Development and Application of Anchor Habitat Approaches to Salmon Conservation: A synthesis of data and observations from the Napa watershed, California.

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July 2003
Prepared for the Friends of the Napa River
(3 maps are part of this report)

Introduction

Since the early 1990's, the idea of protecting the best habitats as the first step in restoration has been gaining acceptance (e.g. FEMAT. 1993, Doppelt et al. 1993, Dewberry 1996). For the terrestrial environment, unmanaged vegetations stands are recognized as the key component of the best. There has been considerable debate about how to determine what constitutes the best with regards to the aquatic environment.

Ecotrust, Oregon Trout, and The Wild Salmon Center (2000) proposed the concept of salmon anchor habitat for the Tillamook and Clatsop State Forests on north coast of Oregon. A salmon anchor habitat is a reach of stream and its associated watershed that produce a higher than average number of salmon given their area during all years. They form the core of salmon production particularly when population numbers are low. The concept was based on two assumptions: 1) That all parts of the watershed are not equally important for salmonids species; 2) These high production areas, while dynamic on long time-scales, are conservative over the decade to decades time scale.

The assumption that all parts of a river system are not equal for salmonid production has recently been suggested by several observations. Reeves (unpublished data from the 1980's in: Hobbs, S.D. et al. 2002) identified "hot spots" (high juvenile salmonid production) in the Elk River basin on the south coast of Oregon. Also, indirect evidence that all portions the watershed are not equal for salmonids production is provided by the experience of the Oregon Department of Fish and Wildlife. During the 1990's their standard index reaches to estimate adult coho (*Onchorynchus kisutch*) escapement did not detect a decline in the populations along the Oregon coast. When the sites were randomized they found that the standard index reaches overestimated the populations. In other words, the standard index reaches had a higher number of fish than non-index reaches and their numbers remained more constant than the non-index reaches. This suggests that portions of the landscape are more important and that salmon production is less variable in these areas.

Direct evidence that all portions of the landscape are not equal for salmonids was provided by Dewberry et al. (1998) from Knowles Creek, a 20 mi^2 tributary basin in the lower Siuslaw basin. The abundance and distribution of coho salmon juveniles were estimated from 1993 through 2002 using snorkel diving. During years with low coho production up to 80% of the coho were found in less than 20% of the basin. In all years, these critical areas produced a higher number of fish than other areas of equal habitat.

During the last three years (2000 – 2002), with funding from the National Fish and Wildlife Foundation, the Giles W. and Elise G. Mead Foundation and other private foundations, Ecotrust has been conducting snorkel surveys to accomplish two objectives with regards to anchor habitats for salmonids: 1) Are the observations from Knowles Creek and the other mentioned observations the exception or are they reflecting a landscape pattern in the Pacific Northwest? 2) If there is indeed a pattern, our objective was to develop and standardize a method for identifying the anchor habitats.

During 2000 to 2002 we gathered information on the abundance and distribution of juvenile salmonids in four basins in the Pacific Northwest: Napa (CA), Coquille (OR), Siuslaw (OR), and Nooksack basin (WA). Snorkel surveys were conducted during the summer months throughout the basin and we covered all the stream reaches that we had access to by private landowners and had adequate visibility to dive. These stream surveys were used to examine the abundance and distribution of each salmonids species found in the basins. This information was then used to evaluate the anchor habitat concept.

Napa Snorkel Surveys 2001 and 2002:

The Napa basin drains 426 sq. miles of central coast range in Northern California, about 50 miles north east of San Francisco, California (see Map #1). The headwaters of the mainstem rise near Mt. St. Helena and the Napa River flows about 50 miles south enters San Pablo Bay at Vallejo, California. There are about 47 tributaries within the basin.

During 2001 and 2002, Ecotrust had dive crews within the basin to estimate the abundance and distribution of steelhead trout within the Napa basin. This information was used to identify the critical anchor habitat within the basin. Historically it has been estimated that there were around 6 thousand adult steelhead in the annual run (ref). In recent years only a few hundred adults are estimated to use the Napa River.

