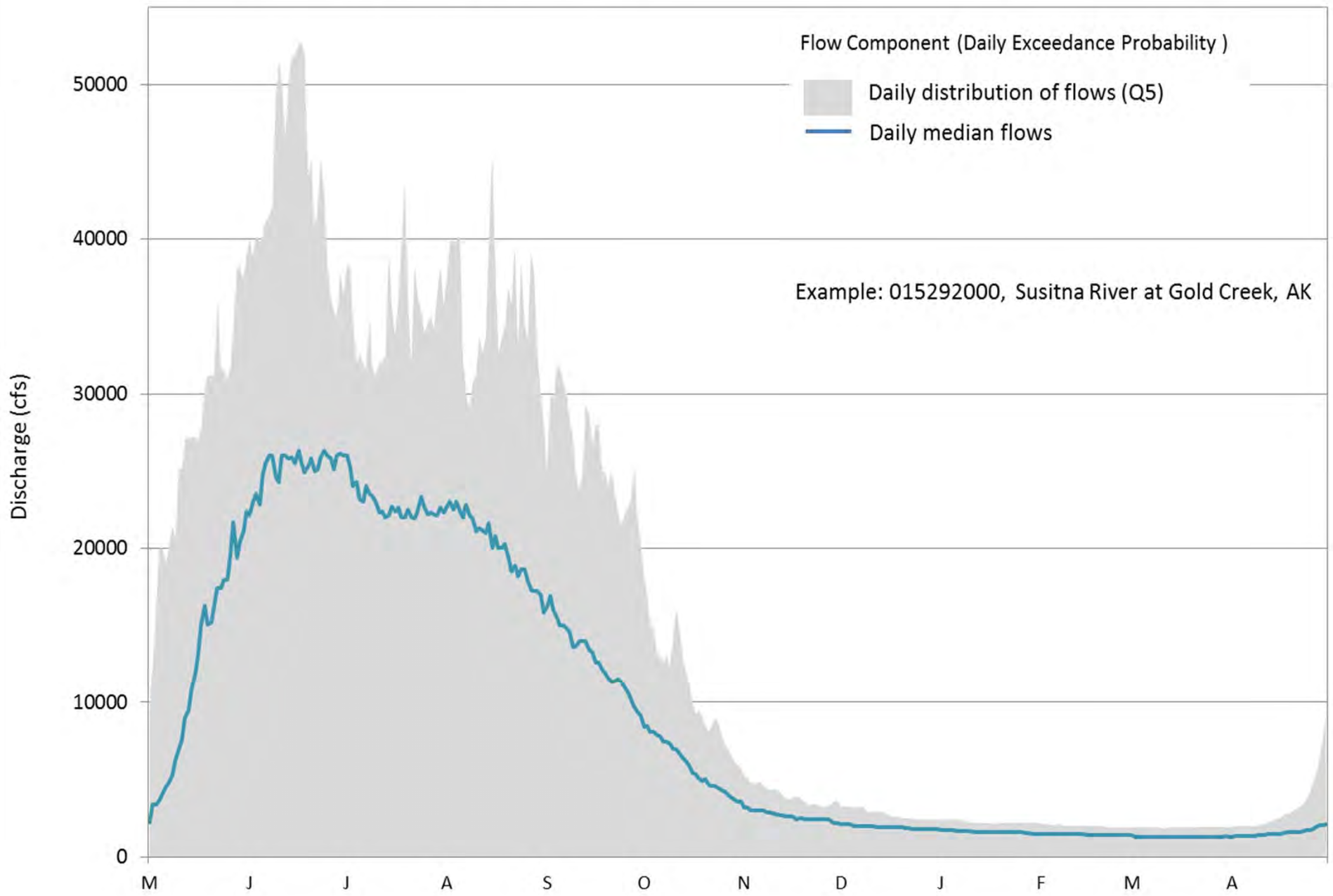
Flow-ecology relationships

Susitna case study

Flow regime

Annual and Interannual Variability



Ecologically-Relevant Flow Regime Characteristics

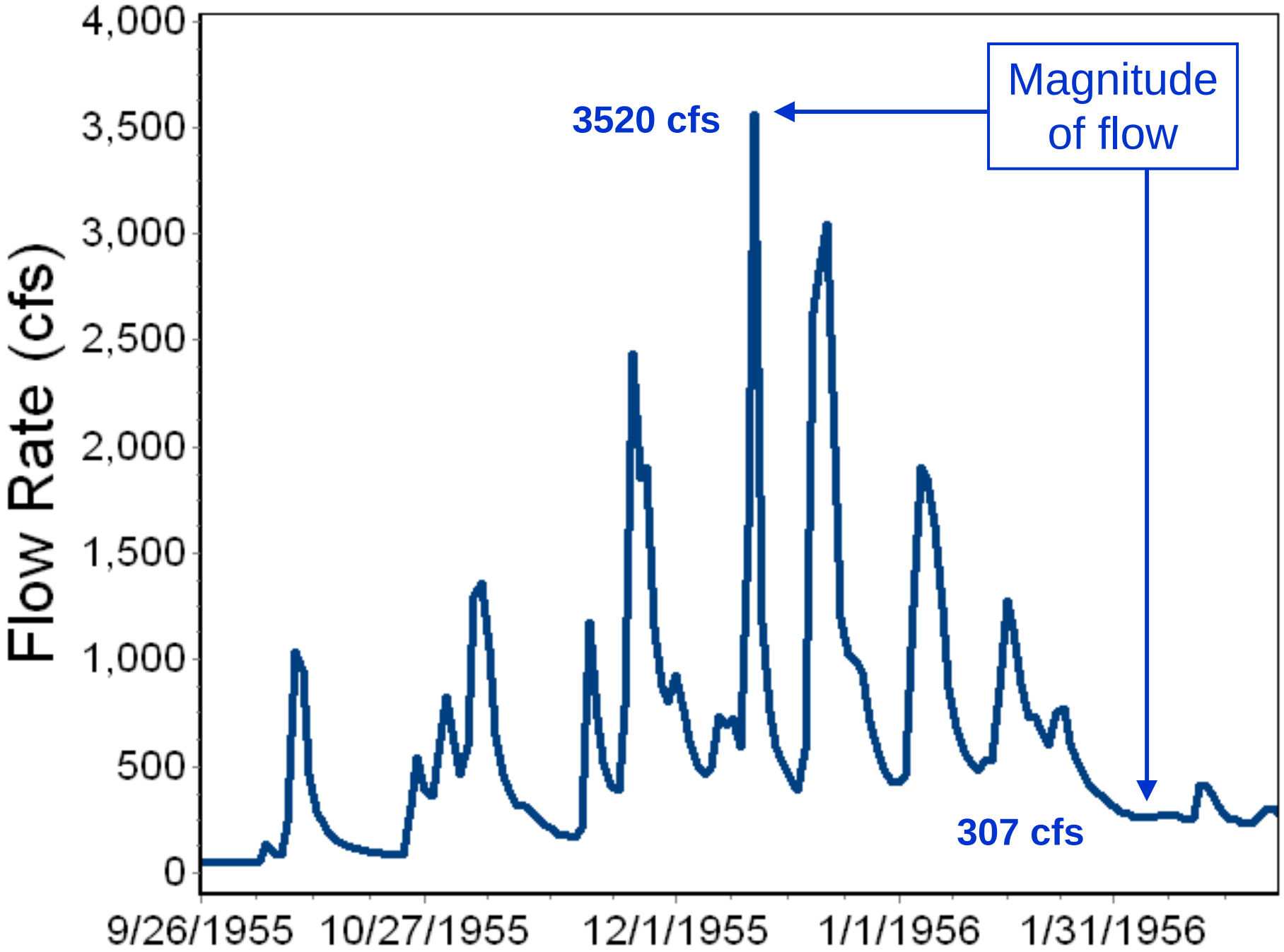
- Seasonal or ‘typical conditions
- Annual extreme conditions
- High and low flow pulses
- Small and large floods
- Rate and frequency of change

