Scope of Potential Frost Protection Impacts on Salmonids

With an Emphasis on the Russian River

David Hines, Fishery Biologist / Water Rights Specialist
Brian Cluer, Ph.D., Hydrologist / Geomorphologist
Robert Hoffman, Assistant Regional Administrator
National Marine Fisheries Service
Presentation Overview

- Species Risk analysis
  - Exposure to threat
  - Biological Response
  - Changes to Extinction Risk

- Hydrologic Analysis
  - Event Frequency

- NMFS Recommendations
  - Chronology
  - Recommendation
Range of all salmonid species listed as threatened or endangered under the Federal Endangered Species Act in California

Range of Salmonids in California

- Steelhead
  - Larson 2009
- Coho Salmon
  - Keeley 2008
- Chinook Salmon
  - House 2001
Potential Areas of Concern

Occupied watersheds with considerable acreage of vineyard development indicating the scope of potential frost protection issues in California.
There are 1,778 miles of potential salmonid habitat in the Russian River. All of this habitat is needed for recovery of the three species as described in the forthcoming NMFS recovery plans.
There are 60,640 acres of vineyard in the Russian River (Heaton 2008). 70% are within 300 feet of salmonid habitat and 25% of salmonid habitat is within 300 feet of a vineyard.
Risks from Vineyards

Proximity of vineyards to habitat suggests easy access to surface diversions and potential impacts from instantaneous reductions in flow during the frost protection season. Adjacency does not necessitate an impact, but one study estimated 30% of tributaries are affected.

**Unknowns:**

- Percentage of vineyards that irrigate for frost protection.
- Proportion of vineyards that rely on surface water diversions for their frost protection needs.
Biological Response

• Life-stage
  – Egg
  – Fry
  – Juvenile
  – Smolt
  – Adult

• Response
  – Timing
  – Behavior
  – Physiological tolerance

Background photo courtesy of Simpson Timber Co. 2001
Fry

- Typically emerge from redds in April or May
- Have poor swimming ability
- Occupy the shallow margins of streams
- Take refuge in cobble substrates
- Highly susceptible to stranding
Smolts

- Typically migrate from March through May
- Represent the net productivity of a watershed
- Strong swimmers
- Less susceptible to stranding than fry
- We *have* observed smolt mortality with frost event drawdowns
Population Viability and Extinction

• Viable Population
  – A population that has a low probability of going extinct over the next 100 years

• 4 viability attributes
  – Abundance
  – Population growth rate
  – Spatial Structure (i.e. distribution)
  – Diversity (genetic and ecological)
General Pattern of Population Decline and Extinction

Coho Salmon

Chinook Salmon
and Steelhead

Coho Salmon

Functional Extinction

Time

C. Johnson 2008
Threats to Survival and Recovery

• Habitat conditions
  – 22 of 35 habitat attributes are limiting production
  – Including instantaneous flow reductions in spring

• Sources of Stress (top 4)
  – Agriculture practices
  – Droughts
  – Roads
  – Water diversion and impoundment

Source: Draft Federal Recovery Plan for CCC coho salmon
Conclusion

• Population viability is low for all three salmonids in the Russian River
  – Coho salmon are at very high risk of extinction
• Exposure to the threat of Frost protection irrigation is high
• This threat (and others) likely limits the survival and recovery of these species
Hydrologic Analysis

• Evaluation of the scope, frequency, and magnitude of streamflow drawdown events associated with irrigation for frost protection
  – Analysis by Berkeley Water Center of Hopland gage data
  – Comparison with tributary observations

• Interpretation of results
  – Frequency and magnitude of drawdown events
  – Historical emergence of drawdown pattern
Full flow record for the 2008 Spring where multiple pumping events were initiated.
Berkeley Water Center
Detailed look at a week with multiple pumping periods, some of which correspond to low temperatures.
2001 had a dry spring and many days in the early April period with rapid water draw downs.
Very wet Spring with little frost to worry about.
R² = 0.601
Signal in Tributaries

Data: Franz Creek, 2004

Stream flow, L/s

Minimum temp, °C

Source: Deitch et al. 2009

RR at Hopland 2004
Hydrologic Conclusions

- Frost pumping drawdown events typically occur multiple times a year.
- They happen on average 3 out of 4 years.
- They are more extreme in dry years.
  - When fish are at greatest risk.
- Events correlate with frost risk
  - Not necessarily with actual frosts
  - Over-response appears to be increasing
- Tributary events are likely more frequent and more severe
2009 Mitigation

- Flow release increases from Coyote Dam, apparently anticipating drawdown events downstream.

