Northwest **Power** and
Conservation Council

October 27, 2014

MEMORANDUM

TO: Fish and Wildlife Committee members

FROM: Jim Ruff – Manager – Mainstem Passage and River Operations

SUBJECT: Presentation on Columbia River streamflow and fish migration data
visualization

BACKGROUND:

Presenter: Dr. Rick Koehler of NOAA's National Weather Service (NWS) in Boulder,
CO will be the presenter. Dr. Koehler is the National Hydrologic and Geospatial Science
Training Coordinator for the NWS. He is also a registered Professional Hydrologist with
the American Institute of Hydrology (AIH).

Summary:
Dr. Koehler will use graphical data visualization to present selected Columbia River flow
and adult Chinook salmon migration data in a new and novel way that may have
application to the revised Fish and Wildlife Program. Specifically, the presentation will
examine historic patterns in daily streamflow records and adult Chinook salmon daily
counts for the lower Columbia River.

Relevance:
A data visualization technique will be presented where large amounts of time-series
data are plotted as "time maps," similar to a geographic information system (GIS). This
approach provides the advantage of being able to see daily, weekly, monthly, seasonal,
annual and inter-annual patterns or trends simultaneously. The technique also permits
visualization of natural short- and long-term variation, as well as artificial fluctuations.

Workplan:
While there are no direct links to the Council's amended Fish and Wildlife Program, there are a number of indirect links to the Program. For example, in the Data Management section of Part Four-Adaptive Management, a principle states "the region should work collaboratively through established forums to continue to refine metrics, methods, and indicators which can be used consistently to evaluate and report on program progress, focal species, and their habitats." In addition, in the measures of the Reporting section it states that monitoring reports "should provide important data about implementation, status and trends;" and that "the Council will continue to work with Bonneville and the ISRP to identify and assemble the information needed to produce an annual summary of results for Council review."

Background:
As a fellow member of AIH and after reviewing the Council's and Fish Passage Center web sites, Dr. Koehler contacted me about presenting selected data from the Columbia River Basin using the visualization technique. We determined that showing both Columbia River flow and adult Chinook salmon migration time series data would provide useful and relevant examples to help the Council visualize temporal patterns or trends and natural short- and long-term variations using this technique.

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Columbia River Streamflow and Fish Migration Data Visualization

Richard Koehler, PhD, PH
richard.koehler@noaa.gov

Recent News

Adult fall chinook returns shatter single-day record set just one year ago

9/11/2014 11:37 AM

Since Sunday, more than 180,354 adult fall chinook have climbed the fish ladders at Bonneville Lock and Dam on their annual migration into the Columbia River Basin.

Source: bpa.gov

Is this a fluke?

Is this part of a trend?

Is this "cherry-picked" data?

How do other years compare?

What are the numbers for adjacent days?

What does this mean for other locations upstream?

What factors play a part in this record?

Show me the data

Timescape

Helps view large amounts of time-based data

Z (value)

Y (year)

2014

2013

2012

329   330   331   **X (day)**

X = Short-term coordinate

Y = Long-term coordinate

Z = Value (cell color)

*Time ⇨ Raster Grid*

Data image

Raster:
A rectangular grid
of colored cells
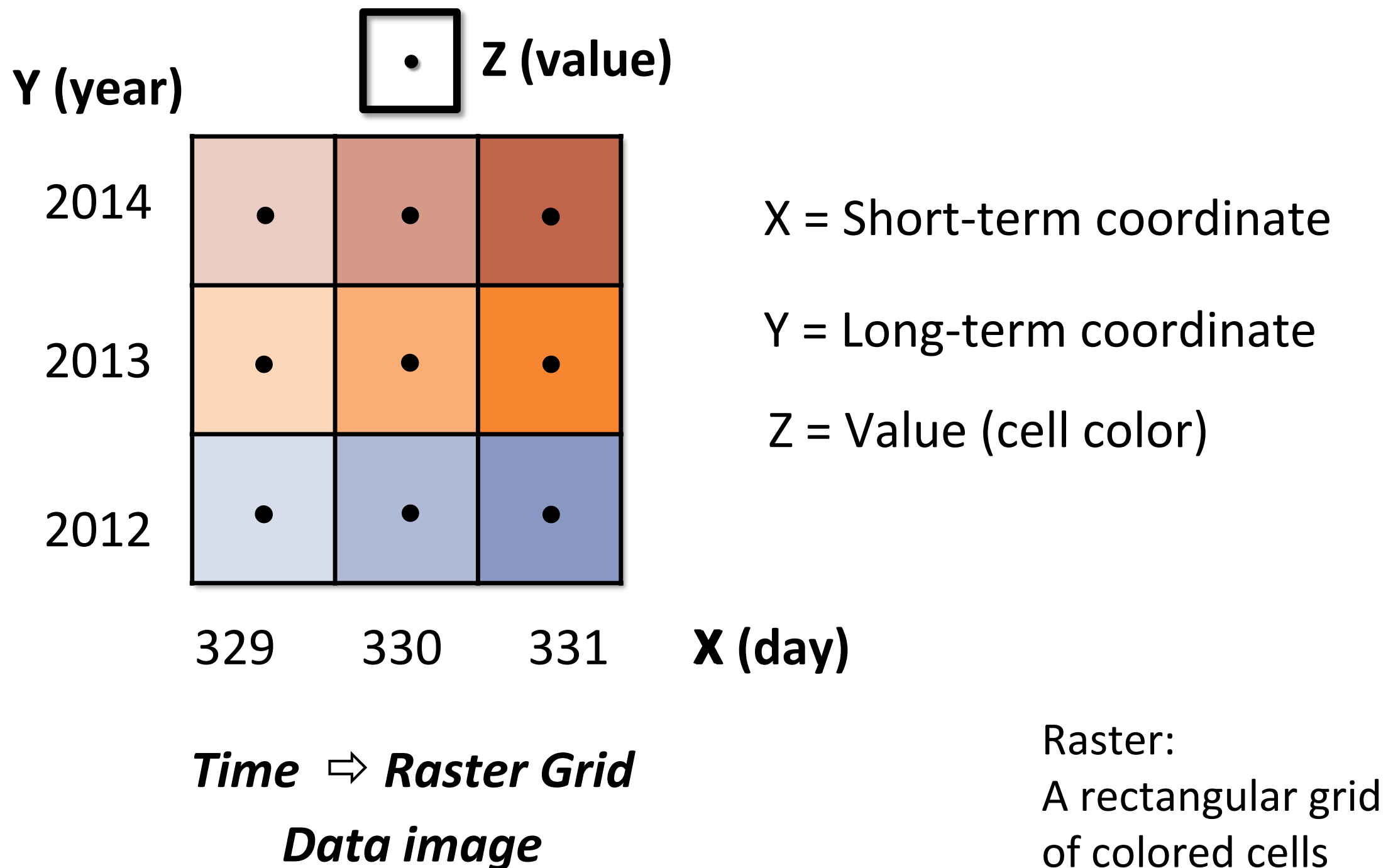
Traditional hydrograph

Columbia River at The Dalles, OR
137 years of daily data (~49,800 values)
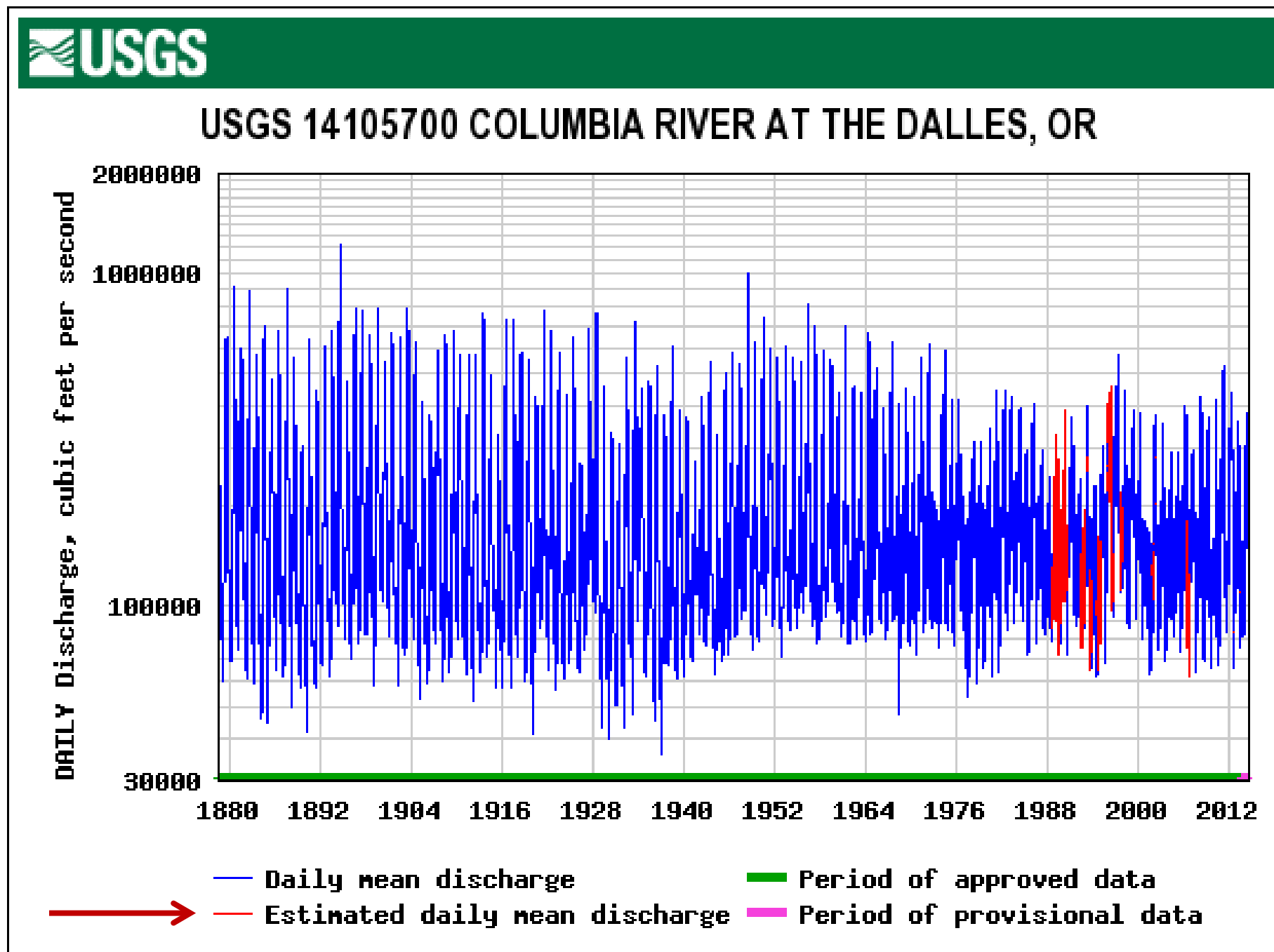
Raster hydrograph

