

MEMO

To: Cherie Padilla

From: Mat Weaver

MW

Date: January 7, 2011

RE: Technical Review of Rate and Volume of Water Beneficially Used for Fish Propagation in association with Water Right Permits 47-7659 and 47-7731

Introduction

This memo is in response to a request by Idaho Department of Water Resources (Department) staff to assist in the technical review and establishment of a diversion rate and annual volume of water associated with water right (WR) permits 47-7659 and 47-7731 (Padilla 2010). It was requested that a recommended diversion rate and volume associated with the permits be based on a technical review of beneficial use of water as opposed to field exam measurements of source water flow rates. Both WR permits are for the beneficial use of fish propagation in the name of Larry Holland.

Review of Department Guidance

In a review of Department guidance documents concerning fish propagation I found five related documents. Application Processing Administrative Memo No. 15 (APM15) provides some guidance regarding the evaluation of fish propagation applications (Shaw 1979). Regarding technical matters, Attachment A of the memo provides specific guidance for the rearing of trout in small facilities with flow rates less than 16 cfs and combined volumes of fish ponds less than 30,000 cubic feet (0.68 AF). Unfortunately the applicability of this guidance is limited as many of the commercial aquaculture facilities in the State exceed these rate and volume limitations and it is specific to trout. There is an additional attachment that summarizes some general Idaho Fish and Game (IDFG) rules of thumb for trout rearing that might be useful, assuming the data is not too dated.

Department staff has been provided technical guidance regarding evaluating the impact of new hatcheries or enlargements of an existing hatchery on adjacent existing fish hatchery facilities in Application Processing Administrative Memo No. 50 (Young 1991). Although useful, this memo does not provide any guidance concerning evaluating the appropriateness of a diversion rate in association with actual beneficial use.

Application Processing Administrative Memo No. 55 gives guidance regarding water quality requirements in association with fish propagation applications and requires the coordination of approval of these types of applications with the Idaho Department of Environmental Quality (Young 1992). This memo provides no guidance regarding evaluating the suitability of a requested diversion rate with a specific facility.

In 1993 a draft adjudication memo was prepared regarding the evaluation of recreational fish ponds (Sterling 1993). This memo does not address detailed methods or references for determining diversion rates and volumes in association with commercial fish propagation.

Adjudication Administrative Memo No. 47¹ is the final guidance document that I found and reviewed regarding fish propagation. This memo summarizes an SRBA court ruling that facility volume is not an appropriate element of a water right for fish propagation and new decrees, permits, and licenses should not contain facility volume limitations or conditions nor will the Department enforce facility volume conditions associated with existing rights (Young 2000).

Technical Review

Any fish hatchery system has a carrying capacity associated with it that represents the animal load that the system can support (Piper 1982). The carrying capacity of a specific hatchery is unique to that hatchery and is a function of the physical configuration and size of the hatchery, the available diversion rate of supply water to the hatchery, and the water quality of the supply water to the hatchery. Water quality consists of characteristics of the water such as temperature, pH, salinity, dissolved oxygen (DO) content, and dissolved and suspended solids among other things. The carrying capacity of a hatchery is typically limited by a combination of these components. If it is limited by physical configuration, i.e. size of the facility, additional water supply or water quality will have a limited effect on increasing capacity. Likewise, regardless of the size of a facility, if the supply of water in quantity or quality is limited, the carrying capacity will reflect that limiting condition. The carrying capacity of a hatchery can change in time, both on a short term and long term basis, as the characteristics of the facility and the supply of water change.

In evaluating the beneficial use associated with fish propagation we can use the carrying capacity of a hatchery to evaluate the reasonableness of the diversion rate and volume of water associated with a water right permit as reported in a proof of beneficial use statement or in a field exam.

The carrying capacity for cold water fish is typically expressed as pounds of fish per cubic foot of water or as pounds of fish per gallon per minute (GPM) of water inflow (Piper 1982). The term Density Index refers to the relationship between fish size (length or weight) and the water volume of the system. The term Flow Index refers to the relationship between fish size (length and weight) and the rate of supply water to the hatchery. There are distinctions between these two relationships and consideration of both can be meaningful when evaluating the actual beneficial use of water associated with a fish propagation WR permit.

¹ Adjudication Memo No. 47 is synonymous to Permit Processing Memo No. 18, Transfer Processing Memo No. 22, and Licensing Memo No. 11.

Density Index

The Density Index (D) reflects the spacial relationship of one fish to another and is a function of the size of a fish hatchery (Piper 1982). Ultimately the combined volume of raceways in a fish hatchery provides an upper spacial limit to the amount of fish that can be raised. However, overcrowding of fish in a hatchery raceway leads to behavioral and physical deficiencies in the fish. As such, there is an ideal ratio of fish to combined raceway volume that is less than the maximum achievable limit, which results in the optimal yield of fish (Piper 1982). This ratio is specific to a hatchery and dependent upon the species of fish being reared. The Density Index relationship is commonly described by the following equation, (1):

- (1) $W = D \times V \times L$, where
W = total permissible weight of fish (pounds)
D = Density Index (unitless),
V = combined volume of raceways (cubic feet), and
L = average fish length (inches).