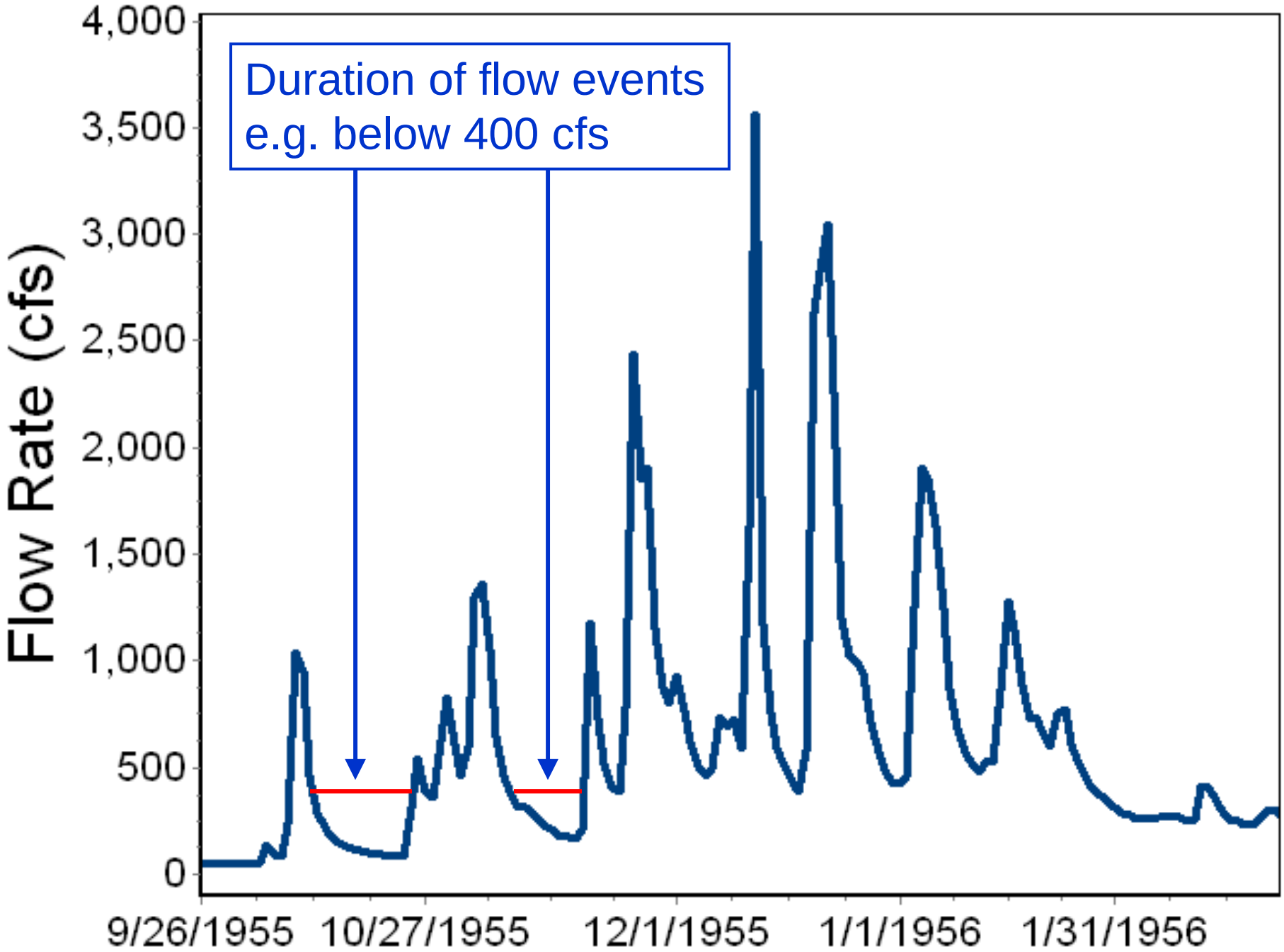
Richter et al. 1996, “A Method for Assessing Hydrologic Alteration Within Ecosystems.”(*Conservation Biology*)