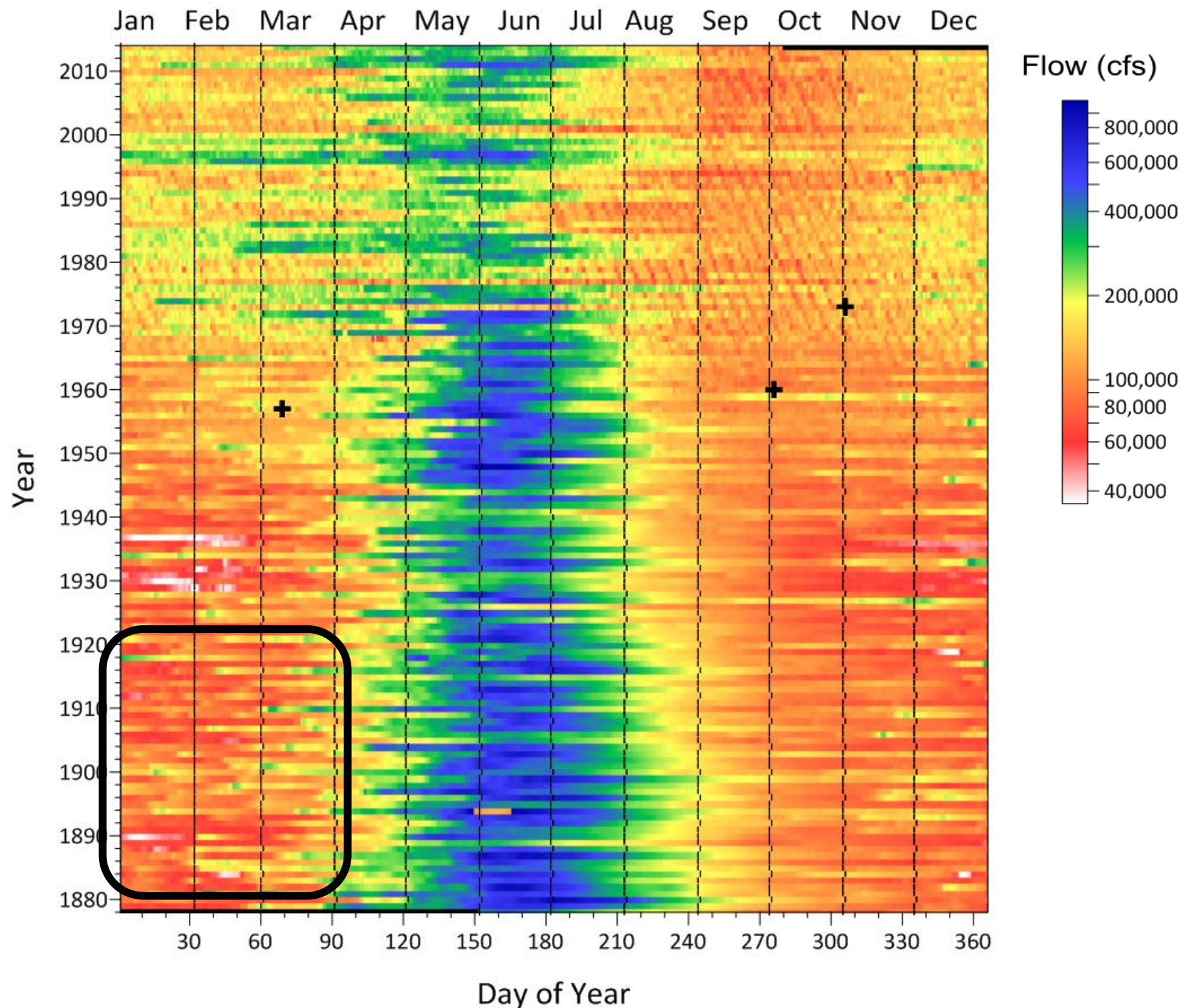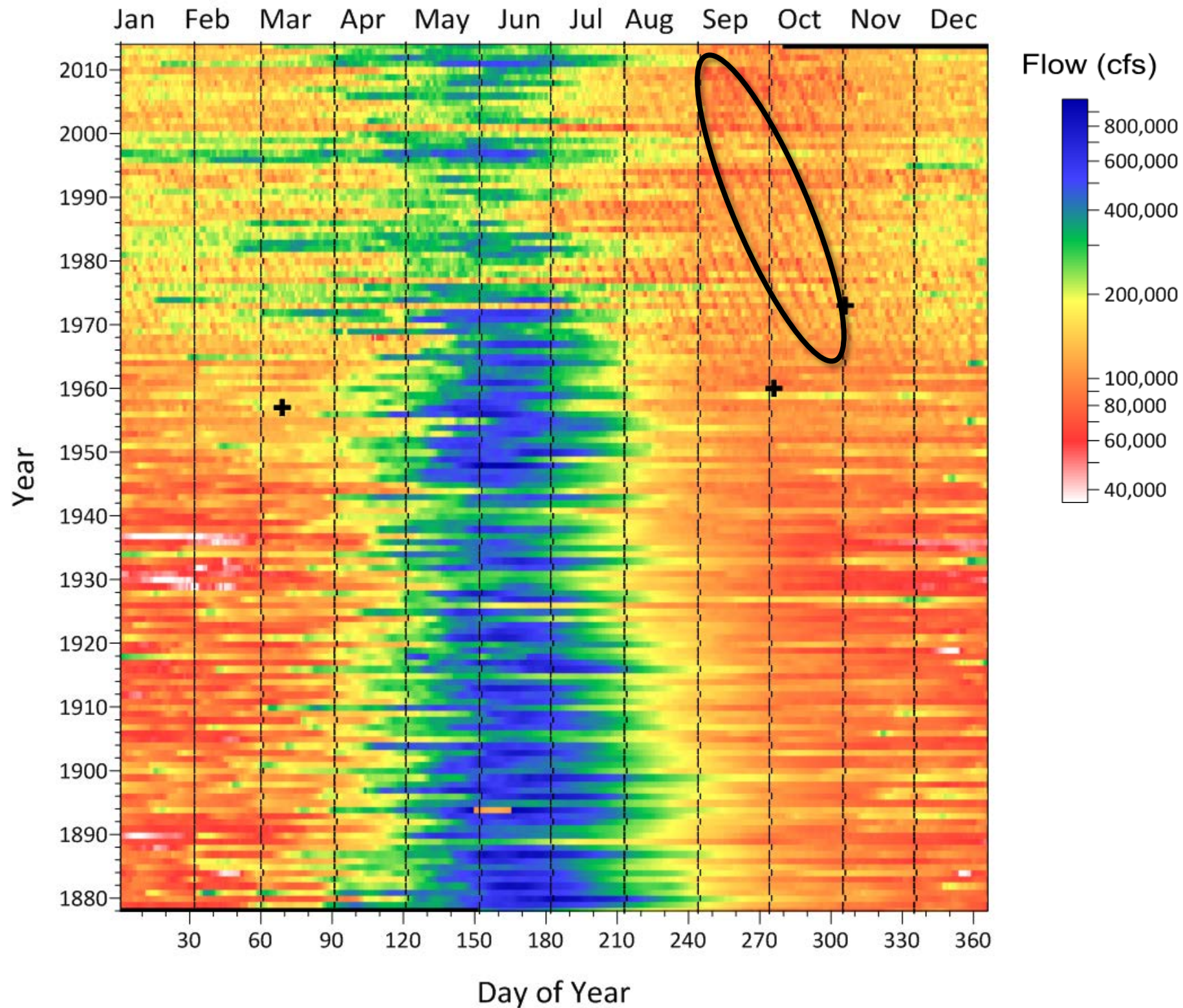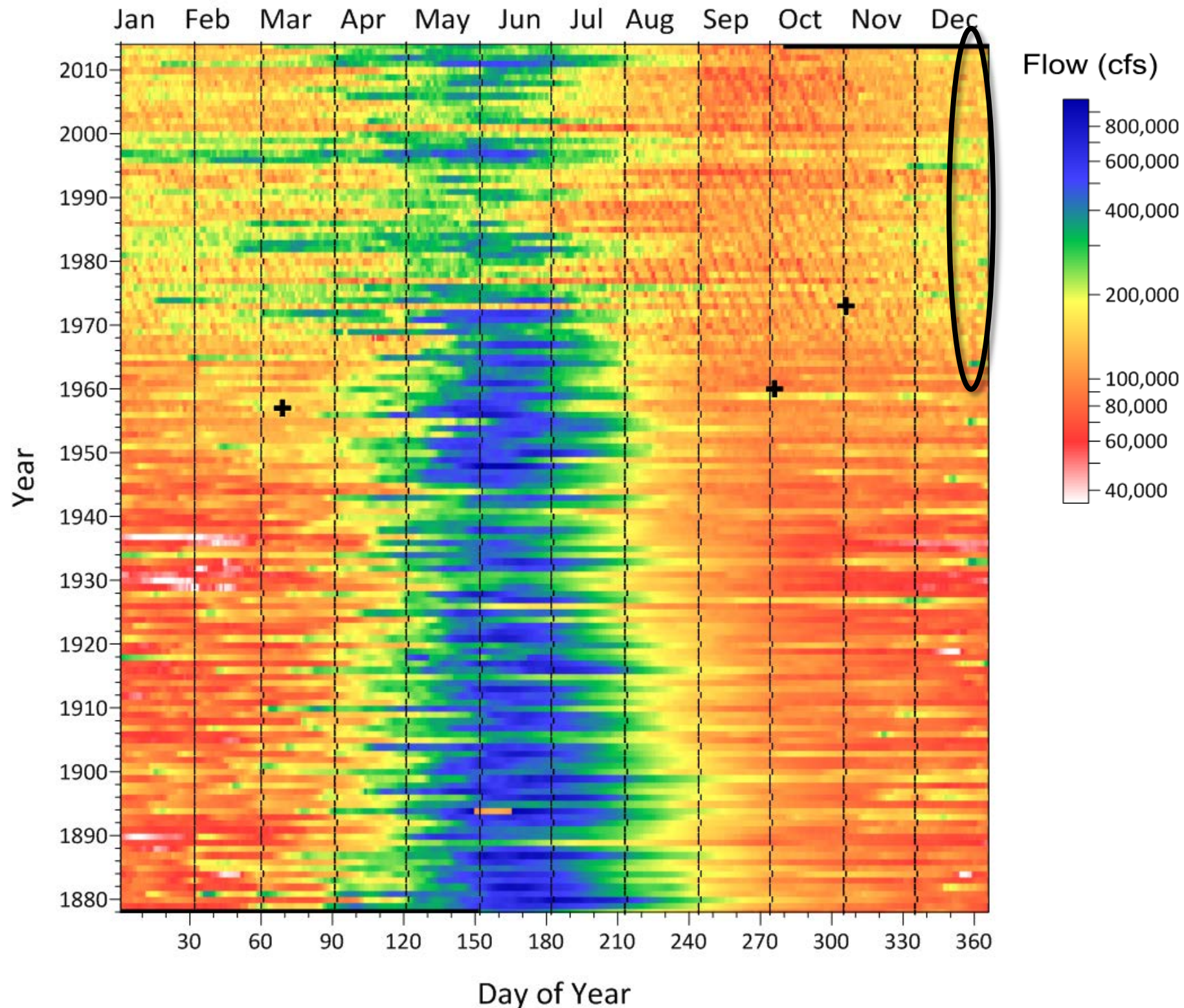*Columbia River at The Dalles, OR*
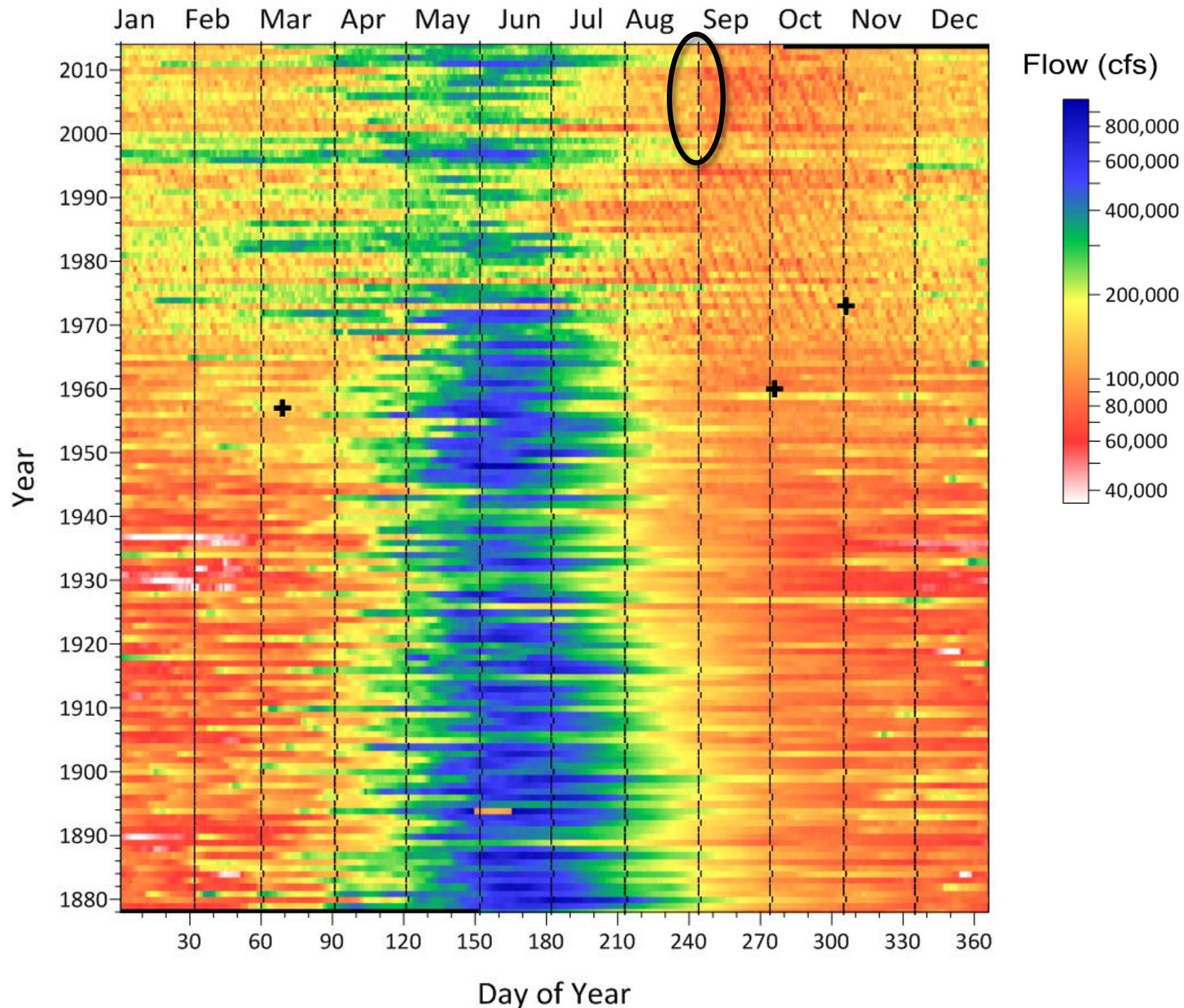*137 years of daily data (~49,800 values)*
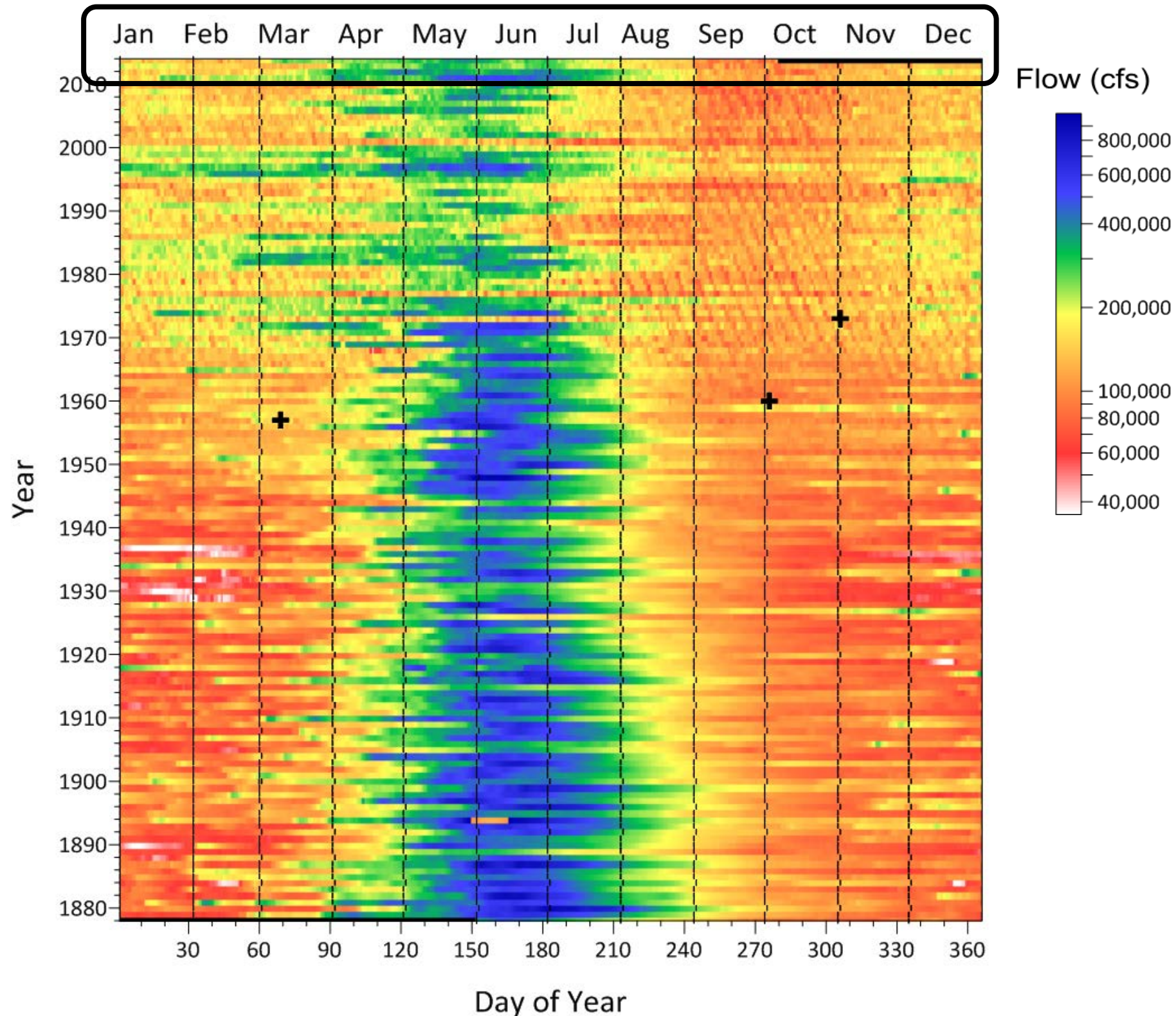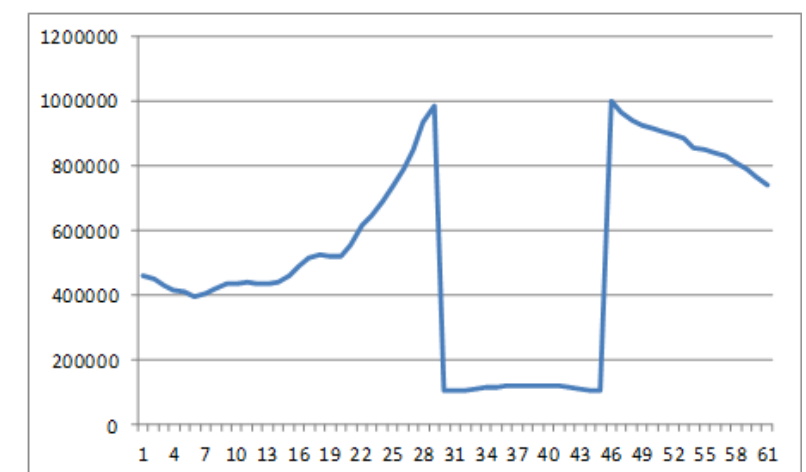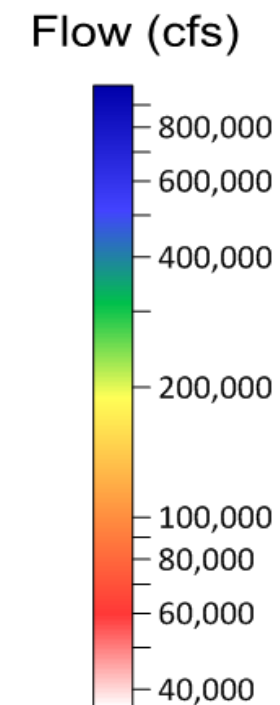
Raster hydrograph

