# Pend Oreille River Temperature TMDL Load Duration Curve Concepts


**presented to Pend Oreille Watershed Advisory Group**

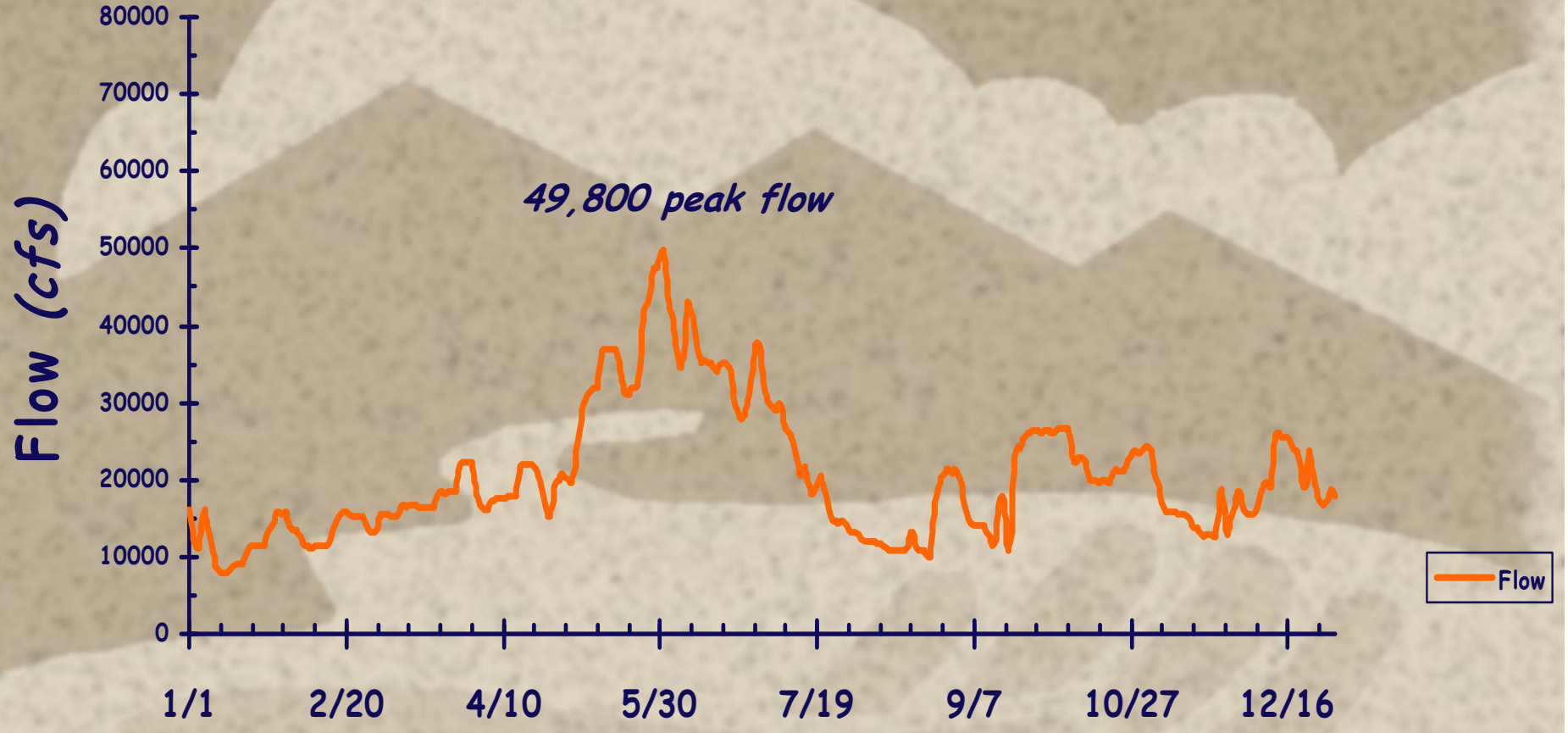
**Feb 25, 2008**

Robert Steed

# Pend Oreille River, ID

## Hydrograph

### *USGS Gage: 12395500*



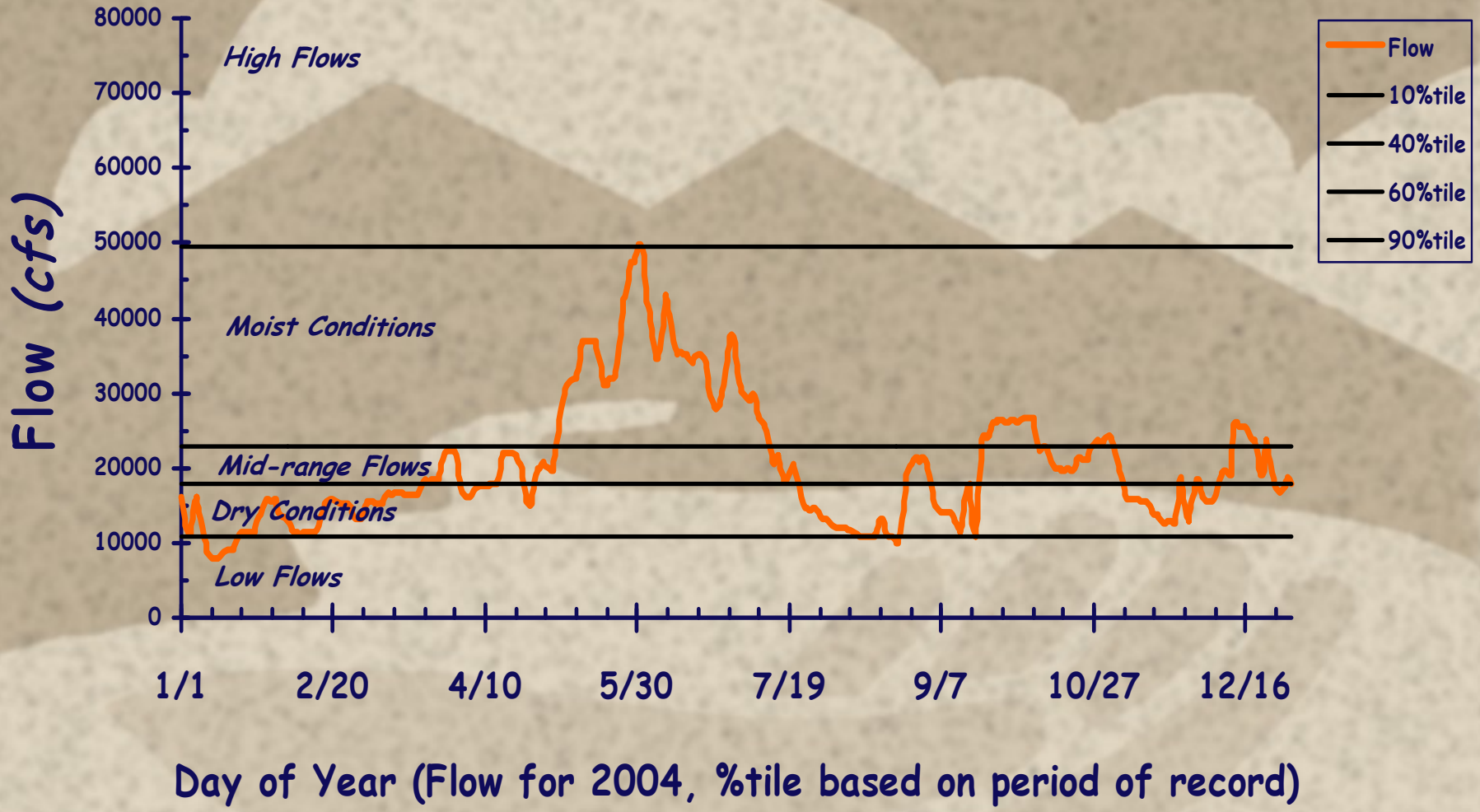

*USGS Flow Data (2004)*

*24,200 square miles*

# Pend Oreille River, ID

## Hydrograph

### *USGS Gage: 12395500*




Day of Year (Flow for 2004, %tile based on period of record)



