfs.

Rangen Opinion (p. 9)

Large Raceways: There are 10 rows of 8 X 80 X 3 ft raceways, 3 in each row. Of these only 3 rows were receiving water, each pond/raceway was receiving 3.8 CFS water flow. Maximum load in each of these was approximately 10-12,000 fish averaging 5 fish/lb. Normal flow at maximum loading when sufficient water is available is 5.5 CFS. Thus, there were 21 empty raceways because of insufficient water flow to raise more fish.

Response

The Large Raceways can be supplied from all of the water available to Rangen from the Curren Spring. According to the Operations Outline, 3.34 cfs is required to run one string of Large Raceways. Therefore, based on the total flow from the Curren Spring, 3 Large Raceway strings (of three ponds) could have been operated during Smith's July visit and 5 Large Raceways strings could have been operated during Smith's October visit.

Rangen Opinion (p. 10)

CTR Raceways: There are 12 concrete rearing ponds (180 X 16 X 3 tt) with 3 raceways having 3 ponds in a series. The center row is being used as a settling area for solid waste from rearing ponds during cleaning. Only one of these ponds, two raceways was being used for fish rearing at this time since there was not enough water to raise more fish. Water flow into the pond was 10.8 CFS.

Response

The CTR Raceways can be supplied from all of the water available to Rangen from the Curren Spring. According to the Operations Outline, 8.4 cfs is required to run one string of CTR Raceways. Therefore, based on the total flow from the Curren Spring, two strings of CTR Raceways could have been operated during Smith's October visit.

Rangen Opinion (p. 10)

Due to low water flows eggs are now only purchased 3 times a year, whereas in the past they were purchased every other month to allow continuous cropping of fish.

Response

Rangen current operations are designed for three fish production cycles per year to provide adult fish under the Idaho Power contracts for the early spring and fall plants in the Snake River, and the late spring plant in American Falls Reservoir. There is no apparent reason why Rangen could not change its operations to conduct more than three fish production cycles per year if it wanted to.

2.4 Rangen Could Raise More Fish and/or Conduct More Research if More Water Was Available

Rangen Opinion (p. 10)

The primary factor limiting the carrying capacity of the Rangen Facility is the availability of water. All other factors being equal, each relative increase in the flow of water would allow Rangen to raise more fish at this facility. The following table summarizes my calculations of the fish that could be raised at various flows in order to illustrate this conclusion. The calculations were made using an unpublished spreadsheet program for estimating the carrying capacity of salmonids in hatcheries based on rate of oxygen consumption, level of crowding and feeding rate. Carrying capacity is the animal load a system can support. The program was developed by Mr. Joe Banks, Fishery Research Biologist, U.S. Fish & Wildlife (Retired). Determining the carrying capacity as related to oxygen in the water is based on the Cannaday and Piper Flow Index table in the book, Fish Hatchery Management on page 69 (Piper, et al. 1983, 2nd *printing). See also pages 63-74. The parameters used for the calculations are detailed on attached Exhibit 3.*

These calculations are conservative estimates of pounds of production at the Research Hatchery based upon water flows of 15 (current), 35, 55 & 75 CFS for the greenhouse/hatch house, small raceways, large raceways, and CTR raceways. Size of fish is average size at time of harvest from the small, large & CTR raceways.

<u>Response</u>

As described above, the Table from the Smith Report purports to show the pounds of fish that could be raised at the Rangen Hatchery at the current flow of 15 cfs, at 35 cfs, at 55 cfs, and 75 cfs. The flow rates are assumed to be constant year-round, an assumption that is contrary to the substantial seasonal flow variations in the Curren Spring flow. Smith provided opinions on the pounds of fish that Rangen could produce at various flow rates assuming that fish production was limited by certain (a) Flow Index values, and (b) Density Index values. His opinions are summarized in the Table attached to his report.

Supporting information for the results in the Smith Table are supposedly provided in Exhibit 3 attached to his report, and in an unpublished spreadsheet model that he provided (Banks 2006). However, in reviewing Exhibit 3 and the spreadsheet model runs it was found that the backup information was difficult to understand and was often inconsistent with the results in the Table. The following is an explanation of some of the problems and inconsistencies.

- There was no analysis provided for the small raceway results.
- Smith provided five runs of the spreadsheet model, of which three were for the Large Raceways ("8 x80 5 CFS DI", "8 x80 15 CFS DI", and "8 x80 5 CFS") and two were for the CTR Raceways ("CTR 35 CFS" and "CTR 35 CFS fresh water top pond"). Smith described at least 24 runs in the Table and Exhibit 3, and therefore, there were at least 19 model runs that were not provided.
- The model runs provide several forms of output data and results for different constraints. Smith was not clear on which output data he used for his analysis.

- The results in the Table typically did not agree with the information in Exhibit 3 and with the limited model runs that were provided. For example, in the "8 x80 15 CFS DI" run, the model computes that a maximum of 5,812 pounds of fish that could be produced in one of the Large Raceways using a maximum Density Index of 0.3. Smith states that 9 large raceways could be in use with 15 cfs of available flow. Multiplying 5,812 pounds/raceway by 9 raceways equals a maximum capacity of 52,308 pounds. However, Exhibit 3 shows a maximum capacity of 53,847 pounds for this scenario. Further, the Table in Smith's Expert Report shows a maximum capacity of 45,599 pounds for this scenario.

In general, because of the lack clearly defined input data and output data, most of the results in the Table could not be reproduced.

Table 2-1, attached hereto, is an attempt to match the information contained in Exhibit 3 and the inputs and outputs of the unpublished spreadsheet that Smith relied upon to the results shown in the Smith Table. The upper part of Table 2-1 shows information from Smith's analysis of the production capacity of the Rangen Hatchery based on certain assumed Flow Index criteria. The lower portion of **Table 2-1** shows information from Smith's analysis of the production capacity based on certain Density Index criteria. In both the upper and lower sections of the table, there are results for the various assumed flow rates of 15 cfs, 35 cfs, 55 cfs, and 75 cfs. Under each of the assumed flow rates, are the figures of the pounds of fish that could be produced taken from the Smith Table, and the comparable pounds of fish from Exhibit 3.

The values shown in red text under the Exhibit 3 headings are the values from Exhibit 3 for which data and analysis clearly showed how the value was computed. Of the four values shown in red, two matched the corresponding value in the Table, and two did not. The black values from the Table that match the red values from Exhibit 3 are highlighted in green. The black values from the Table that do not match the red values from Exhibit 3 are highlighted in yellow.

Most of the information in Exhibit 3 was so confusing that it was not clear how the comparable value in the Table was calculated. In these instances, an attempt was made to derive a value from the information in Exhibit 3 that was comparable to the appropriate value in the Table. The derived value and the calculations that were made to obtain it are shown in blue text. There were only three instances in which the value derived from the confusing information in Exhibit 3 matched the comparable value in the Table. The black values from the Table that match the blue values derived from information in Exhibit 3 are highlighted in green. The black values from the Table that do not match the blue values derived from information in Exhibit 3 are highlighted in red.

Review of the information in Table 2-1 (values not highlighted in green) shows that most of differences between the mismatched Table values and Exhibit 3 values are substantial. Because there is little information in Exhibit 3 that can be used to support the information in the Table, I conclude that insufficient information has been provided by Smith to support the opinions of the fish that could be produced by Rangen at the various assumed flow rates. Until backup data and calculations are provided that correspond to the information in the Table, it is virtually impossible to assess reasonableness and relevance of the Smith opinions on the pounds of fish that could be produced by Rangen at various assumed flow rates.

Also see rebuttal response 1-8 to the Brockway Report.

3.0 New Data and Opinion Based on Newly Disclosed Information

Additional historical data on the Curren Spring flows were disclosed by IDWR on January 17, 2013. These data included measurements and field notes of Curren Tunnel flows and flow measurements in the Rangen Hatchery for the period from January 1967 through January 1974. Prior to the IDWR disclosure, the only flow data that were available for this period were hand written notes of the total hatchery flow that were provided by Rangen. As described in the December 2012 SWE Expert Report, there was not sufficient information to determine where the total flow measurements were made.

Table 3-1 summarizes the new Curren Spring data disclosed by IDWR. Figure 3-1 provides a visual depiction of the data and shows (a) the flow measured in the Large Raceways ("20 pipes races"), (b) the irrigation diversion from the Curren Tunnel ("3 pipes"), (c) the flow measured in Billingsley Creek at the Lodge Dam ("Creek"), and (d) the amount irrigation return flows that were part of the available supply ("Waste").

Based on information in the Lemmon notes, it is appears that the purpose of the flow measurements was to quantify the total flow of the Curren Spring. Mr. Lemmon made this computation based on the sum of the measured flows in the Large Raceways, the irrigation diversion from the Curren Tunnel, and the flow in Billingsley Creek, and then subtracting the irrigation return flow contribution to the supply.

As shown in Figure 3-1, the measured flow in Billingsley Creek at the Lodge Dam was substantial throughout the year between 1967 and 1974, and comprised a substantial portion of the Curren Spring flow. Table 3-1 shows that the Billingsley Creek flow averaged 12.4 cfs, and ranged from an average of 9.7 cfs in April to 19.0 cfs in October. The Billingsley Creek flow comprised an average of 23.9 percent of the total Curren Spring flow. It is unclear whether the flow in Billingsley Creek represented water available to Rangen that was not diverted for beneficial use (i.e., waste), or was water that may have been run through the Hatch House or

Small Raceways and discharged to Billingsley Creek without being run through the Large Raceways (the CTR Raceways had not yet been constructed).

4.0 Updates to Tables and Figures in December 2012 SWE Expert Report

Rangen has disclosed additional information regarding its historical fish production and research. Based on this information, it was necessary to update various figures and tables from my December 2012 Expert Report to reflect the additional information that was provided by Rangen. The updated figures and tables are provided in **Appendix C**. Descriptions of the revisions to the figures and tables, organized by the sections in the 2012 Expert Report, are shown below. None of my opinions contained in the December 2012 Expert Report have changed as a result of the new information produced by Rangen.

4.1 Facility Capacities (Section 2.3)

Figure 2-9 (Raceway Volumes and Identifiers, Rangen Hatchery) was updated to add a new column to show flow information from the "Trout Research Hatchery, Outline of Operations" document that was contained in Doug Ramsey's AquaBounty file provided by Rangen on January 30, 2013, and discussed during the deposition of Brock on January 22, 2013.

4.2 Fish Production (Section 4)

The following tables, figures, and appendix were updated to include the Fall 2012 Idaho Power Hatchery Production Summaries from August – October 2012 that were provided by Rangen on January 1, 2013

- Table 4-1 (Summary of Spring and Fall Fish Sales to Idaho Power),
- Figure 4-5 (Reported Density Index, Idaho Power Production Summaries)
- Figure 4-6 (Reported Flow Index, Idaho Power Production Summaries)
- Figure 4-7 (Daily Flow [cfs], Idaho Power Production Summaries)
- Figure 4-8 (Trough and Small Raceway Flows vs. Curren Tunnel Flows, Idaho Power Production Summaries)
- Figure 4-9 (Large and CTR Raceway Flows vs. Total Rangen Flow, Idaho Power Production Summaries)
- Figure 4-10 (Monthly Flow Through Raceways vs. Total Rangen Flow and Curren Tunnel Flow)

- Appendix G (Idaho Power Production by Fish Cycle)

4.3 Rangen Research (Section 5.0)

The following figures were updated to include additional documentation of Rangen fish research provided by Rangen on January 4, 2013 and January 8, 2013.

- Figures 5-1a to 5-1c (Summary of Research Index Work Units, All Species)
- Figure 5-2 (Summary of Research Documentation Obtained)
- Figures 5-3a to 5-3e (Summary of Research Index Work Units, Cold Water or Unknown Species)
- Figure 5-4 (Summary of Reported Flows in Research Documents)

The additional information provided by Rangen included the following research documentation:

All Species

- 44 research documents from 1984 – 2003.
- 8 documents containing correspondence and reference material (no report or proposal).

Cold Water Species

- 32 research documents.
- 20 additional (new) research documents for Work Units from Index List. Ten of these were reports and the remainder were proposals and/or data.
- 2 new studies not on index list.
- 7 new research documents with flow data. No new raceway studies with flows and 4 new raceway cages studies with flows.

5.0 References

The following information was relied on in preparing this report.

1. Rangen's Response to Additional Expert Report Documentation Request by IGWA, January 16 – 18, and February 1, 2013.

2. Documents disclosed by Rangen on December 26, 2012 and in January 2013 (Jan 1 Upload, Jan 4 Upload, floppy discs January 8, and Jan 30 Upload).

3. Brockway, C.E., Colvin D., and Brannon, J., Expert Report in the Matter of Rangen Inc., Availability of Spring Flow and Injury to Water Rights, Prepared for Rangen, Inc., December 21, 2012.

4. Smith, C., Expert Report In Matter of Distribution of Water to Rangen, Inc's Water Right Nos. 36-02551 and 36-07694, Prepared for Rangen, Inc., December 21, 2012.

5. Sullivan, G.K., Spronk Water Engineer's Expert Report In Matter of Distribution of Water to Rangen, Inc's Water Right Nos. 36-02551 and 36-07694, Prepared for Pocatello, December 21, 2012.

6. Brendecke, C.M., Hydrology, Water Right and Groundwater Modeling Evaluation of Rangen Delivery Call, AMEC Environment & Infrastructure, Prepared for IGWA, December 21, 2012.

7. Hinkley, B., Rangen Groundwater Discharge and ESPAM 2.1 Hydrogeologic Investigation, Prepared for IGWA, December 20, 2012.

8. Rogers, T. L., Rogers, Expert Report In Matter of Distribution of Water to Water Right Nos. 36-02551 and 36-07694, Prepared for IGWA, December 21, 2012, Corrected January 24, 2013.

9. Horton, R.E., Weir Experiments, Coefficients, and Formulas, Revision of Paper No. 150, US Dept. of Interior, US Geological Survey, 1907.

10. Chow, V.T., Open-Channel Hydraulics, McGraw-Hill Book Company, 1959.

11. Henderson, F.M., Open Channel Flow, Macmillan Publishing Company, 1966.

12. Brater, E.F. and King, H.W. Handbook of Hydraulics for the Solution of Hydraulic Engineering Problems, Sixth Edition, McGraw-Hill Book Company, 1976.

13. Larsen, D.C., Water Measurement, Bulletin No. 552, University of Idaho, College of Agriculture, Cooperative Extension Service, February 1976.

14. Aisenbrey, A.J., Hayes, R.B., Warren, H.J., Winsett, D.L., and Young, R.B., Design of Small Canal Structures: Engineering Technology Pertaining to the Design of Small Canal Structures of Less Than 100-Cubic-feet-per-second Capacity, US Dept. of Interior, Bureau of Reclamation, 1978.

15. Chow, V.T., Handbook of Applied Hydrology, A compendium of Water-Resources Technology, McGraw-Hill Book Company, 1984.

16. State of Nevada, State Engineer's Office, Common Methods of Measuring Water As Practiced in Western States, 1986.

17. Vlotman, W.F., Discharge Measurement Structures, Third revised edition, 1989.

18. Haan, C.T., Barfield, B.J., and Hayes, J.C., Design Hydrology and Sedimentology for Small Catchments. Academic Press, 1994.

19. US Dept. of Interior, Bureau of Reclamation, Water Measurement Manual, 2001 revised. Available from: http://www.usbr.gov/pmts/hydraulics_lab/pubs/wmm/.

20. Claydon, J.F., The Broad-Crested Weir, 2011. Available from: http://www.jfccivilengineer.com/broad_crested_weir.htm.

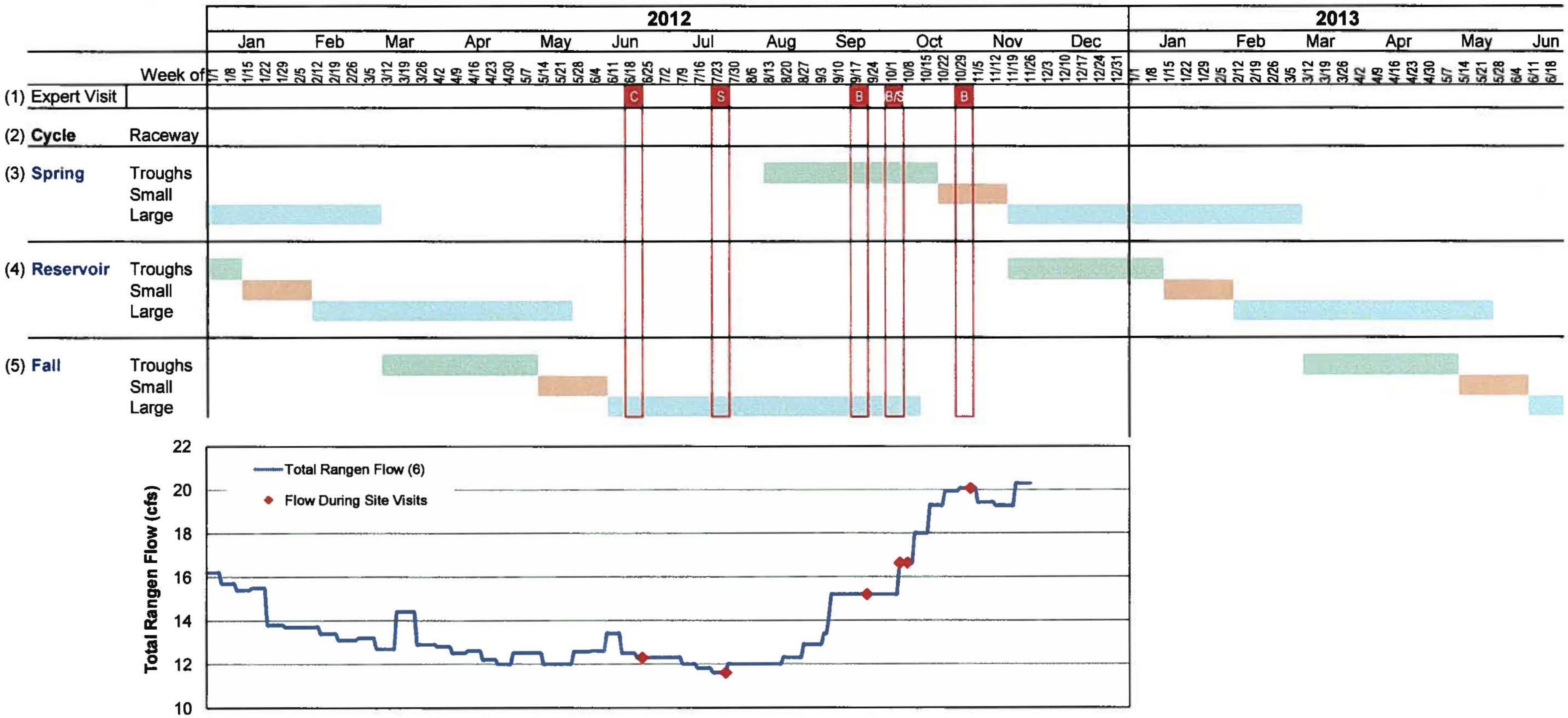
21. US Dept. of Agriculture, Natural Resources Conservation Service, Water References, June 2011. Available from: http://www.wcc.nrcs.usda.gov/ftpref/wntsc/H&H/test/.

22. Bengtson, H. H., Sharp-Crested Weirs for Open Channel Flow Measurement, An online course for PDH credit for Professional Engineers, 2013. Available from: http://www.cedengineering.com/upload/Sharp-Crested%20Weirs.pdf.

Figures

Figure 1-1

Raceway Use and Rangen Expert Site Visits
Rangen Fish Production Cycle



Notes:

(1) Site visits by Rangen experts:

6/21/2012 - David Colvin (C) 7/24/2012 - Charlie Smith (S) 9/18/2012 - Chuck Brockway (B)
10/01/2012 - Chuck Brockway (B) 10/04/2012 - Charlie Smith (S) 10/29/2012 - Chuck Brockway (B)

(2) Fish production cycles for Idaho Power: Spring and Fall cycles for releases to the Snake River, and the Reservoir cycle for releases to American Falls Reservoir. Rangen has not provided monthly fish Inventory Reports for 2012. The raceway contents are based on typical historical practices, and are consistent with the inventories reflected in the 2012 Idaho Power Hatchery Production Summaries.

(3) Production cycle for Spring 2012 Plant from Idaho Power Hatchery Production Summaries.

(4) Production cycle for May Plant is estimated from Rangen's monthly inventory reports (2008 - 2010) and typical life cycles shown in the Idaho Power Hatchery Production Summaries.

(5) Production cycle for Fall 2012 Plant from Idaho Power Hatchery Production Summaries.

(6) Rangen Hatchery weekly flow measurements provided by Rangen on November 21, 2012.