Columbia River at The Dalles, OR
137 years of daily data (~49,800 values)
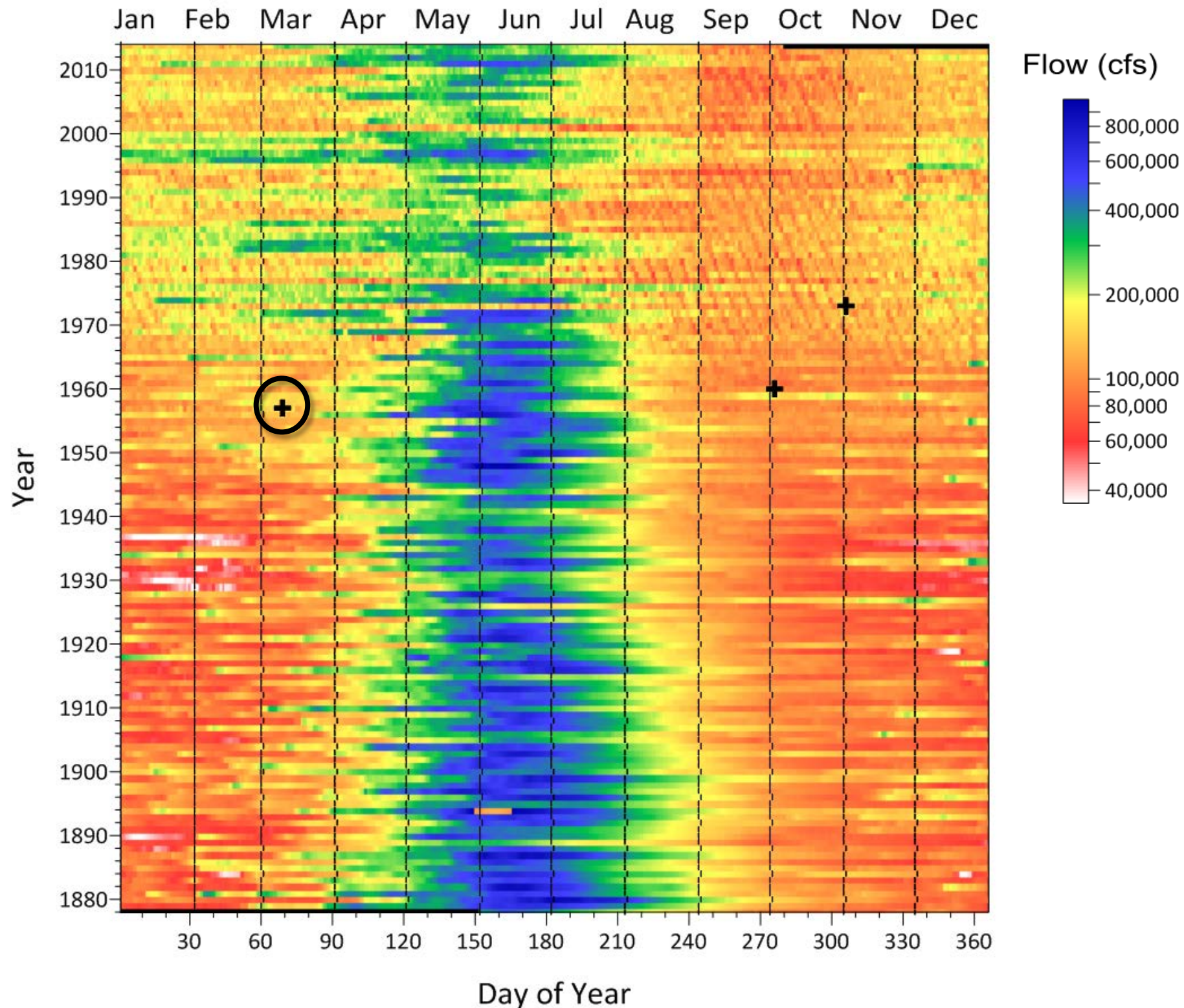
By-pass tunnels close

Lake Celilo begins to fill

Raster hydrograph

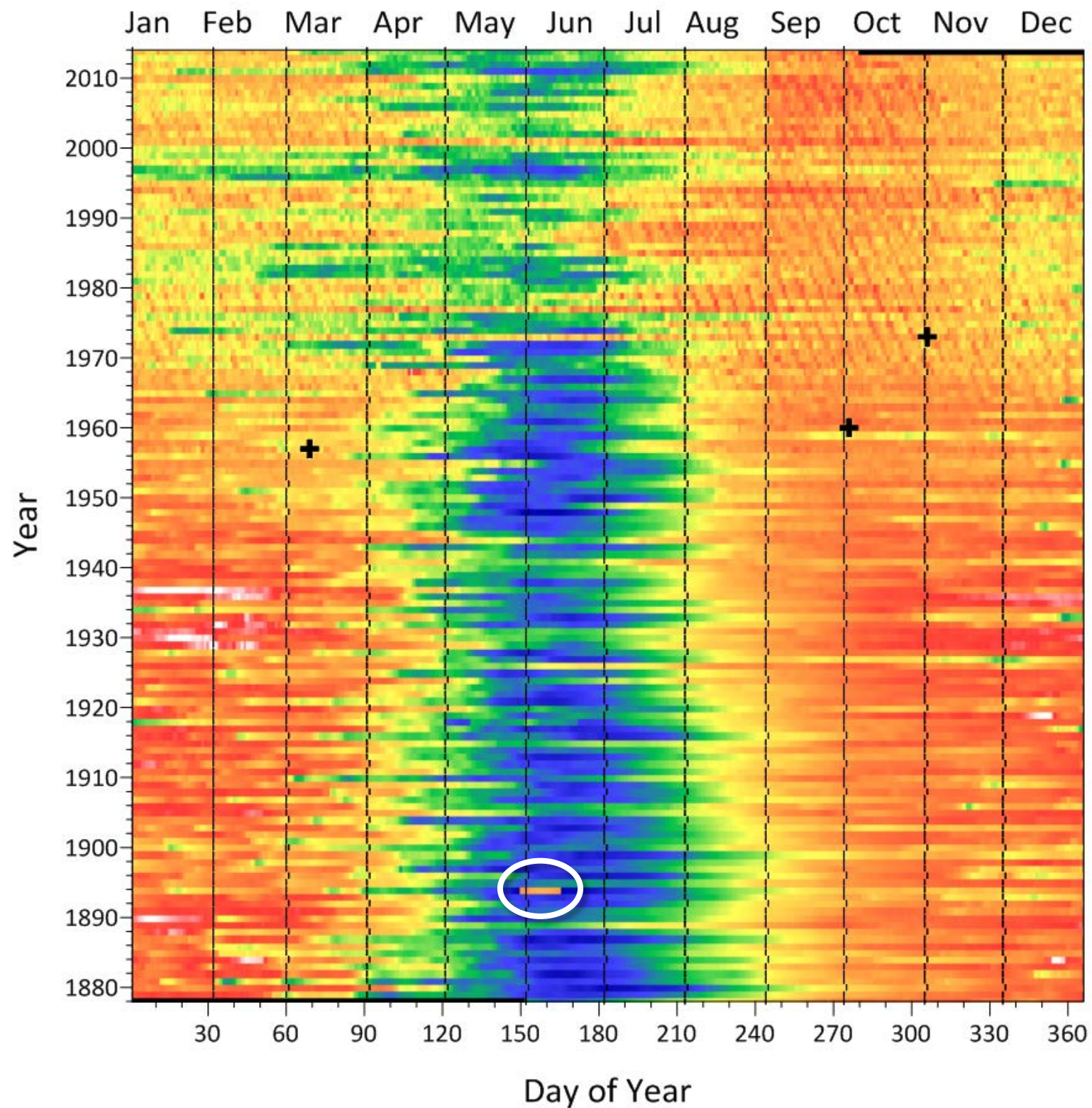*Columbia River at The Dalles, OR*
137 years of daily data (~49,800 values)
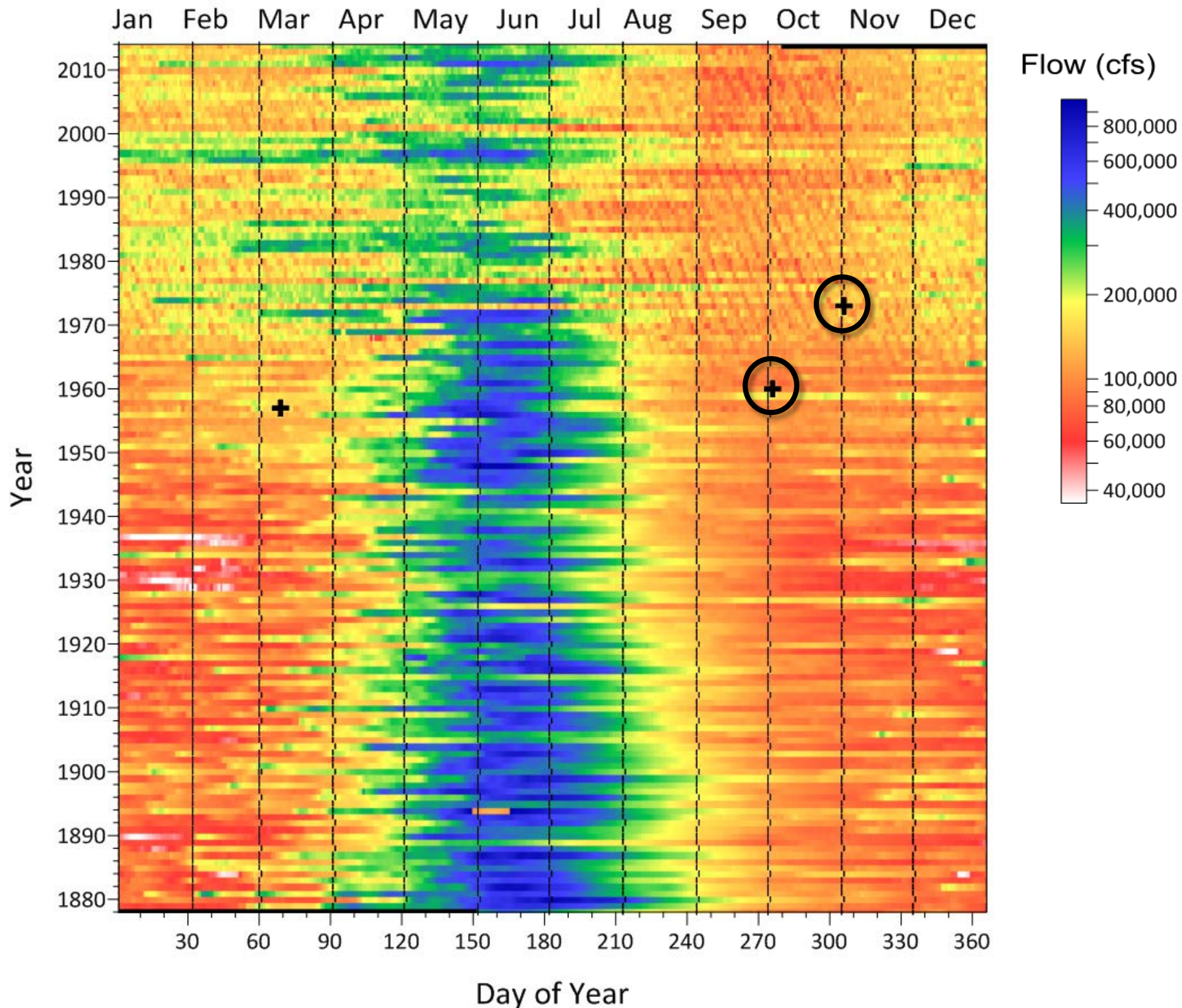
Generators online

Electricity production begins

Raster hydrograph

Columbia River at The Dalles, OR
137 years of daily data (~49,800 values)

Snowmelt runoff
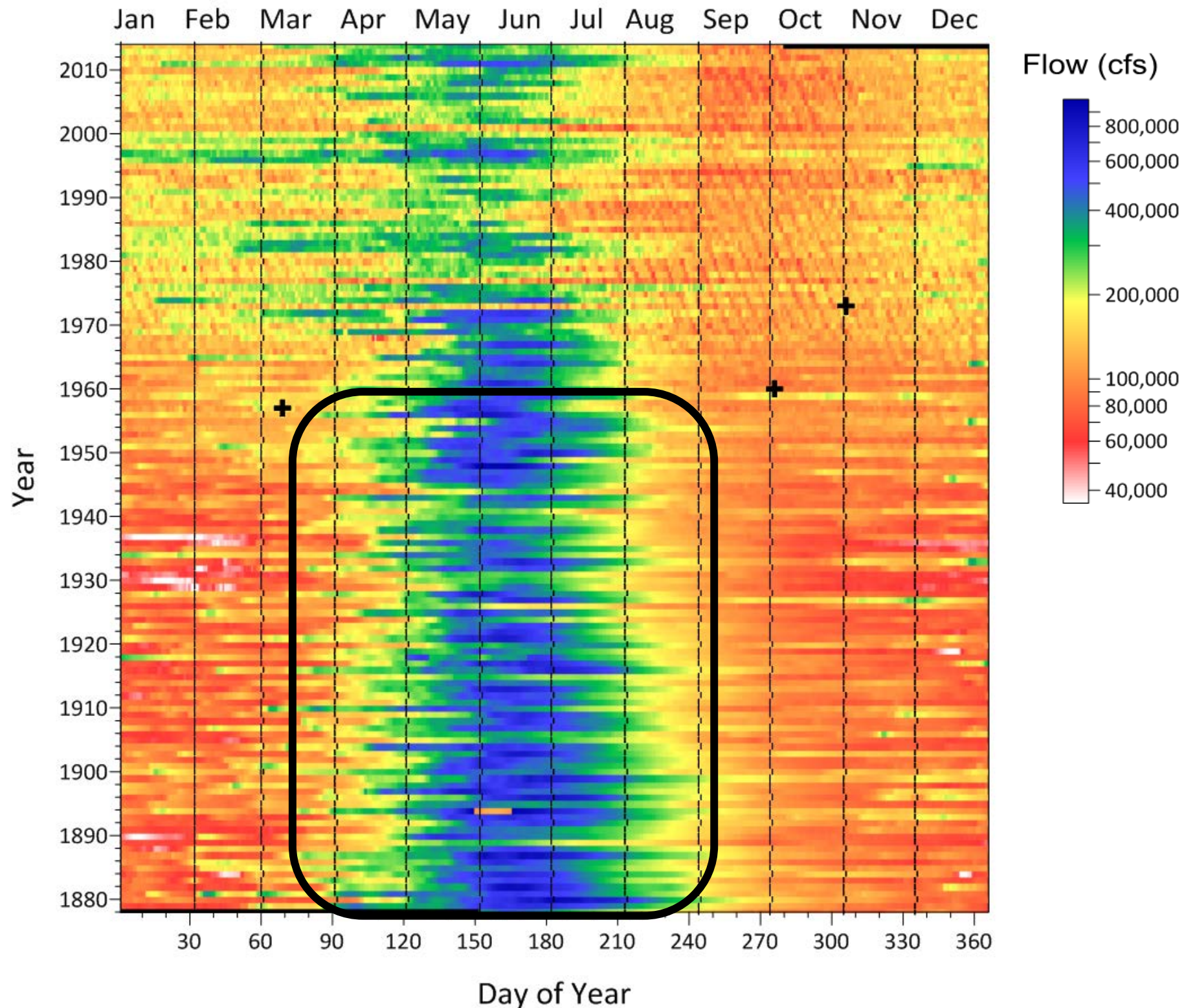
Raster hydrograph

Columbia River at The Dalles, OR
137 years of daily data (~49,800 values)