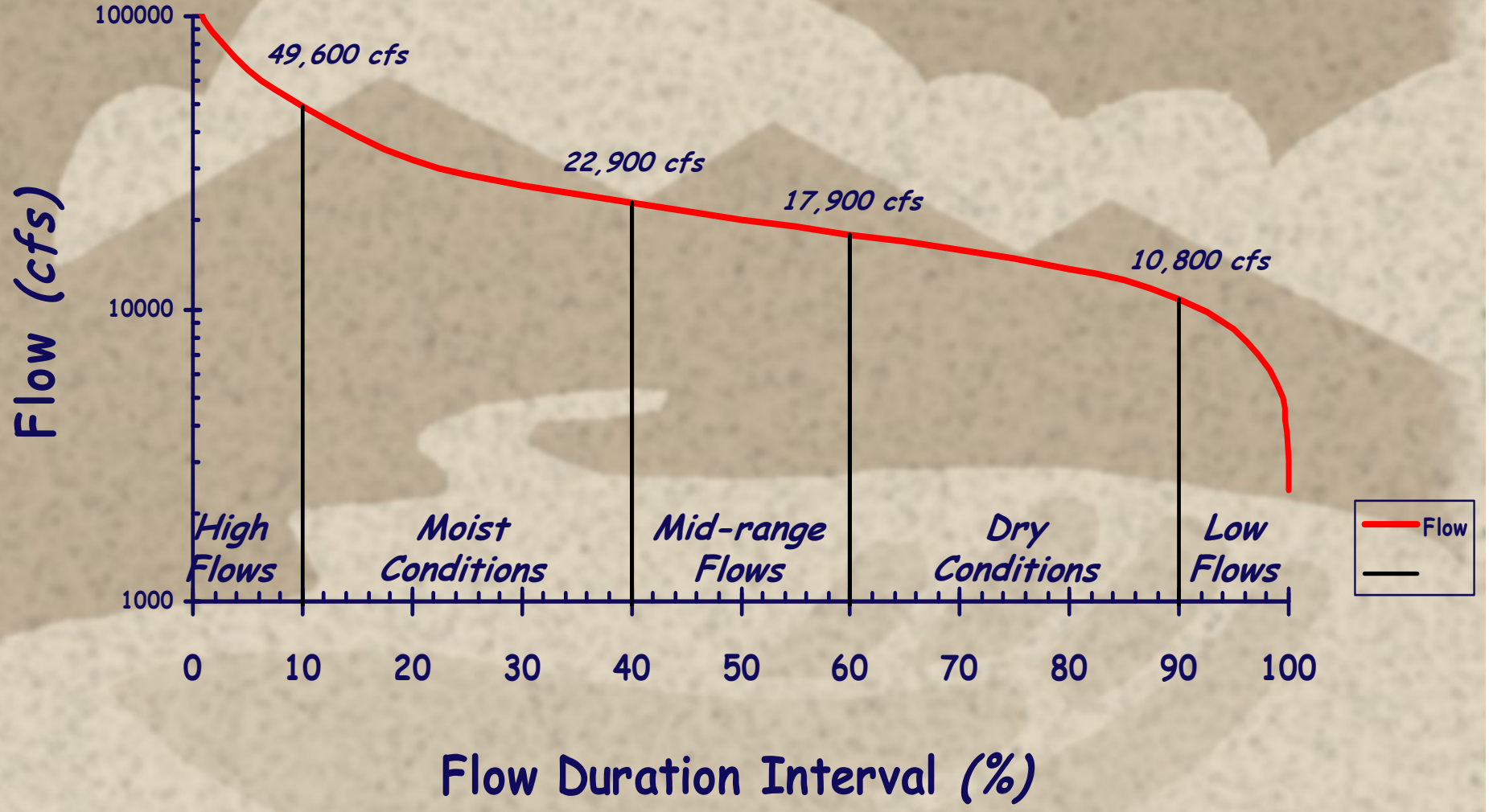
*USGS Flow Data (2004)*

*24,200 square miles*

# Pend Oreille River, ID

## Flow Duration Curve

### *USGS Gage: 12395500*





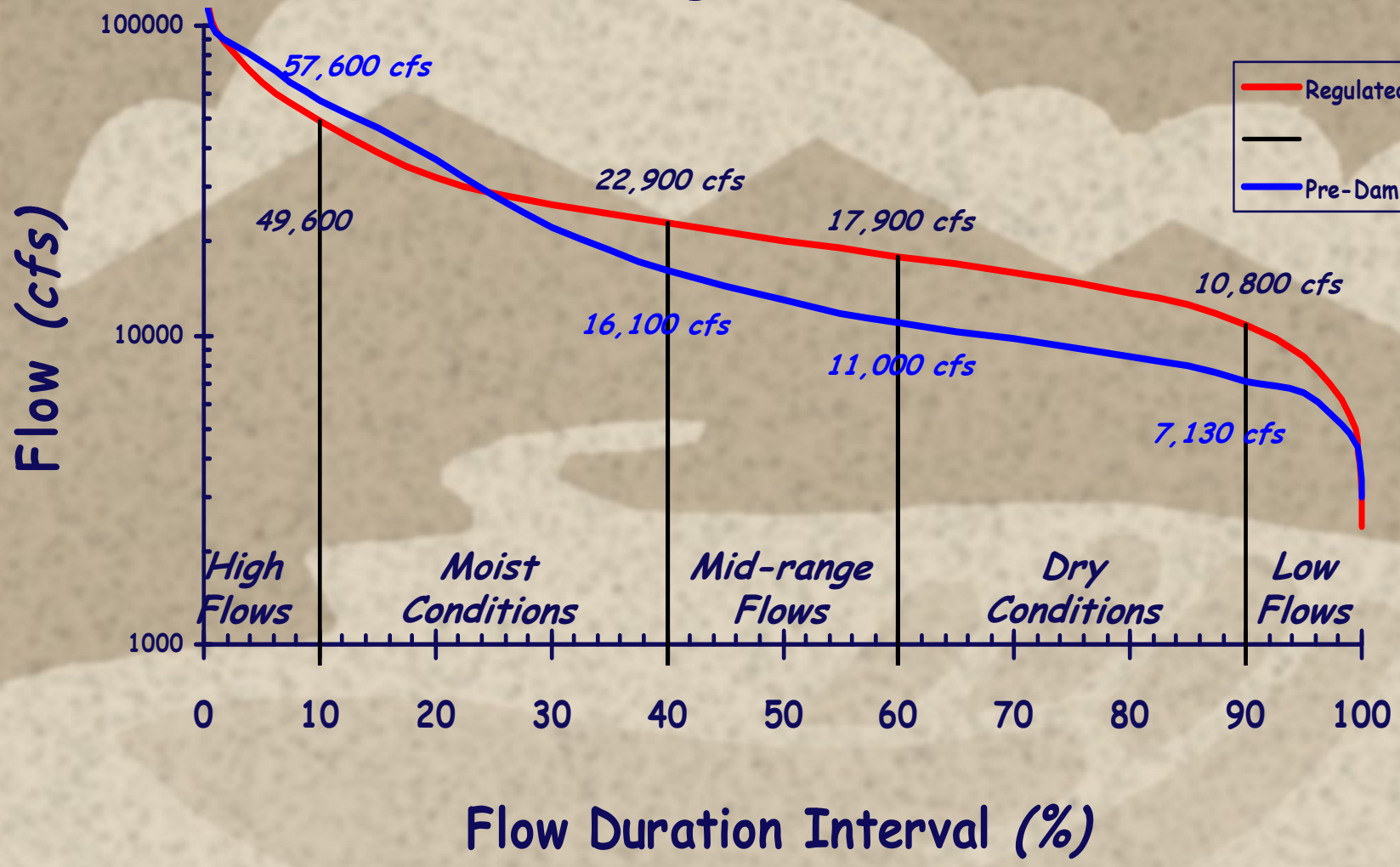

*USGS Flow Data (1956 – 2008)*

*24,200 square miles*

# Pend Oreille River, ID

## Flow Duration Curve

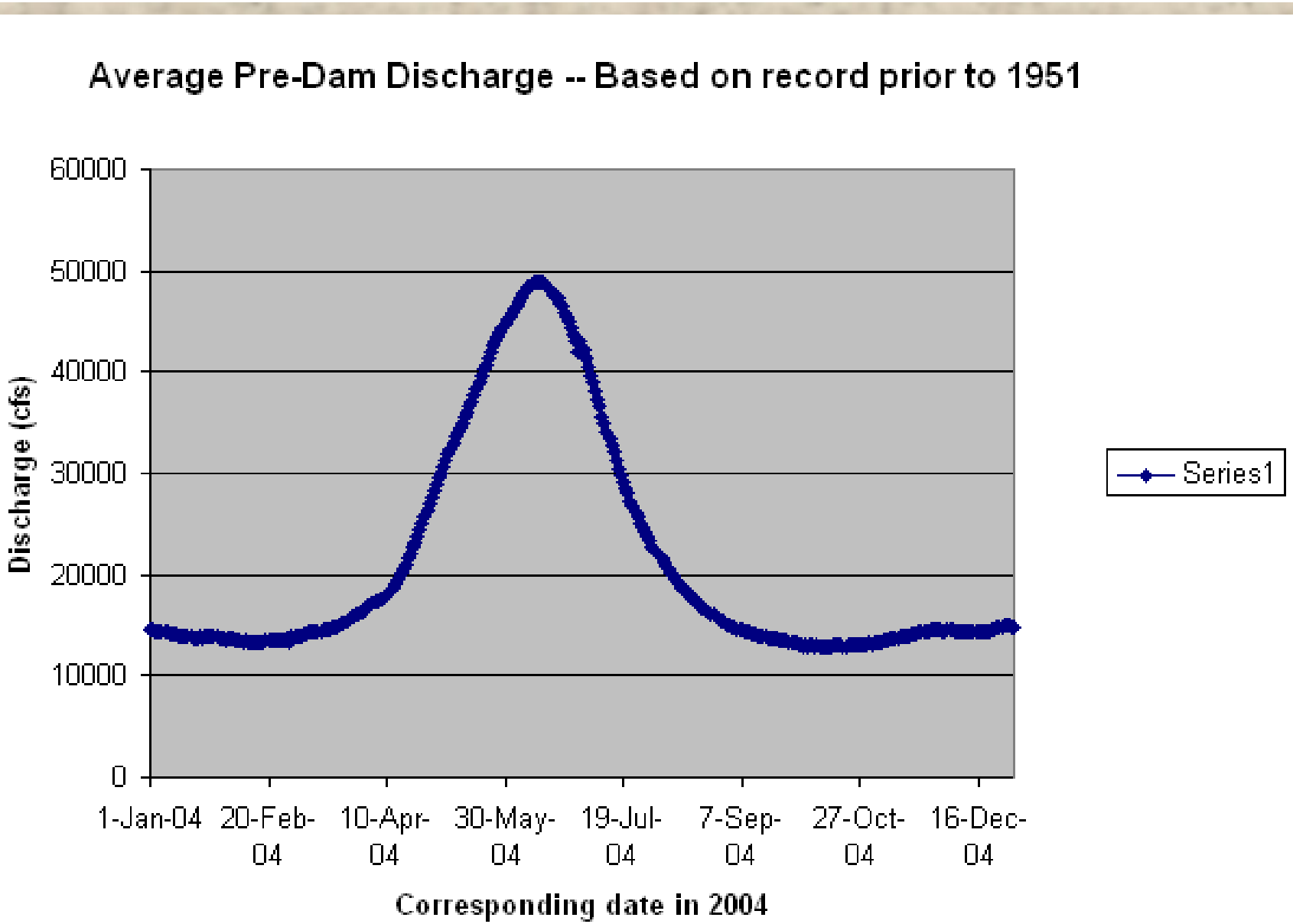