The Density Index is the first relationship that should be considered in evaluating the actual beneficial use of water associated with a specific fish propagation use. In evaluating the WR permits in question, I have analyzed this relationship to assess the veracity of the permit holder's claim that they produced 15,000 pounds of fish a year. The permit holder reported a combined raceway volume of 24,319 cubic feet². It was also reported by the permit holder that the targeted average length of fish at the time of selling, or completion of a fish rearing cycle (9 months), was 13.5 inches³. A recognized D value for rainbow trout, as recommended by the aquaculture industry is 0.50 (Piper 1982). Using this information and equation (1), I have calculated a total permissible, or industry standard, weight of fish that could be in the facility at any one time of 164,153 pounds. This value greatly exceeds the 15,000 pounds of fish raised annually as reported by the permit holder. These findings suggest that beneficial use was not limited by the physical size of the hatchery.

Flow Index

The Flow Index (F) attempts to describe the amount of oxygen available to the fish for life support and growth and the ability of a hatchery to remove waste and flush out the system (Piper 1982). As such it captures, in a general way, the water quantity and quality characteristics associated with a supply of water to a hatchery system. Ideal Flow Index values are specific to a single hatchery system and depend greatly on the quality of the incoming water. F values are determined for a specific system by

² This value does not include the volume of water associated with the fry house. In addition, this value exceeds the combined volume of raceways established by the field examiner, 18,019 cubic feet. I have used the permit holder's estimate in place of the field examination volume to give the benefit of the doubt to the permit holder.

³ Actually the permit holder used a target of one pound as an indication of when the fish were matured to the point that they were ready to be sold (Padilla 2010). Using a commonly recognized relationship between weight and length, a weight of one pound for a rainbow trout equates to a length of 13.5 inches (Piper 1982, Appendix I). I have assumed that only one cycle of fish was raised per year therefore a combined weight of 15,000 pounds can be associated with an average fish length of 13.5 inches.

continuing to add fish until the DO content of the water discharging from the hatchery reaches an established lower threshold, often recognized as being between 0.5-0.7 parts per million for salmon and trout (Piper 1982, Westers 2002). An optimal F value of 1.5 is commonly recognized for salmon and trout, but depending on hatchery conditions and hatchery elevation, the values can range from 0.83-2.70 (Piper 1982). The Flow Index relationship is described by equation (2), as follows:

(2) $F = W / (L \times Q)$, where

F = Flow Index (unitless),

W = total permissible weight of fish (pounds),

L = average fish length (inches), and

Q = water inflow rate GPM).

The Flow Index is the second relationship that should be considered in evaluating the actual beneficial use of water associated with a specific fish propagation use. Regarding the WR permits in question, I have utilized this relationship to evaluate the diversion rate of water actually put to beneficial use within the hatchery system. As previously discussed, the permit holder indicated that the facility produced approximately 15,000 pounds of fish annually and the length of fish at maturity was 13.5 inches. During the field exams the examiner(s) established a combined diversion rate of water to the facility of 8,532 GPM (19.01 cubic feet per second, cfs)⁴. Using this information and equation (2), I calculated a Flow Index value of 0.13. This value is significantly below the range of values recognized for trout by the United States Fish and Wildlife Service both in their general guidelines (Piper 1982) and at their facilities specific to the Magic Valley region⁵ (HHET 2007). This finding suggests that a combined diversion rate of 19.01 cfs was not needed in its entirety to raise 15,000 pounds of fish annually at this facility.

To confirm this suspicion I used equation (2) to solve for W, assuming Q = 19.01 cfs, L = 13.5 inches, and F = 0.83. An F value of 0.83 was used as it represents the most liberal F value recognized in the references reviewed as part of this analysis. Using this information I solved for a total weight of fish of 95,601 pounds that could have reasonably been raised in these facilities with the available flow rate of water. This assumes that the supply of water to the hatchery did not contain some unusual detrimental water quality characteristic, such as high acidity, toxic constituents, or some other unusual parameter, for which no evidence was found in either WR permit file or from correspondence with the permit holder.

Application Processing Memo No. 15

Although specifically intended for review of applications, Attachment A of APM15 also provides a means of evaluating the actual beneficial use associated with the permit (Shaw 1979). By utilizing Attachment

⁴ The field exam associated with WR permit 47-7731 documented 16.45 cfs from Slaughterhouse Gulch and the field exam associated with WR permit 47-7659 reported a flow rate of 2.56 cfs from the spring source or "seep tunnel".

⁵ An F value of 1.2 has been used with "good success" at the Hagerman National Fish Hatchery (HHET 2007, pg. 9).

A and assuming a volume of 24,319 cubic feet, I calculated that a minimum flow rate⁶ of 6.76 cfs is required to rear trout at this facility. Refer to Attachment 1. This value is more than twice the flow rate requirement as determined by the Flow Index method. This memo also summarizes the following IDFG general trout hatchery water requirement guidelines.