Droughts
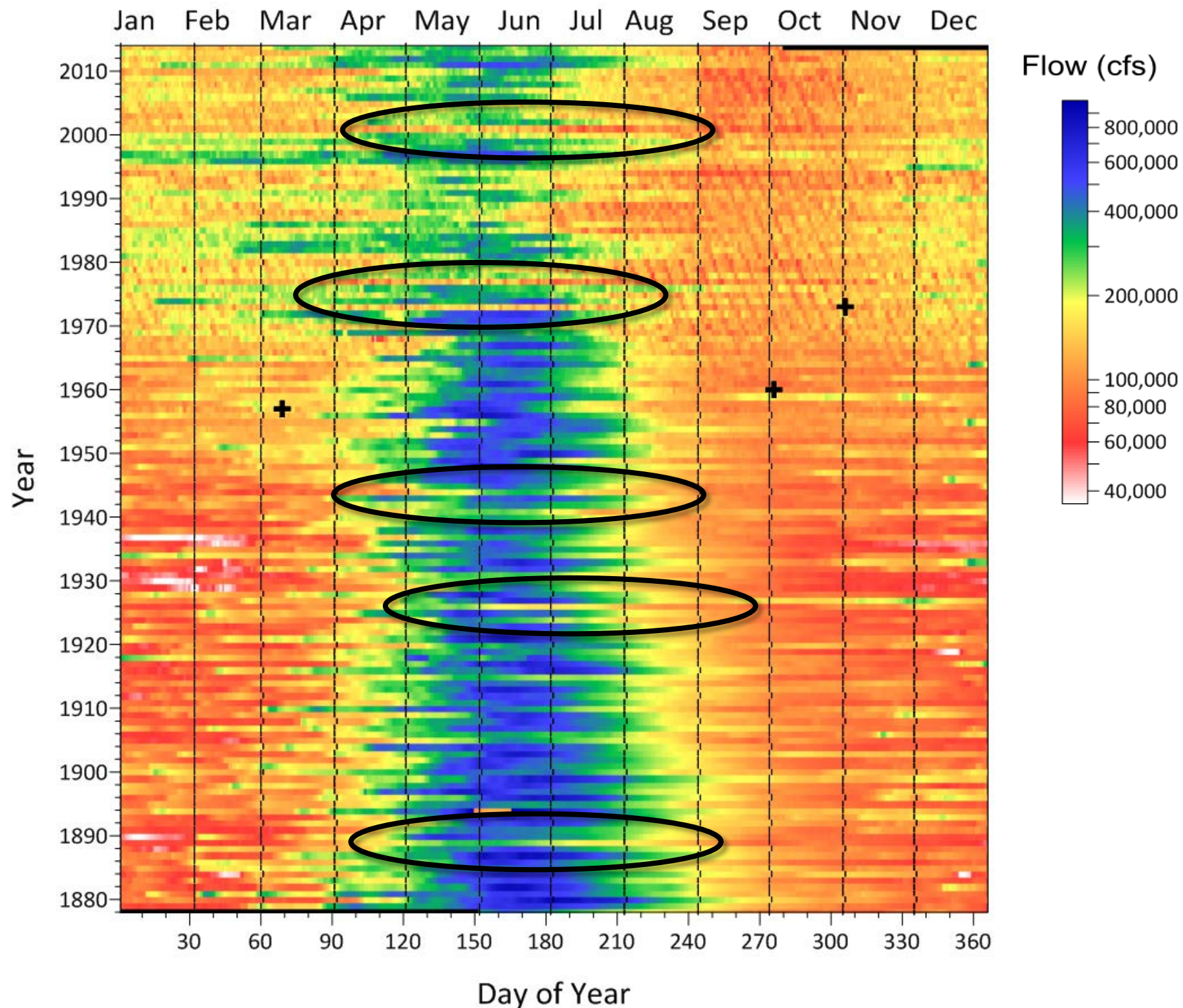
Raster hydrograph

Columbia River at The Dalles, OR
137 years of daily data (~49,800 values)

Record low flow
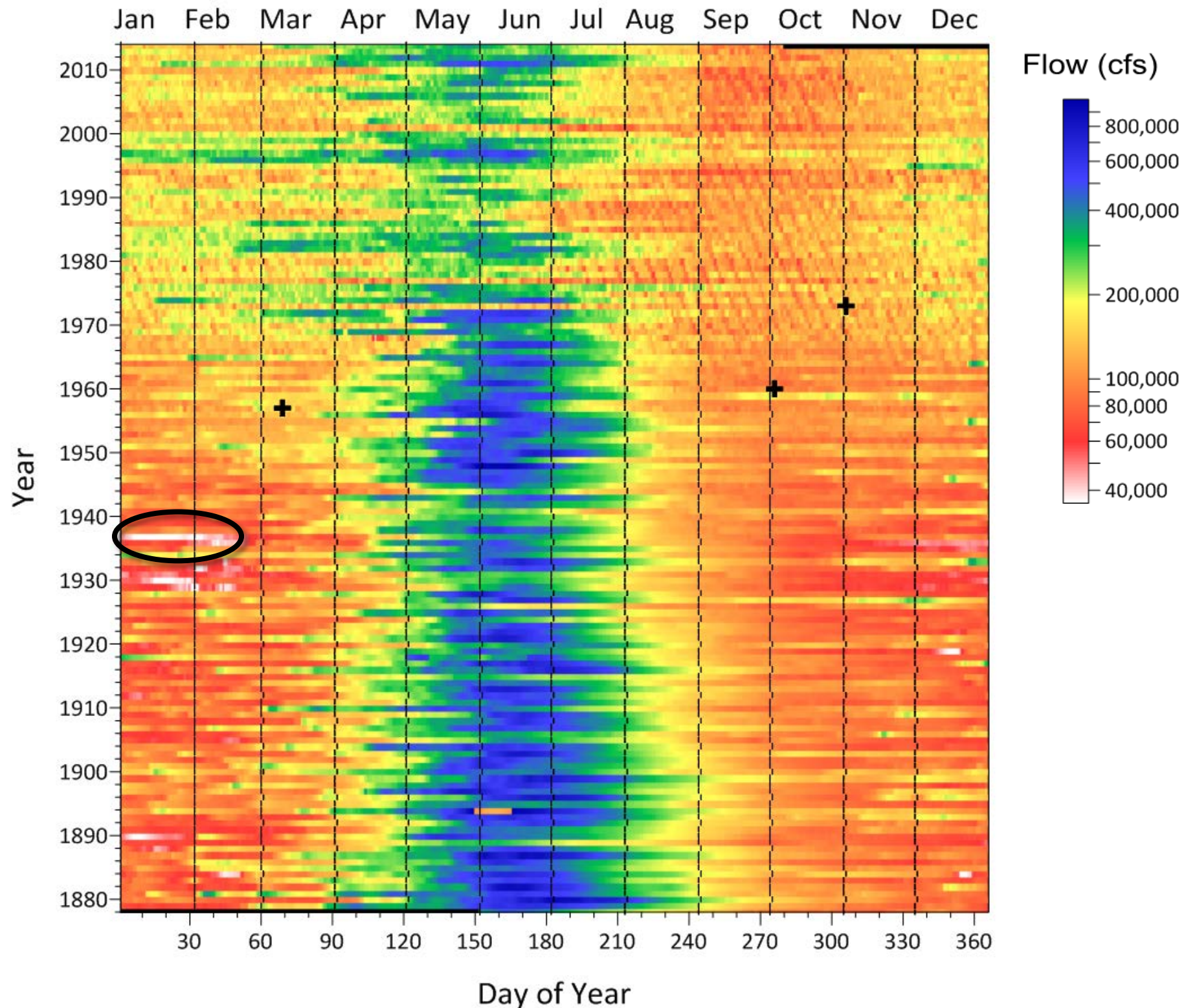
Raster hydrograph

Columbia River at The Dalles, OR
137 years of daily data (~49,800 values)

Storm flow

Raster hydrograph

Columbia River at The Dalles, OR
137 years of daily data (~49,800 values)

Sundays

Raster hydrograph

Columbia River at The Dalles, OR
137 years of daily data (~49,800 values)

Christmas

Raster hydrograph

Columbia River at The Dalles, OR
137 years of daily data (~49,800 values)

Monthly change

Raster hydrograph

Columbia River at The Dalles, OR
137 years of daily data (~49,800 values)

Data artifact

Adopted by the USGS*

Snake River near Anatone, WA

Cumulative volume

Columbia River at The Dalles, OR
Cumulative volume (1879 to 2014)
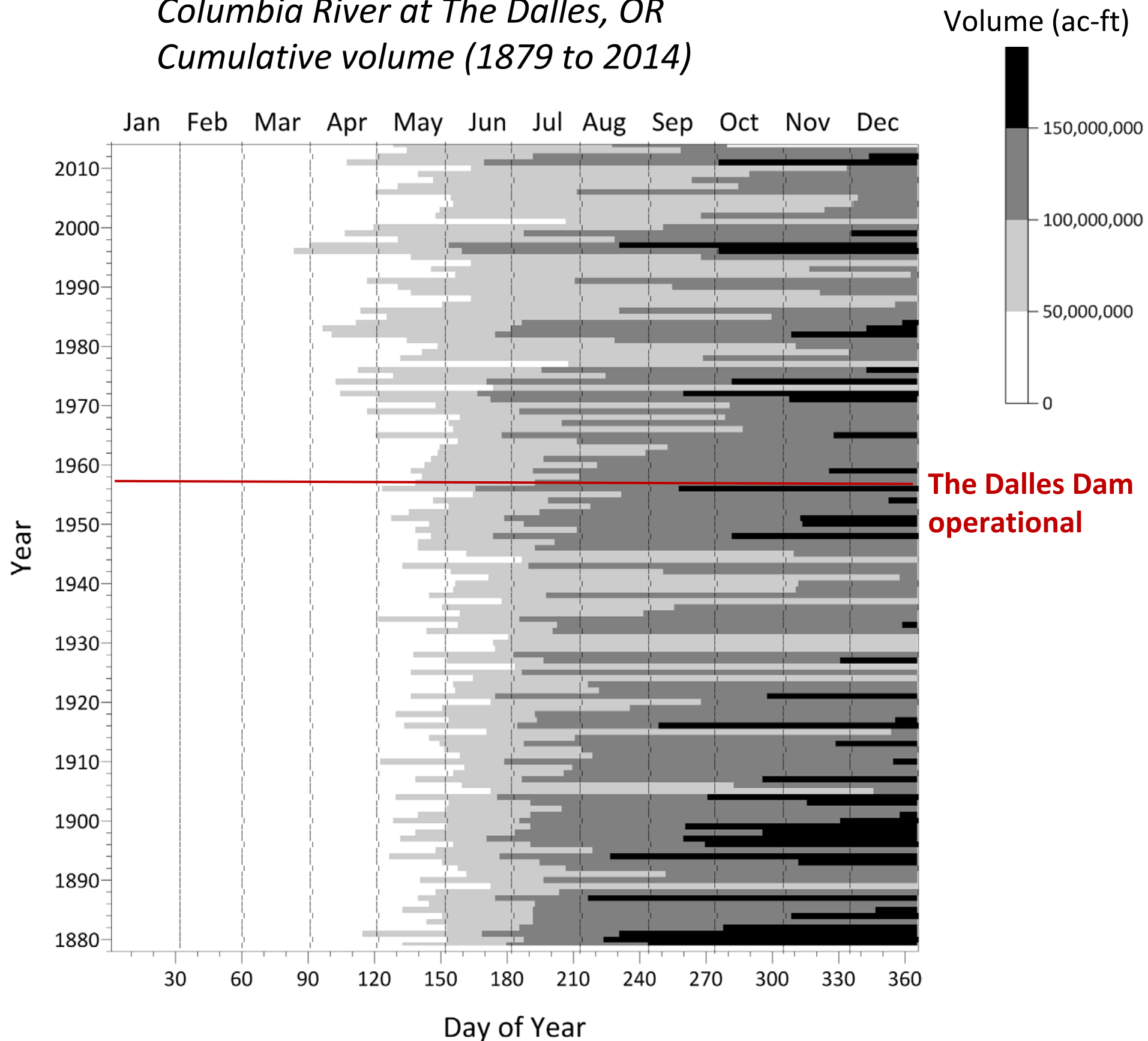
Annual maximum