## *USGS Gage: 12395500*






*USGS Flow Data (1903 – 2008)*

*24,200 square miles*






These findings are for explanatory purposes only, the natural loads are based on unrealistic flows

$$HL(kcal/day) = \frac{Qft3}{\text{sec}} x \frac{m3}{35.314475 ft3} x \frac{1000L}{m3} x \frac{1kcal}{kg/1oC} xTx \frac{60\text{sec}}{\text{min}} x \frac{60\text{min}}{hour} x \frac{24hour}{day}$$

$$\frac{HLGcal}{day} = \frac{HLkcal}{day} x \frac{Mcal}{1000kcal} x \frac{Gcal}{1000Mcal}$$

Bob's Heat Loading Equation

HL = (Q)(2446588.826)(WQT)/1000000

units = (Gcal/day)

Where:

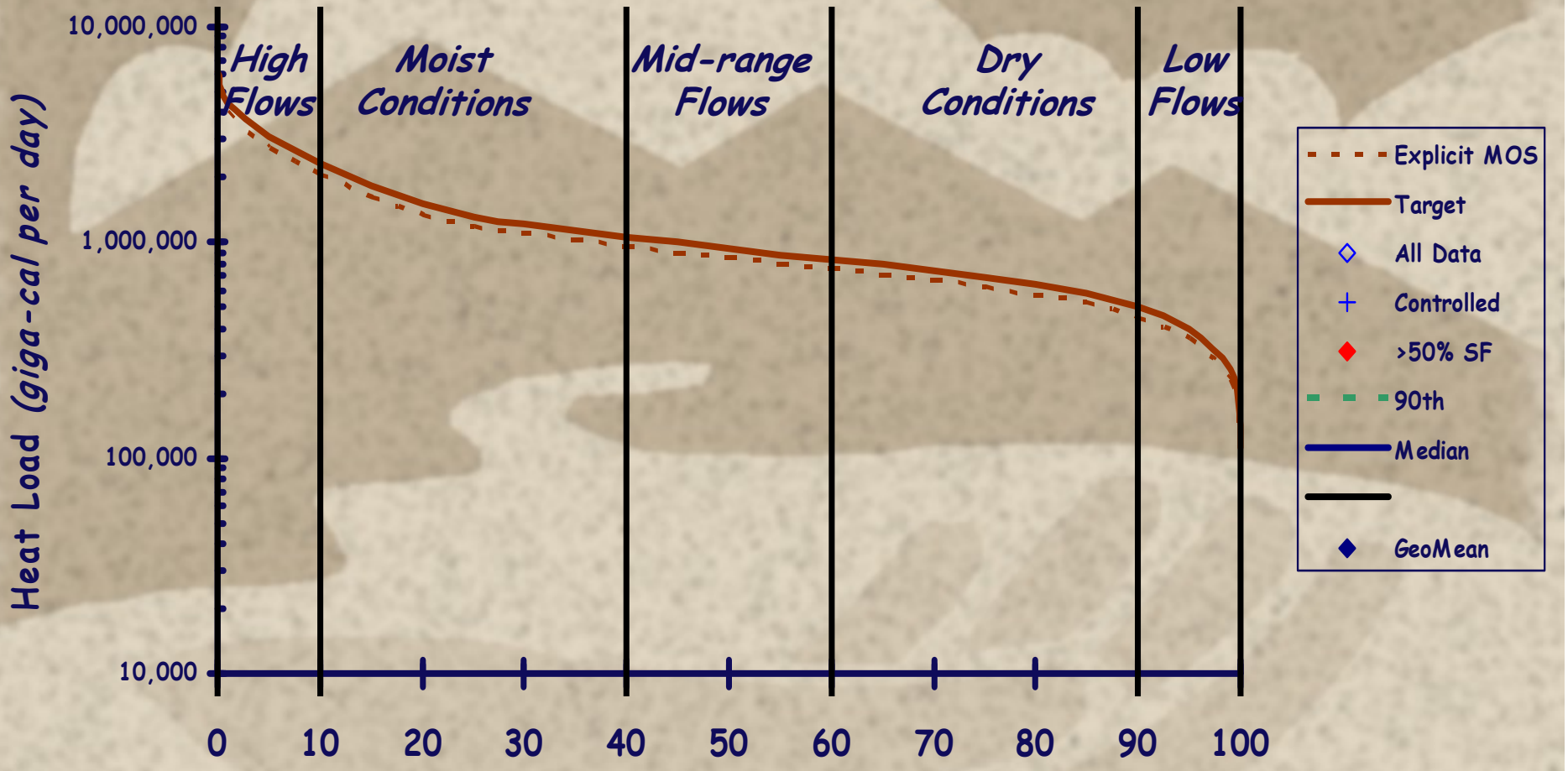
HL = Heat Load (kcal/day)