Methods:

In each year snorkel teams were trained for two weeks at the end of June in the Siuslaw basin, Oregon. Training emphasized fish identification, counting, and identification of pool habitat. In addition, the supervisor also dove with each team at an interval of once every three weeks to ensure the quality of the data.

The stream surveys were conducted from July 1 to October 1. Emphasis was placed on the smaller order streams. The mainstem reaches of the Napa River itself were not attempted as visibility was not adequate to see to the bottom of pools. Previous observations also suggest that the densities of steelhead in these reaches are low because stream temperatures are too high for steelhead during the summer months.

In general, the survey began at the mouth of a tributary and proceeded upstream until no more steelhead were observed. Distances were estimated by pacing, and corrected on the final map by using the distances between tributary junctions obtained from the stream layer in ArcView. With few exceptions, the measured distances were slightly greater than the ArcView stream layer. For this survey, at least 1 out of 10 pools, 1 out of 8 glides, and 1 out of 10 riffles were selected to be snorkeled. This is the standard survey frequency used by Region 6 of the U.S. Forest Service.

The unit to be surveyed was randomly determined. Additionally, potential high quality habitat units such as beaver ponds were added to the survey. It was anticipated that these high quality units might have higher than average fish densities in them and if they were not included in the survey the number of fish would be highly underestimated. (That with very few exceptions, did not turn out to be the case). And the additional units were not incorporated into the survey analysis. However, the data is listed in the survey. Also, a high percentage of the beaver ponds had low visibility, especially in the upper portion of the basin and an adequate count was not possible in them.

Stream habitat units had to meet the minimum requirement of being at least as long as the average stream width. Pools also had to exhibit evidence of scour at high flows and have some form of hydraulic control at the bottom. We did not establish a minimum depth. Riffles are defined as areas of deposition at high flow. These area are usually characterized by steeper local gradient and larger substrate. Off-channel pools where included in the survey however their lengths were not included in the accumulated length column.

The surveyed habitat units were measured with a 50 or 100 m tape. Length and width estimates were made at average dimensions. For highly variable dimensioned units several width measurements were made.

The snorkeler or snorkelers entered the pool from the downstream end and proceeded to the head of the pool. Upon initially entering the pool, the diver would look as far upstream as possible looking for age one or older fish. These individual fish often are only seen on the initial look in the pool. Then the juvenile fish were counted. With rare exceptions densities were not high enough to need multiple passes through the pools, but if there were a large number of fish and the diver was unsure of the count, the unit was snorkeled a second time.

In the larger stream reaches, two divers worked side-by-side. Usually, the streams were small enough for a single diver to see from one bank to the other.

A cover/complexity ranking was developed to characterize each pool. 0 was no cover and 5 was mostly cover throughout the habitat unit.

Visibility was recorded in the first unit snorkeled in the reach. It was scaled from 0-5. With a three being approximately 6 feet visibility to see and identify a juvenile salmonids. If visibility changed it was recorded in the data and entered in the data base. Also, in the first pool the effectiveness was determined on a scale of 0-5. If for any reasons the effectiveness changed it was also reported in the data.

The densities of survey counts were used to create the abundance and distribution of steelhead in the Napa basin. Four classes were determined based on the average calculated densities: 0 steelhead/m^2, 0-0.5, 0.5-1.0,>1. These densities are significantly different. For example, in an average size pool which is 10 m long and 5 m wide (50 m^2), the first category would have 0 steelhead. The low category would have 0-25 steelhead. The medium category would have 25-50 steelhead. The high category would have more than 50 steelhead.

The map was constructed in ArcView (GIS) using dynamic segmentation. The length-class relationships were mapped using the following system. The initial class is the initial stream density of steelhead in the first pool, riffle, glide sequence that is snorkeled. If the density of steelhead in the next pool is a higher class then the segmentation is changed to the higher class. The exact change point is half way between the two pools. For example, if the density of steelhead in the first pool was 0.4 the segmentation class is class 1. The density of steelhead in the second pool is 0.6 the segmentation class is 2. The point of change in class would be half way between the two pools.