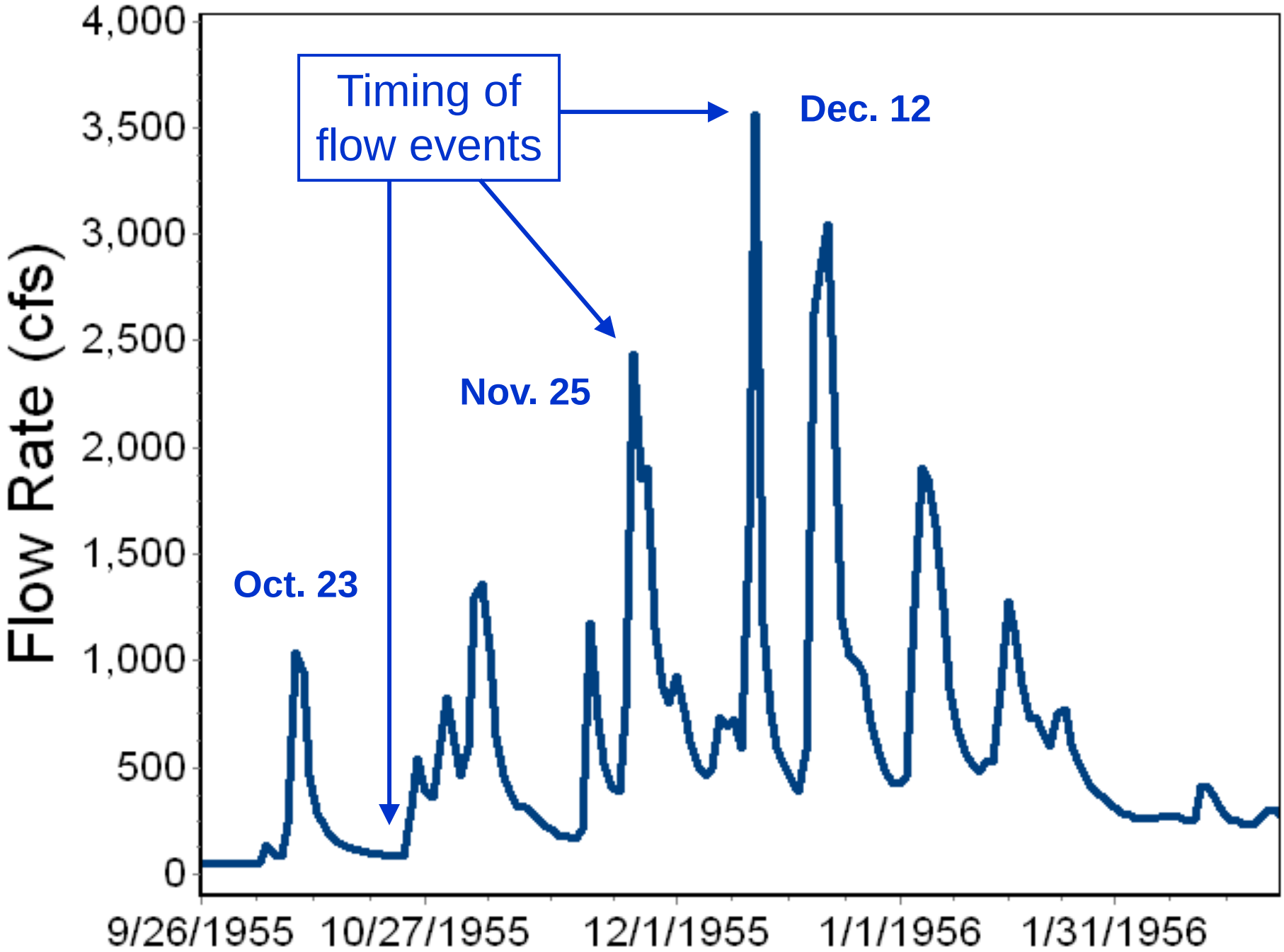
Ecologically-Relevant Flow Regime Characteristics

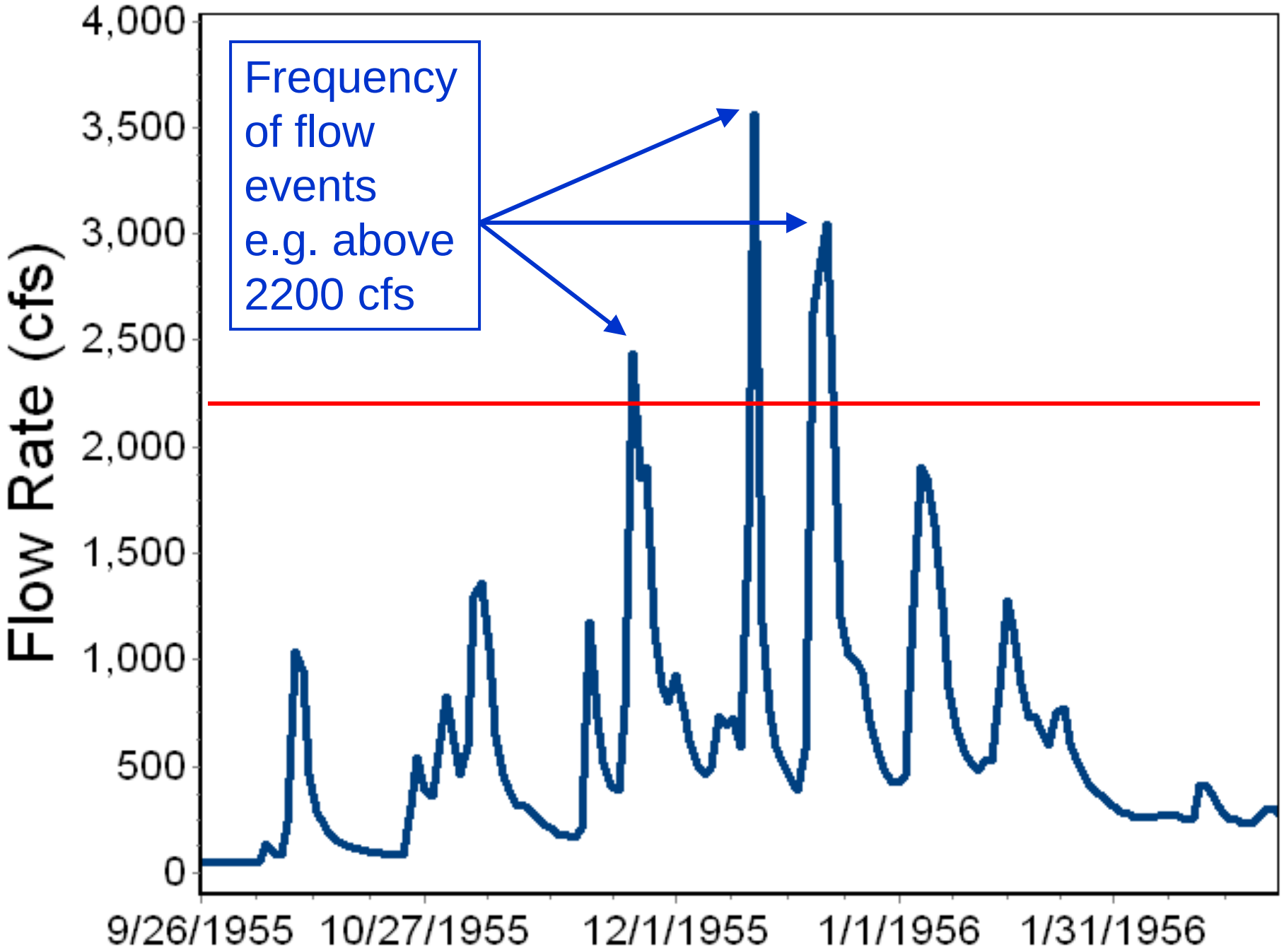
- Magnitude (how much flow or what level?)
- Duration (how long do certain flows or levels last?)
- Timing (when do certain flows or levels occur?)
- Frequency (how often do certain flows or levels occur?)
- Rate of change (how fast do flows or levels change from one condition to another?)