Q = Discharge (cfs)

T = Temperature

WQT = Water Quality Target ($F$11)

# Pend Oreille River
# Temperature Load Duration Curve *(1956 - 2008)*
## *Evaluation Area #4, Average Surface Temperatures at 35 km*
## *Gauge: 12395500*






*USGS Data & Gage 12395500 Duration Interval*

*24,200 square miles*

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# Temperature Load Duration Curve *(1956 - 2008)*
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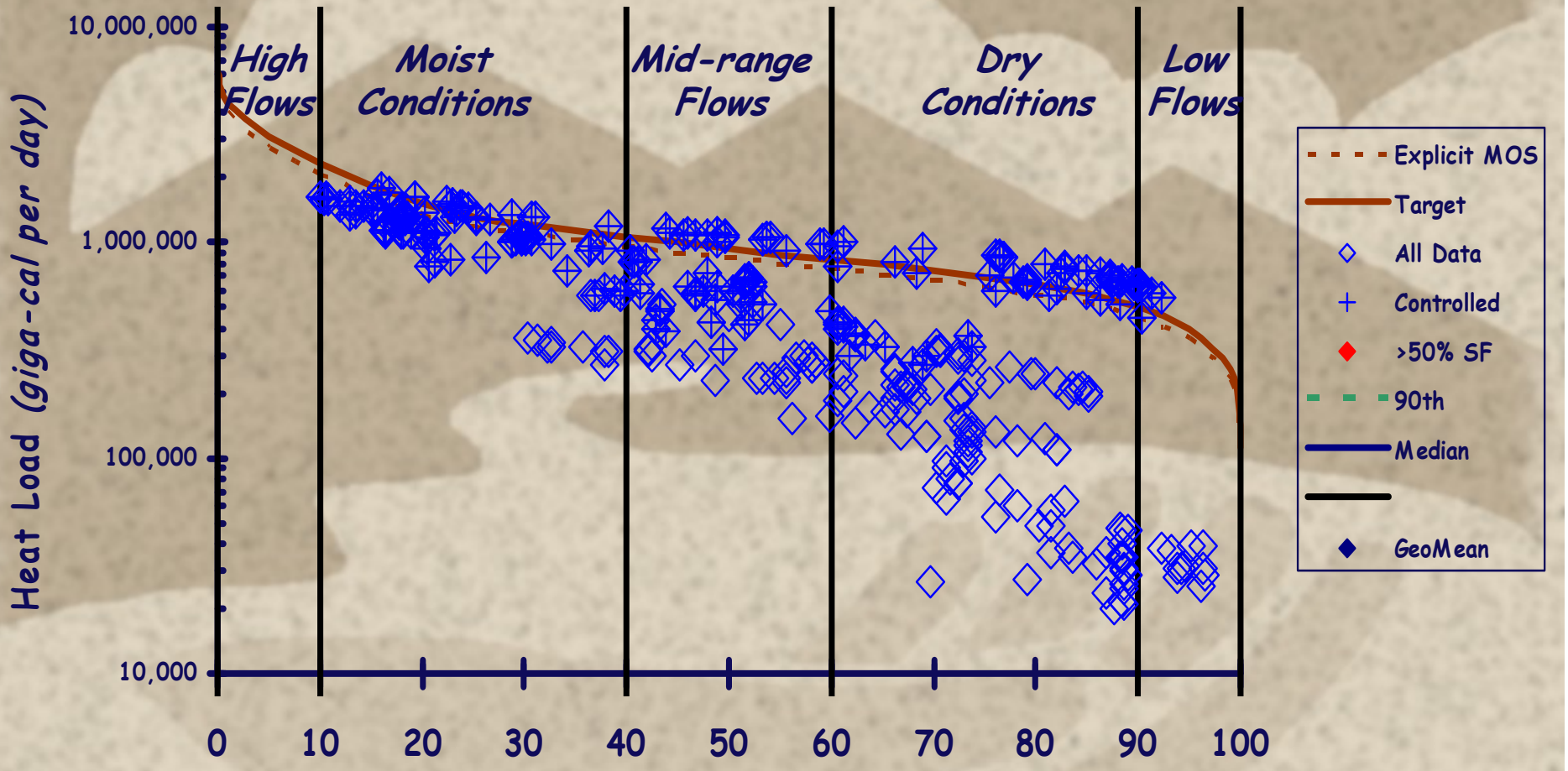