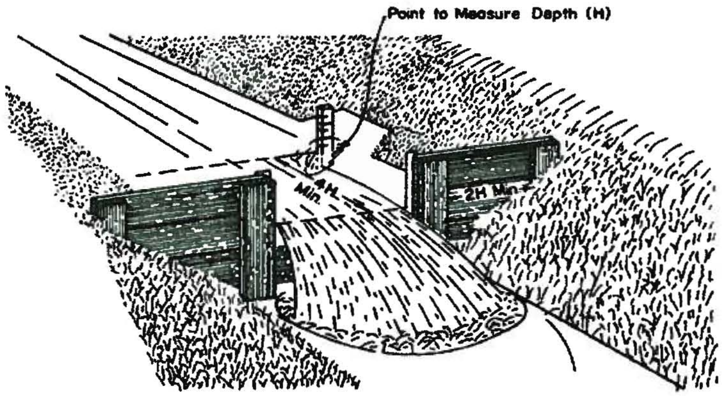
Figure 1-2a

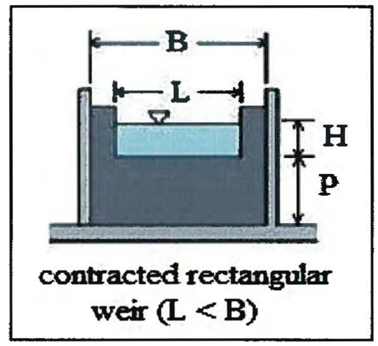
Illustrations of Standard Weir Types

Contracted Rectangular Weir

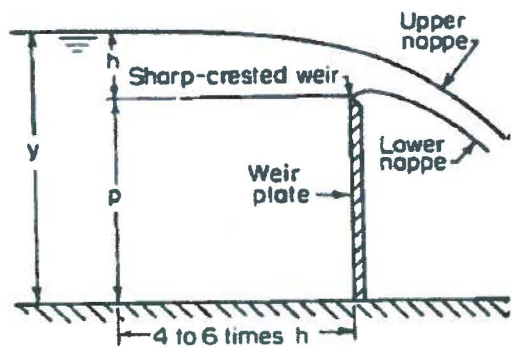
Equation (1): $Q = 3.33(L-0.2H)H^{1.5}$

where: Q = discharge (cfs)
L = the length of weir (ft)
H = head on the weir (ft)





contracted rectangular weir (L < B)

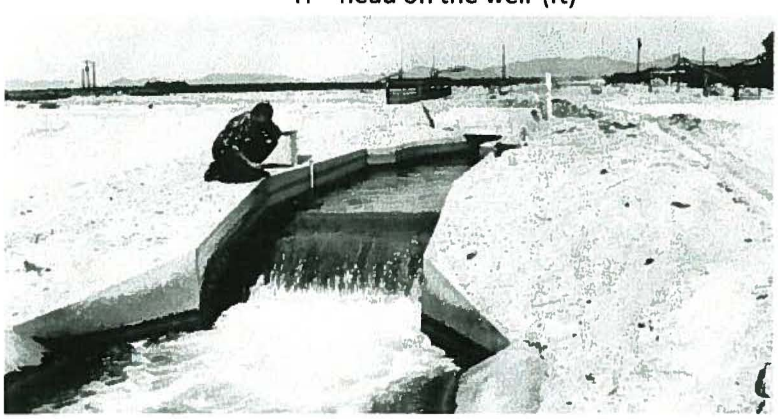


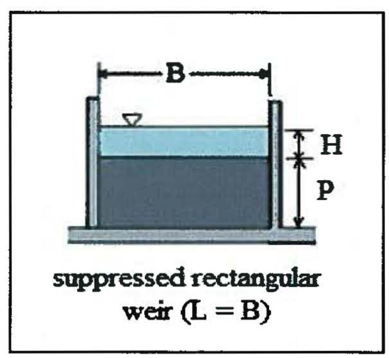
Contracted Weir Images: Upper Left (2), Upper Right (3).
Side view of Standard Rectangular Weir: Lower Right (4).

Suppressed Rectangular Weir

Equation (2): $Q = 3.33LH^{1.5}$

where: Q = discharge (cfs)
L = the length of weir (ft)
H = head on the weir (ft)





suppressed rectangular weir (L = B)

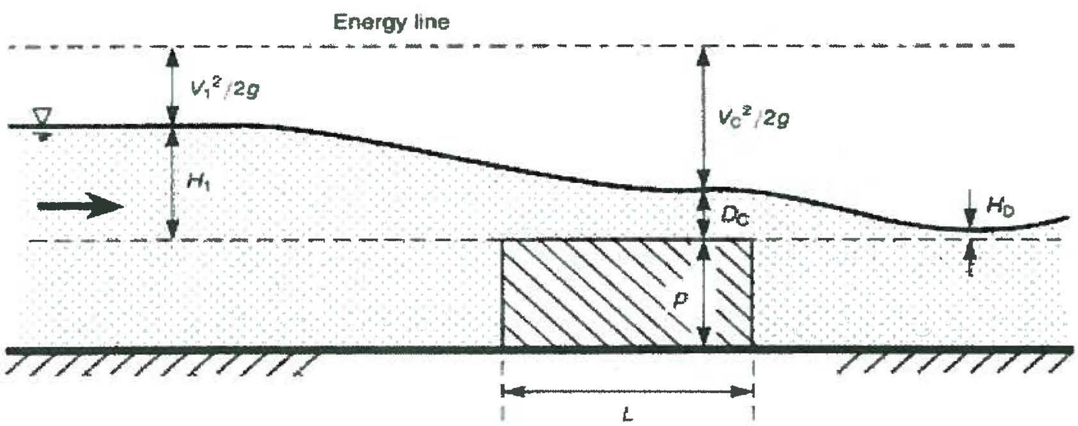
Suppressed Weir Images: Upper Left (1), Upper Right (3).

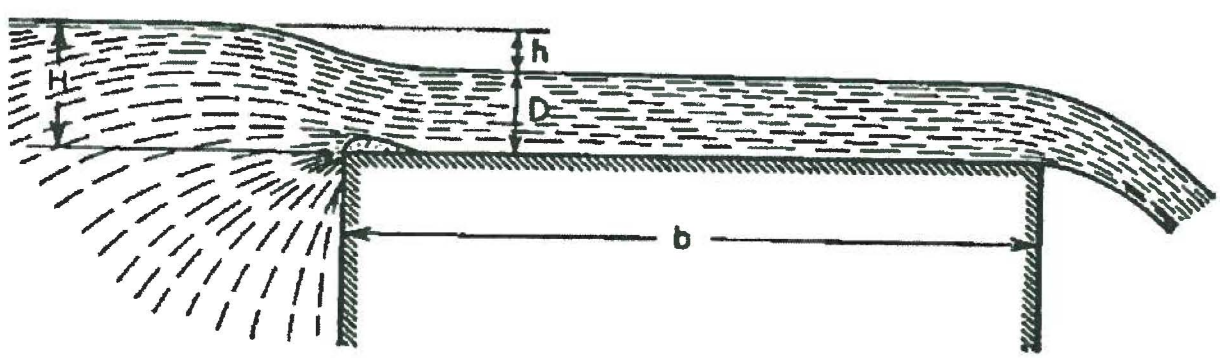
Sources:
(1) US Dept. of Interior, Bureau of Reclamation, 2001 revised, Water Measurement Manual.
(2) US Dept. of Agriculture, Natural Resources Conservation Service, 2011.
(3) Bengtson, H. H., 2013, Sharp-Crested Weirs for Open Channel Flow Measurement.
(4) Chow, V.T., 1984, Handbook of Applied Hydrology.

Figure 1-2b

Illustrations of Standard Weir Types

Broad Crested Weir





Broad Crested Weir Images: Upper (1), Lower (2).

Equation for Broad-Crested Weir (3):

$$Q = 3.09LH^{1.5}$$

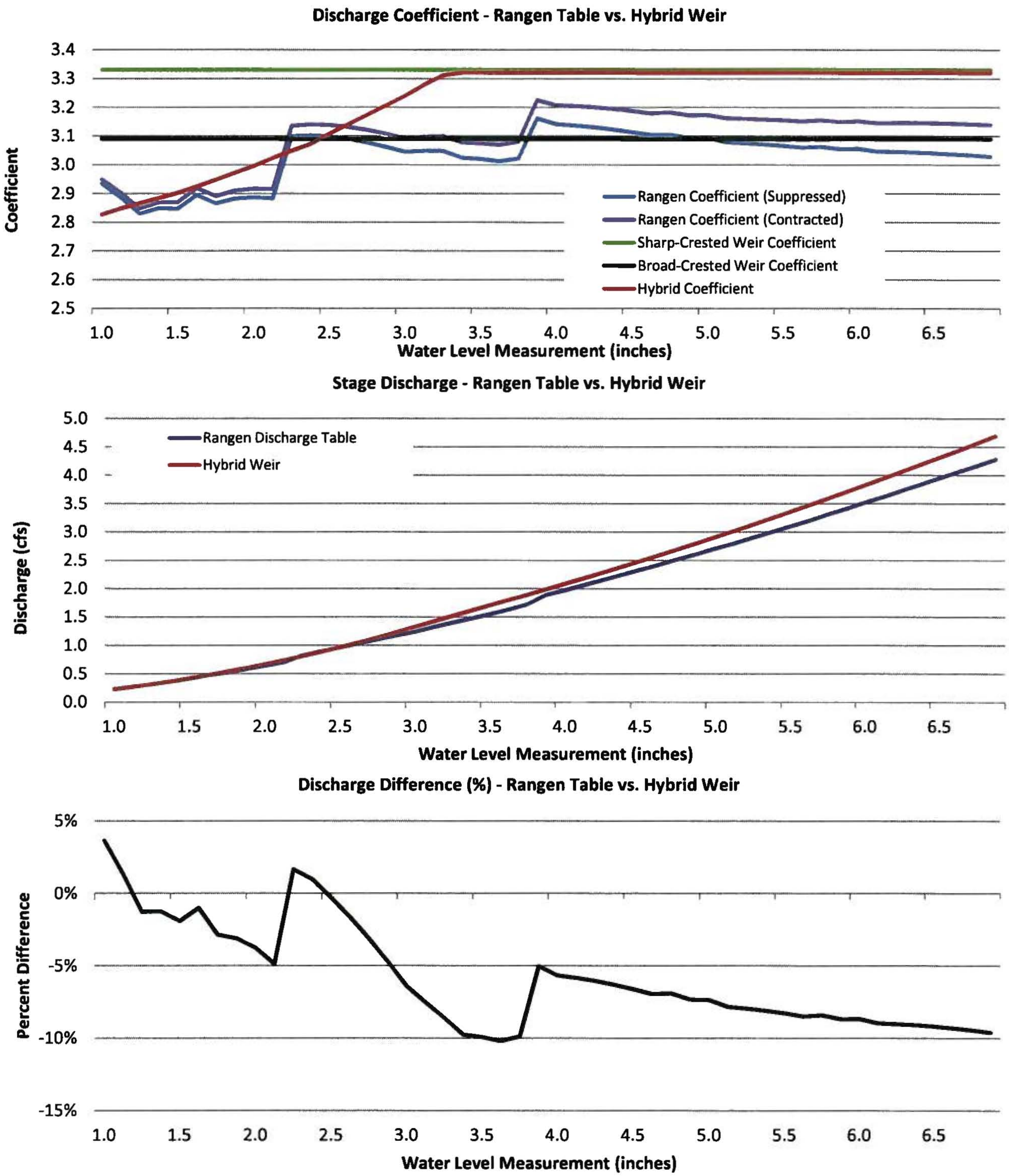
where: Q = discharge (cfs)
L = the length of weir (ft)
H = head on the weir (ft)

Sources:
(1) Claydon, 2011. <http://www.jfccivilengineer.com/broad_crested_weir.htm>.
(2) Brater and King, 1976, Handbook of Hydraulics.
(3) Haan et al., 1994, Design Hydrology and Sedimentology for Small Catchments.

Figure 1-3

Analysis of Rangen Rating Table

Small Raceways

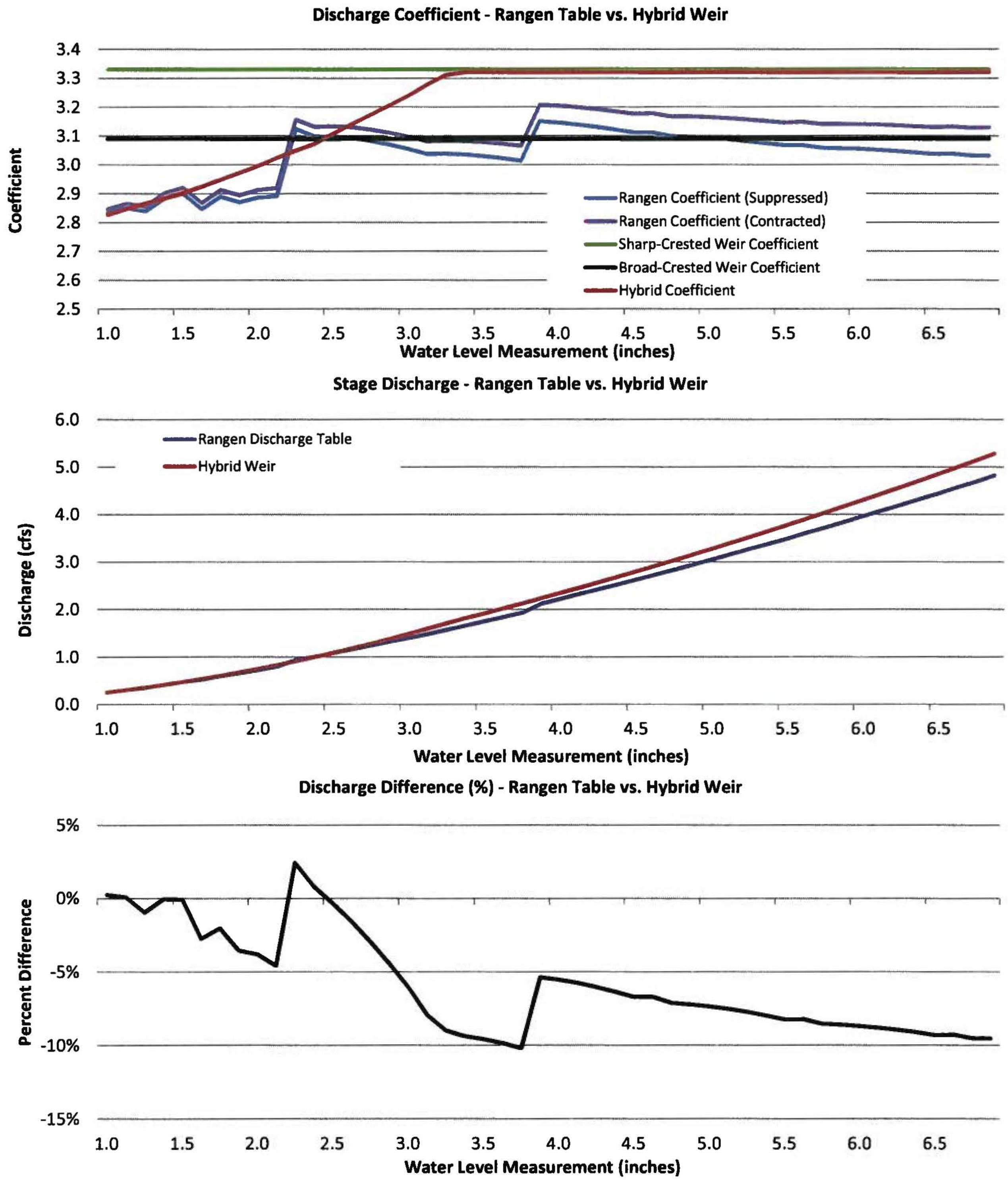


Information from Table 1-2.

Figure 1-4

Analysis of Rangen Rating Table

Large Raceways

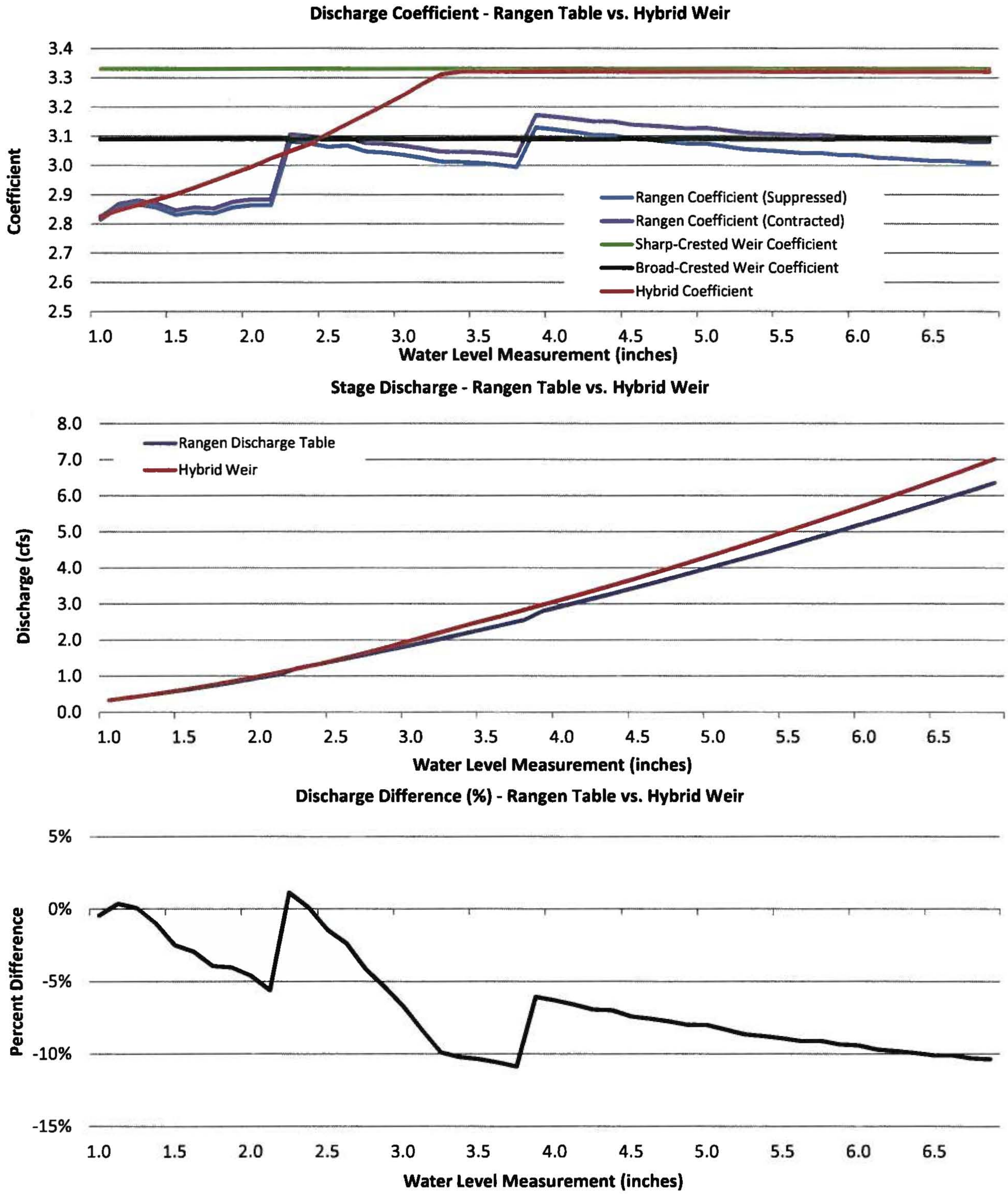


Information from Table 1-3.

Figure 1-5

Analysis of Rangen Rating Table

CTR Raceways

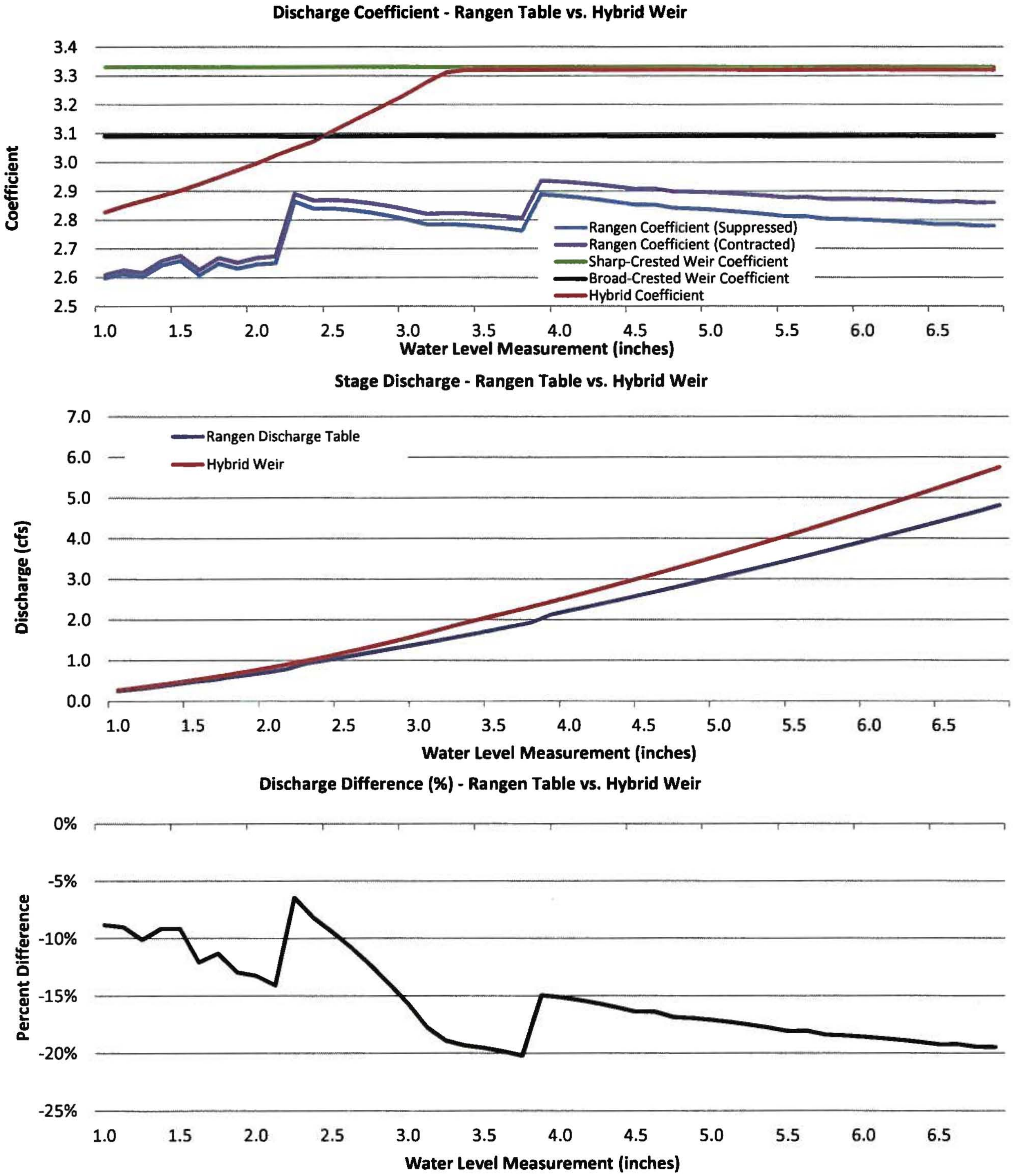


Information from Table 1-4.