Columbia River at The Dalles, OR
Mean Daily Flow, Annual Maximum (1878 to 2014)
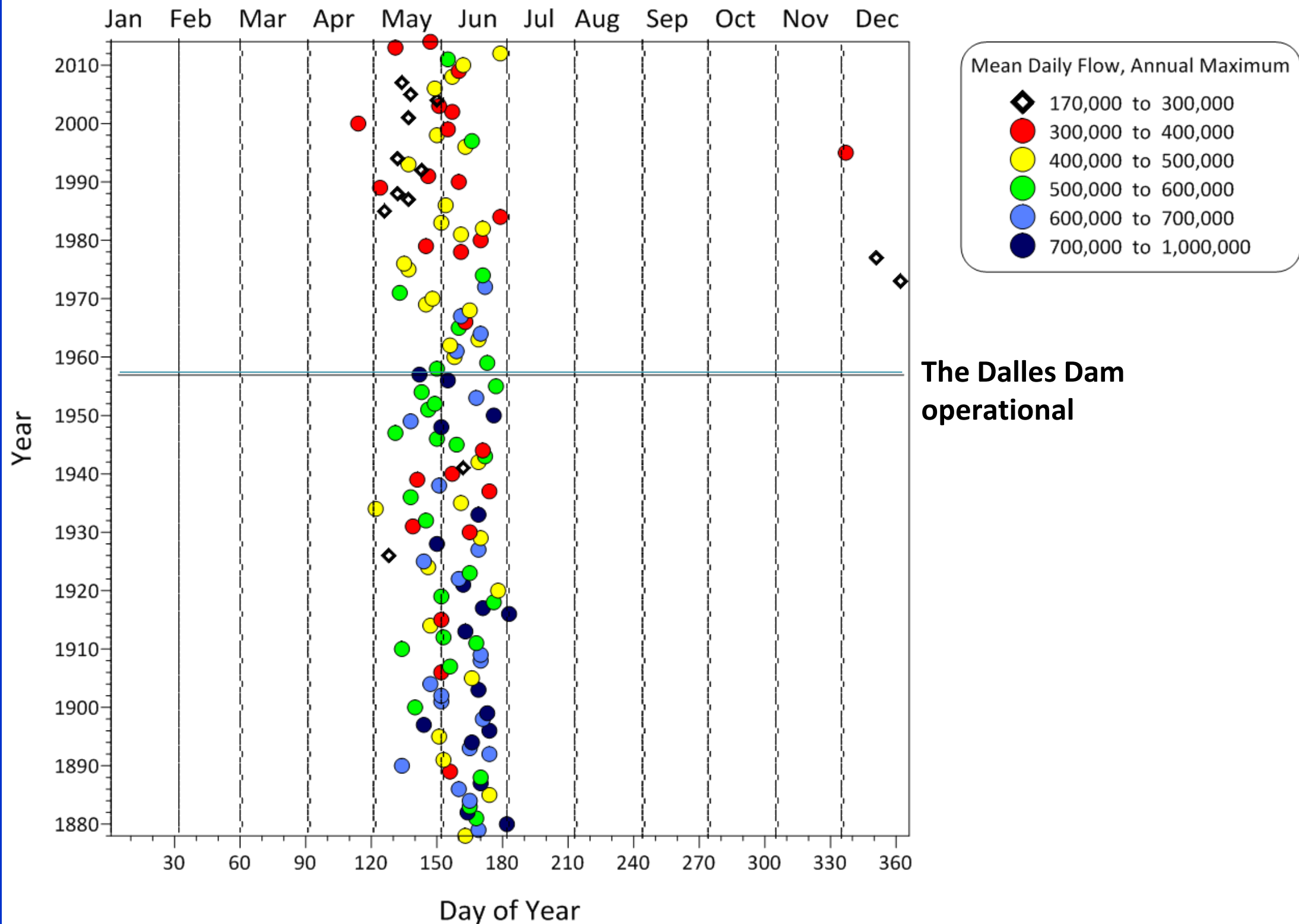
Bonneville Adult Chinook

Daily count (2010 – 2014, 5 years)

Adult Passage/Adult Chinook 10YrAvg
Bonneville, Chinook, 10YrAvg 2013-2004

Adult Passage: 2010 (279233)
Adult Passage: 2011 (208139)
Adult Passage: 2012 (186434)
Adult Passage: 2013 (115587)
Adult Passage: 2014 (227083)
Adult Chin 10YrAvg (160561)
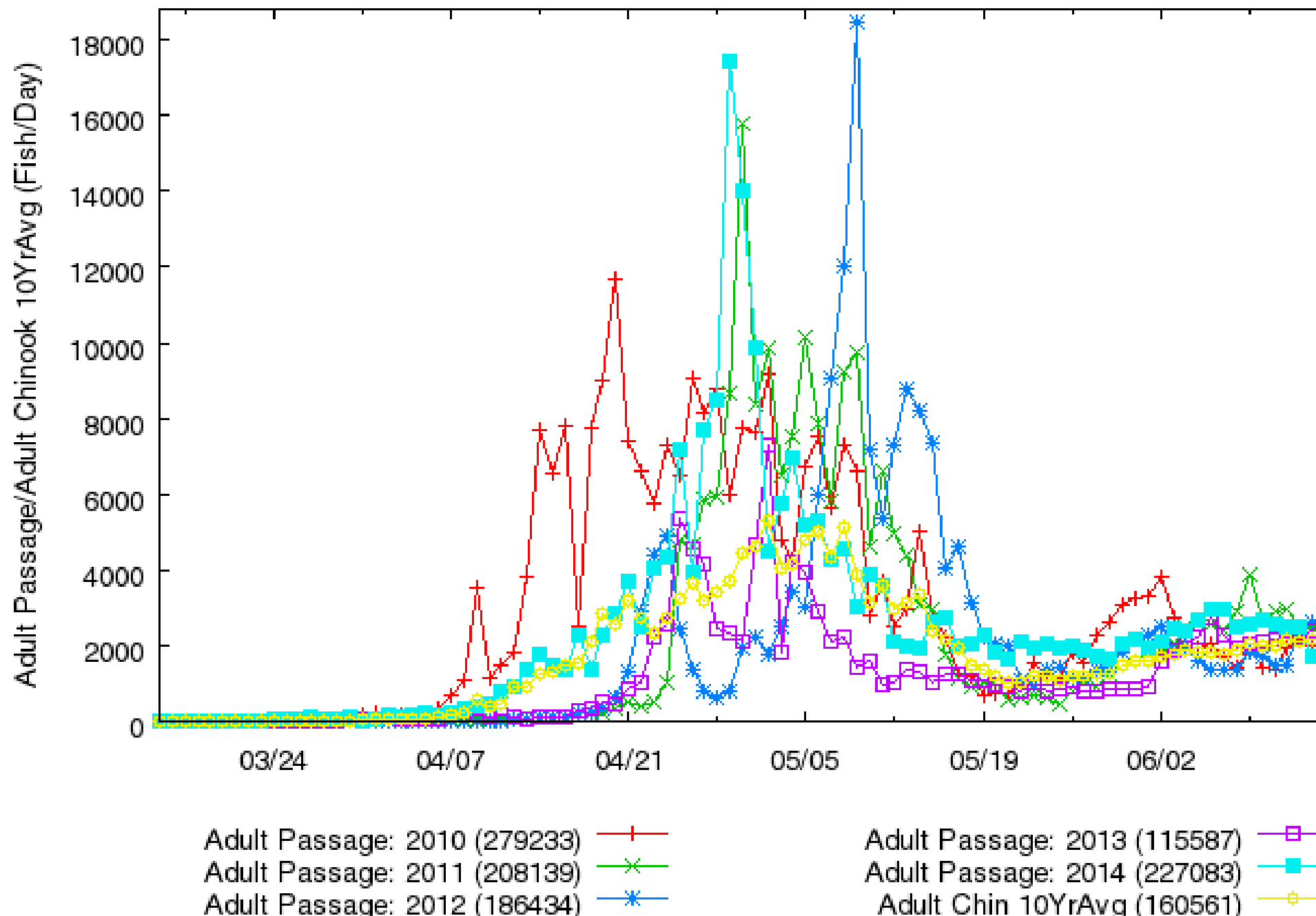
Bonneville Adult Chinook

Daily Count, (1938 – 2014, 76 years)

Bonneville Adult Chinook

Daily Count, (1938 – 2014, 76 years)
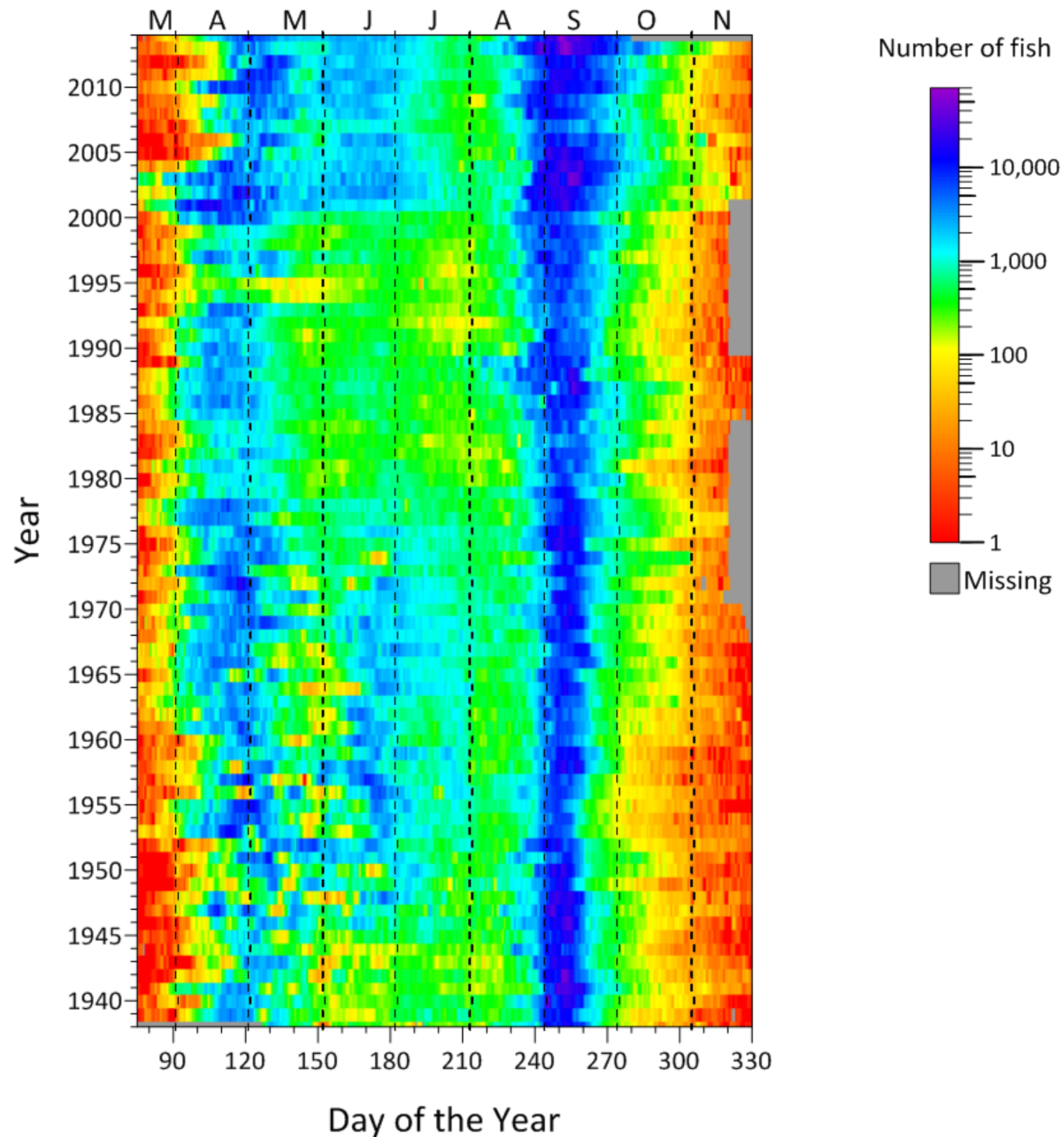
Yearly Maximum Daily Count
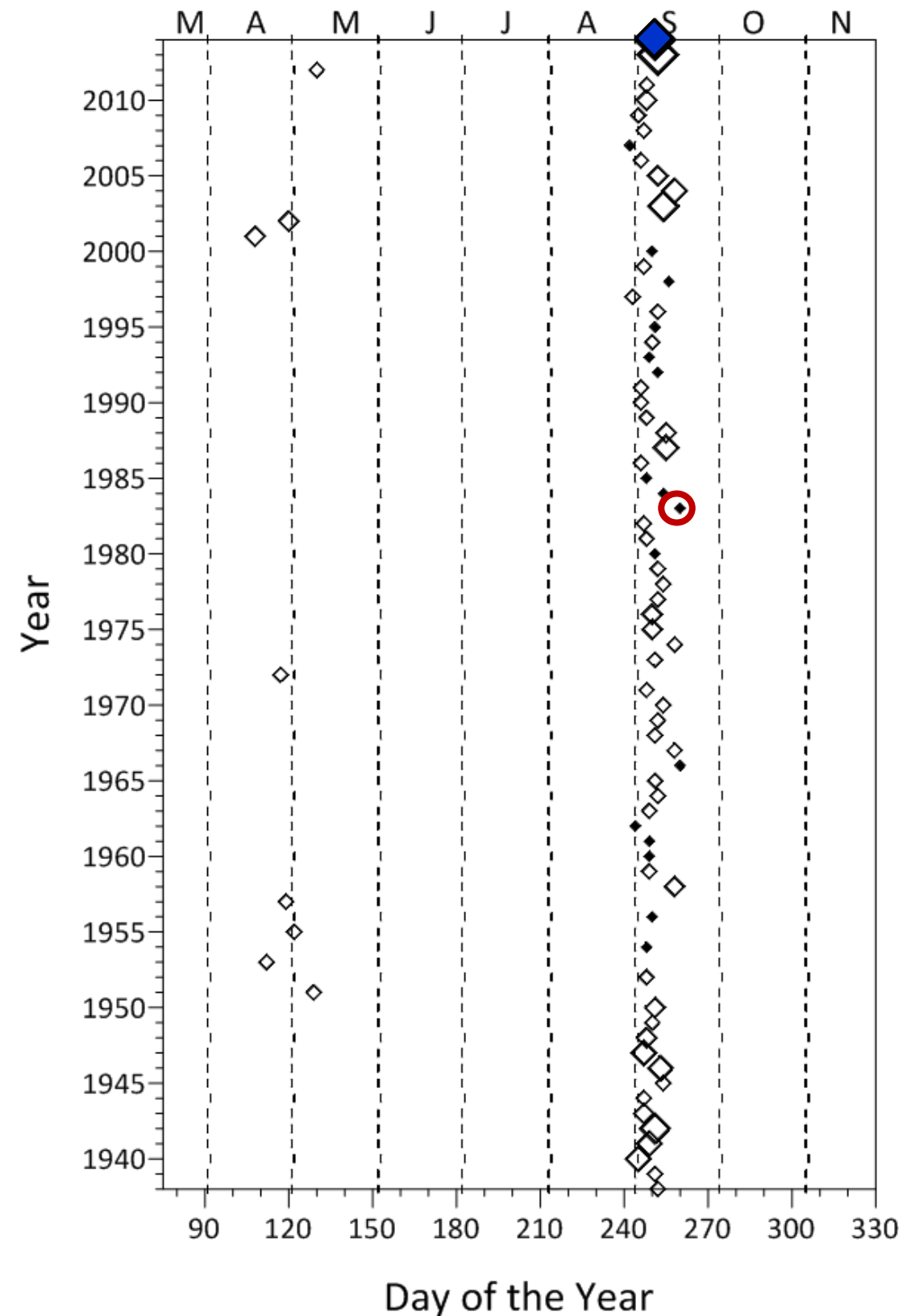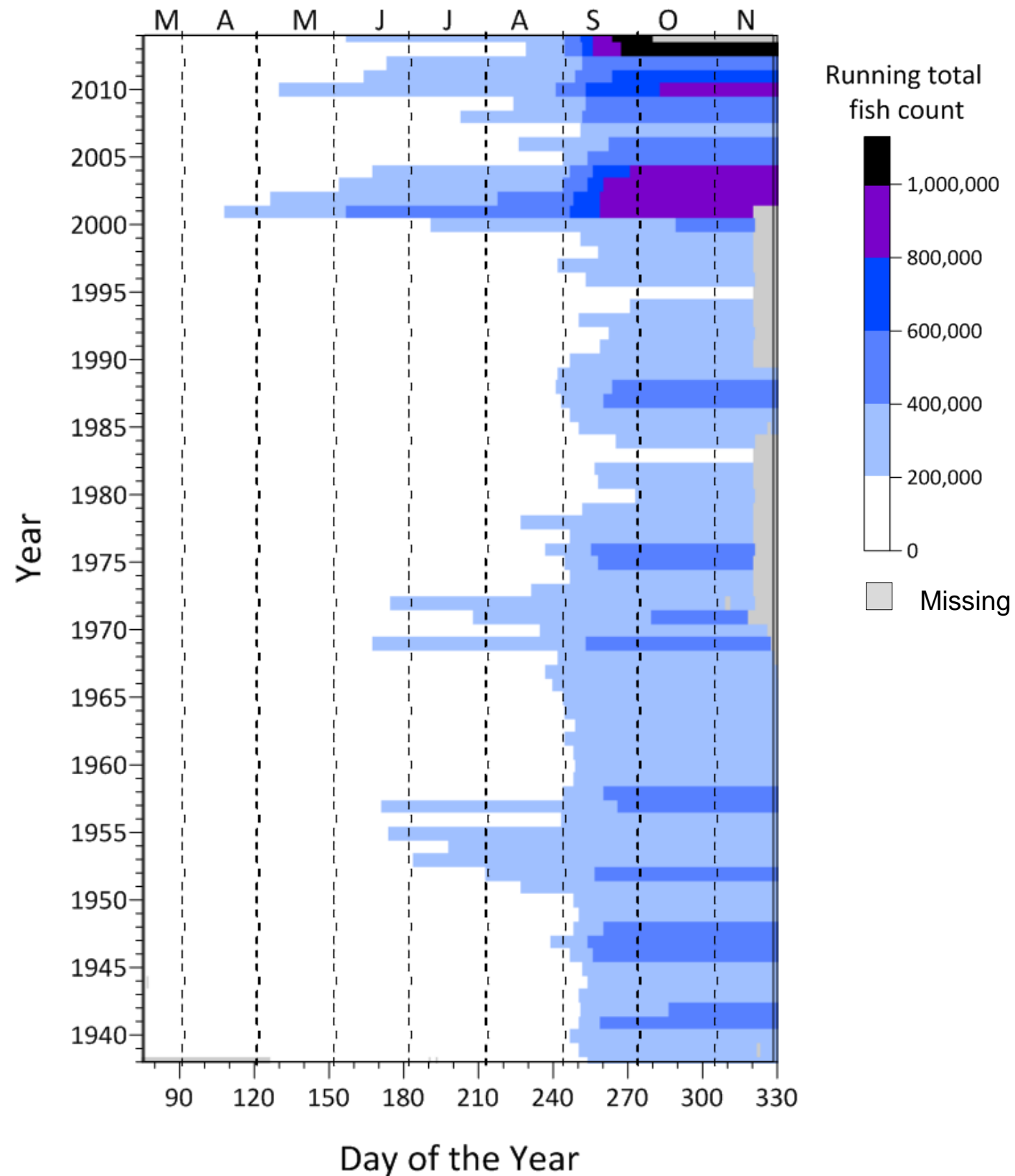
Max = 67,521 (2014)