*USGS Data & Gage 12395500 Duration Interval*

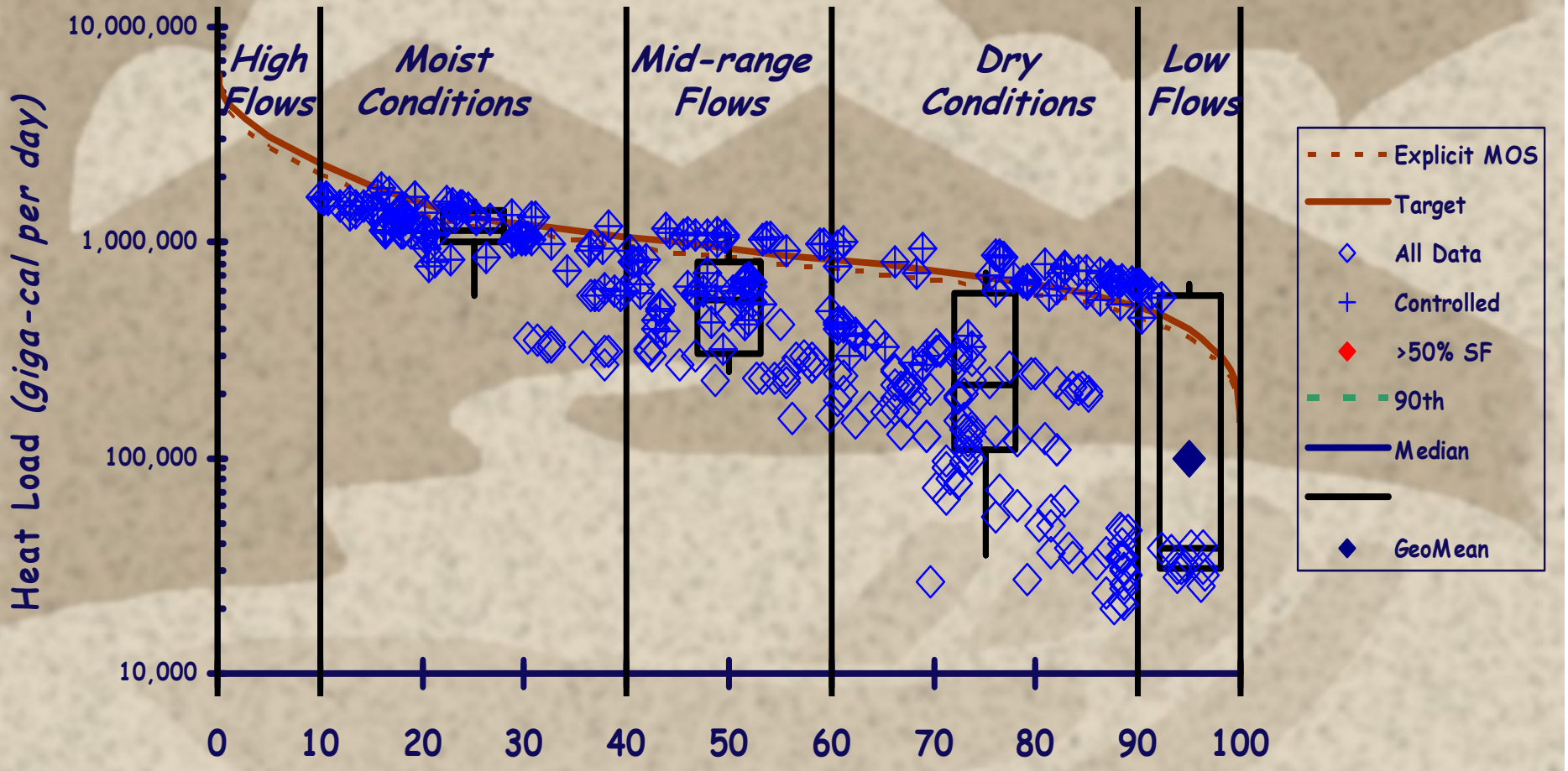
*24,200 square miles*

# Pend Oreille River

## Temperature Load Duration Curve *(Existing Conditions)*

### *Evaluation Area #4, Average Surface Temperatures at 35 km*

### *Gauge: 12395500*