Figure 1-6

Analysis of Rangen Rating Table

Lodge Dam

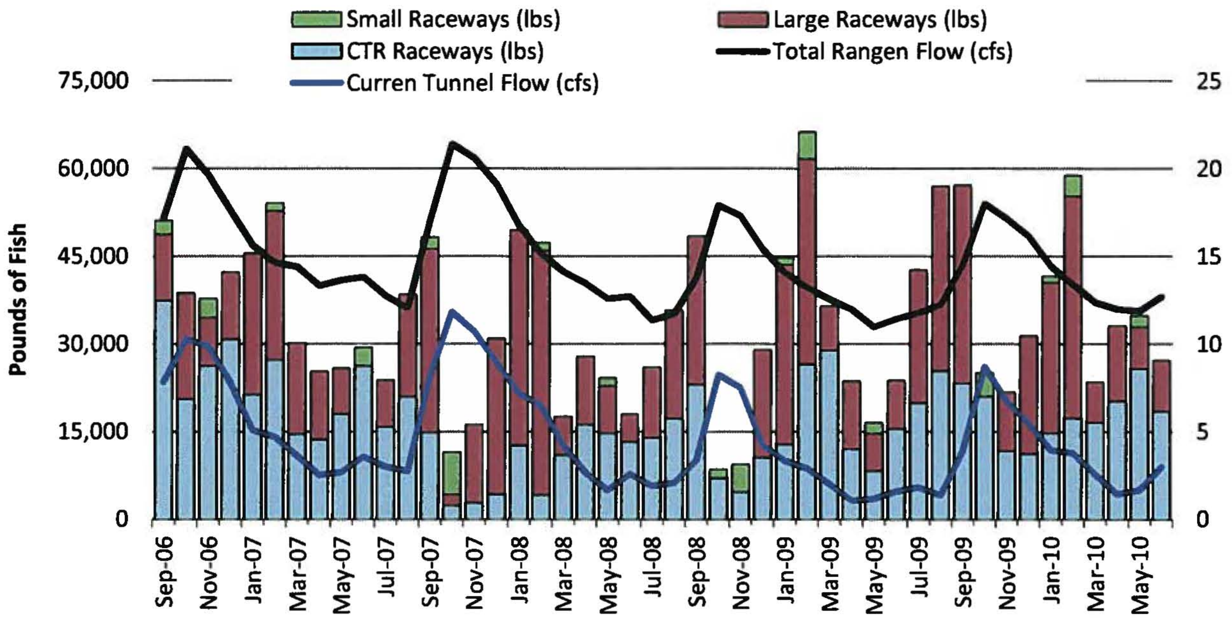


Information from Table 1-5.

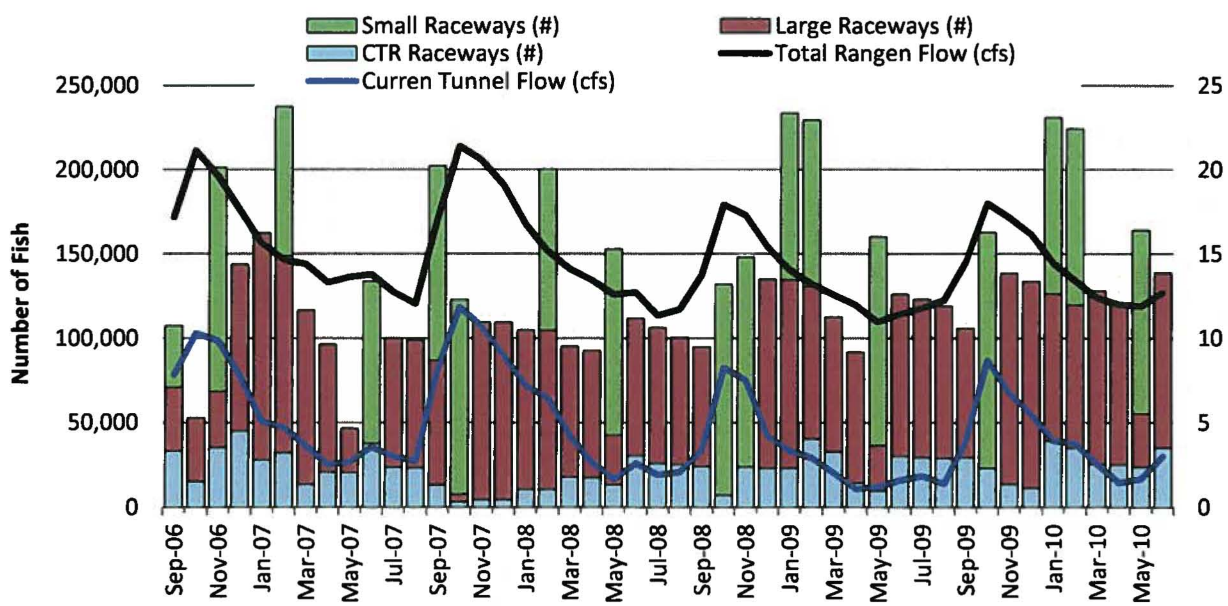
Figure 2-1

End-of-the-Month Fish Inventories
Rangen Hatchery
September 2006 - June 2010

Pounds vs. Flow



Number of Fish vs. Flow

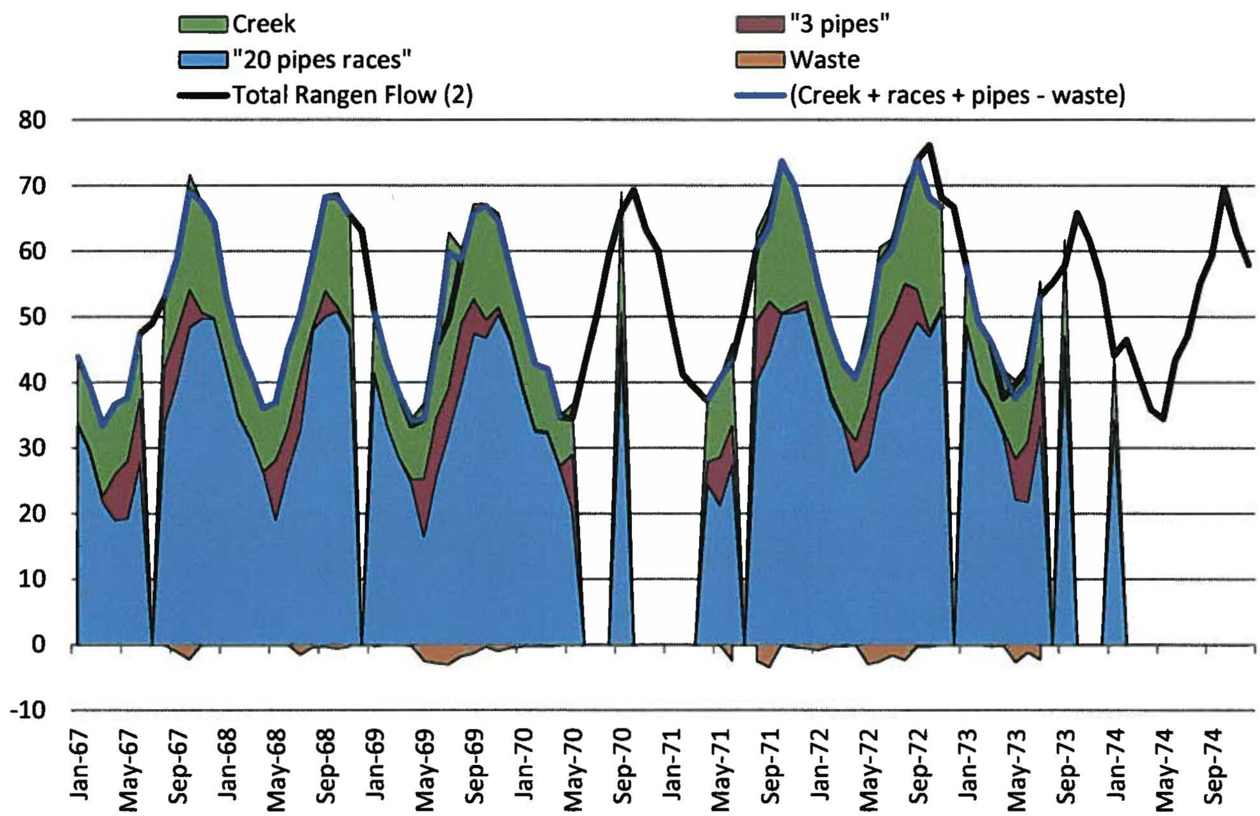


Notes:

(1) End-of-Month number and weight of fish by location from the Monthly Inventories provided by Rangen.
(2) Total Rangen Flow and Curren Tunnel Flow provided by IDWR.
(3) Bars are stacked.

Figure 3-1

Total Curren Spring Flow
1967 - 1974
Values in CFS



Sources: (1) Curren Spring and Tunnel log books provided by IDWR (supplemental disclosures 1/17/2013).
(2) Rangen Hatchery monthly flow measurements provided by Rangen.

Tables

Table 1-1

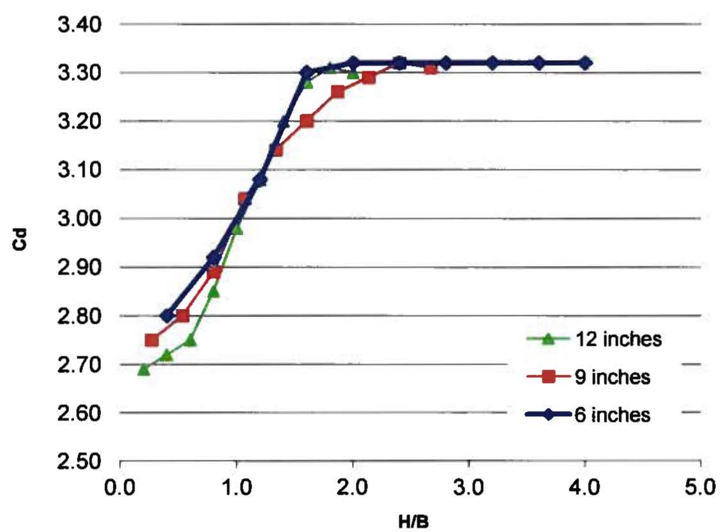
Broad-Crested Weir Stage-Discharge Relationship

from King (1976), Table 5-3

	Breadth of Crest (ft)		
Head (ft)	0.50	0.75	1.00
0.2	2.80	2.75	2.69
0.4	2.92	2.80	2.72
0.6	3.08	2.89	2.75
0.8	3.30	3.04	2.85
1	3.32	3.14	2.98
1.2	3.32	3.20	3.08
1.4	3.32	3.26	3.20
1.6	3.32	3.29	3.28
1.8	3.32	3.32	3.31
2	3.32	3.31	3.30

Crest Width (ft)	**0.50**	Crest Width (ft)	**0.75**	Crest Width (ft)	**1.00**
H/B	**Cd**	H/B	**Cd**	H/B	**Cd**
0.400	2.80	0.267	2.75	0.200	2.69
0.800	2.92	0.533	2.80	0.400	2.72
1.200	3.08	0.800	2.89	0.600	2.75
1.600	3.30	1.067	3.04	0.800	2.85
2.000	3.32	1.333	3.14	1.000	2.98
2.400	3.32	1.600	3.20	1.200	3.08
2.800	3.32	1.867	3.26	1.400	3.20
3.200	3.32	2.133	3.29	1.600	3.28
3.600	3.32	2.400	3.32	1.800	3.31
4.000	3.32	2.667	3.31	2.000	3.30

Broad-Crested Weir Discharge Coefficients



Crest Width (ft)	**0.50**
H/B	Cd
0.4	**2.80**
0.5	2.83
0.6	2.86
0.7	2.89
0.8	**2.92**
0.9	2.96
1.0	3.00
1.1	3.04
1.2	**3.08**
1.3	3.14
1.4	3.19
1.5	3.25
1.6	**3.30**
1.7	3.31
1.8	3.31
1.9	3.32
2.0	**3.32**

Hybrid Weir Stage-Discharge

Crest Width (ft) 2.00

Head (in)	H/B	Cd	Q (cfs/ft)
1.00	0.50	2.830	0.07
1.50	0.75	2.890	0.13
2.00	1.00	3.000	0.20
2.50	1.25	3.080	0.29
3.00	1.50	3.190	0.40
3.50	1.75	3.305	0.52
4.00	2.00	3.315	0.64
4.50	2.25	3.320	0.76
5.00	2.50	3.320	0.89
5.50	2.75	3.320	1.03
6.00	3.00	3.320	1.17
6.50	3.25	3.320	1.32
7.00	3.50	3.320	1.48
7.50	3.75	3.320	1.64
8.00	4.00	3.320	1.81
8.50	4.25	3.320	1.98
9.00	4.50	3.320	2.16

Table 1-2

Analysis of Rangen Rating Table

Small Raceways

Width of Dam Openings (in) 39.1

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Coefficient (C) =			3.33	3.33	3.09	Calculated Discharge Coefficient (C) for		Weir Breadth (in)		2.00		
			Discharge (Q) for Standard Weirs					Discharge (Q) for Hybrid Weir			Rangen vs. Hybrid	
Water Level / Head (H) (inches)	Water Level / Head (H) (feet)	Rangen Discharge Table (cfs)	Suppressed Weir (cfs)	Contracted Weir (cfs)	Broad-Crested Weir (cfs)	Suppressed Weir Equation	Contracted Weir Equation	Head / Breadth (H/B)	Discharge Coefficient (C)	Hybrid Weir Discharge (cfs)	Rangen minus Hybrid (cfs)	Difference %
1	0.083	0.23	0.26	0.26	0.24	2.93	2.95	0.50	2.83	0.22	0.01	3.7%
1 1/8	0.094	0.27	0.31	0.31	0.29	2.89	2.90	0.56	2.85	0.27	0.00	1.3%
1 1/4	0.104	0.31	0.36	0.36	0.34	2.83	2.85	0.63	2.87	0.31	0.00	-1.3%
1 3/8	0.115	0.36	0.42	0.42	0.39	2.85	2.87	0.69	2.88	0.36	0.00	-1.2%
1 1/2	0.125	0.41	0.48	0.48	0.44	2.85	2.87	0.75	2.90	0.42	-0.01	-1.9%
1 5/8	0.135	0.47	0.54	0.54	0.50	2.89	2.92	0.81	2.92	0.47	0.00	-1.0%
1 3/4	0.146	0.52	0.60	0.60	0.56	2.87	2.89	0.88	2.95	0.53	-0.01	-2.9%
1 7/8	0.156	0.58	0.67	0.66	0.62	2.88	2.91	0.94	2.97	0.60	-0.02	-3.1%
2	0.167	0.64	0.74	0.73	0.69	2.89	2.92	1.00	3.00	0.66	-0.02	-3.8%
2 1/8	0.177	0.70	0.81	0.80	0.75	2.88	2.91	1.06	3.02	0.73	-0.03	-4.9%
2 1/4	0.188	0.82	0.88	0.87	0.82	3.10	3.14	1.13	3.05	0.81	0.01	1.7%
2 3/8	0.198	0.89	0.96	0.94	0.89	3.10	3.14	1.19	3.07	0.88	0.01	1.0%
2 1/2	0.208	0.96	1.03	1.02	0.96	3.10	3.14	1.25	3.11	0.96	0.00	-0.3%
2 5/8	0.219	1.03	1.11	1.10	1.03	3.09	3.13	1.31	3.14	1.05	-0.02	-1.6%
2 3/4	0.229	1.10	1.19	1.17	1.10	3.08	3.12	1.38	3.17	1.13	-0.03	-3.1%
2 7/8	0.240	1.17	1.27	1.25	1.18	3.06	3.11	1.44	3.21	1.23	-0.06	-4.7%
3	0.250	1.24	1.36	1.34	1.26	3.04	3.09	1.50	3.24	1.32	-0.08	-6.4%
3 1/8	0.260	1.32	1.44	1.42	1.34	3.05	3.10	1.56	3.28	1.42	-0.10	-7.5%
3 1/4	0.271	1.40	1.53	1.50	1.42	3.05	3.10	1.63	3.31	1.52	-0.12	-8.6%
3 3/8	0.281	1.47	1.62	1.59	1.50	3.02	3.08	1.69	3.32	1.61	-0.14	-9.8%
3 1/2	0.292	1.55	1.71	1.68	1.59	3.02	3.08	1.75	3.32	1.70	-0.15	-9.9%
3 5/8	0.302	1.63	1.80	1.77	1.67	3.01	3.07	1.81	3.32	1.80	-0.17	-10.2%
3 3/4	0.313	1.72	1.90	1.86	1.76	3.02	3.08	1.88	3.32	1.89	-0.17	-9.9%
3 7/8	0.323	1.89	1.99	1.95	1.85	3.16	3.22	1.94	3.32	1.99	-0.10	-5.0%
4	0.333	1.97	2.09	2.05	1.94	3.14	3.21	2.00	3.32	2.08	-0.11	-5.7%
4 1/8	0.344	2.06	2.19	2.14	2.03	3.14	3.20	2.06	3.32	2.18	-0.12	-5.8%
4 1/4	0.354	2.15	2.29	2.24	2.12	3.13	3.20	2.13	3.32	2.28	-0.13	-6.0%
4 3/8	0.365	2.24	2.39	2.34	2.22	3.12	3.19	2.19	3.32	2.38	-0.14	-6.3%
4 1/2	0.375	2.33	2.49	2.43	2.31	3.11	3.19	2.25	3.32	2.48	-0.15	-6.6%
4 5/8	0.385	2.42	2.60	2.53	2.41	3.10	3.18	2.31	3.32	2.59	-0.17	-7.0%
4 3/4	0.396	2.52	2.70	2.64	2.51	3.11	3.18	2.38	3.32	2.69	-0.17	-6.9%
4 7/8	0.406	2.61	2.81	2.74	2.61	3.09	3.17	2.44	3.32	2.80	-0.19	-7.3%
5	0.417	2.71	2.92	2.84	2.71	3.09	3.17	2.50	3.32	2.91	-0.20	-7.4%
5 1/8	0.427	2.80	3.03	2.95	2.81	3.08	3.16	2.56	3.32	3.02	-0.22	-7.8%
5 1/4	0.438	2.90	3.14	3.06	2.91	3.08	3.16	2.63	3.32	3.13	-0.23	-7.9%
5 3/8	0.448	3.00	3.25	3.16	3.02	3.07	3.16	2.69	3.32	3.24	-0.24	-8.1%
5 1/2	0.458	3.10	3.37	3.27	3.12	3.07	3.15	2.75	3.32	3.36	-0.26	-8.3%
5 5/8	0.469	3.20	3.48	3.38	3.23	3.06	3.15	2.81	3.32	3.47	-0.27	-8.5%
5 3/4	0.479	3.31	3.60	3.49	3.34	3.06	3.16	2.88	3.32	3.59	-0.28	-8.4%
5 7/8	0.490	3.41	3.72	3.61	3.45	3.06	3.15	2.94	3.32	3.71	-0.30	-8.7%
6	0.500	3.52	3.84	3.72	3.56	3.06	3.15	3.00	3.32	3.82	-0.30	-8.7%
6 1/8	0.510	3.62	3.96	3.83	3.67	3.05	3.15	3.06	3.32	3.94	-0.32	-9.0%
6 1/4	0.521	3.73	4.08	3.95	3.78	3.05	3.15	3.13	3.32	4.07	-0.34	-9.0%
6 3/8	0.531	3.84	4.20	4.06	3.90	3.04	3.15	3.19	3.32	4.19	-0.35	-9.1%
6 1/2	0.542	3.95	4.33	4.18	4.01	3.04	3.15	3.25	3.32	4.31	-0.36	-9.2%
6 5/8	0.552	4.06	4.45	4.30	4.13	3.04	3.14	3.31	3.32	4.44	-0.38	-9.3%
6 3/4	0.563	4.17	4.58	4.42	4.25	3.03	3.14	3.38	3.32	4.56	-0.39	-9.4%
6 7/8	0.573	4.28	4.71	4.54	4.37	3.03	3.14	3.44	3.32	4.69	-0.41	-9.6%

(1) Stage vs. Discharge by raceway or dam from Appendix A (Rangen Expert Report, Brockway et al., 12/20/12).

(2) Suppressed Weir Eq. Q = C *L*H^1.5 where: Q = discharge (cfs); C = discharge coefficient;

(3) Contracted Weir Eq. Q = C *(L - .2*H)*H^1.5 H = head (ft); L = length of dam board(s).

(4) Broad Crested Weir Eq. Q = C *L*H^1.5

(5,6) Discharge coefficient derived from Suppressed Weir Equation and Contracted Weir Equation using Rangen Discharge Table.

(7) Measured Head (H) divided by Breadth (B) of weir.

(8) Discharge coefficient for H/B for 6-inch weir computed relationship derived from Table 5-3 of King Handbook of Hydraulics (1976).

(9) Computed discharge using Suppressed Weir Eq. (above).

(10) Col. (1) minus col. (9)

(11) Col. (10) / col. (1).

Average weir water level in measurements taken from 6/13/11 to 4/23/2012 "RANGEN000032_WATER MEASUREMENTS 6-13-11 - 4-23-12".