Min = 5,308 (1983)

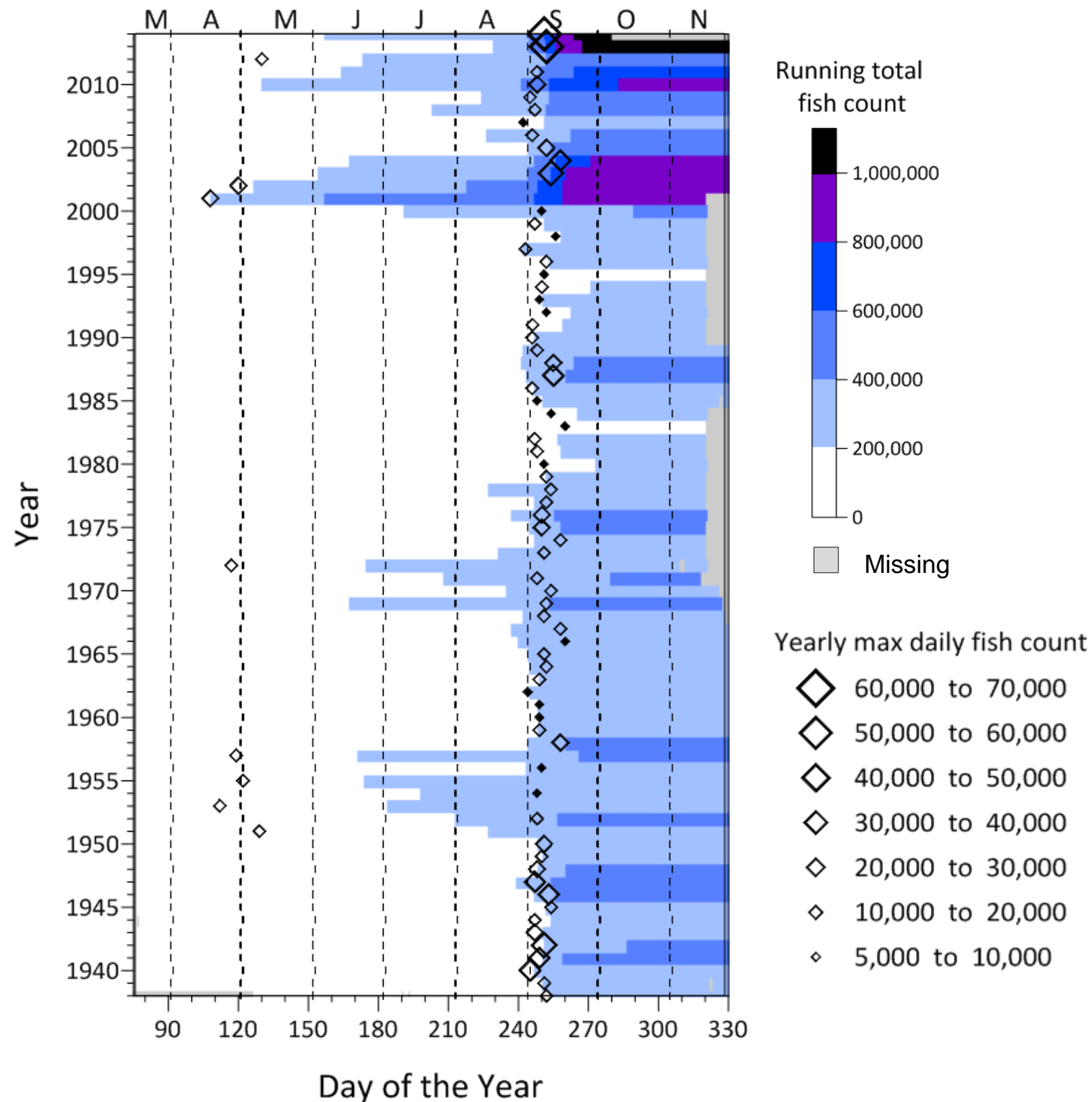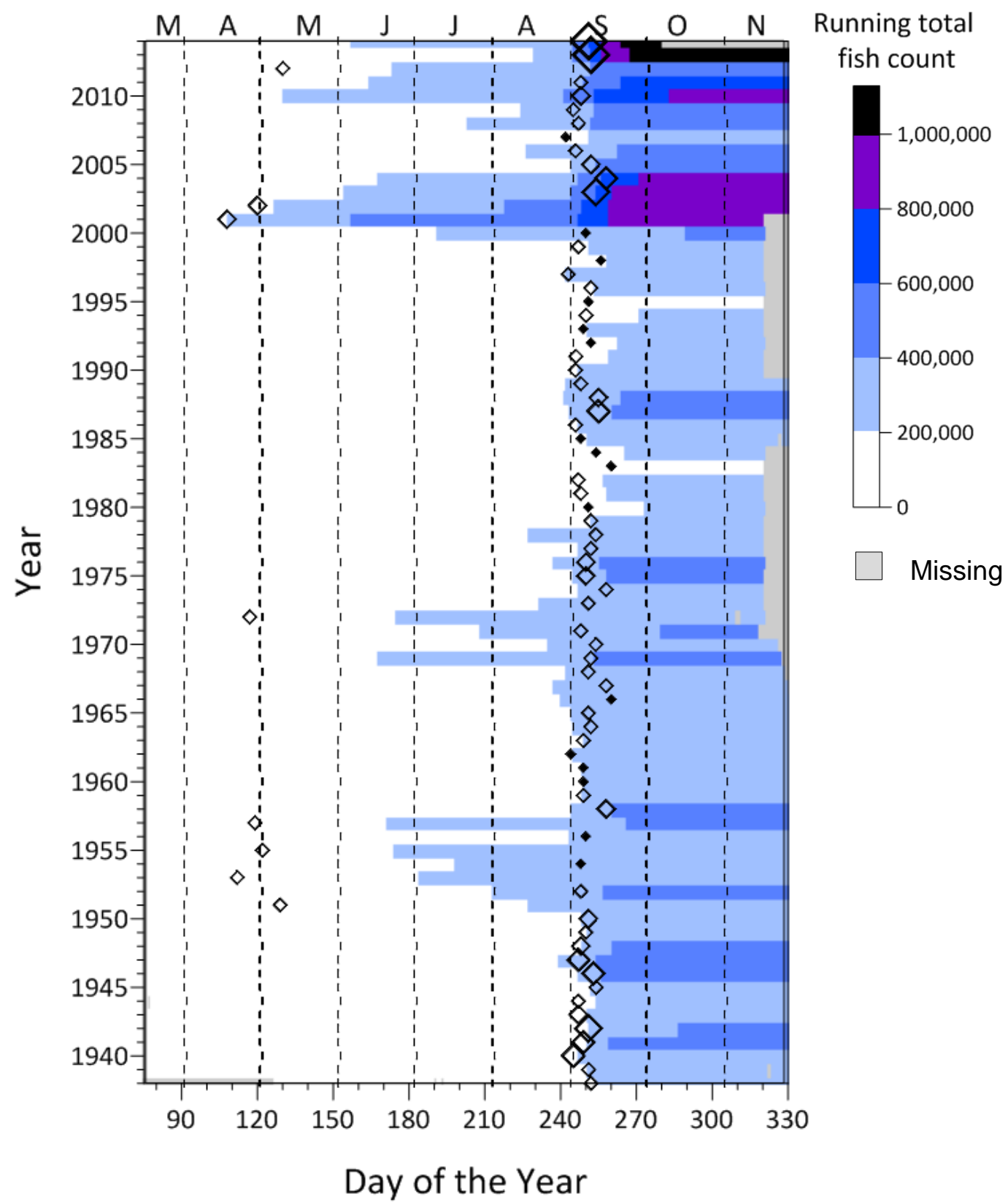Symbol size proportional to √count

Number of fish

Bonneville Adult Chinook

Running yearly total daily count

Bonneville Adult Chinook

Running yearly total daily count

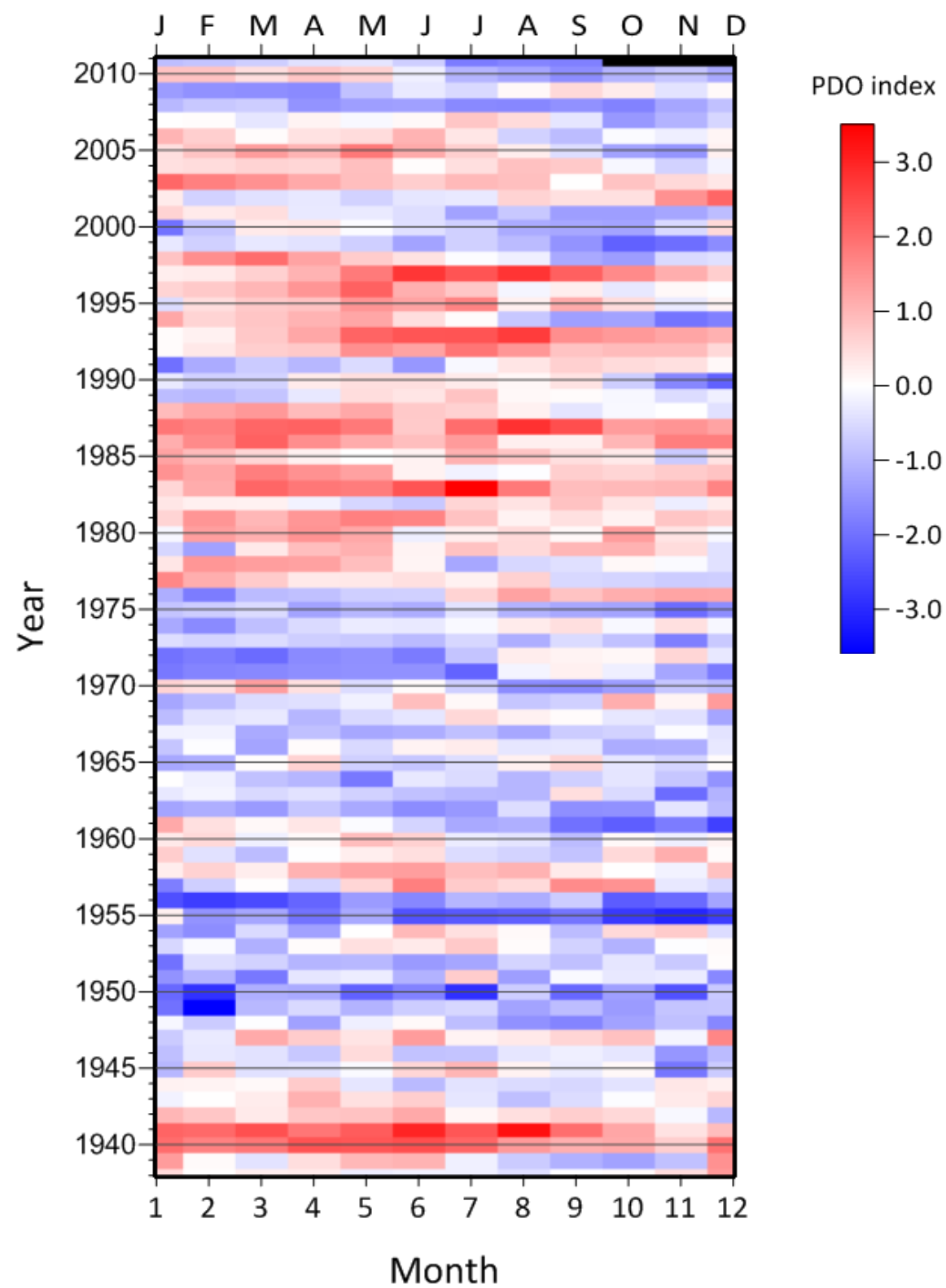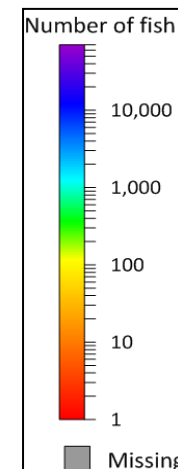# Bonneville Adult Chinook
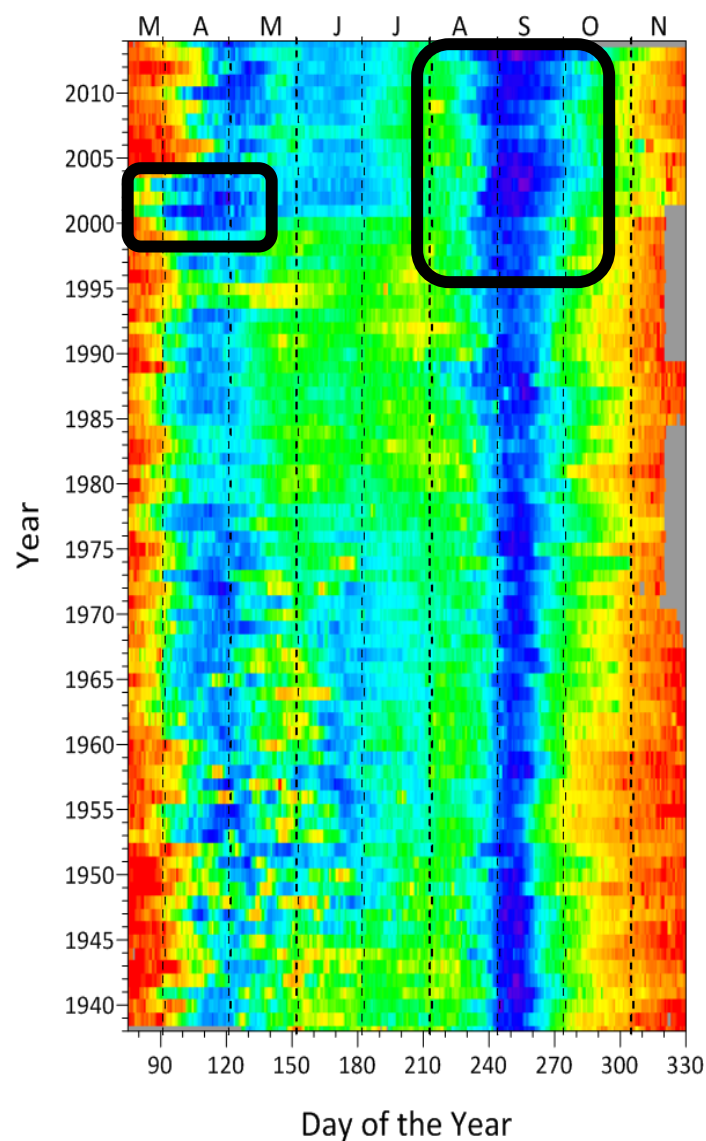
Running yearly total daily count

