Climate Change Impacts on Columbia Basin Tribal Lands: Past-Present-Future

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Tribal CC Webinar Series

Columbia River Inter-Tribal Fish Commission
Portland, Oregon, USA
Columbia River Inter-Tribal Fish Commission - CRITFC

CRITFC website, http://www.critfc.org
Tribes and Climate Change

*Climatic Change* is dedicated to the totality of the problem of climatic variability and change – its descriptions, causes, implications and interactions among these. The purpose of the journal is to provide a means of exchange between those working on problems related to climatic variations but in different disciplines. Interdisciplinary researchers or those in any discipline, be it meteorology, anthropology, agricultural science, astronomy, biology, chemistry, physics, geography, policy analysis, economics, engineering, geology, ecology, or history of climate, are invited to submit articles, provided the articles are of interdisciplinary interest. This means that authors have an opportunity to communicate the essence of their studies to people in other climate related disciplines and to interested laypersons, as well as to report on research in which the originality is in the combinations of (not necessarily original) work from several disciplines. The journal also includes vigorous editorial and book review sections.

ARTICLE WENT PUBLIC (ON-LINE) ON APRIL 17, 2013!!! 😊
Introduction...Methods

- **Goal:** (1) Assess how river flow has changed on Columbia Basin tribal lands over the last 100 years, (2) Possible impacts on salmon.

- **Tributary Flow:** US Geological Survey stream data for 32 basins. Flow data were **naturalized** (no irrigation effects) for 19 basins.

**Study Goals:**

1. Shift in Seasonal Flow Fraction (i.e., Spring-Summer vs. Fall-Winter).
2. Shift in median (50th percentile) annual flow Center Timing,
3. Shift in Spring Flow Onset (i.e., start of the spring snowmelt).
5. Low Flow (summer-autumn).

- **Student “t-test” and Mann-Kendall trend tests** were used.

- **GIS data:** Climate change risk for land below elevation 4000 feet?
Climate Variability and Streamflow in the PNW

Source: Climate Impacts Group, University of Washington, Seattle
Location Map
Seasonal Flow Fraction

SFF = Ratio of SPRING and SUMMER FLOW to ANNUAL FLOW

(e.g., Autumn-Winter vs. Spring-Summer volumes)
Seasonal Flow Fraction: Metolius Basin (Deschutes)

Seasonal Flow: Metolious R., Grandview, OR (1912-2007)

\[ y = -0.0003x + 1.0257 \]

\[ R^2 = 0.0338 \] (or 3% decline)

Source: Dittmer (2013)
Seasonal Flow Fraction: spring-summer vs. autumn-winter

Source: Dittmer (2013)
Seasonal Flow Fraction: Standard Deviation

Seasonal Flow: Okanogan River nr Tonasket, WA (1912 - 2007)

\[ y = 0.0007x + 0.0618 \]

\[ R^2 = 0.3147 \]

Source: Dittmer (2013)
Center-of-mass Timing

CT = MID-POINT (50%) OF WATER YEAR RUNOFF
Snowmelt timing (CT): Metolius Basin (Deschutes)

METOLIUS R. at GRANDVIEW, OR (elev. 1974 ft./602 m)

\[ y = -0.0456x + 187.2 \]

\[ R^2 = 0.0336 \text{ (or -5 days per century)} \]

Source: Dittmer (2013)
Snowmelt timing (CT): Mid-point of seasonal runoff

Source: Dittmer (2013)
Spring Flow Onset

SFO = CUMULATIVE NEGATIVE DEPARTURES FROM THE MEAN FLOW ARE AT A MINIMUM

River flow

JAN APR SFO MEAN FLOW
Spring Flow Onset: Umatilla Basin (at Gibbon)

Spring Flow: Umatilla River at Gibbon, OR (1934 - 2009)

$y = -0.308x + 61.478$

$R^2 = 0.0661$ (or -31 days per century)

Source: Dittmer (2013)
Spring Flow Onset (SFO): start date of the seasonal snow-melt

Source: Dittmer (2013)
<table>
<thead>
<tr>
<th>River - Gauge Location</th>
<th>USGS Gage #</th>
<th>SFF</th>
<th>Mann - Kendall</th>
<th>CT</th>
<th>Mann - Kendall</th>
<th>SFO</th>
<th>Mann - Kendall</th>
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<tbody>
<tr>
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<td>LC vs. EC (p-value)</td>
<td>W-C (p-value)</td>
<td>LC vs. EC (p-value)</td>
<td>W-C (p-value)</td>
<td>LC vs. EC (p-value)</td>
<td>W-C (p-value)</td>
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<td>Moyie - Eastport</td>
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<td>&lt; 0.1</td>
<td>0.331</td>
<td>0.884</td>
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</table>