- Significant drawdowns occurred, despite attempts to mitigate with increased flows.
Summary

- Rapid drawdowns are a threat to species survival and recovery.
- Frost pumping impacts are documented and widespread.
- Fisheries are near extinction.
- 12 years after the SWRCB Staff Report, coho salmon are in danger of extinction in the Russian River.
- Failure of the SWRCB to take appropriate action this year on frost irrigation will likely result in additional fish kills and violations of ESA.
NMFS’ Mandates

• NOAA Fisheries Habitat Program Mandates to protect and restore habitat:
  • Endangered Species Act
  • Magnuson-Stevens Fishery Conservation and Management Act
  • Coastal Wetlands Planning, Protection, and Restoration Act
  • Fish and Wildlife Coordination Act
  • Federal Power Act,
  • Energy Policy Act, and other acts and policies.
NMFS Roles and Recommendations

• NMFS is the agency responsible for implementing the Federal Endangered Species Act as it applies to salmon and steelhead.

• We achieve this via technical assistance, permitting, and enforcement.
  – Building partnerships with stakeholders is our preferred means of protection and recovery
Chronology of Frost Policy

• **1972** SWRCB determines frost protection irrigation is an unreasonable use of water in the Napa River

• **1977** Watermaster system for the Napa River is codified

• **1997** SWRCB Staff Report identifies frost protection impacts to salmonids in the Russian River
  – Concludes it to be a waste and unreasonable use of water
  – Found wind machines to be a reasonable alternative
• **2008** drought and frost events lead to fish kills
  – NMFS Office of Law Enforcement (OLE) opens investigations
  – OLE forms the Frost Protection Task Force in July, 2008
  – NMFS identifies instantaneous flow reductions in spring as a limiting factor for coho salmon in the Federal Recovery Plan
• **2009**
  – NMFS requests emergency regulations from SWRCB
  – Additional fish kills occur with frost protection events
NMFS Recommendation

• We recommend the SWRCB exercise their authorities to regulate water use to protect salmonids, throughout their range, from any harmful water use.
• For this year, we recommend no diversion from surface and hydrologically connected sources for frost protection.
• Implement long term solution.
Long Term Alternatives?

• Wind Machines (Staff report 1997)
• Coordinated water use.
• Vine and Field Management Practices
  – Pruning Timing
  – Soil Moisture and Tilling
  – Cover Crop
  – Frost Resistant Varieties
  – Frost Prone Areas

• Sprinkler automation, reduce false alarms
State Water Resources Control Board
Division of Water Rights

STAFF REPORT
RUSSIAN RIVER WATERSHED

Proposed Actions to be taken by the Division of Water Rights on Pending Water Right Applications within the Russian River Watershed

August 15, 1997
5.3 Spring Frost Protection. There are 11 applications within trinity watersheds requesting water rights for direct diversion for frost protection from March through May. Diversions of water for frost protection present a difficult problem. The period from March through May is a critical season for frost protection, however, maintaining adequate flow in the stream is also important for several critical life stages of coho and steelhead. If all diversions simultaneously divert water for frost protection, flows could be lowered dramatically and impact fish. In order to evaluate the reasonableness of direct diversion for frost protection, Division staff have evaluated alternative methods that could be used to provide frost protection.