- *Maximum annual production of trout in Souther Idaho is 1.5-2 pounds per cubic foot of raceway volume.* This equates to approximately 43,000 pounds annually at the Larry Holland hatchery.
- *A water change of 2.5 times per hour is required to maintain oxygen for trout.* This equates to approximately 16.9 cfs at the Larry Holland hatchery.
- *A profitable trout hatchery requires a minimum of 5 cfs of 50-60 deg-F water.*
- *Maximum production at a good hatchery, where water is reused, produces 8000 pounds of fish per cfs of water.* Assuming 16 cfs of water, this equates to 128,000 pounds of fish annually at the Larry Holland hatchery.

Discussion and Recommendations

According to the field exams associated with water right permits 47-7659 and 47-7731 as much as 19.01 cfs of water was diverted to the hatchery system. In addition, the permit holder reported a system wide combined raceway volume of 24,319 cubic feet. Based upon the analysis conducted in this memo, both the diversion rate associated with the water supply and the physical size of the facilities were adequate to support the production of 15,000 pounds of trout fish a year as claimed by the permit holder. In fact, by any method of analysis, the carrying capacity of the hatchery system far exceeded the total annual weight of fish produced indicating that only a portion of the water measured during the field exam was put to beneficial use.

The diversion rate of water actually put to beneficial use can be estimated with the Flow Index method by rearranging equation (2) to solve for flow rate (Q) and using inputs of W = 15,000 pounds, L = 13.5 inches, and F = 0.83. Based on my calculation a diversion rate of 2.98 cfs is all that was needed to produce 15,000 pounds of fish annually. APM15 provides an alternative means of evaluating the rate of flow required at a hatchery, based strictly on the volume of raceways at the facility. This method does not take into account the actual amount of fish raised at the facility, information that would not typically be available until the time of licensing. By utilizing the APM15 methods (i.e. Attachment A) I calculated a minimum flow rate requirement of 6.76 cfs.

At this time we have a good idea of the maximum amount of fish raised annually at the Larry Holland hatchery – 15,000 pounds. All indications are that this facility was capable in physical size and in water supply to produce significantly more fish than this amount annually. We do not know what limited the

⁶ Attachment A establishes an upper and lower boundary for the rate of change of water through the facility. The upper boundary assumes that a complete turnover of water in the hatchery raceways occurs every 20 minutes, whereas the lower boundary assumes every 60 minutes.

production. We do not know if the entire facility was used in producing 15,000 pounds of fish or if only a reduced section of the facility was used to produce this amount.

It does not seem prudent to issue a water right for the maximum diversion of water that was available to the hatchery, as the full amount of water was clearly not put to beneficial use. In determining a lesser amount of water to be licensed there is some leeway depending on the method relied upon. The Flow Index method estimates a rate of 2.98 cfs. This value however does not account for any error in input values and is less than the IDFG rule of thumb that recommended a minimum of 5 cfs of water for successful trout production. The APM15 method recommends 6.76 cfs, however, this value ignores the actual amount of fish produced annually.

With the above discussion in mind I recommend that the Department recognize a combined diversion rate of 5.00 cfs in association with water right permits 47-7659 and 47-7731. Assuming this water was needed continuously throughout the year, which is the norm for fish propagation, 5.00 cfs equates to an annual volume of 3,620 acre feet.

References

The Hagerman Hatchery Evaluation Team (HHET). 2007. Production Capacity Assessment for Summer Steelhead (*Oncorhynchus mykiss*) Produced at the Hagerman National Fish Hatchery. United States Department of the Interior Fish and Wildlife Service Washington, D.C.

Padilla, C. 2010. Request for Technical Review for 47-7659 and 47-7731. Idaho Department of Water Resources Internal Memo dated December 23, 2010.

Piper, Robert G., Ivan B. McElwain, Leo E. Orme, Joseph P. McCraren, Laurie G. Fowler, and John R. Leonard. 1982. Fish Hatchery Management. United States Department of the Interior Fish and Wildlife Service Washington, D.C.

Shaw, D. 1979. Fish Propagation Applications for Water Rights. Idaho Department of Water Resources Application Processing Administrative Memo No. 15 dated August 7, 1979.

Sterling, M. 1993. Evaluating Recreational Fish Ponds. Idaho Department of Water Resources Draft Administrative Memo dated April 1, 1993.

Westers, Harry. 2002. Gary A. Wedemeyer, editor. Fish Hatchery Management, second edition. American Fisheries Society, Bethesda, Maryland.

Young, N. 1991. Fish Propagation Application Approval Guidelines. Idaho Department of Water Resources Application Processing Administrative Memo No. 50 dated April 1, 1991.

Young, N. 1992. Consideration of Water Right Applications for Fish Propagation. Idaho Department of Water Resources Application Processing Administrative Memo No. 55 dated November 16, 1992.

Young, N. 2000. 1) Adjudication Claims Tolling Forfeiture 2) Fish Propagation Facility Volume. Idaho Department of Water Resources Adjudication Administrative Memo No. 47 dated March 24, 2000.

App. Process. Memo 15: Water Requirement for Trout Rearing