Table 1-3

Analysis of Rangen Rating Table

Large Raceways

Width of Dam Openings (in) 44

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Coefficient (C) =			3.33	3.33	3.09	Calculated Discharge		Weir Breadth (in)		2.00		
			Discharge (Q) for Standard Weirs			Coefficient (C) for		Discharge (Q) for Hybrid Weir			Rangen vs. Hybrid	
Water Level / Head (H) (inches)	Water Level / Head (H) (feet)	Rangen Discharge Table (cfs)	Suppressed Weir (cfs)	Contracted Weir (cfs)	Broad-Crested Weir (cfs)	Suppressed Weir Equation	Contracted Weir Equation	Head / Breadth (H/B)	Discharge Coefficient (C)	Hybrid Weir Discharge (cfs)	Rangen minus Hybrid (cfs)	Difference %
1	0.083	0.25	0.29	0.29	0.27	2.83	2.85	0.50	2.83	0.25	0.00	0.3%
1 1/8	0.094	0.30	0.35	0.35	0.33	2.85	2.86	0.56	2.85	0.30	0.00	0.1%
1 1/4	0.104	0.35	0.41	0.41	0.38	2.84	2.86	0.63	2.87	0.35	0.00	-0.9%
1 3/8	0.115	0.41	0.47	0.47	0.44	2.88	2.90	0.69	2.88	0.41	0.00	0.0%
1 1/2	0.125	0.47	0.54	0.54	0.50	2.90	2.92	0.75	2.90	0.47	0.00	-0.1%
1 5/8	0.135	0.52	0.61	0.60	0.56	2.85	2.87	0.81	2.92	0.53	-0.01	-2.7%
1 3/4	0.146	0.59	0.68	0.67	0.63	2.89	2.91	0.88	2.95	0.60	-0.01	-2.0%
1 7/8	0.156	0.65	0.75	0.75	0.70	2.87	2.89	0.94	2.97	0.67	-0.02	-3.5%
2	0.167	0.72	0.83	0.82	0.77	2.89	2.91	1.00	3.00	0.75	-0.03	-3.8%
2 1/8	0.177	0.79	0.91	0.90	0.84	2.89	2.92	1.06	3.02	0.83	-0.04	-4.6%
2 1/4	0.188	0.93	0.99	0.98	0.92	3.12	3.16	1.13	3.05	0.91	0.02	2.4%
2 3/8	0.198	1.00	1.08	1.06	1.00	3.10	3.13	1.19	3.07	0.99	0.01	0.8%
2 1/2	0.208	1.08	1.16	1.15	1.08	3.10	3.13	1.25	3.11	1.08	0.00	-0.3%
2 5/8	0.219	1.16	1.25	1.23	1.16	3.09	3.13	1.31	3.14	1.18	-0.02	-1.6%
2 3/4	0.229	1.24	1.34	1.32	1.24	3.08	3.12	1.38	3.17	1.28	-0.04	-2.9%
2 7/8	0.240	1.32	1.43	1.41	1.33	3.07	3.11	1.44	3.21	1.38	-0.06	-4.5%
3	0.250	1.40	1.53	1.51	1.42	3.05	3.10	1.50	3.24	1.48	-0.08	-6.1%
3 1/8	0.260	1.48	1.62	1.60	1.51	3.04	3.08	1.56	3.28	1.60	-0.12	-7.9%
3 1/4	0.271	1.57	1.72	1.70	1.60	3.04	3.08	1.63	3.31	1.71	-0.14	-9.0%
3 3/8	0.281	1.66	1.82	1.79	1.69	3.04	3.08	1.69	3.32	1.82	-0.16	-9.4%
3 1/2	0.292	1.75	1.92	1.89	1.78	3.03	3.08	1.75	3.32	1.92	-0.17	-9.6%
3 5/8	0.302	1.84	2.03	1.99	1.88	3.02	3.07	1.81	3.32	2.02	-0.18	-9.8%
3 3/4	0.313	1.93	2.13	2.10	1.98	3.01	3.07	1.88	3.32	2.13	-0.20	-10.2%
3 7/8	0.323	2.12	2.24	2.20	2.08	3.15	3.21	1.94	3.32	2.23	-0.11	-5.4%
4	0.333	2.22	2.35	2.31	2.18	3.15	3.20	2.00	3.32	2.34	-0.12	-5.5%
4 1/8	0.344	2.32	2.46	2.41	2.28	3.14	3.20	2.06	3.32	2.45	-0.13	-5.8%
4 1/4	0.354	2.42	2.57	2.52	2.39	3.13	3.19	2.13	3.32	2.57	-0.15	-6.0%
4 3/8	0.365	2.52	2.69	2.63	2.49	3.12	3.19	2.19	3.32	2.68	-0.16	-6.3%
4 1/2	0.375	2.62	2.80	2.75	2.60	3.11	3.18	2.25	3.32	2.80	-0.18	-6.7%
4 5/8	0.385	2.73	2.92	2.86	2.71	3.11	3.18	2.31	3.32	2.91	-0.18	-6.7%
4 3/4	0.396	2.83	3.04	2.98	2.82	3.10	3.17	2.38	3.32	3.03	-0.20	-7.1%
4 7/8	0.406	2.94	3.16	3.09	2.93	3.10	3.17	2.44	3.32	3.15	-0.21	-7.2%
5	0.417	3.05	3.28	3.21	3.05	3.09	3.16	2.50	3.32	3.27	-0.22	-7.3%
5 1/8	0.427	3.16	3.41	3.33	3.16	3.09	3.16	2.56	3.32	3.40	-0.24	-7.5%
5 1/4	0.438	3.27	3.53	3.45	3.28	3.08	3.16	2.63	3.32	3.52	-0.25	-7.7%
5 3/8	0.448	3.38	3.66	3.57	3.40	3.08	3.15	2.69	3.32	3.65	-0.27	-8.0%
5 1/2	0.458	3.49	3.79	3.69	3.52	3.07	3.15	2.75	3.32	3.78	-0.29	-8.2%
5 5/8	0.469	3.61	3.92	3.82	3.64	3.07	3.15	2.81	3.32	3.91	-0.30	-8.2%
5 3/4	0.479	3.72	4.05	3.94	3.76	3.06	3.14	2.88	3.32	4.04	-0.32	-8.5%
5 7/8	0.490	3.84	4.18	4.07	3.88	3.06	3.14	2.94	3.32	4.17	-0.33	-8.6%
6	0.500	3.96	4.32	4.20	4.01	3.05	3.14	3.00	3.32	4.30	-0.34	-8.7%
6 1/8	0.510	4.08	4.45	4.33	4.13	3.05	3.14	3.06	3.32	4.44	-0.36	-8.8%
6 1/4	0.521	4.20	4.59	4.46	4.26	3.05	3.14	3.13	3.32	4.58	-0.38	-8.9%
6 3/8	0.531	4.32	4.73	4.59	4.39	3.04	3.13	3.19	3.32	4.71	-0.39	-9.1%
6 1/2	0.542	4.44	4.87	4.72	4.52	3.04	3.13	3.25	3.32	4.85	-0.41	-9.3%
6 5/8	0.552	4.57	5.01	4.86	4.65	3.04	3.13	3.31	3.32	4.99	-0.42	-9.3%
6 3/4	0.563	4.69	5.15	4.99	4.78	3.03	3.13	3.38	3.32	5.14	-0.45	-9.5%
6 7/8	0.573	4.82	5.29	5.13	4.91	3.03	3.13	3.44	3.32	5.28	-0.46	-9.5%

(1) Stage vs. Discharge by raceway or dam from Appendix A (Rangen Expert Report, Brockway et al., 12/20/12).

(2) Suppressed Weir Eq. Q = C *L*H^1.5 where: Q = discharge (cfs); C = discharge coefficient;

(3) Contracted Weir Eq. Q = C *(L - .2*H)*H^1.5 H = head (ft); L = length of dam board(s).

(4) Broad Crested Weir Eq. Q = C *L*H^1.5

(5,6) Discharge coefficient derived from Suppressed Weir Equation and Contracted Weir Equation using Rangen Discharge Table.

(7) Measured Head (H) divided by Breadth (B) of weir.

(8) Discharge coefficient for H/B for 6-inch weir computed relationship derived from Table 5-3 of King Handbook of Hydraulics (1976).

(9) Computed discharge using Suppressed Weir Eq. (above).

(10) Col. (1) minus col. (9)

(11) Col. (10) / col. (1).

Average weir water level in measurements taken from 6/13/11 to 4/23/2012 "RANGEN000032_WATER MEASUREMENTS 6-13-11 - 4-23-12".

Table 1-4

Analysis of Rangen Rating Table

CTR Raceways

Width of Dam Openings (in) 58.5

Water Level / Head (H) (inches)	Water Level / Head (H) (feet)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Coefficient (C) =		3.33	3.33	3.09	Calculated Discharge Coefficient (C) for Rangen's Table		Weir Breadth (in)		2.00	Rangen vs. Hybrid Discharge (Q)	
			Discharge (Q) for Standard Weirs					Discharge (Q) for Hybrid Weir				
		Rangen Discharge Table (cfs)	Suppressed Weir (cfs)	Contracted Weir (cfs)	Broad-Crested Weir (cfs)	Suppressed Weir Equation	Contracted Weir Equation	Head / Breadth (H/B)	Discharge Coefficient (C)	Hybrid Weir Discharge (cfs)	Rangen minus Hybrid (cfs)	Difference %
1	0.083	0.33	0.39	0.39	0.36	2.81	2.82	0.50	2.8270	0.33	0.00	-0.5%
1 1/8	0.094	0.40	0.47	0.46	0.43	2.86	2.87	0.56	2.8480	0.40	0.00	0.4%
1 1/4	0.104	0.47	0.55	0.54	0.51	2.87	2.88	0.63	2.8660	0.47	0.00	0.1%
1 3/8	0.115	0.54	0.63	0.63	0.58	2.86	2.87	0.69	2.8840	0.55	-0.01	-1.0%
1 1/2	0.125	0.61	0.72	0.71	0.67	2.83	2.85	0.75	2.9020	0.63	-0.02	-2.5%
1 5/8	0.135	0.69	0.81	0.80	0.75	2.84	2.86	0.81	2.9240	0.71	-0.02	-2.9%
1 3/4	0.146	0.77	0.90	0.90	0.84	2.84	2.85	0.88	2.9480	0.80	-0.03	-3.9%
1 7/8	0.156	0.86	1.00	1.00	0.93	2.86	2.87	0.94	2.9720	0.89	-0.03	-4.1%
2	0.167	0.95	1.10	1.10	1.02	2.86	2.88	1.00	2.9960	0.99	-0.04	-4.6%
2 1/8	0.177	1.04	1.21	1.20	1.12	2.86	2.88	1.06	3.0240	1.10	-0.06	-5.6%
2 1/4	0.188	1.22	1.32	1.31	1.22	3.08	3.11	1.13	3.0480	1.21	0.01	1.1%
2 3/8	0.198	1.32	1.43	1.42	1.33	3.08	3.10	1.19	3.0720	1.32	0.00	0.1%
2 1/2	0.208	1.42	1.54	1.53	1.43	3.06	3.09	1.25	3.1075	1.44	-0.02	-1.4%
2 5/8	0.219	1.53	1.66	1.65	1.54	3.07	3.10	1.31	3.1405	1.57	-0.04	-2.4%
2 3/4	0.229	1.63	1.78	1.76	1.65	3.05	3.08	1.38	3.1735	1.70	-0.07	-4.1%
2 7/8	0.240	1.74	1.90	1.89	1.77	3.04	3.07	1.44	3.2065	1.83	-0.09	-5.4%
3	0.250	1.85	2.03	2.01	1.88	3.04	3.07	1.50	3.2395	1.97	-0.12	-6.7%
3 1/8	0.260	1.96	2.16	2.13	2.00	3.03	3.06	1.56	3.2780	2.12	-0.16	-8.4%
3 1/4	0.271	2.07	2.29	2.26	2.12	3.01	3.05	1.63	3.3110	2.28	-0.21	-9.9%
3 3/8	0.281	2.19	2.42	2.39	2.25	3.01	3.05	1.69	3.3200	2.41	-0.22	-10.2%
3 1/2	0.292	2.31	2.56	2.53	2.37	3.01	3.04	1.75	3.3200	2.55	-0.24	-10.4%
3 5/8	0.302	2.43	2.70	2.66	2.50	3.00	3.04	1.81	3.3200	2.69	-0.26	-10.6%
3 3/4	0.313	2.55	2.84	2.80	2.63	2.99	3.03	1.88	3.3200	2.83	-0.28	-10.9%
3 7/8	0.323	2.80	2.98	2.94	2.76	3.13	3.17	1.94	3.3200	2.97	-0.17	-6.1%
4	0.333	2.93	3.12	3.08	2.90	3.12	3.17	2.00	3.3200	3.11	-0.18	-6.3%
4 1/8	0.344	3.06	3.27	3.23	3.04	3.11	3.16	2.06	3.3200	3.26	-0.20	-6.6%
4 1/4	0.354	3.19	3.42	3.37	3.18	3.10	3.15	2.13	3.3200	3.41	-0.22	-6.9%
4 3/8	0.365	3.33	3.57	3.52	3.32	3.10	3.15	2.19	3.3200	3.56	-0.23	-7.0%
4 1/2	0.375	3.46	3.73	3.67	3.46	3.09	3.14	2.25	3.3200	3.72	-0.26	-7.4%
4 5/8	0.385	3.60	3.88	3.82	3.60	3.09	3.14	2.31	3.3200	3.87	-0.27	-7.6%
4 3/4	0.396	3.74	4.04	3.98	3.75	3.08	3.13	2.38	3.3200	4.03	-0.29	-7.8%
4 7/8	0.406	3.88	4.20	4.13	3.90	3.07	3.13	2.44	3.3200	4.19	-0.31	-8.0%
5	0.417	4.03	4.37	4.29	4.05	3.07	3.13	2.50	3.3200	4.35	-0.32	-8.0%
5 1/8	0.427	4.17	4.53	4.45	4.20	3.06	3.12	2.56	3.3200	4.52	-0.35	-8.3%
5 1/4	0.438	4.31	4.70	4.61	4.36	3.06	3.11	2.63	3.3200	4.68	-0.37	-8.7%
5 3/8	0.448	4.46	4.87	4.78	4.52	3.05	3.11	2.69	3.3200	4.85	-0.39	-8.8%
5 1/2	0.458	4.61	5.04	4.94	4.67	3.05	3.11	2.75	3.3200	5.02	-0.41	-8.9%
5 5/8	0.469	4.76	5.21	5.11	4.83	3.04	3.10	2.81	3.3200	5.19	-0.43	-9.1%
5 3/4	0.479	4.92	5.38	5.28	5.00	3.04	3.10	2.88	3.3200	5.37	-0.45	-9.1%
5 7/8	0.490	5.07	5.56	5.45	5.16	3.04	3.10	2.94	3.3200	5.54	-0.47	-9.4%
6	0.500	5.23	5.74	5.62	5.33	3.03	3.10	3.00	3.3200	5.72	-0.49	-9.4%
6 1/8	0.510	5.38	5.92	5.80	5.49	3.03	3.09	3.06	3.3200	5.90	-0.52	-9.7%
6 1/4	0.521	5.54	6.10	5.97	5.66	3.02	3.09	3.13	3.3200	6.08	-0.54	-9.8%
6 3/8	0.531	5.70	6.29	6.15	5.83	3.02	3.09	3.19	3.3200	6.27	-0.57	-9.9%
6 1/2	0.542	5.86	6.47	6.33	6.01	3.02	3.08	3.25	3.3200	6.45	-0.59	-10.1%
6 5/8	0.552	6.03	6.66	6.51	6.18	3.02	3.09	3.31	3.3200	6.64	-0.61	-10.1%
6 3/4	0.563	6.19	6.85	6.69	6.36	3.01	3.08	3.38	3.3200	6.83	-0.64	-10.3%
6 7/8	0.573	6.36	7.04	6.87	6.53	3.01	3.08	3.44	3.3200	7.02	-0.66	-10.4%

(1) Stage vs. Discharge by raceway or dam from Appendix A (Rangen Expert Report, Brockway et al., 12/20/12)

(2) Suppressed Weir Eq. Q = C *L*H^1.5 where: Q = discharge (cfs); C = discharge coefficient;

(3) Contracted Weir Eq. Q = C *(L - .2*H)*H^1.5 H = head (ft); L = length of dam board(s).

(4) Broad Crested Weir Eq. Q = C *L*H^1.5

(5,6) Discharge coefficient derived from Suppressed Weir Equation and Contracted Weir Equation using Rangen Discharge Table

(7) Measured Head (H) divided by Breadth (B) of weir.

(8) Discharge coefficient for H/B for 6-inch weir computed relationship derived from Table 5-3 of King Handbook of Hydraulics (1976).

(9) Computed discharge using Suppressed Weir Eq. (above).

(10) Col. (1) minus col. (9)

(11) Col. (10) / col. (1).

Average weir water level in measurements taken from 6/13/11 to 4/23/2012 "RANGEN000032_WATER MEASUREMENTS 6-13-11 - 4-23-12".

Table 1-5

Analysis of Rangen Rating Table

Lodge Dam

Width of Dam Openings (in) 48

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Coefficient (C) =			3.33	3.33	3.09	Calculated Discharge		Weir Breadth (in)		2.00		
			Discharge (Q) for Standard Weirs			Coefficient (C) for		Discharge (Q) for Hybrid Weir			Rangen vs. Hybrid	
Water Level / Head (H) (inches)	Water Level / Head (H) (feet)	Rangen Discharge Table (cfs)	Suppressed Weir (cfs)	Contracted Weir (cfs)	Broad-Crested Weir (cfs)	Suppressed Weir Equation	Contracted Weir Equation	Head / Breadth (H/B)	Discharge Coefficient (C)	Hybrid Weir Discharge (cfs)	Rangen minus Hybrid (cfs)	Difference %
1	0.083	0.25	0.32	0.32	0.30	2.60	2.61	0.50	2.83	0.27	-0.02	-8.8%
1 1/8	0.094	0.30	0.38	0.38	0.35	2.61	2.63	0.56	2.85	0.33	-0.03	-9.0%
1 1/4	0.104	0.35	0.45	0.45	0.42	2.60	2.62	0.63	2.87	0.39	-0.04	-10.1%
1 3/8	0.115	0.41	0.52	0.51	0.48	2.64	2.66	0.69	2.88	0.45	-0.04	-9.1%
1 1/2	0.125	0.47	0.59	0.58	0.55	2.66	2.68	0.75	2.90	0.51	-0.04	-9.2%
1 5/8	0.135	0.52	0.66	0.66	0.62	2.61	2.63	0.81	2.92	0.58	-0.06	-12.1%
1 3/4	0.146	0.59	0.74	0.74	0.69	2.65	2.67	0.88	2.95	0.66	-0.07	-11.3%
1 7/8	0.156	0.65	0.82	0.82	0.76	2.63	2.65	0.94	2.97	0.73	-0.08	-13.0%
2	0.167	0.72	0.91	0.90	0.84	2.65	2.67	1.00	3.00	0.82	-0.10	-13.3%
2 1/8	0.177	0.79	0.99	0.98	0.92	2.65	2.67	1.06	3.02	0.90	-0.11	-14.1%
2 1/4	0.188	0.93	1.08	1.07	1.00	2.86	2.89	1.13	3.05	0.99	-0.06	-6.4%
2 3/8	0.198	1.00	1.17	1.16	1.09	2.84	2.87	1.19	3.07	1.08	-0.08	-8.2%
2 1/2	0.208	1.08	1.27	1.25	1.18	2.84	2.87	1.25	3.11	1.18	-0.10	-9.4%
2 5/8	0.219	1.16	1.36	1.35	1.26	2.83	2.87	1.31	3.14	1.29	-0.13	-10.8%
2 3/4	0.229	1.24	1.46	1.44	1.36	2.83	2.86	1.38	3.17	1.39	-0.15	-12.3%
2 7/8	0.240	1.32	1.56	1.54	1.45	2.81	2.85	1.44	3.21	1.50	-0.18	-13.9%
3	0.250	1.40	1.67	1.64	1.55	2.80	2.84	1.50	3.24	1.62	-0.22	-15.7%
3 1/8	0.260	1.48	1.77	1.75	1.64	2.78	2.82	1.56	3.28	1.74	-0.26	-17.7%
3 1/4	0.271	1.57	1.88	1.85	1.74	2.78	2.82	1.63	3.31	1.87	-0.30	-18.9%
3 3/8	0.281	1.66	1.99	1.96	1.84	2.78	2.82	1.69	3.32	1.98	-0.32	-19.3%
3 1/2	0.292	1.75	2.10	2.07	1.95	2.78	2.82	1.75	3.32	2.09	-0.34	-19.5%
3 5/8	0.302	1.84	2.21	2.18	2.05	2.77	2.81	1.81	3.32	2.20	-0.36	-19.8%
3 3/4	0.313	1.93	2.33	2.29	2.16	2.76	2.81	1.88	3.32	2.32	-0.39	-20.2%
3 7/8	0.323	2.12	2.44	2.40	2.27	2.89	2.94	1.94	3.32	2.44	-0.32	-14.9%
4	0.333	2.22	2.56	2.52	2.38	2.88	2.93	2.00	3.32	2.56	-0.34	-15.1%
4 1/8	0.344	2.32	2.68	2.64	2.49	2.88	2.93	2.06	3.32	2.68	-0.36	-15.4%
4 1/4	0.354	2.42	2.81	2.76	2.61	2.87	2.92	2.13	3.32	2.80	-0.38	-15.7%
4 3/8	0.365	2.52	2.93	2.88	2.72	2.86	2.91	2.19	3.32	2.92	-0.40	-16.0%
4 1/2	0.375	2.62	3.06	3.00	2.84	2.85	2.91	2.25	3.32	3.05	-0.43	-16.4%
4 5/8	0.385	2.73	3.19	3.13	2.96	2.85	2.91	2.31	3.32	3.18	-0.45	-16.4%
4 3/4	0.396	2.83	3.32	3.25	3.08	2.84	2.90	2.38	3.32	3.31	-0.48	-16.9%
4 7/8	0.406	2.94	3.45	3.38	3.20	2.84	2.90	2.44	3.32	3.44	-0.50	-17.0%
5	0.417	3.05	3.58	3.51	3.32	2.84	2.90	2.50	3.32	3.57	-0.52	-17.1%
5 1/8	0.427	3.16	3.72	3.64	3.45	2.83	2.89	2.56	3.32	3.71	-0.55	-17.3%
5 1/4	0.438	3.27	3.85	3.77	3.58	2.83	2.89	2.63	3.32	3.84	-0.57	-17.5%
5 3/8	0.448	3.38	3.99	3.90	3.71	2.82	2.88	2.69	3.32	3.98	-0.60	-17.8%
5 1/2	0.458	3.49	4.13	4.04	3.84	2.81	2.88	2.75	3.32	4.12	-0.63	-18.1%
5 5/8	0.469	3.61	4.27	4.17	3.97	2.81	2.88	2.81	3.32	4.26	-0.65	-18.1%
5 3/4	0.479	3.72	4.42	4.31	4.10	2.80	2.87	2.88	3.32	4.40	-0.68	-18.4%
5 7/8	0.490	3.84	4.56	4.45	4.23	2.80	2.87	2.94	3.32	4.55	-0.71	-18.5%
6	0.500	3.96	4.71	4.59	4.37	2.80	2.87	3.00	3.32	4.70	-0.74	-18.6%
6 1/8	0.510	4.08	4.86	4.73	4.51	2.80	2.87	3.06	3.32	4.84	-0.76	-18.7%
6 1/4	0.521	4.20	5.01	4.88	4.65	2.79	2.87	3.13	3.32	4.99	-0.79	-18.8%
6 3/8	0.531	4.32	5.16	5.02	4.79	2.79	2.87	3.19	3.32	5.14	-0.82	-19.0%
6 1/2	0.542	4.44	5.31	5.17	4.93	2.78	2.86	3.25	3.32	5.29	-0.85	-19.2%
6 5/8	0.552	4.57	5.46	5.31	5.07	2.79	2.86	3.31	3.32	5.45	-0.88	-19.2%
6 3/4	0.563	4.69	5.62	5.46	5.21	2.78	2.86	3.38	3.32	5.60	-0.91	-19.5%
6 7/8	0.573	4.82	5.78	5.61	5.36	2.78	2.86	3.44	3.32	5.76	-0.94	-19.5%

(1) Stage vs. Discharge by raceway or dam from Appendix A (Rangen Expert Report, Brockway et al., 12/20/12).