The SRBC was faced with a similar situation on the Napa River. In that particular case, the SRBC determined in 1979 that direct diversion for frost protection, when the river contained insufficient flow to supply all needs, represented an unreasonable method of diversion and use of water. The SRBC restricted diversions from the Napa River for frost protection purposes, and required diverters to participate in a trial distribution program controlled by a water bank. Sections 559 and 560 were added to the Regulations to define SRBC policy for diversion of water from the Napa River for frost protection. A law suit was brought in the Superior Court of Napa County by the SRBC against diverters who were in violation of SRBC policy. The lawsuit was ultimately settled by a stipulated judgment which required the diverters to participate in the trial distribution program.

A publication prepared by the Cooperative Extension at the University of California at Davis (Leaflet #3743) discusses frost protection measures for vineyards in Napa, Sonoma and Mendocino counties. The report presents comparative cost data for the two principal methods used for frost protection -- wind machines and sprinklers. The report states that the total annual costs of the two methods are:

<table>
<thead>
<tr>
<th>Method</th>
<th>Cost per Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind machines and heaters</td>
<td>$190 to $200</td>
</tr>
<tr>
<td>Sprinklers</td>
<td></td>
</tr>
</tbody>
</table>

These data indicate that using wind machines, rather than directly diverting water from streams, is more expensive but is a reasonable, cost-effective, alternative method for providing frost protection. As described in the SRBC memo on reasonableness, "The overriding public interest may require an individual to incur additional expense in order to maximize beneficial uses of water."

The Cooperative Extension report also discusses the requirements for construction of small reservoirs to provide for winter time storage of water that could then be used to supply water for frost protection in the spring. The report states that a reservoir with a capacity of 22 af would provide sufficient capacity to provide frost protection for a 40 acre vineyard for a total of 60 hours of frost conditions. The total area required for the reservoir would depend on the topography of the site and the depth of the reservoir. The report indicates that a 22 af reservoir would require about three acres of land.

The report also discusses the cost and practicality of using wells to provide water for frost protection. As indicated above, there are reasonable, cost-effective alternative methods of providing frost protection, other than further direct diversions from the streams. As discussed in Attachment B, there are limited data available to define the flow regime in the spring to protect the fishery resources, however, providing adequate flow during this period is important for several life stages of coho and steelhead. Consequently, staff concludes that new diversions for frost protection represent an unreasonable method of diversion and use of water. Accordingly, staff recommend that new diversions not be allowed after March 15, until the applicant submits specific studies which demonstrate that further diversions in the spring will have no significant effect on coho and steelhead.

If applicants wish to construct off-stream storage reservoirs for storage of water for frost protection, rather than requesting a water right for direct diversion of water, it may be necessary for parties to submit a new application. Those new applications would have lower priorities than the pending applications. Where allowed, the Division will modify the applications for direct diversion and issue permits for off-stream storage reservoirs.

5.4 Projects on Main Stems. Water is available for appropriation under D-1030 reservations for Mendocino and Sonoma Counties. Staff recommends the conditional approval of these pending applications, provided that existing protests can be resolved. Approval of the pending applications will have an unmeasurable impact on the flow in the main stem of the Russian River.

5.5 Municipal. There is one pending application that requests a water right for existing diversion from the underflow of Austin Creek to supply 91.59 acre feet of water for municipal purposes in the town of Calistoga, which has about 280 permanent residents and 380 vacation residents. There is one other pending application that requests a water right for existing diversion from the underflow of Austin Creek to supply 10.6 acre feet for municipal purposes at 25 homes. There may be concerning public interest considerations that would preclude the SRBC from canceling these applications. In such cases, the SRBC is the lead agency and must prepare an environmental document. Staff will conduct an evaluation to determine whether there are reasonable alternatives to the existing diversions and/or whether measures can be developed that would mitigate the potential impacts to fishery resources resulting from these diversions.

5.6 Domestic. Several applications request the right to store up to 10 acre feet of water for domestic purposes. Section 1228(d)(3) of the Water Code provides for the issuance of small domestic registration certificates for domestic uses not exceeding direct diversions of 4,000 gpd or diversion by storage of 10 acres. For pending applications that meet these criteria, staff proposes to issue small Domestic Registration certificates.