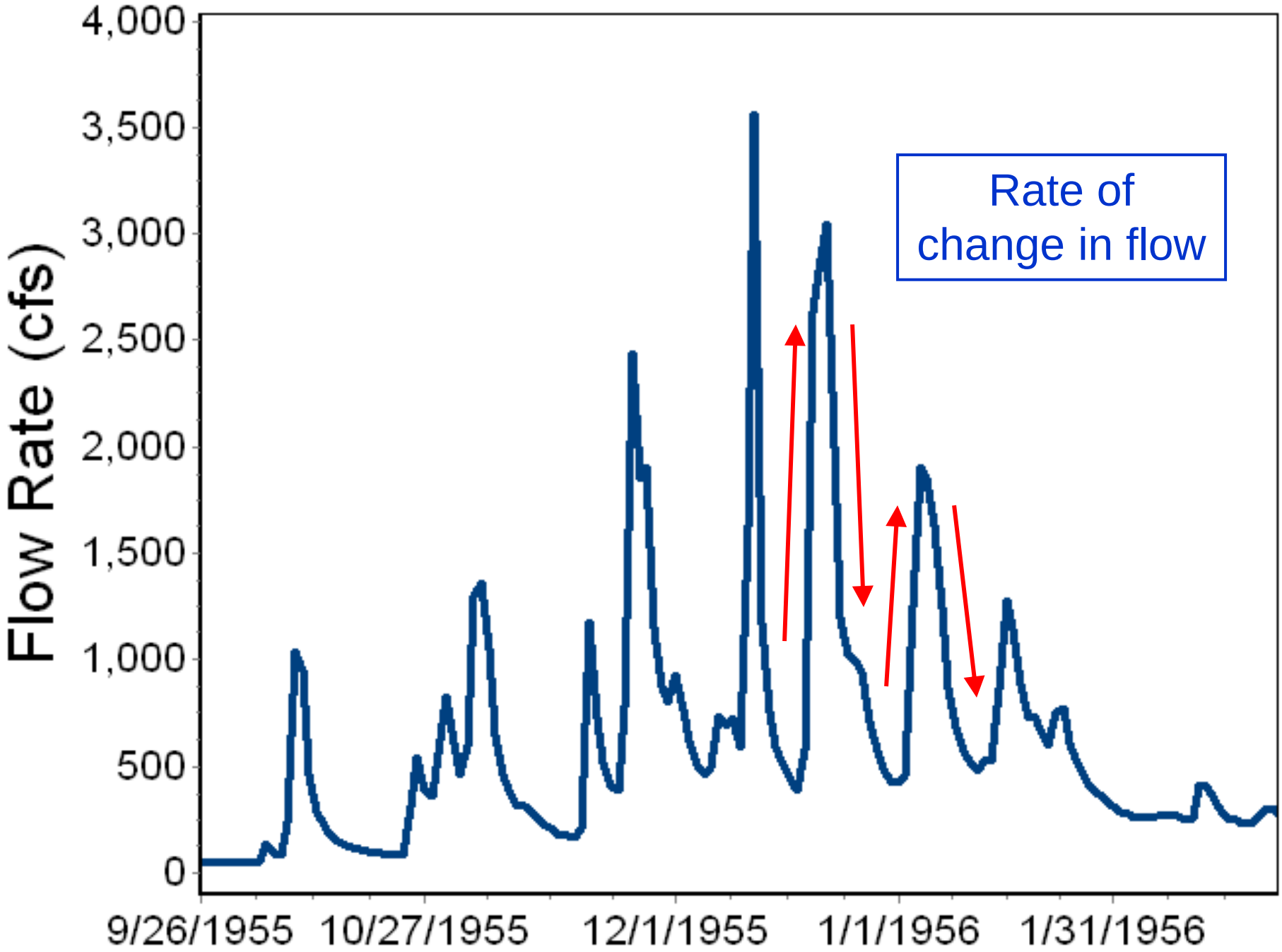
Richter et al. 1996, "A Method for Assessing Hydrologic Alteration Within Ecosystems."(*Conservation Biology*)


Flow Rate (cfs)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
9/26/1955
10/27/1955
12/1/1955
1/1/1956
1/31/1956
3520 cfs
Magnitude of flow
307 cfs


Duration of flow events
e.g. below 400 cfs
Flow Rate (cfs)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
9/26/1955
10/27/1955
12/1/1955
1/1/1956
1/31/1956


Timing of flow events
Dec. 12
Nov. 25
Oct. 23
Flow Rate (cfs)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
9/26/1955
10/27/1955
12/1/1955
1/1/1956
1/31/1956


Frequency of flow events e.g. above 2200 cfs
Flow Rate (cfs)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
9/26/1955
10/27/1955
12/1/1955
1/1/1956
1/31/1956


Flow Rate (cfs)
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
9/26/1955
10/27/1955
12/1/1955
1/1/1956
1/31/1956
Rate of change in flow

flow-ecology

Key terms

Flow Needs – relationships defined from literature and expert input that document which flow components should be considered to *support a specific ecosystem function*

Flow Hypotheses – relationships derived from data, literature and expert input about the expected *influence of change* to a flow component