(2) Suppressed Weir Eq. Q = C *L*H^1.5 where: Q = discharge (cfs); C = discharge coefficient;

(3) Contracted Weir Eq. Q = C *(L - .2*H)*H^1.5 H = head (ft); L = length of dam board(s).

(4) Broad Crested Weir Eq. Q = C *L*H^1.5

(5,6) Discharge coefficient derived from Suppressed Weir Equation and Contracted Weir Equation using Rangen Discharge Table.

(7) Measured Head (H) divided by Breadth (B) of weir.

(8) Discharge coefficient for H/B for 6-inch weir computed relationship derived from Table 5-3 of King Handbook of Hydraulics (1976).

(9) Computed discharge using Suppressed Weir Eq. (above).

(10) Col. (1) minus col. (9)

(11) Col. (10) / col. (1).

Average weir water level in measurements taken from 6/13/11 to 4/23/2012 "RANGEN000032_WATER MEASUREMENTS 6-13-11 - 4-23-12".

Table 2-1

Comparison of Charlie Smith's Expert Report Table vs. Exhibit 3

Flow Index (0.8 for IPC fish and 1.0 for production fish)

	Current/15 cfs		35 cfs		55 cfs		75 cfs	
Rearing container	Table (lbs)	Exhibit 3 (lbs)	Table (lbs)	Exhibit 3 (lbs)	Table (lbs)	Exhibit 3 (lbs)	Table (lbs)	Exhibit 3 (lbs)
Greenhouse/Hatchhouse								
Small raceways (20 total)	9,880	9,880	19,760	19,760 *(9,880 x 2)*	19,760	19,760 *(9,880 x 2)*	19,760	19,760 *(9,880 x 2)*
Large Raceways (30 total)	58,125	70,959	158,515	144,893 *(20,699 x 4 rows IPC = 82,796) + (20,699 x 3 rows production fish = 62,097)*	198,044	301,140 *(30,114 x 4 rows IPC = 120,456) + (30,144 x 6 rows production fish = 180,864)*	239,530	No value.
CTR raceways (9 totals)	93,468	84,093 *(28,031 x 3 raceways)*	283,796	394,242 *(65,707 x 6 raceways)*	378,350	462,537 *(51,393 x 9 raceways)*	347,822	743,397 *(95,305 x 3 + 76,247 x 6)*
Totals	161,473		462,071		596,154		607,112	

Density Index (0.3 for IPC fish and 1.0 for production fish)

	Current/15 cfs		35 cfs		55 cfs		75 cfs	
Rearing container	Table (lbs)	Exhibit 3 (lbs)	Table (lbs)	Exhibit 3 (lbs)	Table (lbs)	Exhibit 3 (lbs)	Table (lbs)	Exhibit 3 (lbs)
Greenhouse/Hatchhouse								
Small raceways (20 total)	8,492	8,492	36,799	16,984 *(8,492 x 2)*	36,799	16,984 *(8,492 x 2)*	36,799	16,984 *(8,492 x 2)*
Large Raceways (30 total)	45,999	53,847	214,656	144,893 *(20,699 x 7 rows)*	367,980	No value.	367,980	No value.
CTR raceways (9 totals)	265,653	164,271 *(54,757 x 3 raceways)*	719,886	654,888 *(109,148 x 6 raceways)*	1,079,829	294,696 *(32,744 x 9 raceways)*	1,079,829	982,332 *(109,148 x 9 raceways)*
Totals	320,144		971,341		1,484,608		1,484,608	

Notes:

Black text are original values from the Table in Charlie Smith's Report.

Red text are values taken directly from Exhibit 3 of Charlie Smith's report.

Blue text are calculated totals using values and inputs described in Exhibit 3 of Charlie Smith's report.

Columns highlighted in yellow are values from the Exhibit 3 that match the Table values.

Columns highlighted in green are values taken directly from Exhibit 3 that do not match values in the Table.

Columns highlighted in red are values calculated from Exhibit 3 that do not match values in the Table.

Table 3-1

Historical Curren Spring Water Measurements
1966 - 1974
Values in CFS

Date of Measurement	(1) Large Raceways	(2) Irrigation Diversions	(3) Lodge Dam	(4) Sub-Total	(5) Irrigation Returns	(6) Total	(7) Total Rangen Flow	(8) Diff.
1/26/1967	33.4	0.4	10.1	43.9	0.0	43.9	43.9	0.0
2/24/1967	29.2	0.4	9.6	39.3	0.0	39.3	39.3	0.0
3/27/1967	21.8	0.8	10.8	33.4	0.0	33.4	33.4	0.0
4/27/1967	19.0	6.9	10.7	36.6	0.0	36.6	36.6	0.0
5/28/1967	19.3	8.8	9.6	37.6	0.0	37.6	37.6	0.0
6/28/1967	28.0	9.4	10.0	47.4	0.0	47.4	47.4	0.0
8/2/1967	33.9	8.5	10.5	52.9	0.0	52.9	52.9	0.0
9/4/1967	40.2	7.8	12.1	60.0	1.1	58.9	58.9	0.0
10/6/1967	48.5	5.6	17.6	71.6	2.3	69.4	69.4	0.0
11/1/1967	49.7	0.9	16.7	67.4	0.0	67.4	67.4	0.1
12/5/1967	49.7	0.0	14.6	64.3	0.0	64.3	64.3	0.0
1/6/1968	42.3	0.3	10.2	52.8	0.0	52.8	52.8	0.0
2/14/1968	34.8	0.3	10.7	45.8	0.0	45.8	45.8	0.0
3/9/1968	31.2	0.2	9.8	41.2	0.0	41.2	41.2	0.0
4/13/1968	26.3	0.0	9.7	36.0	0.0	36.0	36.0	0.0
5/15/1968	19.0	9.1	8.7	36.8	0.0	36.8	36.8	0.0
6/12/1968	26.6	6.5	11.9	45.0	0.0	45.0	45.0	0.0
7/17/1968	32.8	8.4	10.9	52.0	1.6	50.5	50.5	0.0
8/18/1968	48.1	0.4	10.9	59.4	0.4	59.0	58.9	-0.1
9/22/1968	50.0	3.9	14.6	68.5	0.3	68.2	68.2	0.0
10/22/1968	50.8	0.6	17.4	68.8	0.6	68.2	68.2	0.0
11/25/1968	47.5	0.6	17.7	65.8	0.3	65.5	65.5	0.0
1/2/1969	41.2	0.3	9.6	51.1	0.3	50.8	50.8	0.0
2/4/1969	33.6	0.0	9.8	43.4	0.0	43.4	43.4	0.0
3/9/1969	28.4	0.0	9.8	38.2	0.0	38.2	38.2	0.0
4/7/1969	24.6	0.6	9.3	34.4	0.2	34.2	33.4	-0.8
5/8/1969	16.5	8.7	11.5	36.8	2.5	34.3	34.3	0.0
6/7/1969	25.8	8.8	13.7	48.3	2.8	45.5	45.5	0.0
7/8/1969	32.3	6.9	23.6	62.9	3.0	59.9	49.6	-10.3
8/8/1969	39.4	9.6	11.3	60.3	1.8	58.5	58.5	0.0
9/18/1969	47.5	5.2	14.4	67.2	1.3	65.9	65.9	0.0
10/10/1969	46.8	2.7	17.7	67.2	0.3	66.9	66.9	0.0
11/14/1969	50.4	1.0	14.3	65.7	1.0	64.7	64.7	0.0
12/12/1969	46.2	0.5	11.0	57.6	0.5	57.2	57.2	0.0

Table 3-1

Historical Curren Spring Water Measurements
1966 - 1974
Values in CFS

Date of Measurement	(1) Large Raceways	(2) Irrigation Diversions	(3) Lodge Dam	(4) Sub-Total	(5) Irrigation Returns	(6) Total	(7) Total Rangen Flow	(8) Diff.
1/12/1970	38.7	0.7	10.8	50.1	0.3	49.8	49.8	0.0
2/16/1970	32.5	0.3	10.2	43.0	0.3	42.7	42.7	0.0
3/10/1970	32.2	0.3	9.8	42.3	0.3	42.0	42.0	0.1
4/9/1970	26.9	0.3	7.6	34.8	0.1	34.7	34.7	0.0
5/11/1970	20.8	8.2	7.7	36.6	ND	ND	34.5	ND
9/22/1970	46.4	4.4	18.3	69.0	3.0	66.0	66.0	0.0
4/12/1971	24.6	3.3	9.4	37.2	0.0	37.2	37.2	0.0
5/14/1971	21.2	7.4	11.9	40.5	0.0	40.5	40.5	0.0
6/11/1971	27.6	5.8	12.5	45.9	2.5	43.4	43.4	0.0
8/10/1971	40.3	9.3	13.4	63.0	2.5	60.5	60.5	0.0
9/15/1971	44.4	8.0	14.7	67.1	3.4	63.6	64.8	1.2
10/19/1971	50.5	0.0	23.2	73.7	0.0	73.7	73.7	0.0
11/17/1971	50.7	0.8	19.2	70.6	0.4	70.2	70.2	0.0
12/13/1971	51.3	1.0	11.5	63.9	0.5	63.4	63.4	0.0
1/21/1972	44.3	1.0	10.6	55.9	0.8	55.1	55.1	0.0
2/13/1972	37.3	1.0	10.1	48.4	0.3	48.1	48.1	0.0
3/18/1972	33.6	0.4	9.2	43.3	0.3	43.0	43.0	0.0
4/18/1972	26.3	4.7	9.5	40.6	0.0	40.6	40.6	0.0
5/30/1972	28.9	7.5	12.5	48.9	3.0	45.9	45.9	0.0
6/28/1972	38.3	8.7	13.7	60.6	2.5	58.1	58.1	0.0
7/21/1972	41.1	9.0	11.8	61.9	1.6	60.3	61.0	0.7
8/26/1972	45.4	9.6	14.7	69.7	2.4	67.3	67.3	0.0
9/29/1972	49.3	4.9	20.1	74.3	0.3	74.0	73.9	-0.1
11/4/1972	47.0	0.8	20.7	68.5	0.3	68.2	76.1	7.9
12/1/1972	51.0	0.5	15.3	66.7	0.0	66.7	68.2	1.5
1/6/1973	48.2	0.5	9.1	57.9	0.0	57.9	57.9	0.0
2/12/1973	40.1	0.5	8.6	49.1	0.0	49.1	49.1	0.0
3/20/1973	36.7	0.5	9.3	46.5	0.3	46.2	46.2	0.0
4/4/1973	32.1	0.5	9.2	41.8	0.1	41.7	37.6	-4.1
4/25/1973	22.2	6.1	12.1	40.3	2.8	37.6	39.6	2.1
5/28/1973	21.8	9.2	10.2	41.2	1.2	40.0	42.1	2.1
7/13/1973	33.4	9.4	12.6	55.4	2.3	53.1	53.1	0.0
9/14/1973	44.7	2.5	14.6	61.7	1.5	60.2	57.8	-2.4
1/2/1974	34.2	0.0	9.9	44.1	0.0	44.1	44.1	0.0

Table 3-1

Historical Curren Spring Water Measurements
1966 - 1974
Values in CFS

Date of Measurement	(1) Large Raceways	(2) Irrigation Diversions	(3) Lodge Dam	(4) Sub-Total	(5) Irrigation Returns	(6) Total	(7) Total Rangen Flow	(8) Diff.
Average	36.4	3.7	12.4	52.6	0.8	52.0	51.7	-
Monthly Averages								
Jan	40.3	0.5	10.0	50.8	0.2	50.6	50.6	-
Feb	34.6	0.4	9.8	44.8	0.1	44.7	44.7	-
Mar	30.6	0.4	9.8	40.8	0.1	40.7	40.7	-
Apr	25.2	2.8	9.7	37.7	0.4	37.3	37.0	-
May	21.1	8.4	10.3	39.8	1.1	39.2	38.8	-
Jun	29.2	7.8	12.4	49.5	1.6	47.9	47.9	-
Jul	34.9	8.4	14.7	58.1	2.1	55.9	53.6	-
Aug	41.4	7.5	12.2	61.1	1.4	59.6	59.6	-
Sep	46.1	5.2	15.5	66.8	1.6	65.3	65.1	-
Oct	49.2	2.2	19.0	70.3	0.8	69.6	69.6	-
Nov	49.1	0.8	17.7	67.6	0.4	67.2	68.8	-
Dec	49.6	0.5	13.1	63.1	0.2	62.9	63.3	-

Source: Curren Spring and Tunnel log books provided by IDWR (supplemental disclosures 1/17/2013).

Notes:

(1) Listed as "20 pipes races" in log books.

(2) Listed as "3 pipes" in log books.

(3) Listed as "Creek" in log books.

(4) Sub-Total = (1) + (2) + (3).

(5) Listed as "Waste" in log books (water not originating from Curren Spring).

(6) Total flow = (4) - (5).

(7) Total Rangen Flow provided by Rangen.

(8) Difference = (7) - (6).

Appendices

Appendix A Rangen Tables

INCHES		LG RW	CTR	SM	DAM
	0	0.25	0.33	0.23	0.28
1	1/8	0.30	0.40	0.27	0.33
1	1/4	0.35	0.47	0.31	0.39
1	3/8	0.41	0.54	0.36	0.45
1	1/2	0.47	0.61	0.41	0.51
1	5/8	0.52	0.69	0.47	0.57
1	3/4	0.59	0.77	0.52	0.64
1	7/8	0.65	0.86	0.58	0.71
2	0	0.72	0.95	0.64	0.78
2	1/8	0.79	1.04	0.70	0.86
2	1/4	0.93	1.22	0.82	1.01
2	3/8	1.00	1.32	0.89	1.09
2	1/2	1.08	1.42	0.96	1.18
2	5/8	1.16	1.53	1.03	1.26
2	3/4	1.24	1.63	1.10	1.35
2	7/8	1.32	1.74	1.17	1.44
3	0	1.40	1.85	1.24	1.53
3	1/8	1.48	1.96	1.32	1.62
3	1/4	1.57	2.07	1.40	1.72
3	3/8	1.66	2.19	1.47	1.81
3	1/2	1.75	2.31	1.55	1.91
3	5/8	1.84	2.43	1.63	2.01
3	3/4	1.93	2.55	1.72	2.11
3	7/8	2.12	2.80	1.89	2.32
4	0	2.22	2.93	1.97	2.43
4	1/8	2.32	3.06	2.06	2.53
4	1/4	2.42	3.19	2.15	2.64
4	3/8	2.52	3.33	2.24	2.75
4	1/2	2.62	3.46	2.33	2.87
4	5/8	2.73	3.60	2.42	2.98
4	3/4	2.83	3.74	2.52	3.10
4	7/8	2.94	3.88	2.61	3.21
5	0	3.05	4.02	2.71	3.33
5	1/8	3.16	4.17	2.80	3.45
5	1/4	3.27	4.31	2.90	3.57
5	3/8	3.38	4.46	3.00	3.69
5	1/2	3.49	4.61	3.10	3.82
5	5/8	3.61	4.76	3.20	3.94
5	3/4	3.72	4.92	3.31	4.07
5	7/8	3.84	5.07	3.41	4.20
6	0	3.96	5.23	3.52	4.33
6	1/8	4.08	5.38	3.62	4.46
6	1/4	4.20	5.54	3.73	4.59
6	3/8	4.32	5.70	3.84	4.72
6	1/2	4.44	5.86	3.95	4.86
6	5/8	4.57	6.03	4.06	4.99
6	3/4	4.69	6.19	4.17	5.13
6	7/8	4.82	6.36	4.28	5.27

** table adjusted for measurement over 2" boards

Source: Appendix A, Rangen Expert Report, Brockway et. al., December 2012.

Appendix B

Selected Photographs from Site Visits of Rangen Experts

Photo B-1 Small Raceways (10/29/2012) - by Charles Brockway.

Photo B-2 Small Raceways (10/29/2012) - by Charles Brockway.

Photo B-3 Lodge Dam (6/21/2012) - by David Colvin.

Photo B-4 Lodge Dam (9/18/2012) - by Charles Brockway.

Appendix B

Selected Photographs from Site Visits of Rangen Experts

Photo B-5 Large Raceways (9/18/2012) - by Charles Brockway.

Photo B-6 Large Raceways (9/18/2012) - by Charles Brockway.

Photo B-7 Large Raceways (10/29/2012) - by Charles Brockway.

Photo B-8 Large Raceways (10/29/2012) - by Charles Brockway.

Appendix B
Selected Photographs from Site Visits of Rangen Experts

Photo B-9 CTR Raceways (6/21/2012) - by David Colvin.

Photo B-10 CTR Raceways (6/21/2012) - by David Colvin.

Photo B-11 CTR Raceways (6/21/2012) - by David Colvin.

Photo B-12 CTR Raceways (6/21/2012) - by David Colvin.

Appendix C
Updated Tables and Figures
2012 Expert Report

Figure 2-9

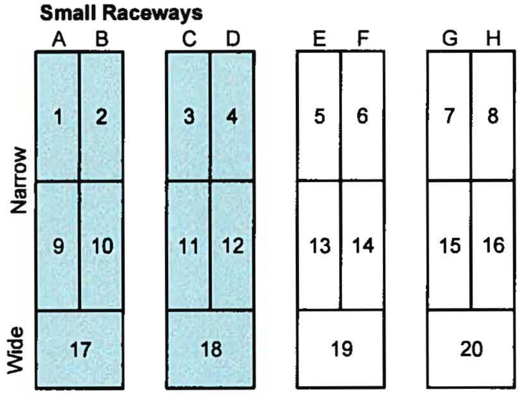
Updated February 2013

Raceway Volumes and Identifiers
Rangen Hatchery

Raceway Type	Volume (ft^3)	Identifier
Green House Tank	27	(1-24)
Hatch House Trough	17	(1-12)
Small Raceway (narrow)	580	(1-16)
Small Raceway (wide)	934	(17-20)
Large Raceway	1,640	(1-10 T,C, B)
CTR Raceway	8,244	(A, B, & D)

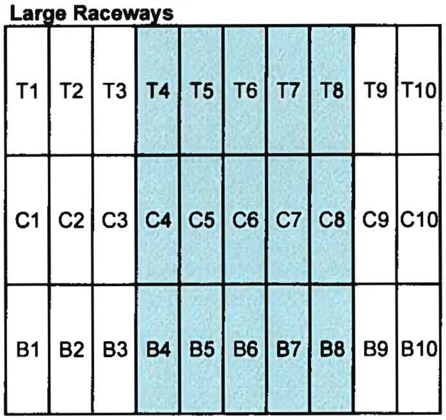
	(1) Records	(2) Rangen	
Based on flow restrictors			
Max Tank flow (11.5 GPM) =	0.03	-	cfs
~Capacity Flow (flow x 24) =	0.61	-	cfs
Based on maximum flows (2007-2012)*			
Max Trough flow =	0.06	0.07	cfs
~Capacity Flow (avg flow x 12) =	0.75	0.80	cfs
Est. capacity of Tanks and Troughs =	1.36	1.42	cfs

Small Raceways



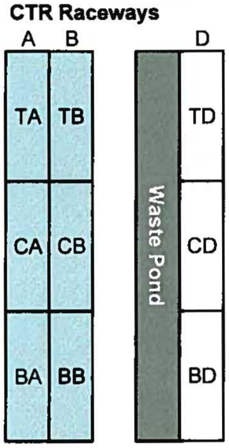
	(1) Records	(2) Rangen	
Based on average flows (2007-2012)			
Avg Sm. Raceway (wide) flow =	2.28	1.11	cfs
~Capacity Flow (avg flow x 4) =	9.11	4.46	cfs
Based on maximum flows (2007-2012)*			
Max Sm. Raceway (wide) flow =	2.68	2.99	cfs
~Capacity Flow (avg flow x 4) =	10.72	11.98	cfs

Large Raceways



	(1) Records	(2) Rangen	
Based on average flows (2007-2012)			
Avg Lg. Raceway flow =	4.29	3.34	cfs
~Capacity Flow (avg flow x 10) =	42.92	33.42	cfs
Based on maximum flows (2007-2012)*			
Max Lg. Raceway flow =	4.82		
~Capacity Flow (max flow x 10) =	48.18		

CTR Raceways



	(1) Records	(2) Rangen	
Based on average flows (2007-2012)			
Avg CTR flow =	12.39	8.36	cfs
~Capacity Flow (avg flows x3) =	37.18	25.07	cfs
~Capacity Flow w/o WP (avg flows x4) =	49.58	33.42	cfs
Based on maximum flows (2007-2012)			
Max CTR flow =	17.26		
~Capacity Flow (max flows x3) =	51.77		
~Capacity Flow w/o WP (avg flows x4) =	69.03		

*Total reported flow divided by number of raceways in operation.