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*24,200 square miles*

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## *Evaluation Area #4, Average Surface Temperatures at 35 km*
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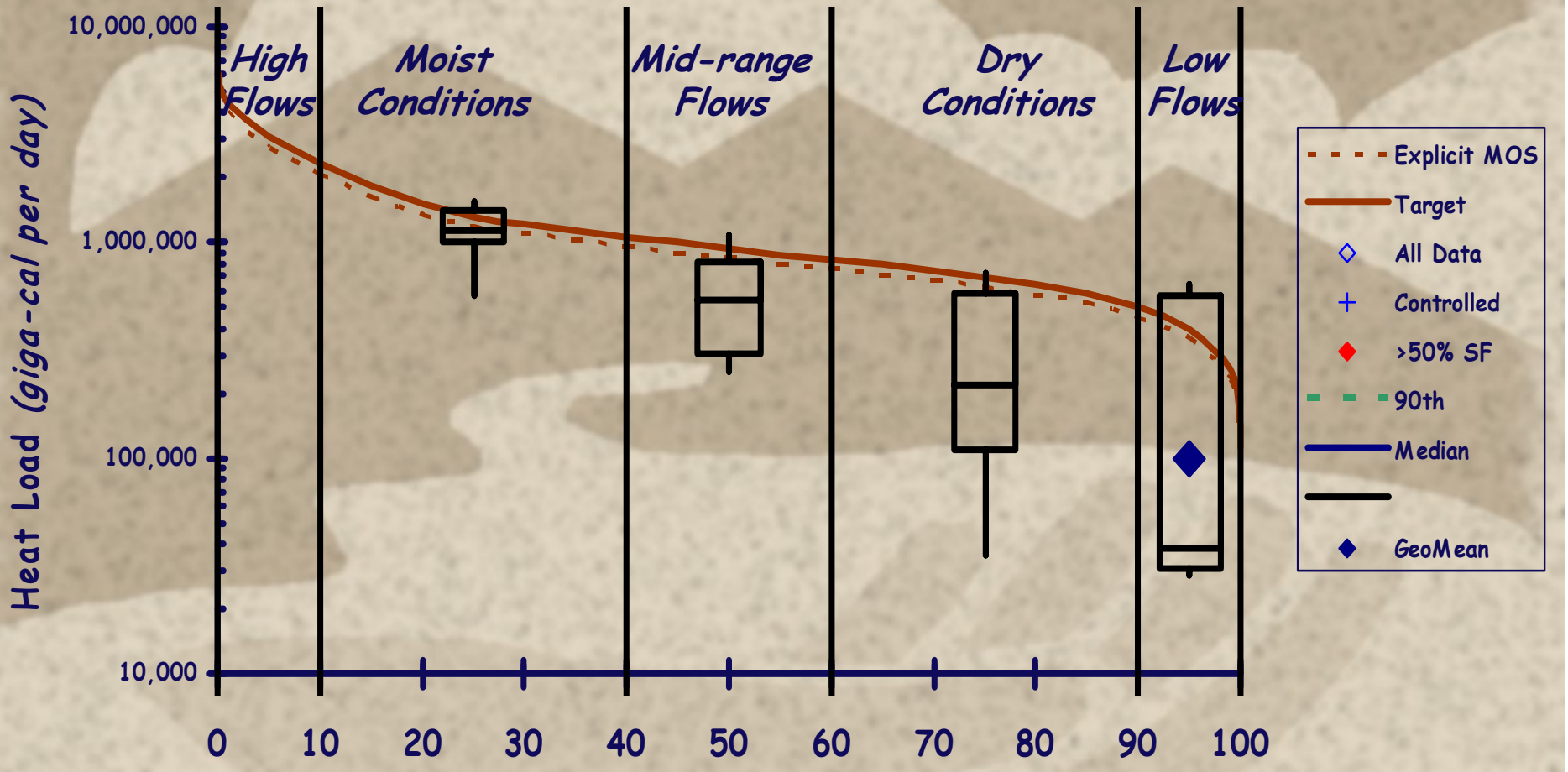
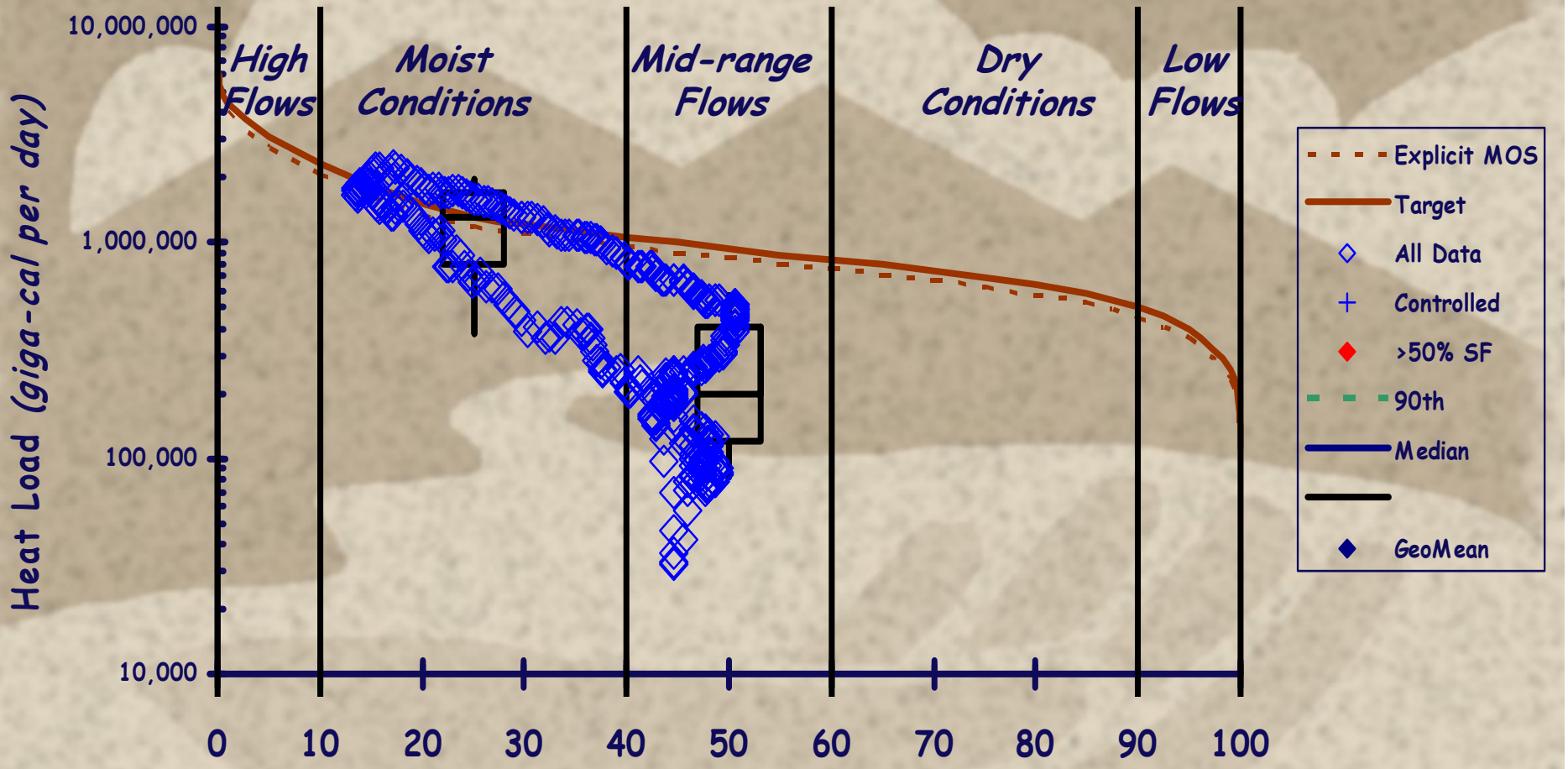