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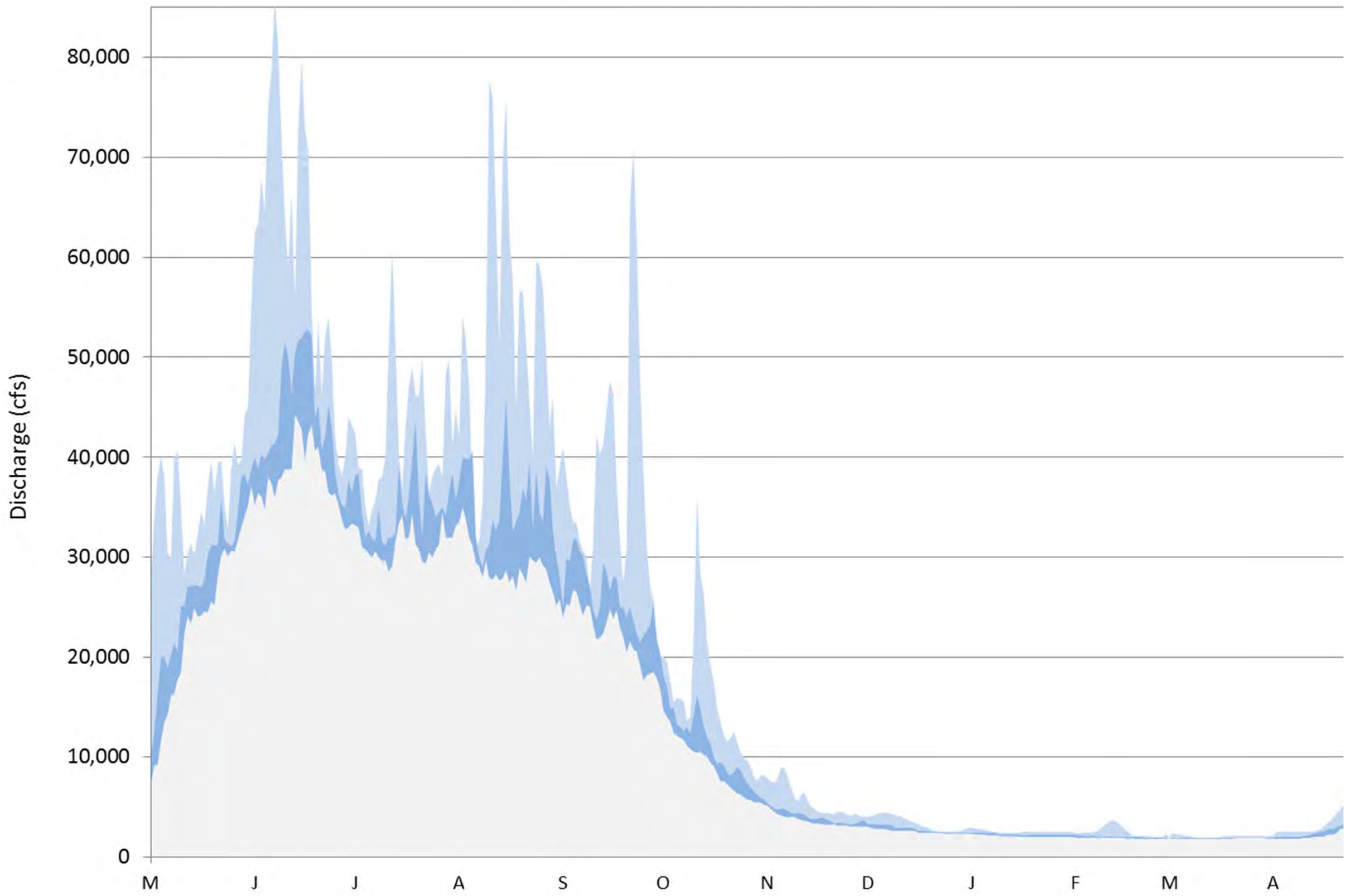
High Flow Components Example: 015292000, Susitna River at Gold Creek, AK



High Flow Components Example: 015292000, Susitna River at Gold Creek, AK

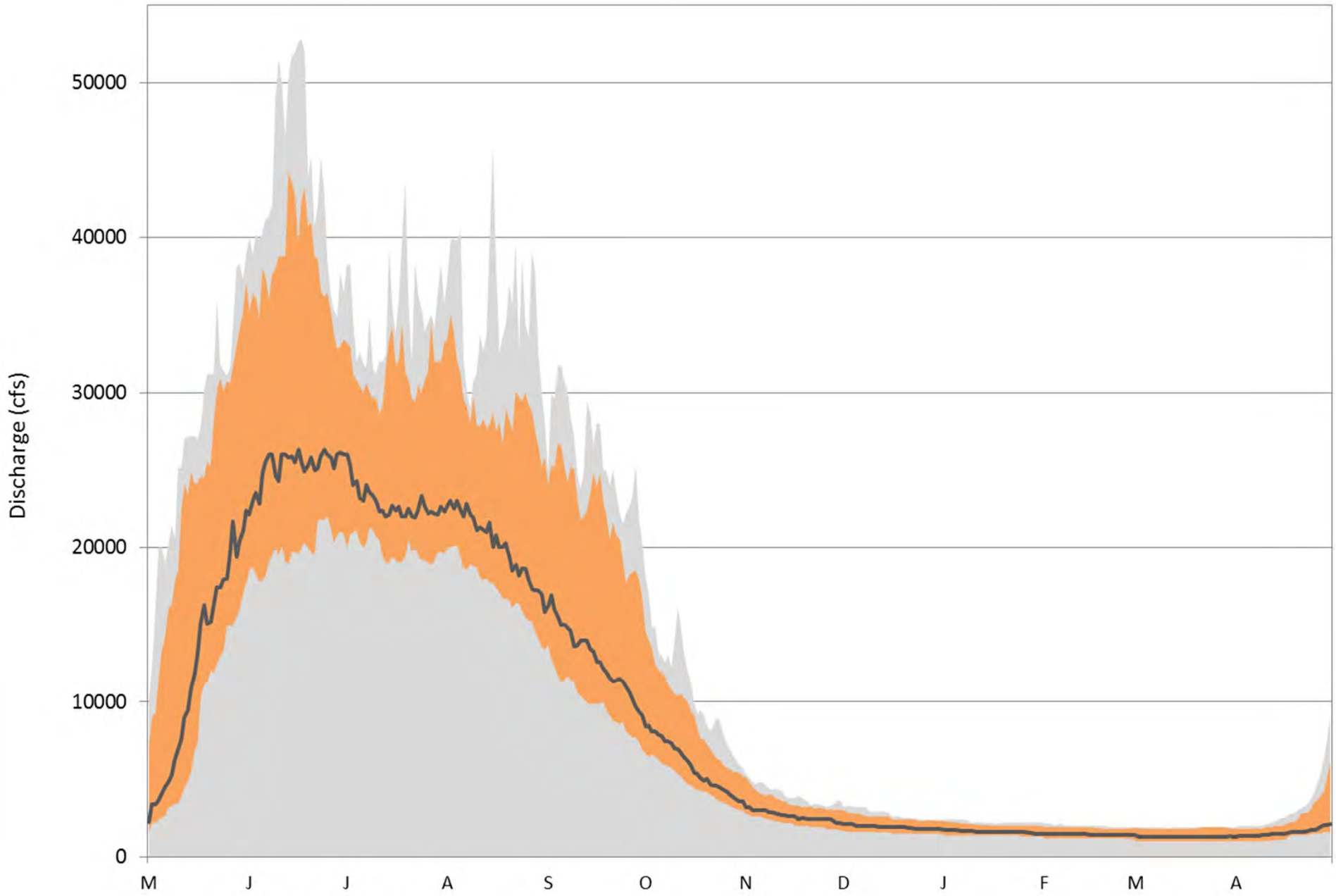
- **Maintain island formation, channel morphology and sediment distribution**
- **Transport LWD and CPOM**
- **Inundate floodplain habitats and recharge groundwater**
- **Scour (ice break up and flood) margins to support successional floodplain vegetation and sediment redistribution**