Average: 0.11 | 0.08 | 0.40 | 0.34 | 0.45 | 0.46
Maximum: 0.55 | 0.61 | 0.94 | 0.93 | 0.94 | 0.92
Minimum: 0.01 | 0.00 | 0.09 | 0.02 | 0.03 | 0.05

Bold: p = 0.05 - 0.1
Bold-shade: p < 0.05

Source: Dittmer (2013)
High Flow events: Similkameen Basin (at Nighthawk)

Source: Dittmer (2013)
High Flow events:
Late 20^{th} century vs. Early century 100-year flow

Source: Dittmer (2013)
High Flow events:
Late 20th century vs. Early century 100-year flow

Source: Dittmer (2013)
High Flow events:
Late 20th century vs. Early century 100-year flow

Changes to 100-yr December High Flow
-30% to +0%
+0% to +30%
+30% to +60%
+60% to +135%

Source: Dittmer (2013)
Low Flow events:
Late 20\textsuperscript{th} century vs Early century 7Q10-year flow

Source: Dittmer (2013)
Shift in Median Runoff Timing vs. Basin Elevation

SHIFT IN MEDIAN WY RUNOFF vs. MEAN BASIN ELEVATION

\[ y = 7324x^{-0.318} \]

\[ R^2 = 0.5185 \]

Source: Dittmer (2013)
Climate Change Sensitivity: GIS assessment – tribal land

Source: David Graves, CRITFC (GIS data)
Current Climate Change Issues

- Weather patterns are becoming more extreme and variable. Examples: more severe hurricane days, new records set for temperature (day & night), severe weather (e.g., tornadoes) in the off-season, persistent dry spells and drought, etc.

- Extreme weather variability will make water management in reservoirs more difficult and prone to more operational errors.

- The incubation of redds is sooner due to warmer winter water.

- Invasive warm water species is a growing problem.

- Hot summer Columbia R. water temperatures often exceed state standards for salmon. Adult salmon migration delays are more common at Bonneville Dam due to high temperatures (exceeds 68 degF). Fish may stray into cooler tributary streams to survive.
Water Temperature: Columbia River Basin

**SPRING & SUMMER 1940-2009: COLUMBIA RIVER - BONNEVILLE**

$$y = 0.0207x + 53.163$$  \( R^2 = 0.09 \)

$$y = 0.0607x + 64.688$$  \( R^2 = 0.3858 \)

Data Source: US Army Corps of Engineers
Note what happens when water temperatures cool down to 68 degF (next slide).
Traffic jam of salmon at the fish ladders of Bonneville Dam!!
Future PNW Impacts

- Increasingly highly variable (and harder to predict) spring and summer water supply. Water quality is at high risk.
- Warming water temperatures will really stress the salmon. Will the Columbia Salmon retreat to cooler BC and/or Alaska?
- Increased competition — salmon water vs. irrigation water.
- Increase in Pacific Northwest coastal “Dead Zones.”
  (http://www.latimes.com/news/nationworld/nation/la-na-deadzone2-2008may02,0,1285619.story)
- Extreme weather. New June 19, 2008 Government Report:
  (http://www.climatescience.gov/Library/sap/sap3-3/final-report/default.htm#chapters)
- Human health- more disease, air-borne pollutants, heat stroke.
- Could “climate refugees” move to the PNW and strain our land and water resources? Conflicts over PNW natural resources? Nexus of population growth and “climate refugees”? Great impacts to human health – poor, elderly, and young children.
Unstoppable Climate Change?

Future PNW Climate

Source: Mantua et.al. (2010)
(http://csees.washington.edu/cig/res/ae/aekeyfindings.shtml)
Future PNW River Timing

Natural Flow (no dams), Columbia River: Past and Future

Data source: UW-Climate Impacts Group (www.cses.washington.edu/cig)
Traditional tribal diets were highly rich in salmon.

PNW tribal populations were in sharp decline for over 100 years. Now they are rebounding – hence their need for more traditional foods.

Shifting water resources will be difficult for many tribal communities, given their current water-use infrastructure.

Salmon are a major part of PNW tribal religion and culture.
What Can be Done?

- More **Flexibility** and **Adaptability** built in our ecosystems and economies. Prepare society for increased weather variability and extremes.

- Reduce greenhouse gas emissions. Use more “green” energy (wind, solar) and less oil. **Absorb excess** greenhouse gas emissions from atmosphere.


- “Carbon Sequestration” using **Ultramafic** (i.e., special volcanic) rocks (http://pubs.usgs.gov/ds/414) and Methane sequestration (**new idea**).


- Maintain climate reporting stations (“coop” sites). **Restore** closed stations.

- Very bad climate change scenarios may **not** be inevitable. Don’t panic!
Protect our Future...
What are your questions?
(Thank you very much for your time!)

Thank you to: David Graves, CRITFC’s GIS Specialist, and Laura Gephart, Watershed Programs Coordinator.
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