If the segmentation class decreases then the following system is used. It takes two consecutive lower classes to drop the segmentation class to the lower level. Again, the point of segment change is between the two initial pools. If there is only 1 pool with a lower density class and then following pool after that is the initial class then the segmentation class remains the same.

Results and Discussion:

In 2001, 144.66 km of stream were snorkeled (see Map #1). This was the limit of stream reaches where steelhead had access to and we could obtain landowner permission. Especially on the east side of the basin there are a number of impassible dams that limit steelhead migration. In addition, most of these dams reduce summer stream flow. Therefore, downstream of the dams the stream reaches are not suitable steelhead habitat as the reduced stream flow results in high stream temperatures. During 2001, which was a severe drought year, 9.27 km of stream had a high density of steelhead during the survey period. These high density steelhead reaches only comprised approximately 6% of the stream reaches surveyed within the Napa basin. Streams which had at least 500 m with high density steelhead included: Dry Creek and several of its major tributaries, Redwood Creek and its tributary Pickle Creek, Mill and Heath Creek. All of these streams are west side streams. Two streams, Milliken and

Dutch Henry Creeks, on the east side had some high density reaches however it was less than 500 m.

During 2002, 38 km of stream were surveyed (see Map #2). The aim of the 2002 survey was to ground truth the pattern observed during the previous year. We wanted to determine if the high density steelhead streams remained high density the following year and if additional areas of likely high density steelhead streams (given the pattern observed for the previous year) could be identified. Again the surveys were limited to tributary streams in the basin which steelhead had access to and we had landowner permission. In 2002, 7.19 km, or 19% of the total distance surveyed, had a high density of steelhead. A similar pattern as 2001 was observed. Streams which had at least 500 m with high density steelhead included: Ritchey Creek, Sulphur Creek, Dry Creek and its tributaries, Carneros Creek, and Huichica Creek. Again all of these streams are on the west side.

Map #3 provides a synthesis of both years of survey. Tier 1 streams are those that had over 500 m of high density steelhead reaches in both years. These are the most important reaches of stream within the Napa basin for steelhead. Only Dry Creek and some of its tributaries were tier 1 for 2001 and 2002.

Tier 2 streams are those that have over 500 m of high density steelhead reaches in some years of survey. In this case, in one of the two years of survey they had over 500 m of high density steelhead reaches. Tier 2 streams include: Huichica Creek, Carneros Creek, Redwood Creek including Pickle Creek, Heath Creek, and Ritchey Creek. All of these streams are on the west side of the basin.

Tier 3 streams are those that have some but less than 500 m of high density steelhead reaches in some years. In this case, in one of the two years these streams had up to 500 m of high density steelhead reaches. These streams include: Sulphur Creek, Jericho Creek, Mill Creek, Dutch Henry Creek, and Milliken Creek.

Management Considerations:

There are at least five management concerns for protecting and restoring steelhead trout in the Napa basin. They are: Stream flow, stream temperature, barriers, sediment, and nutrient enrichment or pesticide concentrations.

Stream flow is the basic need of steelhead in the Napa basin. Not only does stream flow provide aquatic habitat but adequate stream flow also is necessary to ensure adequate flow to maintain insect drift, well-oxygenated water and cooler stream temperatures. Stream flow can be reduced by groundwater pumping as well as direct removal.

Stream temperature must remain cool enough to sustain steelhead trout. As previously mentioned stream flow is one of the major elements that control stream temperature. The second major factor controlling stream temperature is the riparian canopy.

There are also a number of barriers that currently limit the upstream migration of adult steelhead. A few are large reservoirs, but there are also numerous small barriers found throughout the Napa basin. There are a number of possible options to provide fish passage over these barriers.

Excess sediment can create a number of problems for salmonids. Excess sediment can reduce the survival of salmonids eggs by limiting the flow of oxygen rich water through the redd (nest). In some cases it can cement the gravel together making it difficult or impossible for the salmonids to dig their redds. Excess sediment also reduces survival of juveniles by decreasing subsurface flow, an important factor maintaining cooler stream temperatures, reducing the interstitial spaces which are hiding locations for steelhead, reducing the algal production by decreasing light penetration and sand blasting algae off rocks. Excess sediment also decreases the production of macroinvertebrates by all the same mentioned factors. This in turn limits steelhead production.