High Flow Components Example: 015292000, Susitna River at Gold Creek, AK

- **Stable overwinter habitats for juvenile and adult fish**
- **Maintain ice cover and thermal buffer**
- **Support winter spawning fish**

Seasonal Flow Components

Example: 015292000, Susitna River at Gold Creek, AK



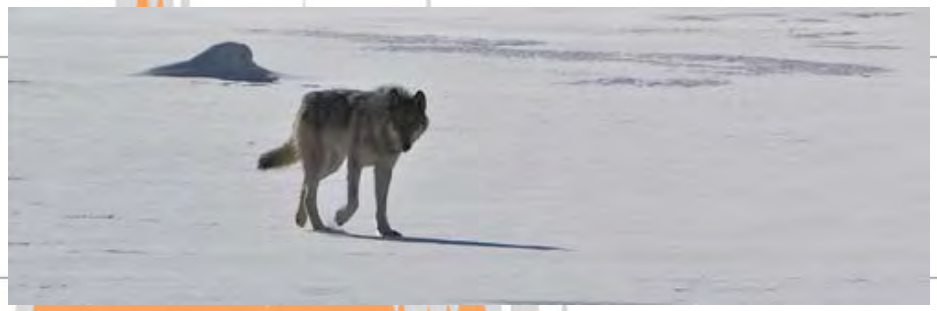
Seasonal Flow Components

Example: 015292000, Susitna River at Gold Creek, AK

- **Cue upstream migration and maintain access to spawning habitats**
- **Support fish egg, larval and juvenile development**
- **Direct juvenile salmonid emigration**
- **Process and transport organic matter**
- **Provide abundant and distributed food sources for birds and mammals**

Seasonal Flow Components

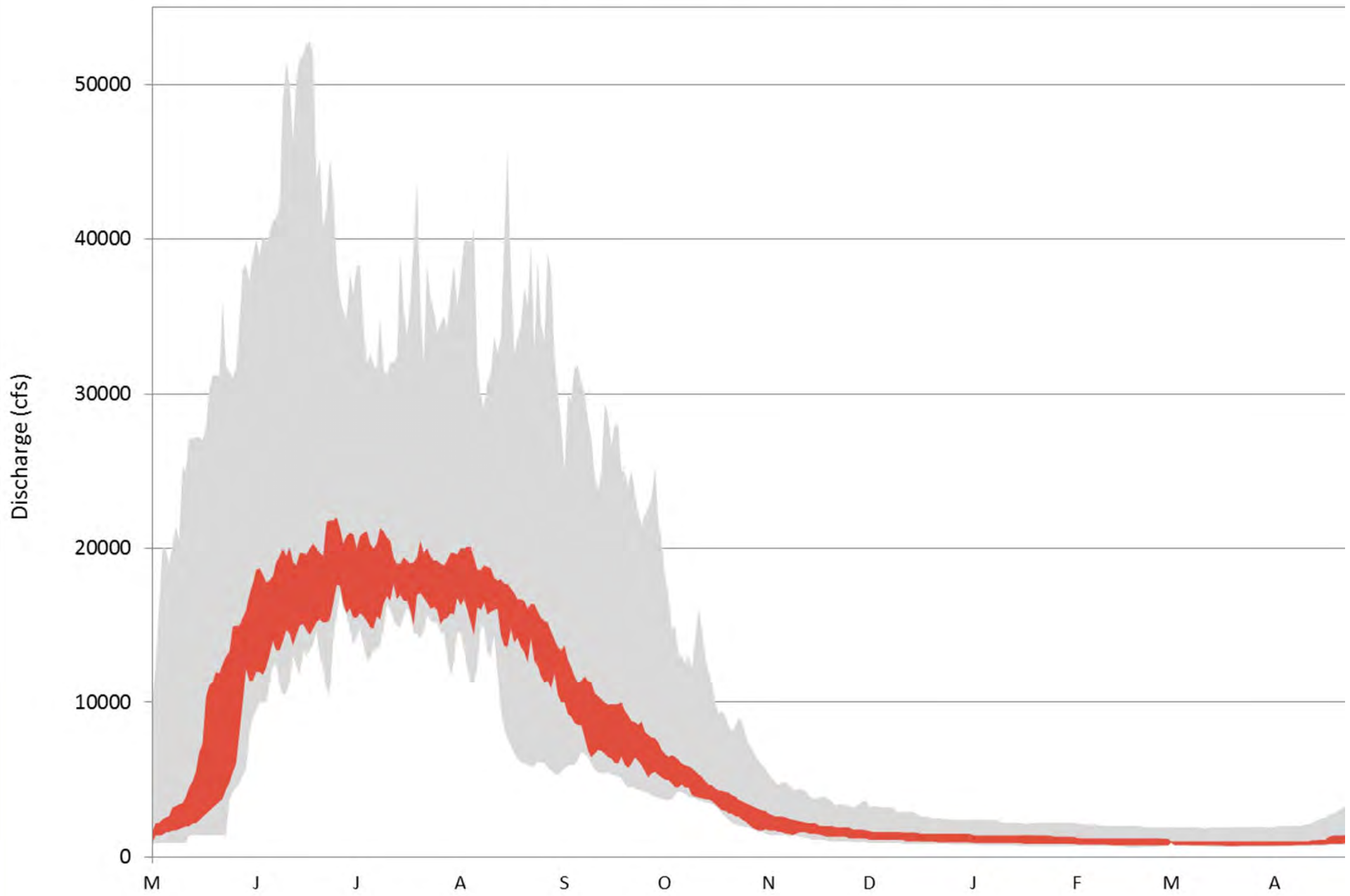
Example: 015292000, Susitna River at Gold Creek, AK