Notes

(1) Volumes from Idaho Power Hatchery Production Summaries.
(2) Flows from "Rangen Trough Research Hatchery, Outline of Operations" provided by Rangen (1/30/2013).
(3) Raceway identifiers provided by Lonny Tate during his deposition on September 11, 2012.

Table 4-1

Updated February 2013

Summary of Spring and Fall Fish Sales to Idaho Power
Rangen Hatchery
Spring 2007 - Spring 2012

Idaho Power Hatchery Production Summaries						Fish Sales Summaries		
Cycle	Date	# Fish	Weight (lbs)	Mean Length (in.)	Mean Fish Per lb	Weight Sold to IPC (lbs)	Approx. No. of Fish (1)	Annual Approx. No. of Fish Sold
Spring 2007	2/28/2007	116,456	36,321	8.72	3.25	27,126	88,099	148,968
Fall 2007	10/19/2007	72,593	34,431	10.40	2.10	28,985	60,869	
Spring 2008	2/27/2008	95,356	44,511	10.03	2.15	38,915	83,505	153,531
Fall 2008	10/11/2008	72,162	25,849	9.93	2.81	24,930	70,026	
Spring 2009	3/18/2009	95,157	41,933	10.11	2.27	38,870	88,149	151,025
Fall 2009	10/21/2009	62,946	28,374	10.04	2.21	28,465	62,876	
Spring 2010	3/10/2010	100,671	42,072	10.26	2.19	37,680	82,595	145,373
Fall 2010	10/20/2010	98,446	45,107	10.47	2.19	28,640	62,779	
Spring 2011	3/9/2011	97,156	44,017	9.65	2.21	36,665	81,063	143,257
Fall 2011	10/19/2011	88,912	40,594	10.34	2.22	27,965	62,194	
Spring 2012	3/7/2012	72,508	32,360	9.95	2.25	ND	ND	
Fall 2012	10/15/2012	88,260	40,683	10.27	2.17	ND	ND	
Average		88,397	37,779	9.99	2.35	31,824	74,215	148,431
Spring		96,217	40,202	9.79	2.39	35,851	84,682	
Fall		80,553	35,840	10.24	2.28	27,797	63,749	
Annual		176,771	76,042	20.03	4.67	63,648	148,431	

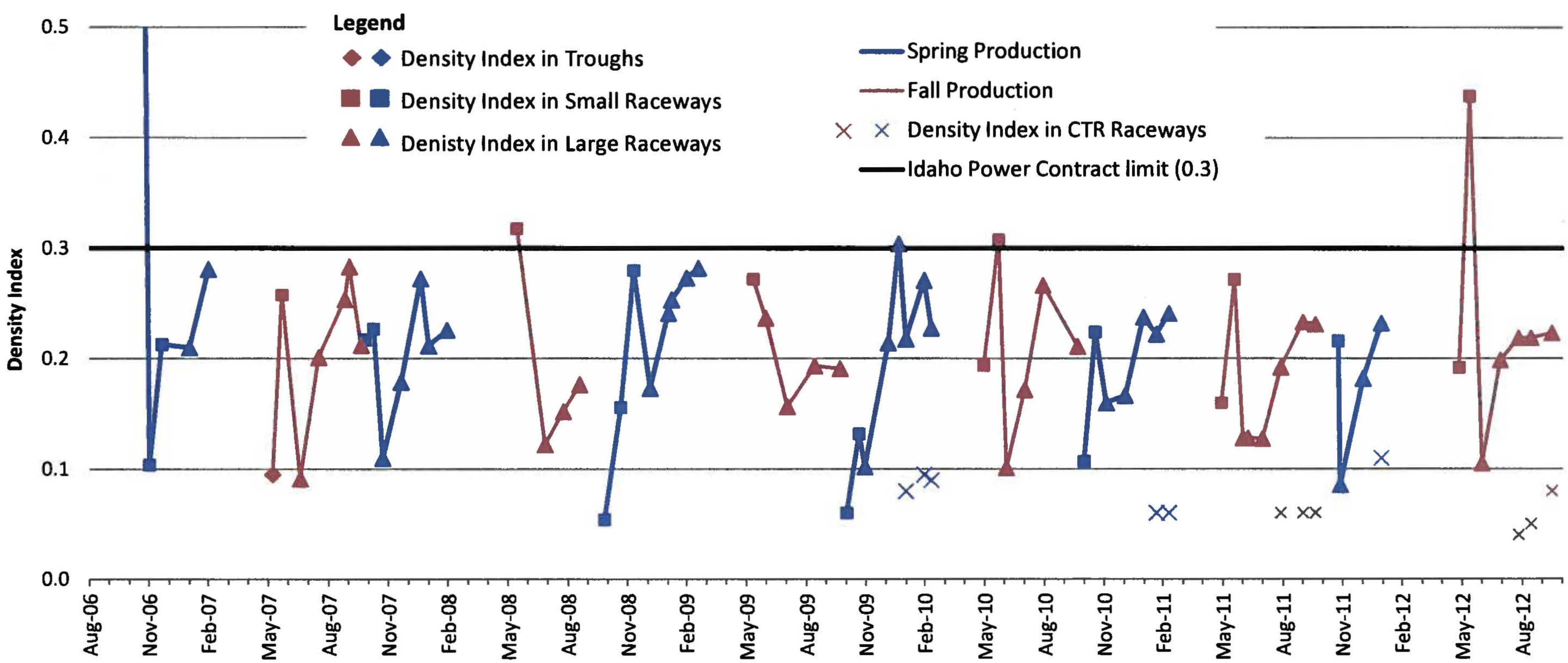
Sources: Number of fish, weight of fish, mean length of fish, and mean fish per pound contained in the Idaho Power Hatchery Production Summaries nearest to the time of the sale.
Weight of fish sold to Idaho Power Company from monthly Sales Summaries provided by Rangen.

Notes: (1) Weight sold to IPC (lbs) multiplied by mean fish per pound.
ND = No sales data for 2012.

Figure 4-5

Updated February 2013

Reported Density Index
Idaho Power Hatchery Production Summaries
Rangen Hatchery
2006 - 2012

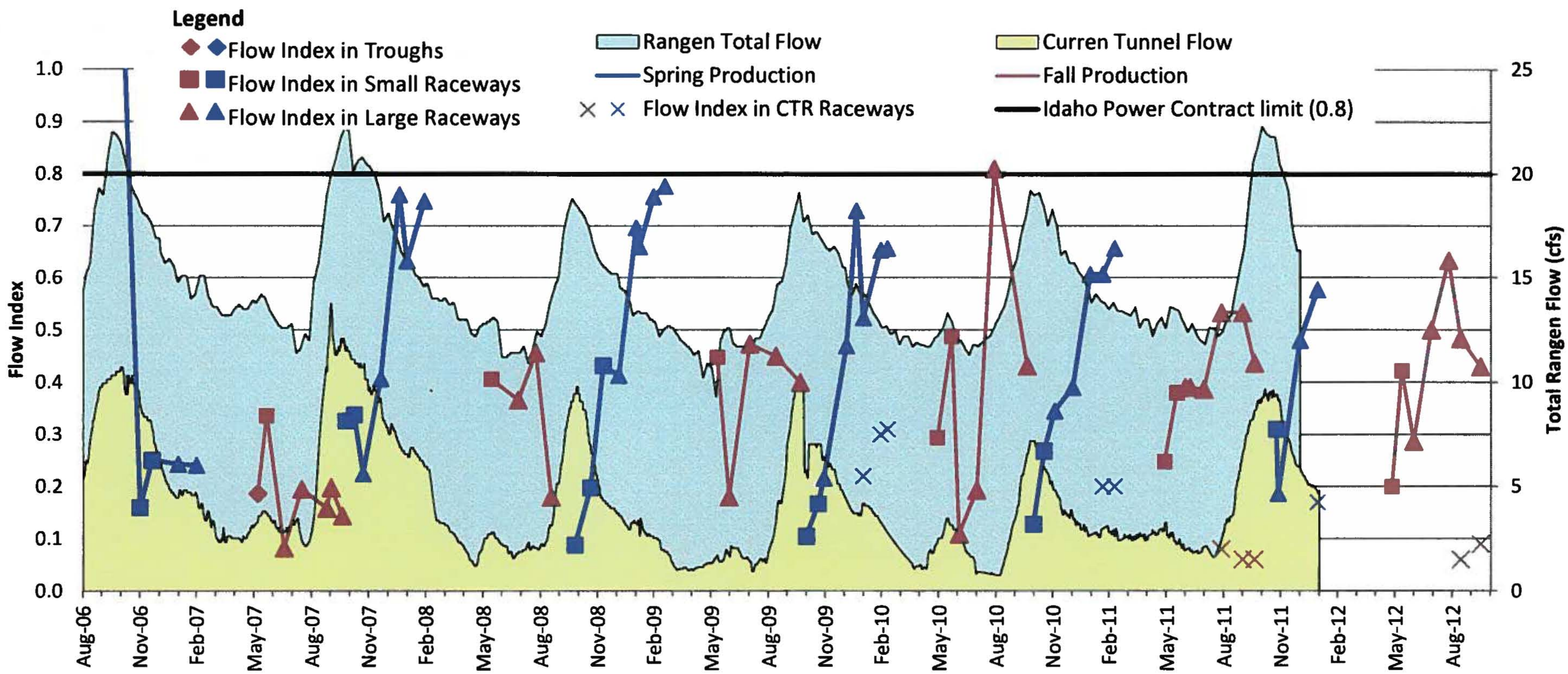


Source: Average of the Density Index values by structure type contained in the Idaho Power Hatchery Production Summaries.
Notes: Density Index = Fish Weight (lbs) / (Length of Fish (in) x Volume of Raceway or Container (cubic feet))
Density Index limit in Idaho Power Contract = 0.3.
In October 2006, the reported average density index in Troughs is 2.1.

Figure 4-6

Updated February 2013

Reported Flow Index
Idaho Power Hatchery Production Summaries
Rangen Hatchery
2006 - 2012



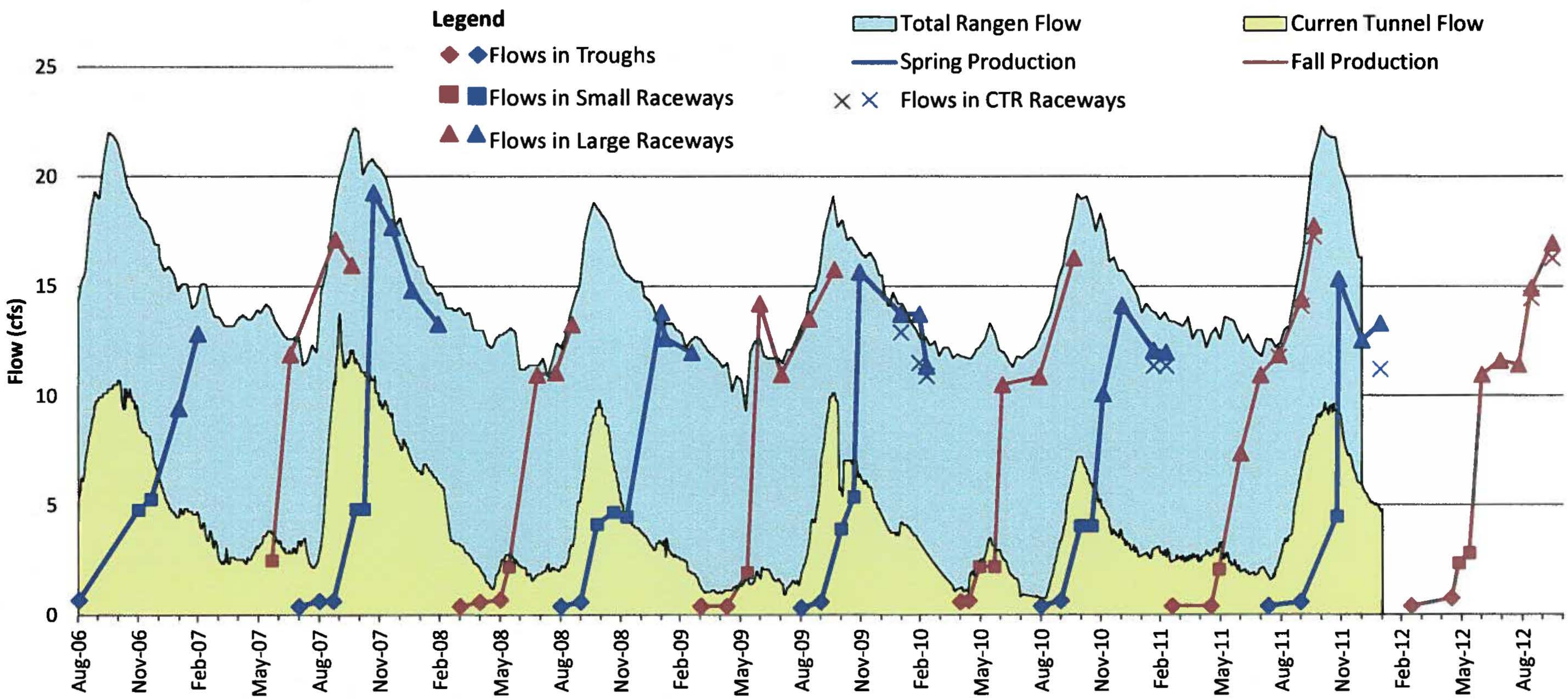
Sources: Average of the Flow Index values by structure type contained in the Idaho Power Hatchery Production Summaries.
Daily Total Rangen flow and daily Curren Tunnel flow data reported by IDWR.

Notes: Flow Index (FI) = Fish Weight (lbs) / (Length of Fish (in) x Flow rate (gallons per minute))
Flow Index limit in Idaho Power Contract = 0.8.
The reported average flow index in the Troughs is 1.2

Figure 4-7

Updated February 2013

Daily Flow (cfs)
Idaho Power Hatchery Production Summaries
Rangen Hatchery
2006 - 2012



Sources: Structure flow data based on the sum of the daily flows contained in the Idaho Power Hatchery Production Summaries.
Daily Total Rangen flow and daily Curren Tunnel flow data reported by IDWR.

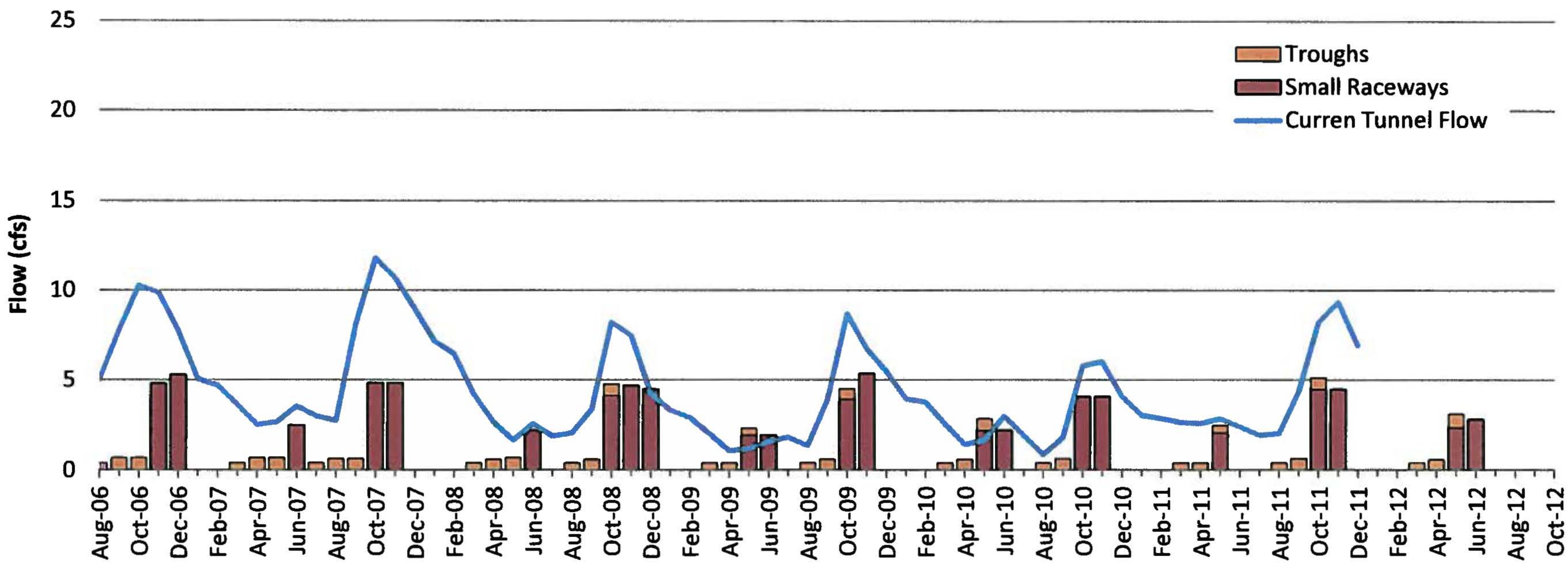
Note: Missing data for Troughs in March to May 2007.

Figure 4-8

Updated February 2013

Trough and Small Raceway Flows vs. Curren Tunnel Flows
Idaho Power Hatchery Production Summaries
Rangen Hatchery
August 2006 - October 2012

Values in CFS



Sources: Daily Trough and Small Raceway reported flow values from the Idaho Power Hatchery Production Summaries are shown in month of occurrence. Monthly Curren Tunnel flow from IDWR. No data are available for 2012.

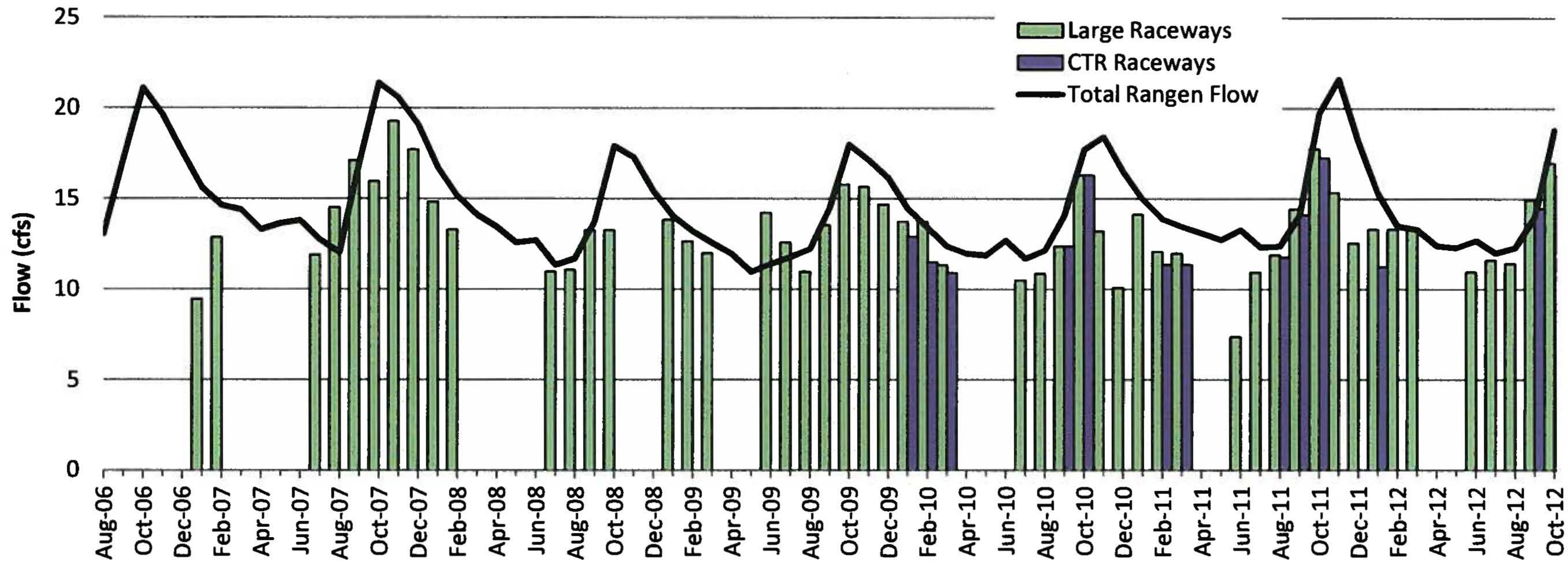
Notes: Missing Trough flow data filled in with average values in 8/2006, 10/2006, 10/2009, 10/2011, and 5/2012.
Monthly flows during a production cycle without daily Small Raceway flow data in that month were estimated by averaging flows in the previous and subsequent months (5/2009 and 10/2011).
There did not appear to be information in the Idaho Power Hatchery Production Summaries regarding the production of fish for the 8,000 pounds of fish that are delivered to Rangen in late May or early June for release at American Falls Reservoir. As a result, this chart does not reflect the presence of these fish in the hatchery.