Monthly PDO index
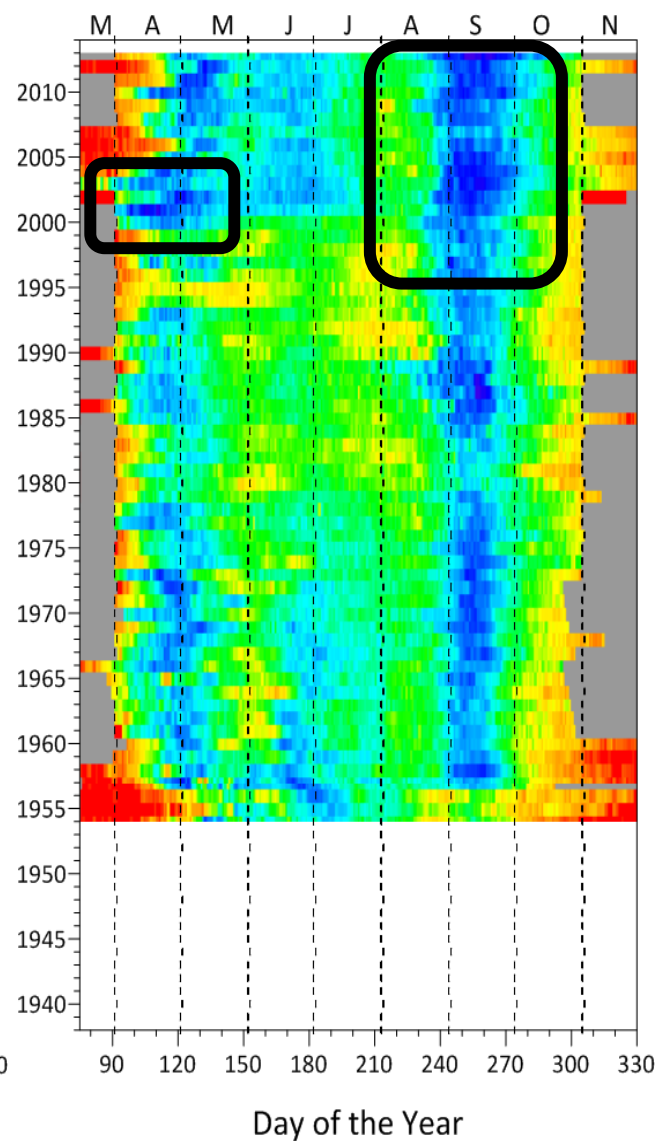
Lower Columbia River System
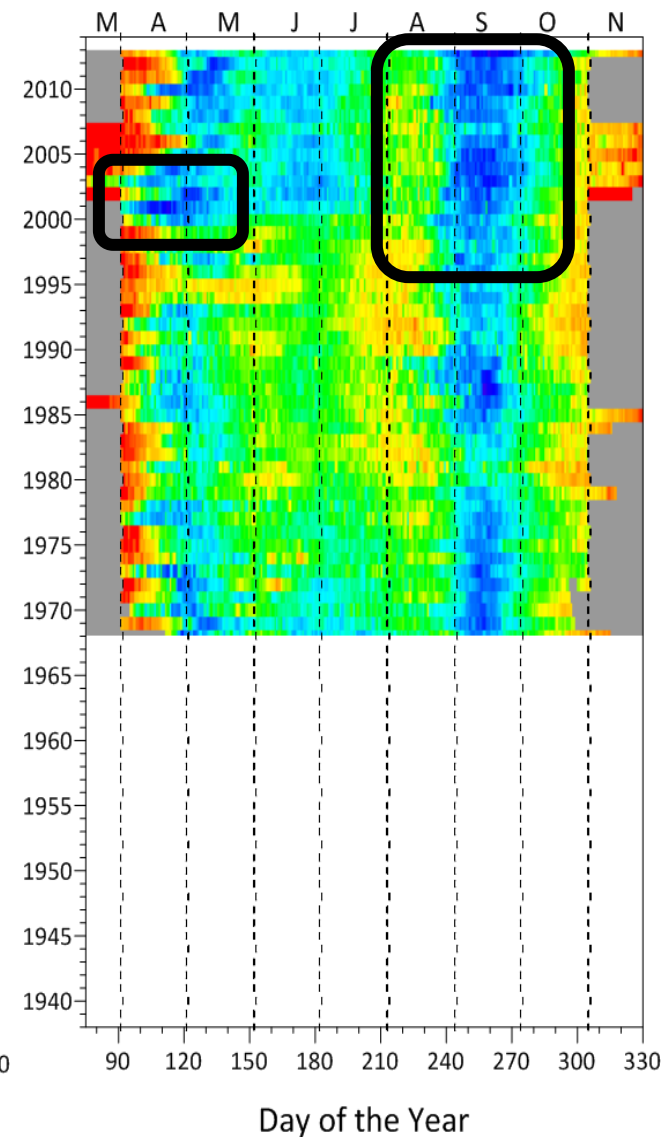## Daily count at four projects
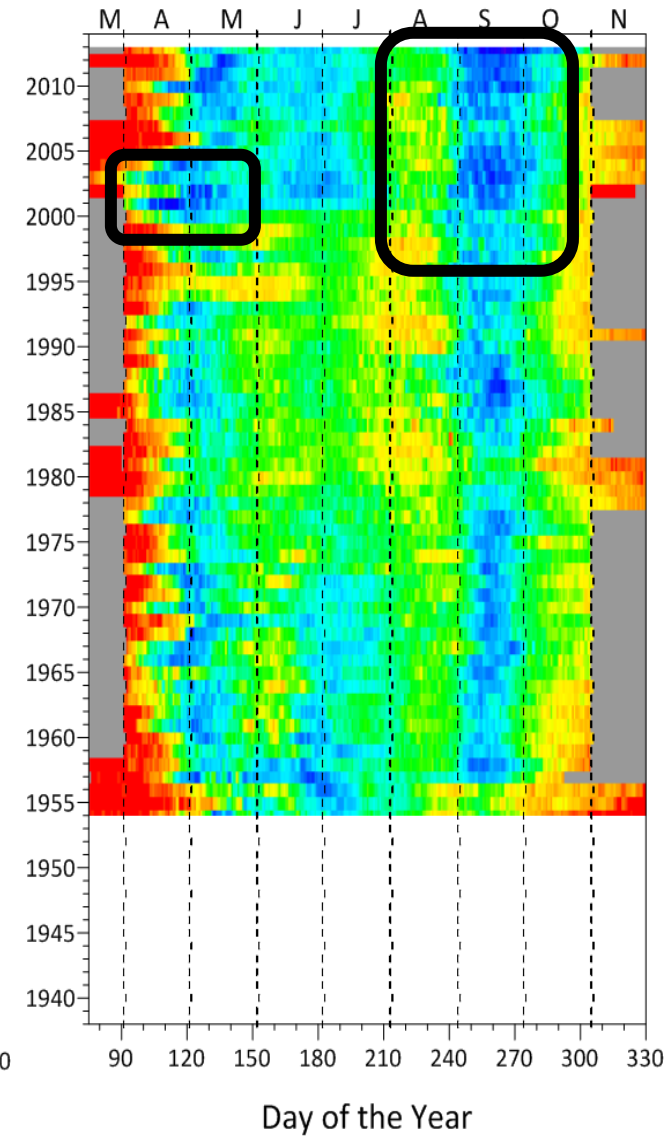
Summary

1. Quickly get the "Big Picture"

2. See all the data

3. Better understanding

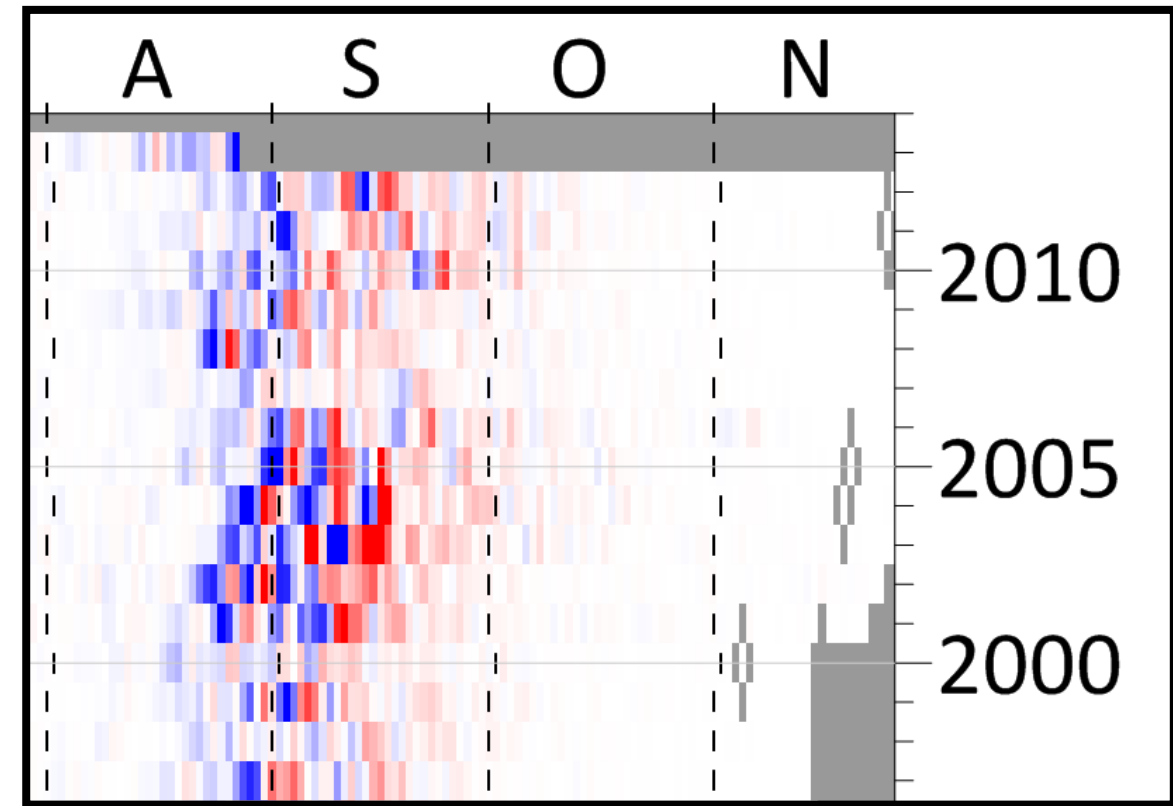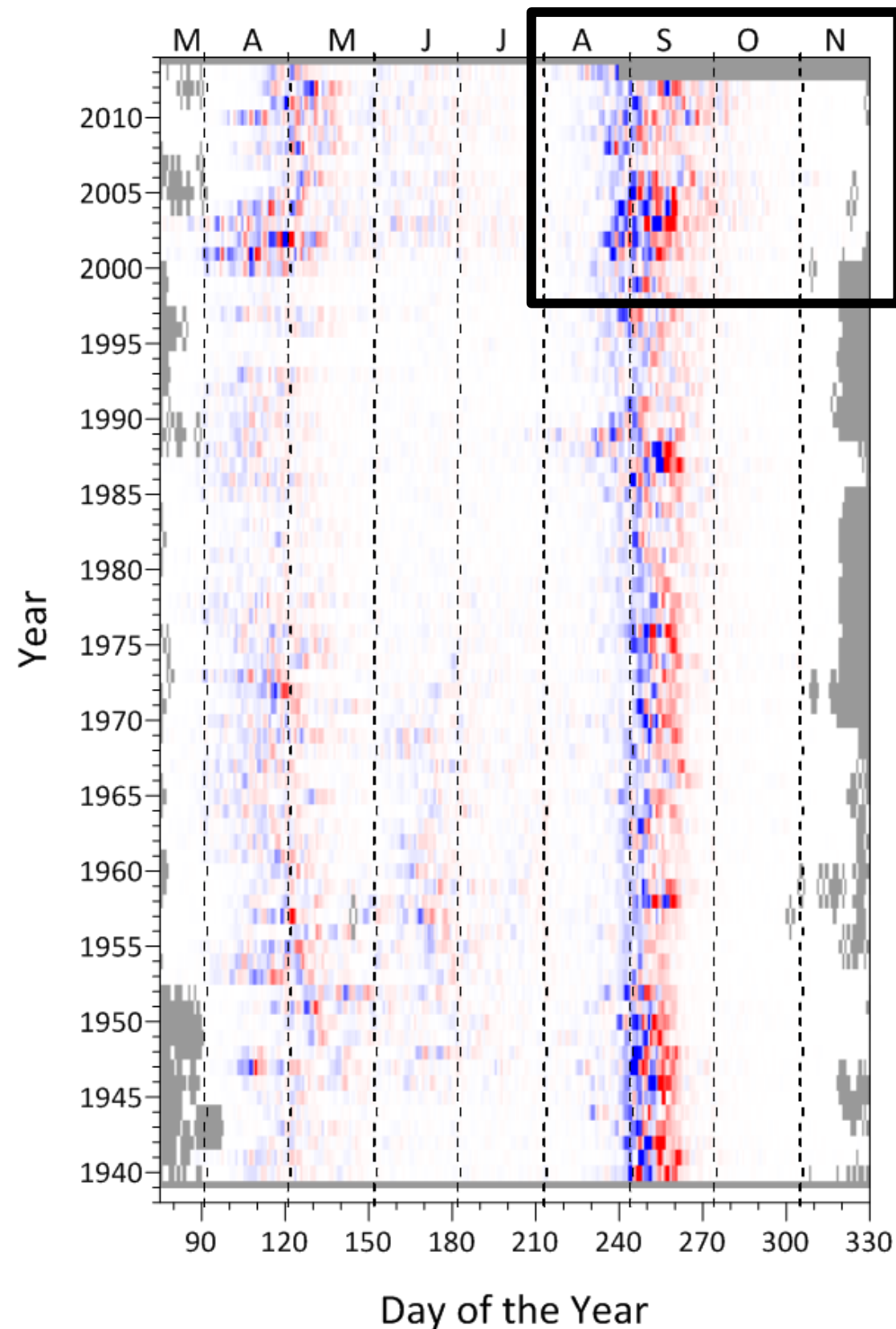4. New ways to examine your data

Works with any time-series:

Power production, water temperature, dissolved gases, snowpack, precipitation, water diversions, tons of cargo shipped, …
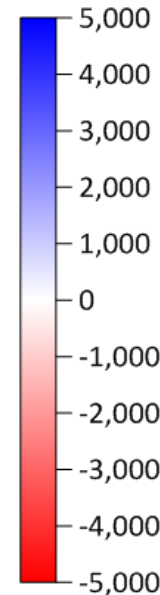
Questions?