- **Maintain stable incubation and rearing habitats**
- **Stable ice cover provides transport and migration corridors for mammals**

Low Flow Component

Example: 015292000, Susitna River at Gold Creek, AK



Low Flow Component

Example: 015292000, Susitna River at Gold Creek, AK

- **Provides competitive access to spawning and rearing habitats**
- **Sustains thermal regimes and downstream salinity gradients**
- **Concentrates prey and favors predators**
- **Transports and keeps glacial fines in suspension**

Key terms

Flow Needs – relationships defined from literature and expert input that document which flow components should be considered to *support a specific ecosystem function*

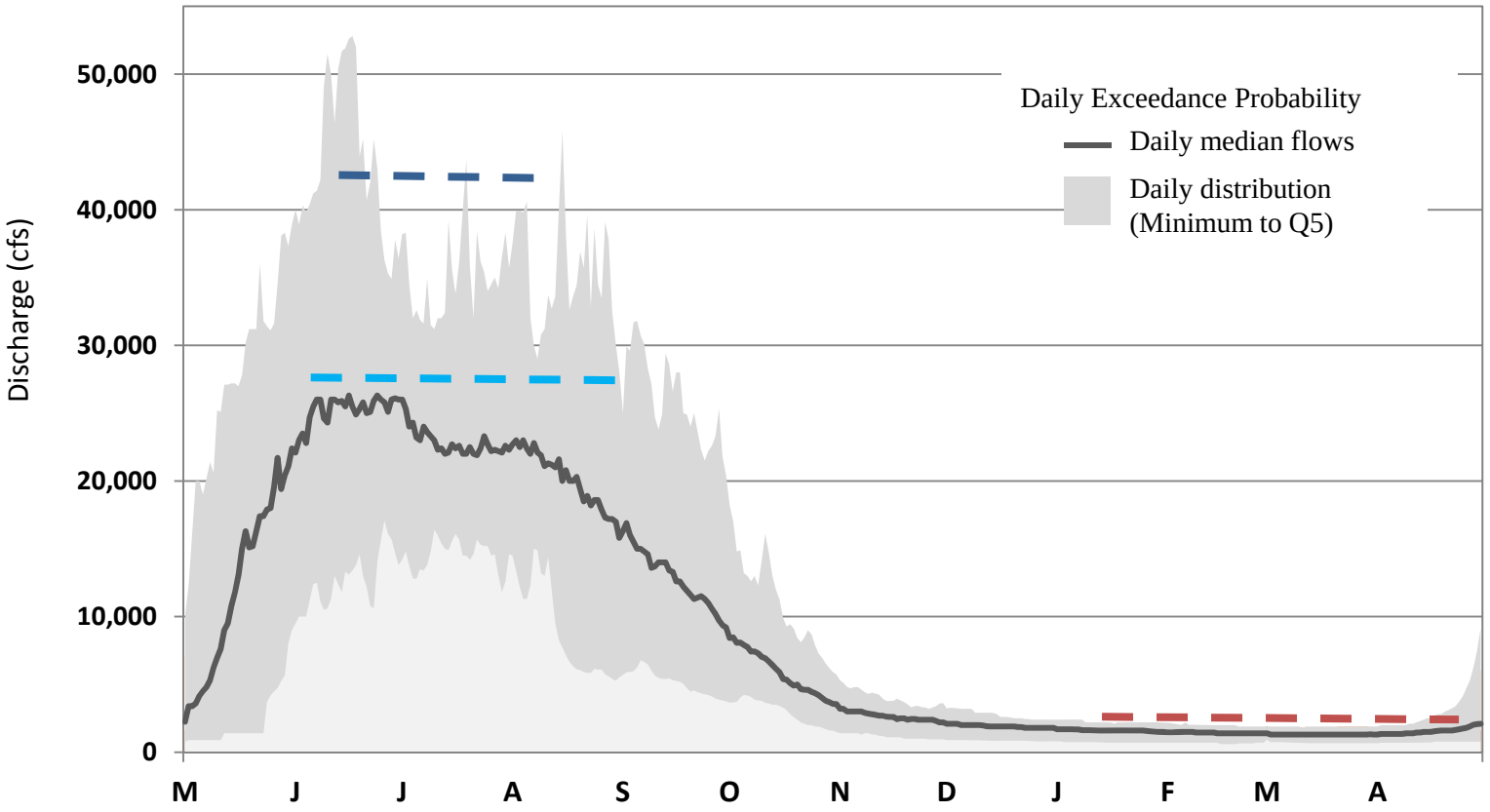
Flow Hypotheses – relationships derived from data, literature and expert input about the expected *influence of change* to a flow component

Flow hypotheses

- Who (species or group of species)
- What (flow component)
- When (month or season)
- Where (river type, reach, habitat)
- Why/how (expected ecological response)

Flow-Ecology Diagram: Chinook Salmon

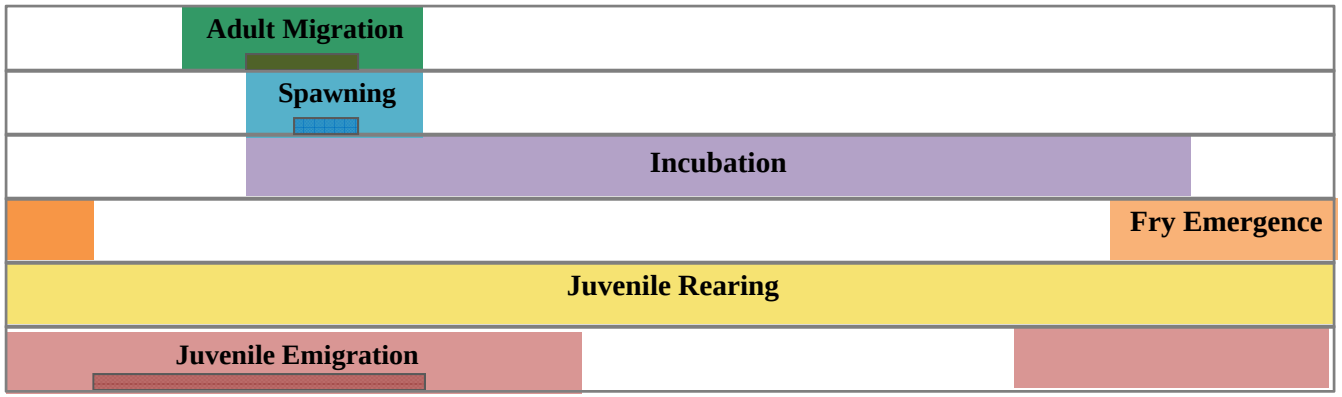
Middle River, Susitna River at Gold Creek, AK (USGS Gage 015292000)