Figure 4-9

Updated February 2013

Large and CTR Raceway Flows vs. Total Rangen Flow
Idaho Power Hatchery Production Summaries
Rangen Hatchery
August 2006 - October 2012

Values in CFS



Sources: Daily Large Raceway and CTR Raceway reported flows from Idaho Power Hatchery Production Summaries. The reported daily values are shown in month of occurrence.

Monthly average total Rangen flow reported by Rangen.

Notes: Monthly flows during a production cycle without daily flow data were estimated by averaging flows in the previous and subsequent months (8/2007, 10/2008, 9/2010, and 3/2012 for the Large Raceways and 9/2010 and 10/2010 for the CTR Raceways).

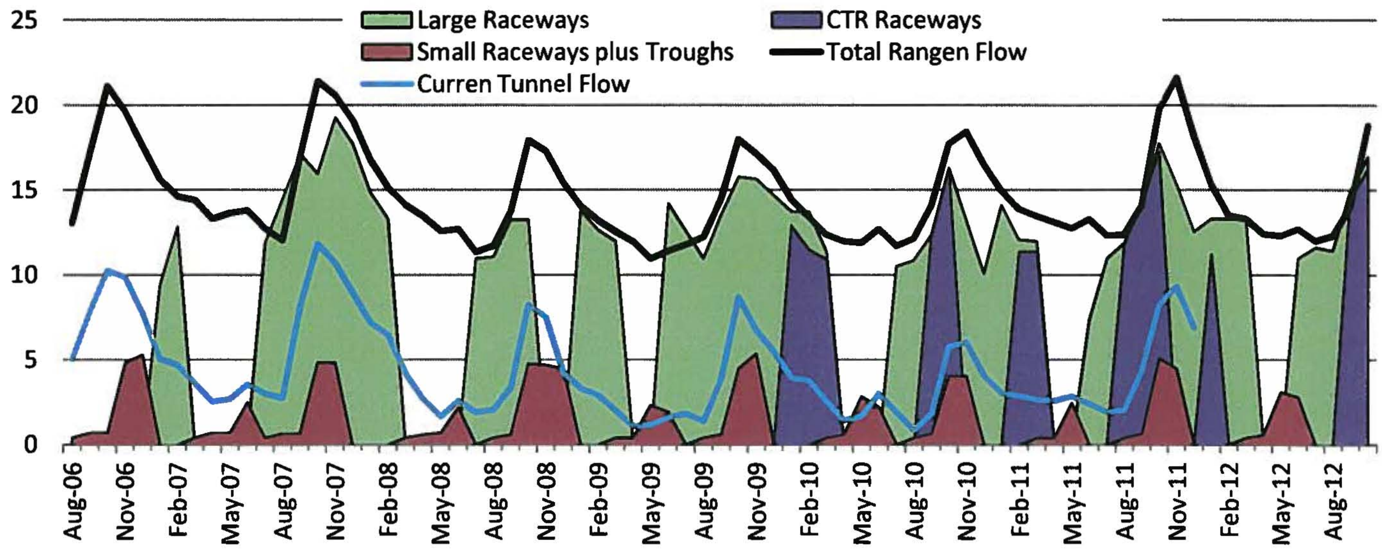
There did not appear to be information in the Idaho Power Hatchery Production Summaries regarding the production of fish for the 8,000 pounds of fish that are delivered to Rangen in late May or early June for release at American Falls Reservoir. As a result, this chart does not reflect the presence of these fish in the hatchery.

Figure 4-10

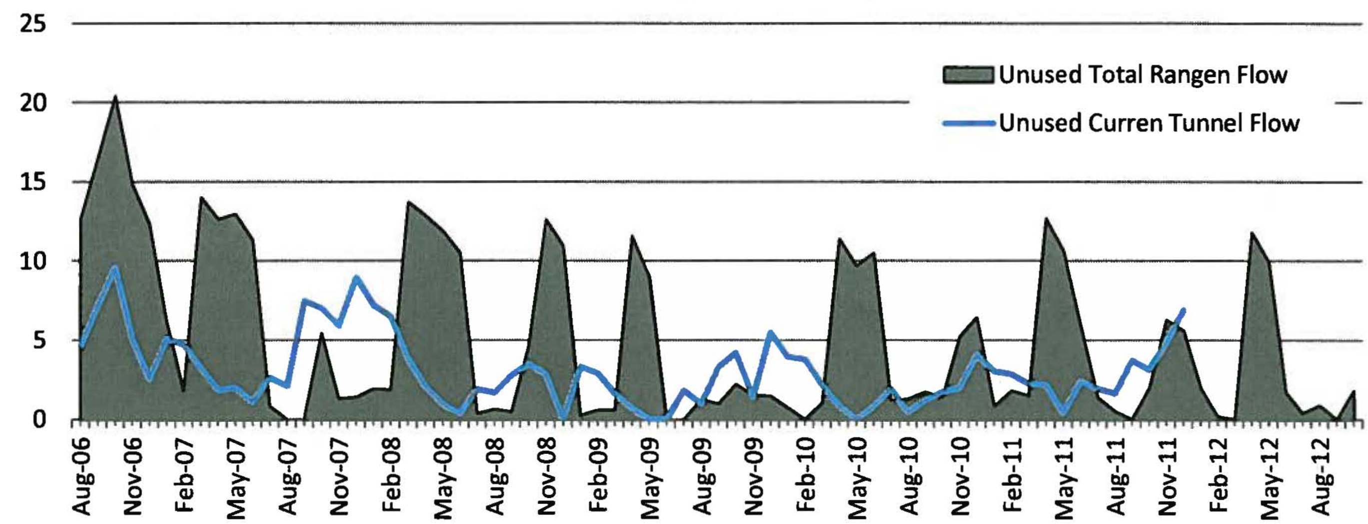
Updated February 2013

Monthly Flow Through Raceways vs. Total Rangen Flow and Curren Tunnel Flow
Rangen Hatchery
August 2006 - October 2012

Values in CFS



Total Unused Rangen Hatchery Flows



<u>Sources:</u> Raceway flows in the monthly Idaho Power Hatchery Production Summaries.
Total Rangen flow reported by Rangen and Curren Tunnel flow reported by IDWR.

<u>Notes:</u> Unused Curren Tunnel Flow is the Curren Tunnel flow minus the sum of the flows in Troughs and Small Raceways.
Unused Total Flow is the Total Rangen Flow minus the greater of the flows measured in the (Troughs plus Small Raceways), Large Raceways, or CTR Raceways.
There did not appear to be information in the Idaho Power Hatchery Production Summaries regarding the production of fish for the 8,000 pounds of fish that are delivered to Rangen in late May or early June for release at American Falls Reservoir. As a result, this chart does not reflect the presence of these fish in the hatchery.

Appendix G

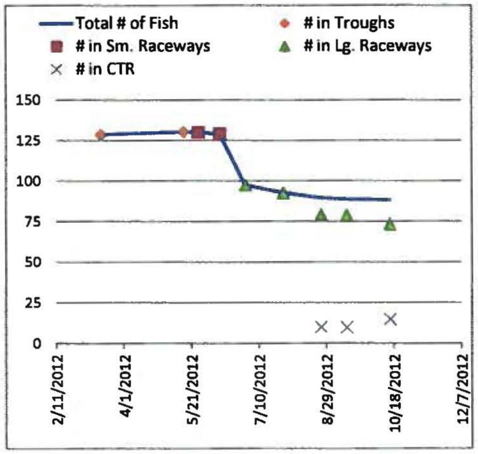
Updated February 2013

Idaho Power Company Production by Fish Cycle

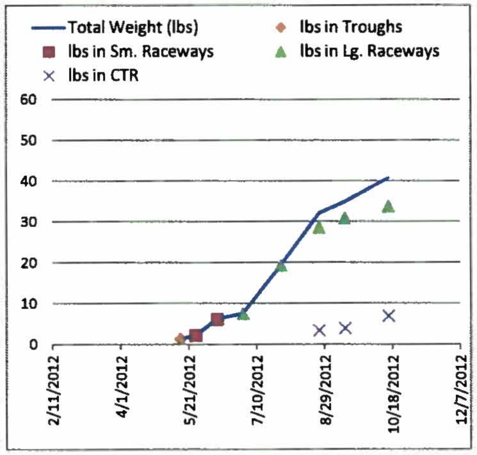
Rangen Hatchery

Fall 2012

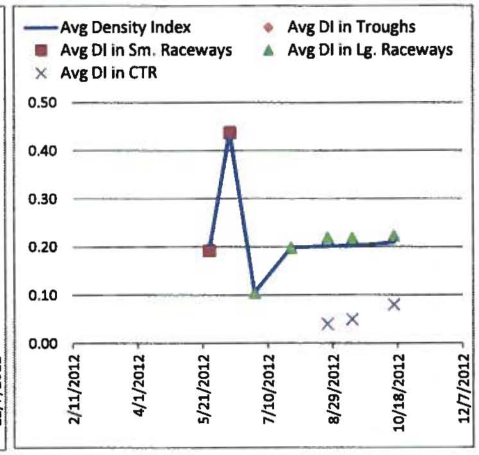
Total Number of Fish (x 1,000)



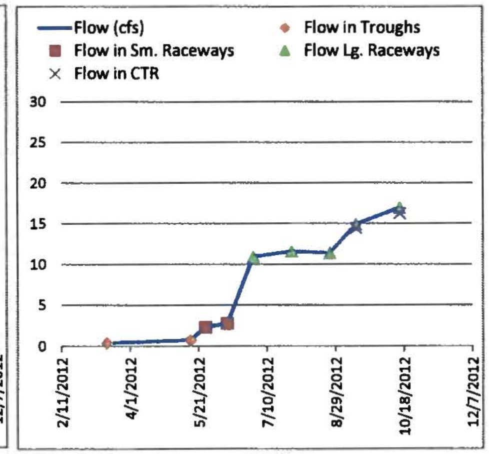
Total Weight of Fish in 1,000 Pounds



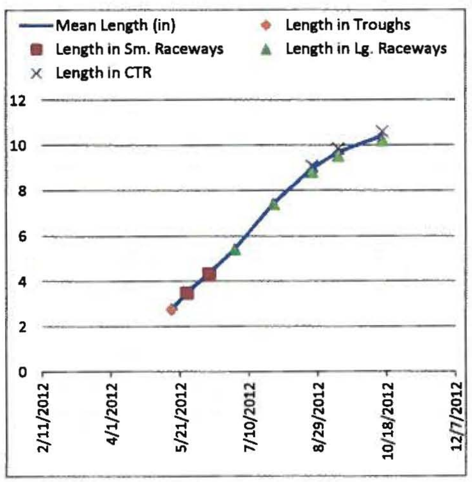
Average Density Index



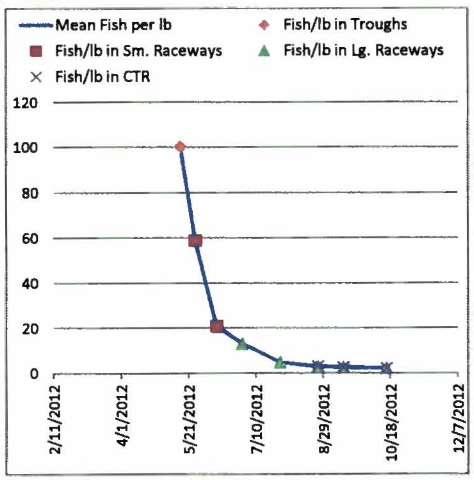
Average Flow Through Raceways (CFS)



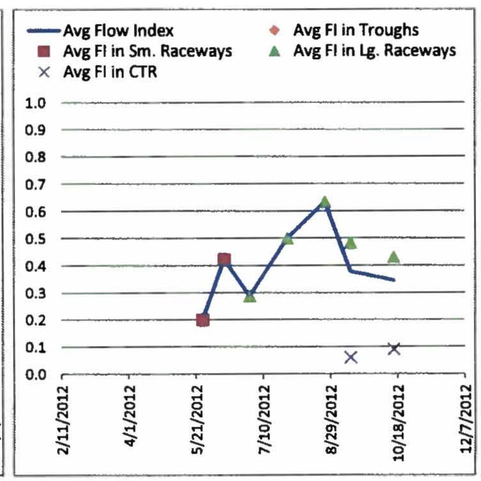
Mean Length of Fish in Inches



Mean Number of Fish per Pound



Average Flow Index

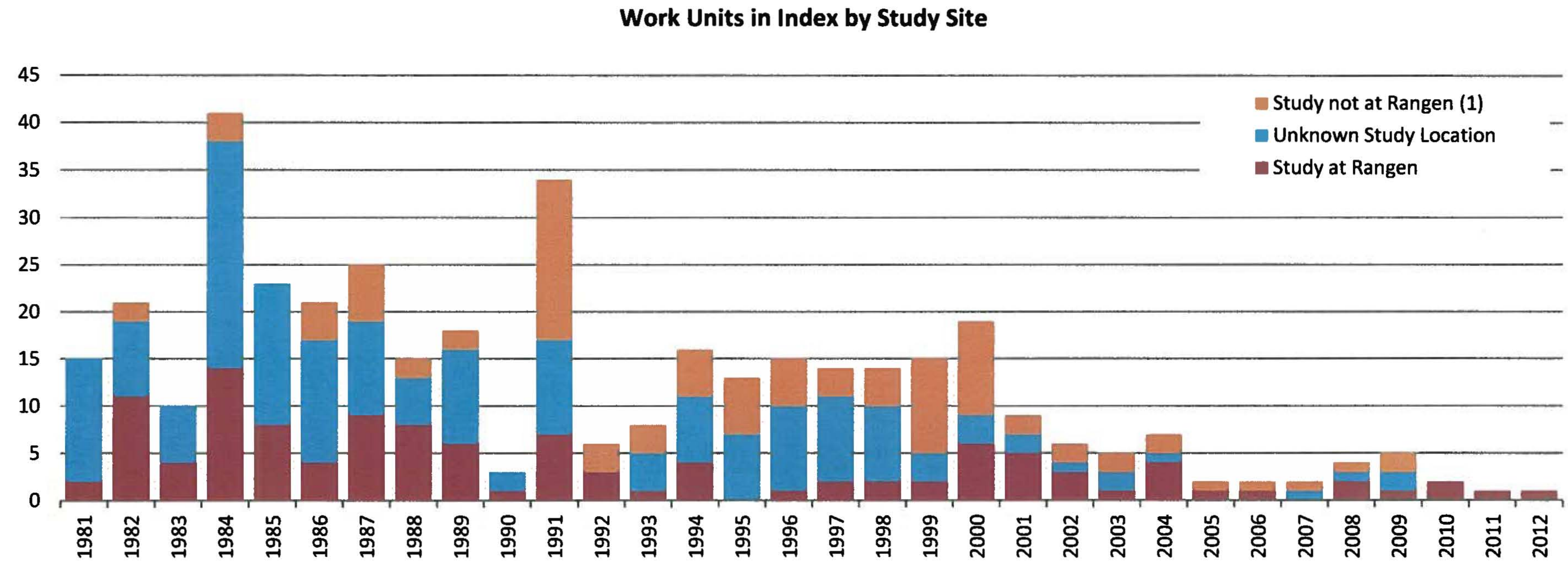


Source: Idaho Power Hatchery Production Summaries.

Figure 5-1a

Updated February 2013

Summary of Research Index Work Units
All Species
Rangen Hatchery
1981 - 2012



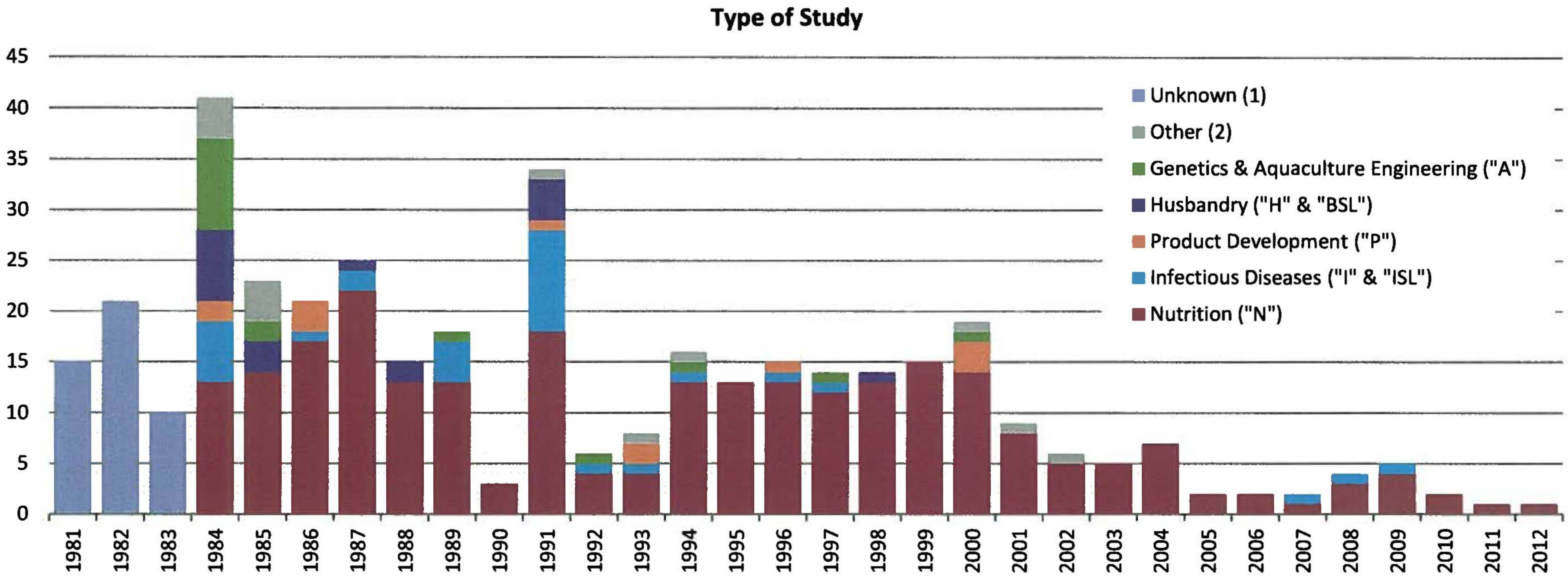
Notes:

*Documentation or study names indicated that the research was conducted at a different site. Tilapia and other warm water fish research was assumed to be done off-site.

Figure 5-1b

Updated February 2013

Summary of Research Index Work Units
All Species
Rangen Hatchery
1981 - 2012



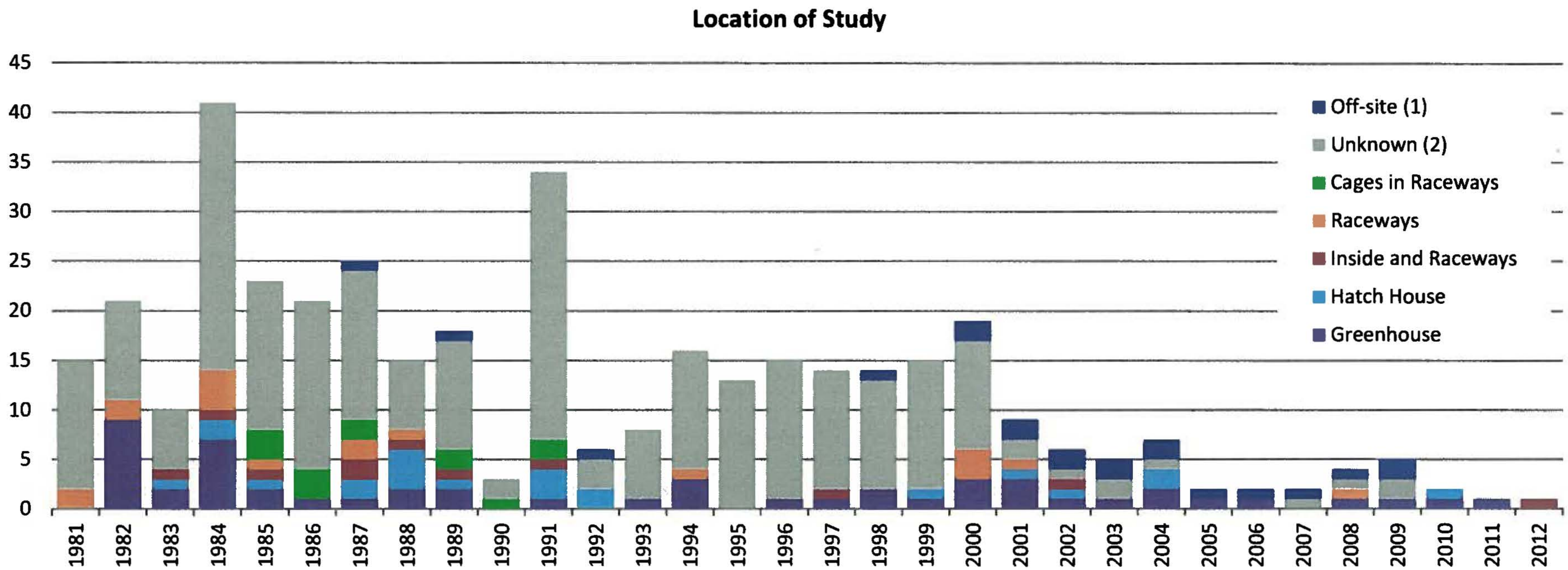
(1) Unknown types include pre-1984 studies. Nature of pre-1984 studies cannot be determined based on numbering system in index.

(2) Other types include physiology/biology/analytical chemistry ("B"), toxicology ("T"), extension service ("E"), and other ("O").

