Saving Salmon in California: Fresh water

Peter Moyle

September 10, 2015
COHO SALMON LIFE CYCLES: California

COHO SALMON POPULATION CYCLES

- **SPawner**
  - 3-4 spawners
  - 11-13 mo
  - Stream Mortality: Good Conditions
  - OCEAN Mortality: Good Conditions

- **COMPENSATION**
  - 3-4 spawners
  - 12 mo
  - Stream Mortality: Poor Conditions
  - OCEAN Mortality: Poor Conditions

- **RESTORATION**
  - Stream Mortality: Poor Conditions Human-caused
  - OCEAN Mortality: Poor Conditions + Fishing

- **SMALL POPULATION CYCLE**

- **Extinction Spiral**

COLOR CODE:
- Embryos
- Summer Juveniles
- Winter Juveniles
- Smolts
- Subadults
- Adults
- Ocean Entry

COHO SALMON LIFE CYCLES
<table>
<thead>
<tr>
<th>OCEAN CONDITIONS</th>
<th>FRESHWATER CONDITIONS</th>
<th>SALMON POPULATION SIZE</th>
<th>MAIN LIMITING FACTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GOOD</td>
<td>GOOD</td>
<td>LARGE</td>
<td>COMPETITION, PREDATION, HABITAT</td>
</tr>
<tr>
<td>GOOD</td>
<td>POOR</td>
<td>MODERATE</td>
<td>FRESHWATER HABITAT</td>
</tr>
<tr>
<td>POOR</td>
<td>GOOD</td>
<td>MODERATE</td>
<td>OCEAN CONDITIONS (FOOD)</td>
</tr>
<tr>
<td>POOR</td>
<td>POOR</td>
<td>SMALL</td>
<td>FOOD &amp; SPACE; EXTINCTION SPIRAL</td>
</tr>
</tbody>
</table>
STATUS OF CALIFORNIA SALMONIDS 2010, N = 32
Anadromous 21, Non-anadromous 11

- Listed: 44%
- Qualified for Listing: 25%
- Watch List: 16%
- Special Concern: 9%
- Relatively Secure: 3%
- Extinct: 3%
ANADROMOUS CA SALMONIDS

- Listed: 52%
- Qualify for listing: 24%
- Special Concern: 10%
- Watch list: 14%

N = 21

INCLUDES BOTH COHO SALMON ESUS
Natural Factors

CALIFORNIA'S PRECIPITATION IS MUCH MORE VARIABLE THAN REST OF USA.

U.S. Drought Monitor
California

May 5, 2015
(Released Thursday, May 7, 2015)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>D0-D4</th>
<th>D1-D4</th>
<th>D2-D4</th>
<th>D3-D4</th>
<th>D4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>0.14</td>
<td>99.86</td>
<td>98.28</td>
<td>93.91</td>
<td>66.60</td>
<td>46.77</td>
</tr>
<tr>
<td>Last Week 4/28/2015</td>
<td>0.14</td>
<td>99.86</td>
<td>98.11</td>
<td>93.44</td>
<td>66.60</td>
<td>46.77</td>
</tr>
<tr>
<td>3 Months Ago 2/3/2015</td>
<td>0.16</td>
<td>99.84</td>
<td>98.13</td>
<td>93.57</td>
<td>77.46</td>
<td>39.99</td>
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<tr>
<td>Start of Calendar Year 12/20/2014</td>
<td>0.00</td>
<td>100.00</td>
<td>98.12</td>
<td>94.34</td>
<td>77.94</td>
<td>32.21</td>
</tr>
<tr>
<td>Start of Water Year 9/30/2014</td>
<td>0.00</td>
<td>100.00</td>
<td>100.00</td>
<td>95.04</td>
<td>81.92</td>
<td>58.41</td>
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<tr>
<td>One Year Ago 5/5/2014</td>
<td>0.00</td>
<td>100.00</td>
<td>100.00</td>
<td>95.93</td>
<td>76.68</td>
<td>24.77</td>
</tr>
</tbody>
</table>

Intensity:
- Yellow: D0 Abnormally Dry
- Light Orange: D1 Moderate Drought
- Orange: D2 Severe Drought
- Medium Red: D3 Extreme Drought
- Red: D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Mark Svoboda
National Drought Mitigation Center

http://droughtmonitor.unl.edu/
Water Stored in Reservoirs has Fallen

CA is experiencing record heat
Streamgages recording flows in the bottom 10th percentile of the historical record

% with lowest flows

2010

40+% CA streamgages recording flows in lowest 10% of historic flows (PPIC 2015)
Competition for water

1440 ‘large’ dams (1.8+ m)

753 potentially harming fish

250 more than 20 m high

Grantham et al. 2014
SALMON & STEELHEAD: 70% of habitat lost
Other factors

Climate change
Land use
Diversions
Hatchery practices
Contaminants
Alien species
Disease
Etc...
What should we do?

“Most experts concluded that by 2100 wild salmon in the Central Valley will be extirpated or minimally abundant if current trends continue.”

Franks and Lackey 2015, OSU
Statewide strategy for aquatic conservation

**GOALS:**
- Protect examples of all major habitats
- Self-sustaining populations of all native species
- Drought protection
Protect best of what is left
Blue Creek

Yurok Tribal Salmon Sanctuary
Spring-fed Streams

Cold + high productivity
Salmon can thrive in rice fields in winter

\[ y = 42.5 + 1.06 \cdot x, \quad R^2 = 0.886 \]

\[ y = 45 - 0.2 \cdot x + 0.055 \cdot x^2, \quad R^2 = 0.889 \]
Environmental Flows Below Dams

FOLSOM RESERVOIR, AMERICAN RIVER

JAN 2014
Legal tools for dam reoperation

• Section 5937, California Fish and Game Code

• Public Trust Doctrine

• Does not say “except during drought.”

• Data base (Grantham et al. 2014)
CASE STUDY

LOWER PUTAH CREEK

- Regulated by dams
- 30km Riparian “shred”
- Novel Ecosystem
- Model for reconciled aquatic/riparian ecosystems

Feb 2, 2014
LOWER PUTAH CREEK

• 30km Riparian Remnant
• Novel Ecosystem
• Model for reconciled aquatic/riparian ecosystems

CASE STUDY
MANAGING THE FLOW REGIME FOR NATIVE FISHES

BEFORE

1991-1997
N= 7

1998-2008
N= 10

AFTER

NATIVES
Chinook salmon spawning, December 2013
Photo by Ken Davis
Reconciliation Ecology

A basic approach to conservation

- Humans dominate all ecosystems
- Most ecosystems are *novel ecosystems*
- Alien species & altered habitats
- Drought & climate change increase need
- How do we incorporate conservation into human ecosystems?