Additional slides

Bonneville Adult Chinook

Daily count change

"Pulses" of fish pass through Bonneville.

Only a few large pulses per season.

GIS-like analysis

Puget Sound paralytic shellfish toxins[*]
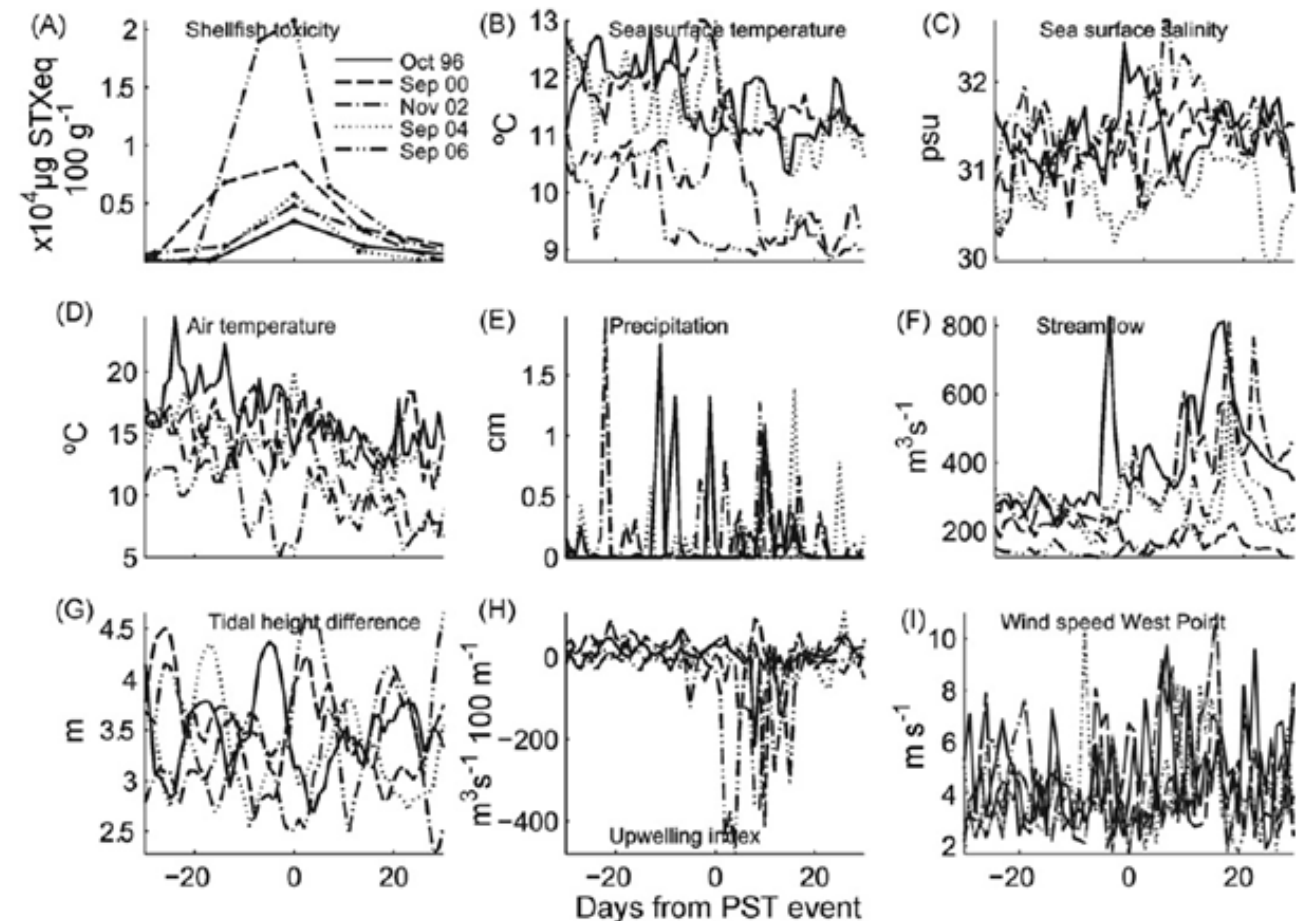
Time-series datasets:

Traditional plots:

Environmental factors

1. Sea surface temp (°C)
2. Sea surface salinity (psu)
3. Air temp (°C)
4. Precipitation (cm)
5. Streamflow (m^3s^{-1})
6. Tidal height difference (m)
7. Upwelling ($m^3s^{-1}100\ m^{-1}$)
8. Wind speed (ms^{-1})

[*] Moore, S.K., et al., 2009. Recent trends in paralytic shellfish toxins in Puget Sound, relationships to climate, and capacity for prediction of toxic events. Harmful Algae 8, 463–477 doi:410.1016/ j.hal.2008.1010.1003.
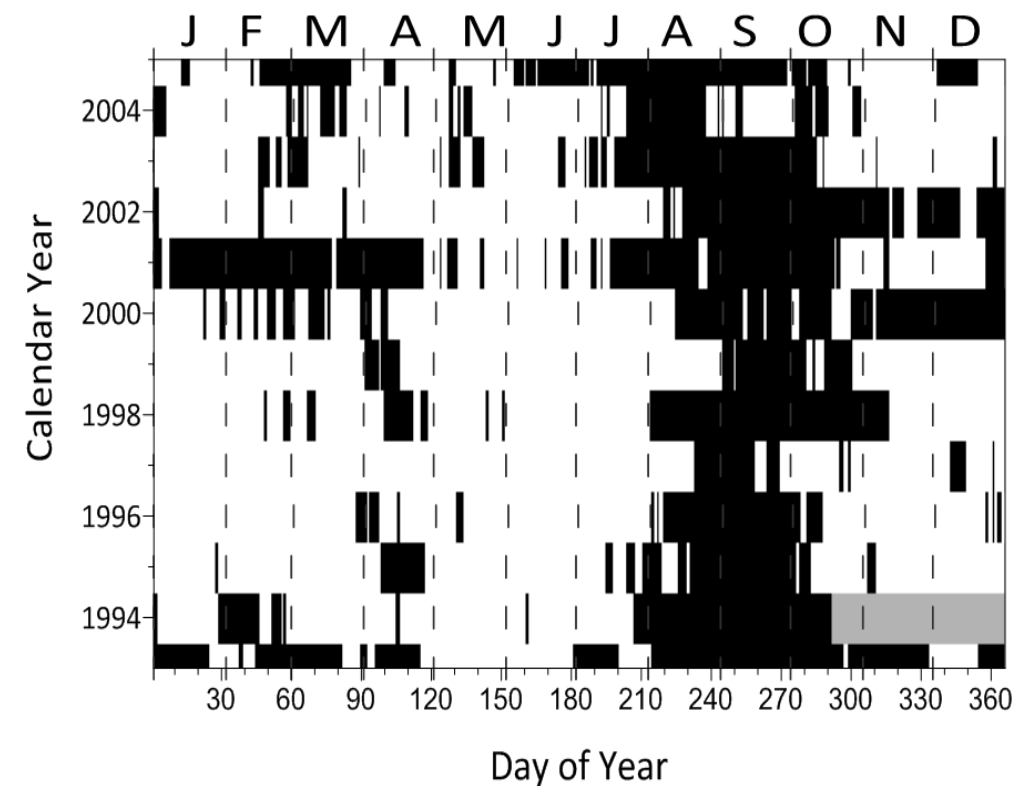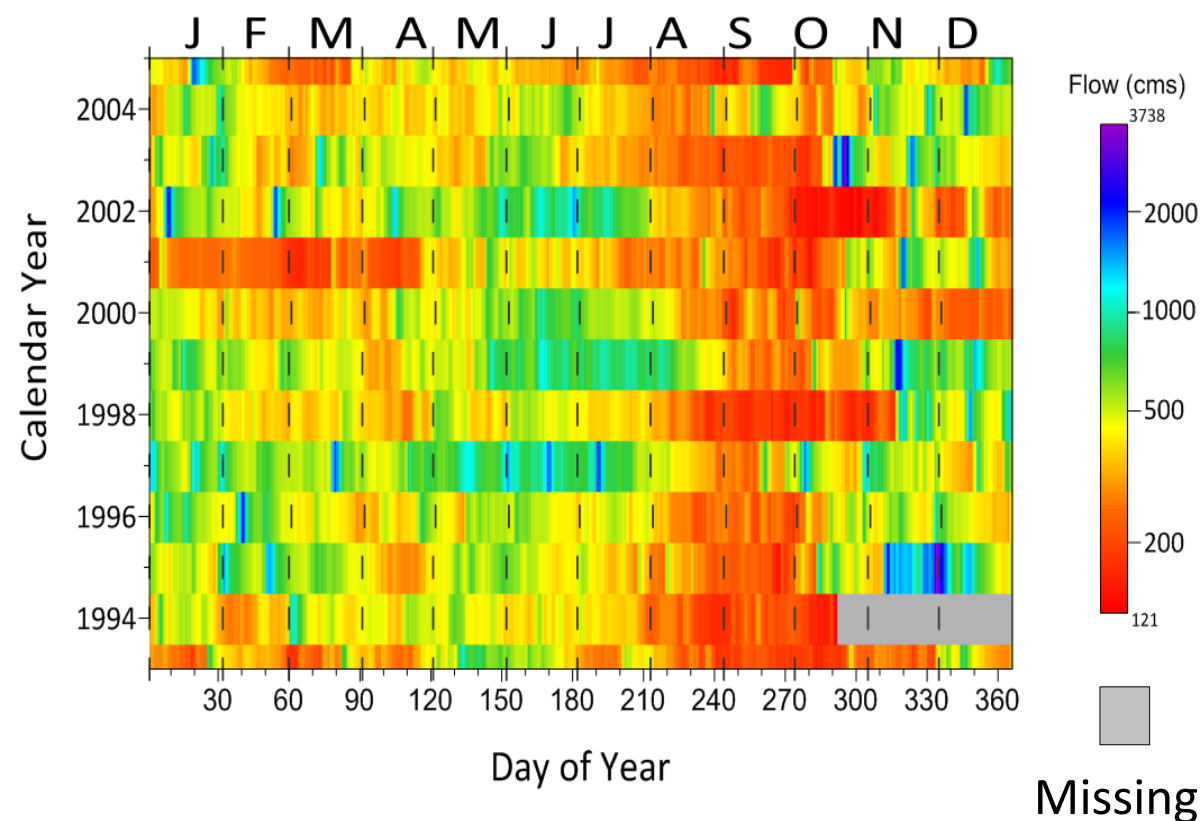
Binary filter

Find days with favorable conditions
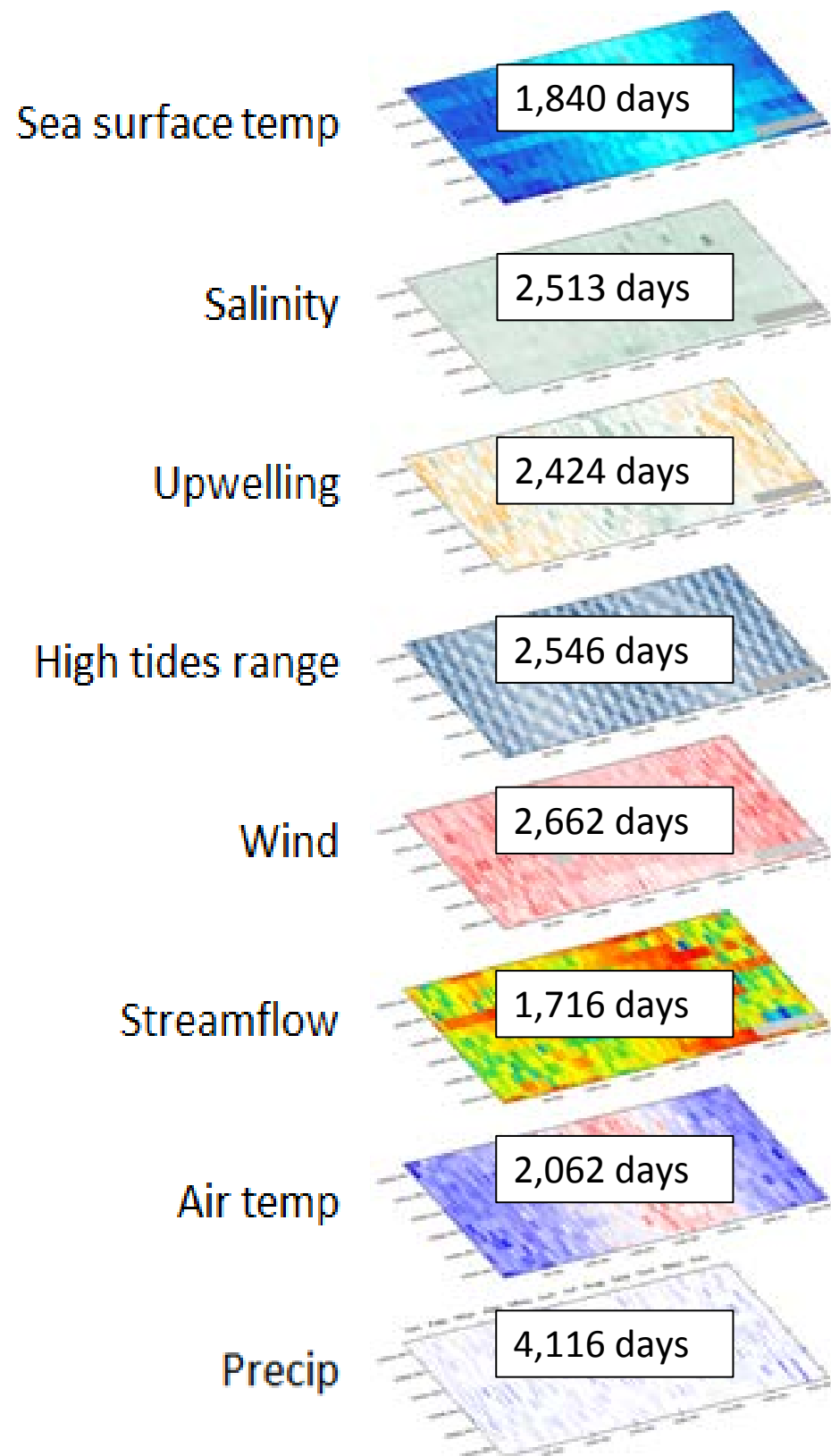
Criterion: Flow ≤ 350 m³s⁻¹

■ *Met = 1*   □ *Not met = 0*

Observed streamflow

1,716 days or "event windows"

36%

Habitat analysis results

Apply specific criterion to specific layer

If Σ layers = 8 for specific day;
Then conditions favorable for an event

Potential Event Windows

127 days
(~3%)