Figure 5-1c

Updated February 2013

Summary of Research Index Work Units
All Species
Rangen Hatchery
1981 - 2012



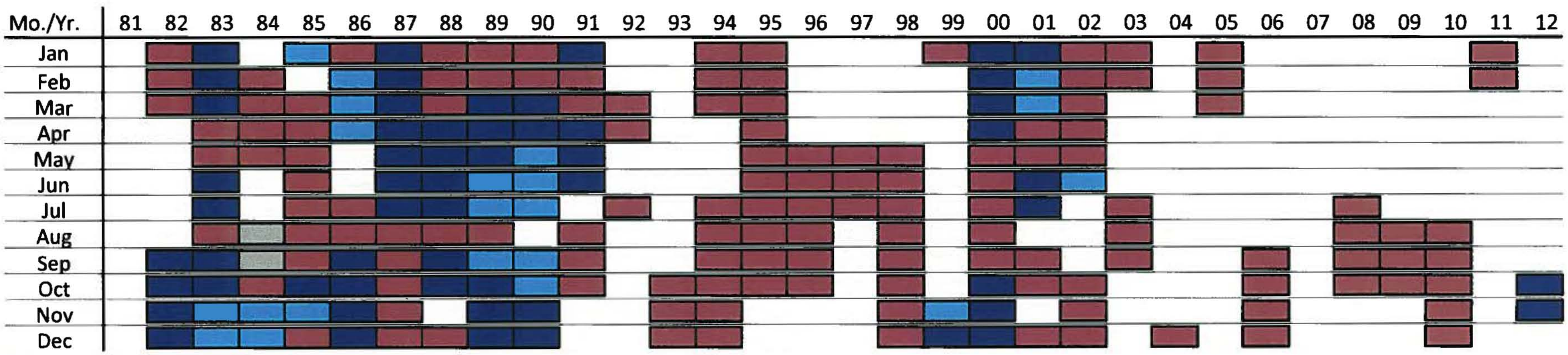
(1) Off-site means that the location of the study is known and is not at Rangen. Off-site locations include Rangen's warm water facility in Buhl, Clear Springs, etc.

(2) Unknown means location is not known. Warm water species assumed to not be at Rangen, but are included in this unknown category.

Figure 5-2

Updated February 2013

Summary of Research Documentation Obtained
Rangen Hatchery
1981 - 2012



Source: Rangen's research proposals and documents obtained on October 16, 2012 and research documentation disclosed by Rangen.

Note: There are additional research proposals and documents that do not have dates and are not listed in the above chart.

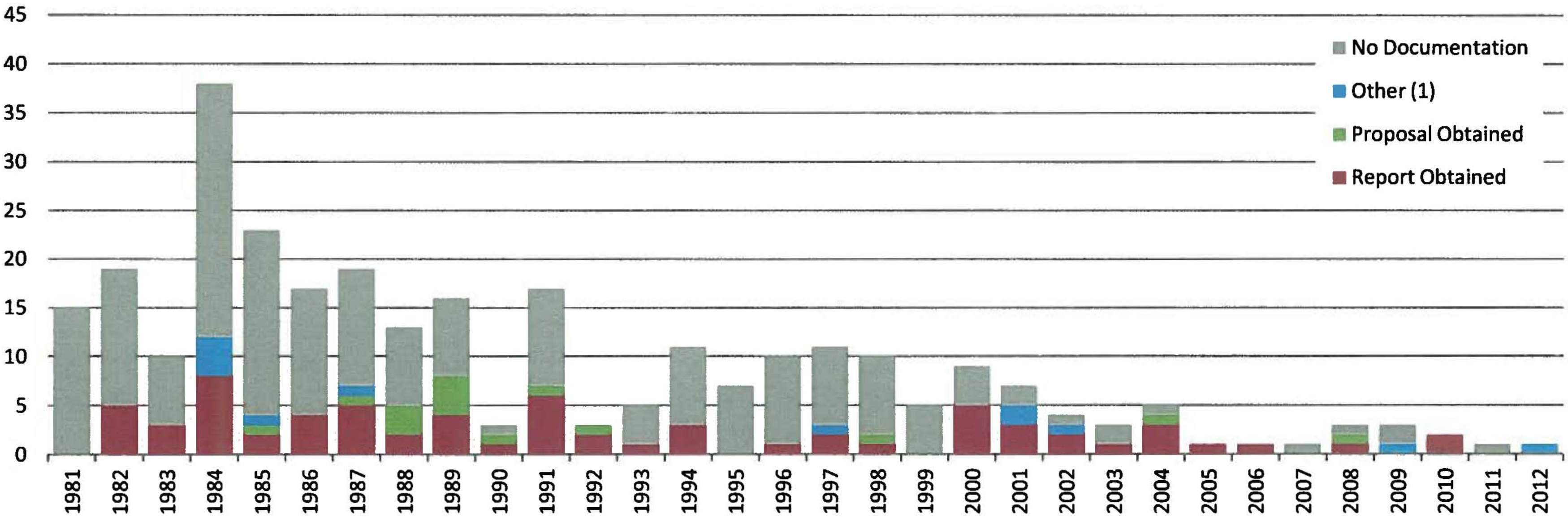
Code:
- Research conducted in outside raceways (includes raceway cages).
- Research conducted in indoor facilities.
- Research conducted in both indoor and outdoor facilities (includes raceway cages).
- Research dates listed, but there are no location data.

Figure 5-3a

Updated February 2013

Summary of Research Index Work Units
Cold Water or Unknown Species
Rangen Hatchery
1981 - 2012

Type of Documentation



(1) Other documentation includes spreadsheets, data tables, mid-year reports, indices with start/end dates, or other documentation indicating research took place.

Figure 5-3b

Updated February 2013

Summary of Research Index Work Units

Cold Water or Unknown Species

Rangen Hatchery

1981 - 2012

Information Contained in Documentation

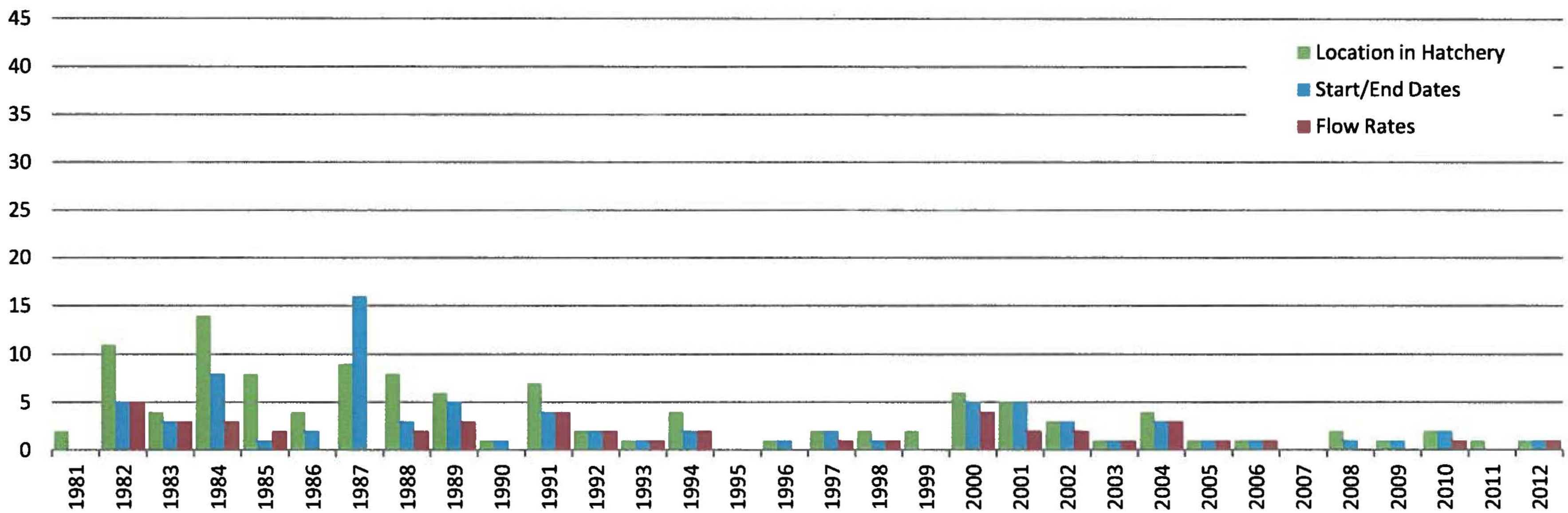
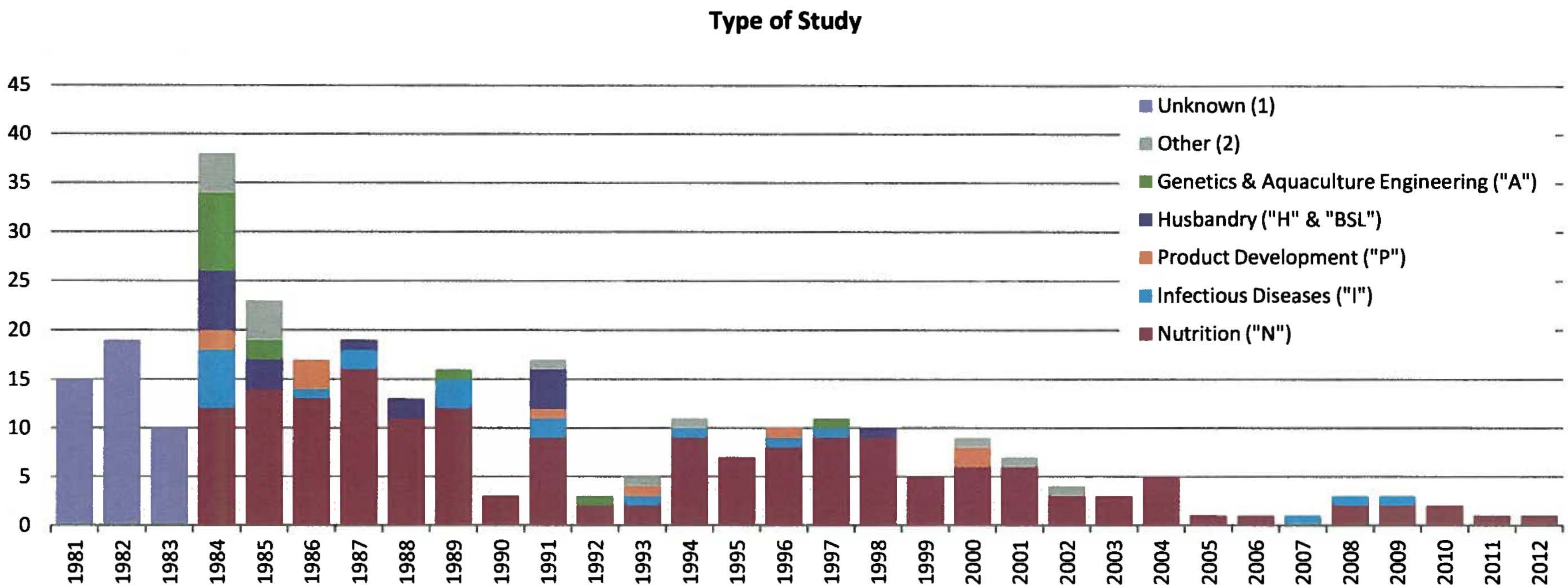


Figure 5-3c

Updated February 2013

Summary of Research Index Work Units
Cold Water or Unknown Species
Rangen Hatchery
1981 - 2012

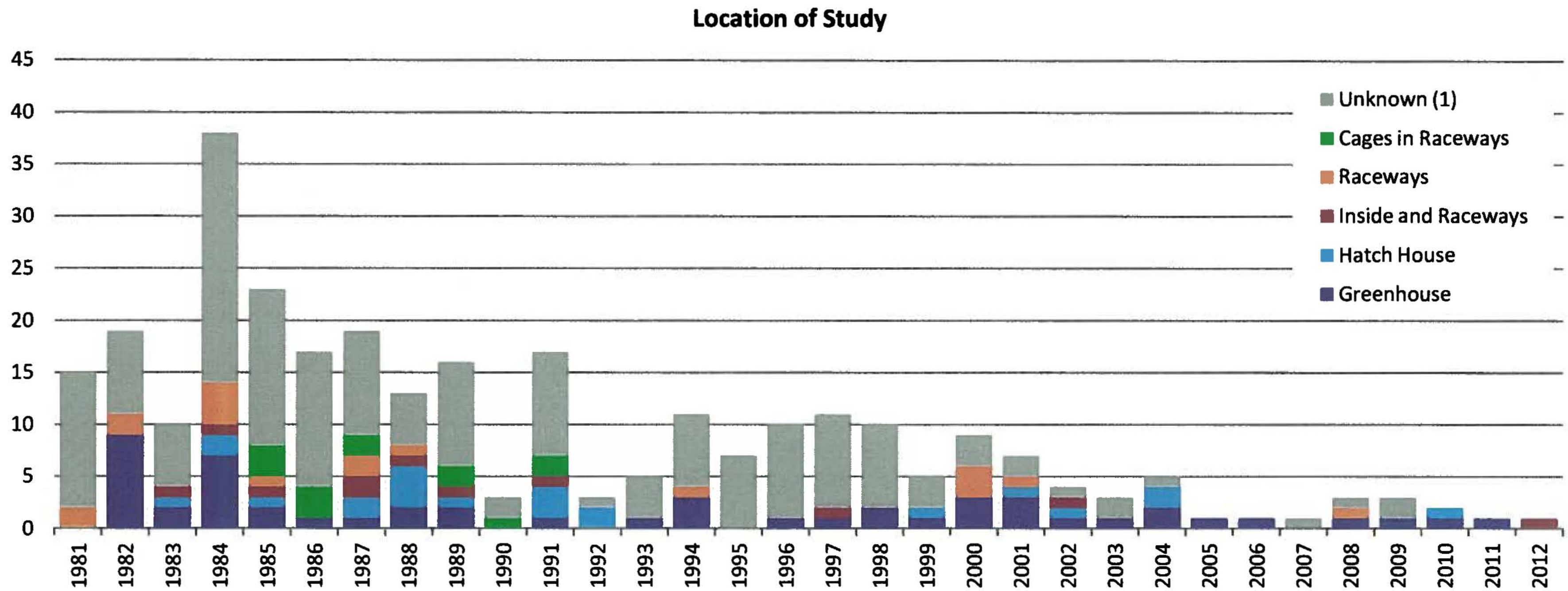


(1) Unknown include pre-1984 studies. Nature of pre-1984 studies cannot be determined based on numbering system in index.
(2) Other types include physiology/biology/analytical chemistry ("B"), toxicology ("T"), extension service ("E"), and other ("O").

Figure 5-3d

Updated February 2013

Summary of Research Index Work Units
Cold Water or Unknown Species
Rangen Hatchery
1981 - 2012

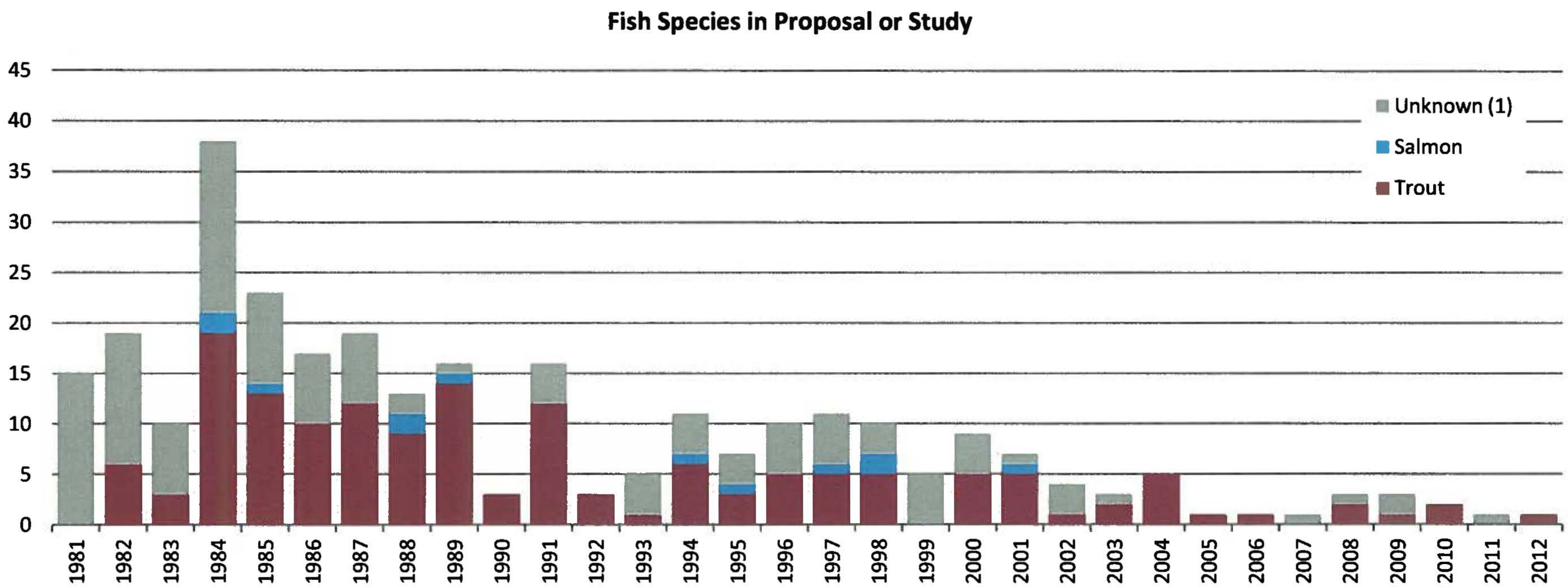


(1) Unknown means that there is not enough information to determine where the study took place (inside, outside, or off-site).

Figure 5-3e

Updated February 2013

Summary of Research Index Work Units
Cold Water or Unknown Species
Rangen Hatchery
1981 - 2012



(1) Unknown means that there is not enough information to determine species type. Species could be warm water or cold water species.

Figure 5-4

Updated February 2013

Summary of Reported Flows in Research Documents

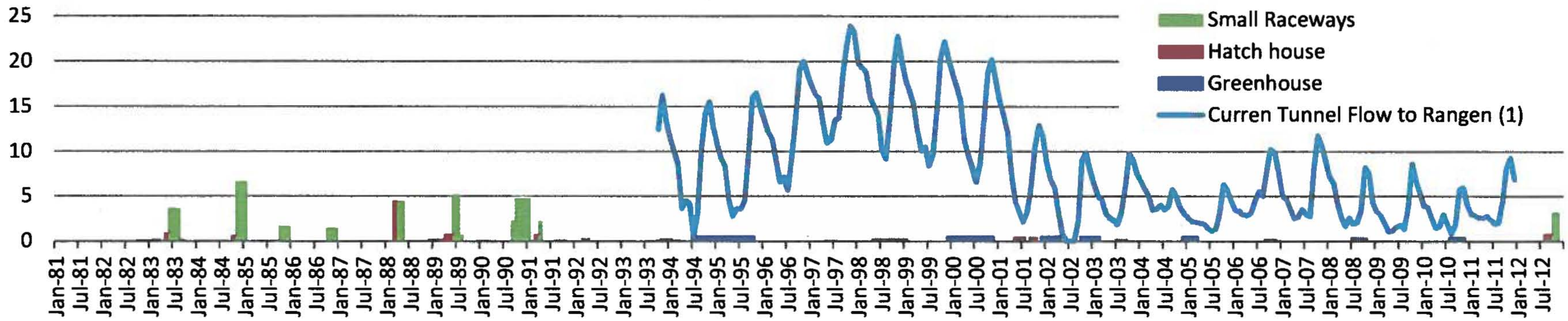
Rangen Hatchery

1981 - 2012

Values in CFS

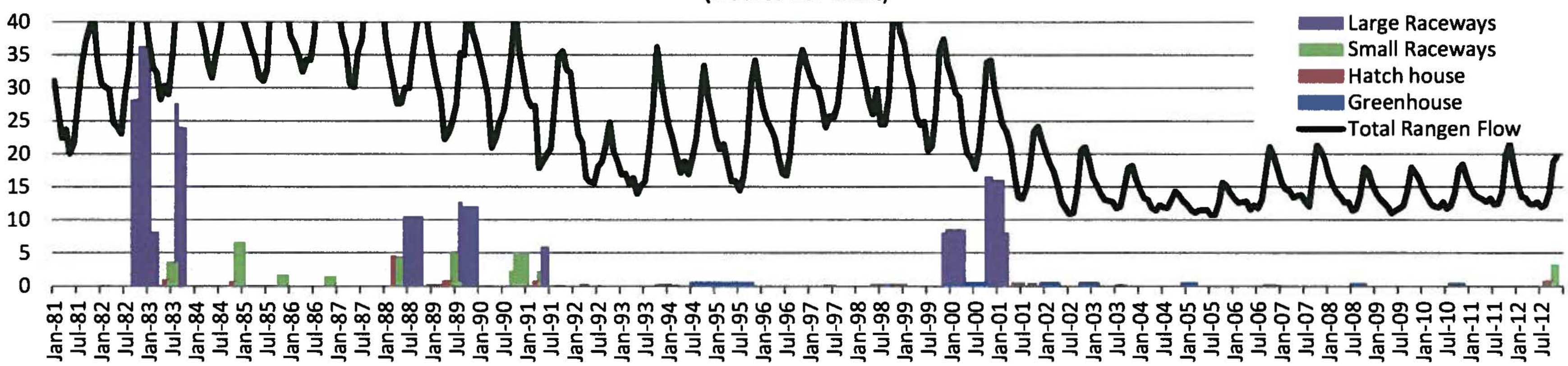
Inside Facilities and Small Raceway Research Flows vs. Curren Tunnel Flow

(Stacked Bar Chart)



All Research Flows vs. Total Rangen Flow

(Stacked Bar Chart)



<u>Note:</u> This summary only shows the flows that were reported. There were other research experiments conducted during this period that did not have reported flow data.
It was conservatively assumed that only first use water was used in the experiments and the flows in simultaneous experiments were additive.
(1) Total Curren Tunnel flow to Rangen is total Curren Tunnel flow reported by the IDWR (1993 - 2011) minus diversions to irrigation from 1993 - 2002.
Total Rangen flow reported provided by Rangen (1981 - Feb 1995 and Jan 2012 - Nov 2012) and total Rangen flow reported by IDWR (Mar 1995 - 2011).