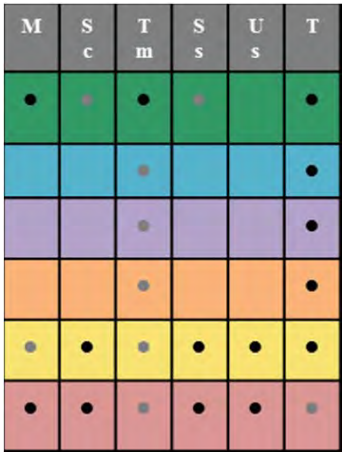
SMALL FLOOD
(2 Yr Recurrence)
early June- mid-Aug
40,000 to 70,000 cfs
0 to 1 events / year
4o to 90 days / event

HIGH PULSE (≥Q10)
26,000 cfs
2 to 6 events / year
4 to 11 days/ event

LOW PULSE (≤Q90)
Flow ≤ 1600 cfs
0 to 3 events / year
3 to 9 days / event



Habitat Type



Flow hypotheses

The goal is creating a hypothesis that is testable through subsequent quantitative analysis or literature review:

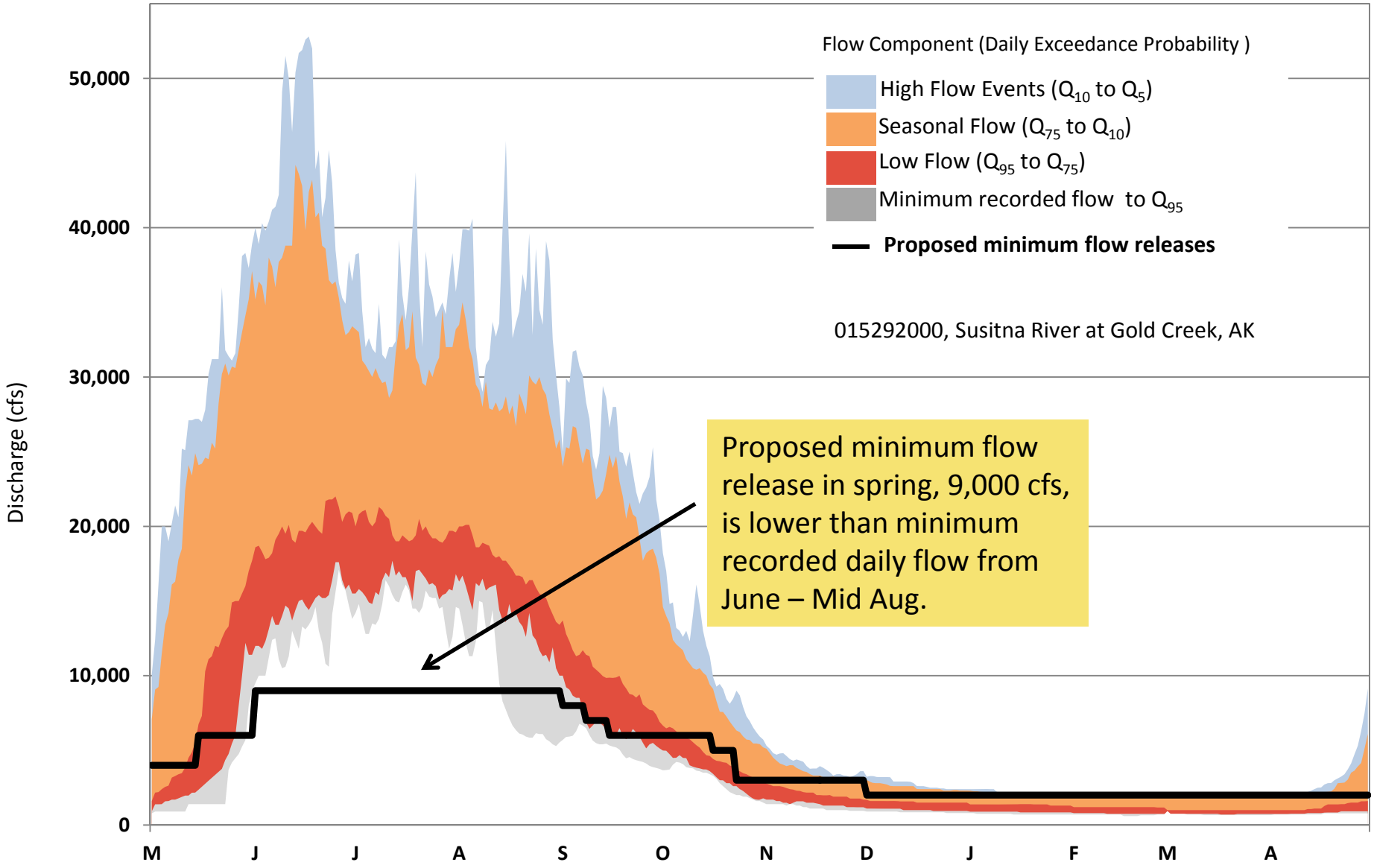
- Example: From mid-June through mid-August (*when*) if monthly median flows decrease (*what*) access to tributary mouths and tributaries (*where*) for adult migrating Chinook (*who*) may be reduced or eliminated, resulting in reduced extent of upstream migration (*why/how*)

Susitna case study

Goals using IHA:

- Baseline statistics to characterize hydrology
- Discuss methods to trend with a biological dataset
- Identify climate trends
- Two-period analysis with one timeseries
- Scope potential impact of proposed hydropower operation

Proposed Operating Rules for Susitna-Watana Hydroelectric Project, Base Case Scenario as Submitted in the Pre-Application Document



Proposed Operating Rules for Susitna-Watana Hydroelectric Project, Base Case Scenario as Submitted in the Pre-Application Document