Excess sediment originates by two main sorts of erosion. One is surface run off from soil without adequate cover; the other is mass erosion which originates on steep slopes where the soil column strength is reduced, usually by reducing vegetation (trees or grass) on the slope.

Excess nutrients can lead to excess algal production that can deplete oxygen concentrations when the excess algae decomposes or during the early morning hours (after a night of high algal respiration). On the other hand herbicides that enter the water inhibit algal growth that can limit algal production. Pesticides can reduce macroinvertebrate production as well as pest production. Also a number of pesticides are toxic to fish.

The most effective restoration strategy for steelhead in the Napa basin is to first stop the degradation of remaining salmonid habitat in the anchor habitats. The highest priority areas are the tier 1 areas followed by the other two tiers. Reducing the risks to steelhead in these areas alone does not insure recovery of steelhead in the basin. However, if the risks are not reduced in these area it greatly reduces the chances for recovery of steelhead no matter what else is done in the basin. These recommendations are a reasonable first step to stop the continued decline of steelhead in the basin. They alone however do not ensure the recovery of steelhead. Only a comprehensive recovery plan for the entire basin can accomplish that goal.

Overall Program Summary and Conclusions

This project began with two objectives. One was that the pattern of anchor habitats observed in Knowles Creek, Oregon was a common pattern and not a unique case for salmonids in the Pacific Northwest. Toward this end we surveyed the larger Siuslaw system, and the Nooksack system in Washington. We also surveyed the Napa basin, California that is dominated by steelhead rather than coho. In each of these three basins we observed that the salmonids were not uniformly distributed throughout the basins. In Siuslaw only 8% and 21% of reaches surveyed in 2001 and 2002 respectively had a high density of juvenile coho. The majority of the stream reaches that were high in one year were high in the other year. This is a similar pattern to the one observed in Knowles. In fact the top three ranked tributaries for greatest length of stream in the high density category for coho accounted for almost 50% of the total stream reaches with a high density of coho in the entire Siuslaw system. Protection and restoration of these three tributaries should be the highest priority in the Siuslaw basin.

In the Nooksack basin, coho salmon were found in high densities in 19% and 35% percent of the stream reaches surveyed in 2001 and 2002 respectively. All the high density coho reaches surveyed in 2001 were also high in 2002. This indicates that the coho salmon in the Nooksack basin are keying into the same stream reaches from year to year. Again this is similar to the pattern observed in Knowles Creek. A significant reason for the higher percentages found in the Nooksack basin is that much of the basin has natural barriers to anadromous fish and therefore was not snorkeled.

Steelhead are the dominant salmonid in the Napa basin. They were found in 6% and 19% during the two surveys. As in the case of coho in Oregon and Washington, steelhead were found in almost the same reaches during the two years. The overwhelming majority of the steelhead were found in west side tributaries. Again it appears that steelhead in the Napa system are distributed similarly to the pattern observed in Knowles Creek.

The surveys from all three basins show the same pattern that was observed in Knowles Creek, i.e. certain portions of the landscape are more important than others for salmonids production. Identifying and protecting these anchor habitats is an important restoration tool for the recovery of Pacific salmonids.

Acknowledgments: Acknowledgments:

We are grateful to the snorkel divers who participated in this survey, Mike Davidson, Chris Malan, Rain Ananael, Todd Adams and Chris Passarelli. Also, Chris Malan, Rain Ananael, Josh Malan and Chris Passerarelli worked on gaining landowner permission in the basin to complete the survey. We appreciate the generous funding received from The Rose Foundation, Napa County Fish and Wildlife Commission, the Giles W. and Elise G. Mead Foundation and the Sierra Club to the Friends of the Napa River and from the Goldman and Compton Foundations to Ecotrust.

Charles Steinback produced the GIS database and maps. Caitlin O'Brady and Ben Donaldson performed data entry tasks.

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