*USGS Data & Gage 12395500 Duration Interval*

*24,200 square miles*

# Pend Oreille River
## Temperature Load Duration Curve *(Natural Conditions)*
### *Evaluation Area #4, Average Surface Temperatures at 35 km*
### *Gauge: 12395500*

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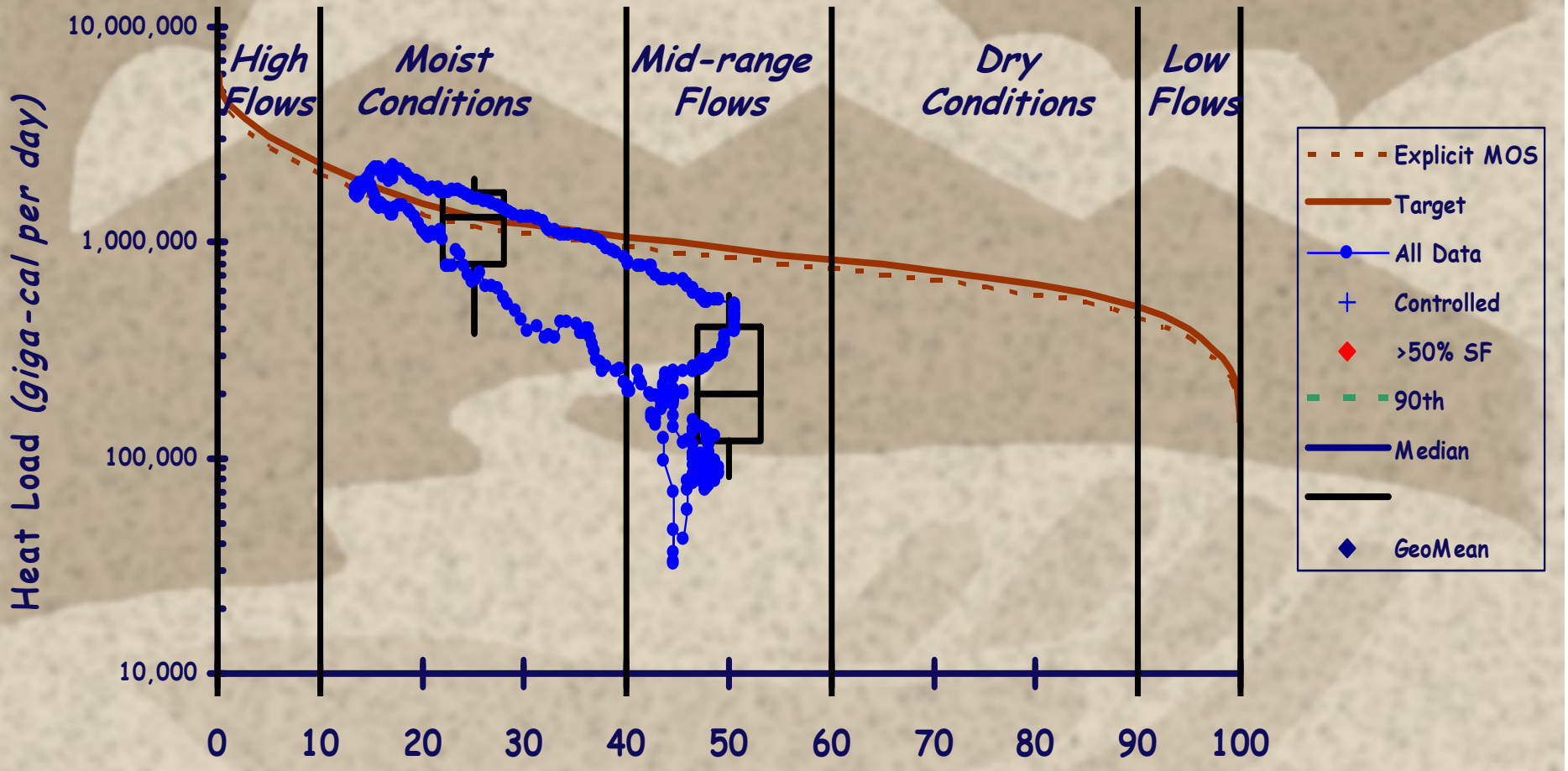
*USGS Data & Gage 12395500 Duration Interval*

*24,200 square miles*

# Pend Oreille River
## Temperature Load Duration Curve *(Natural Conditions)*
### *Evaluation Area #4, Average Surface Temperatures at 35 km*
### *Gauge: 12395500*

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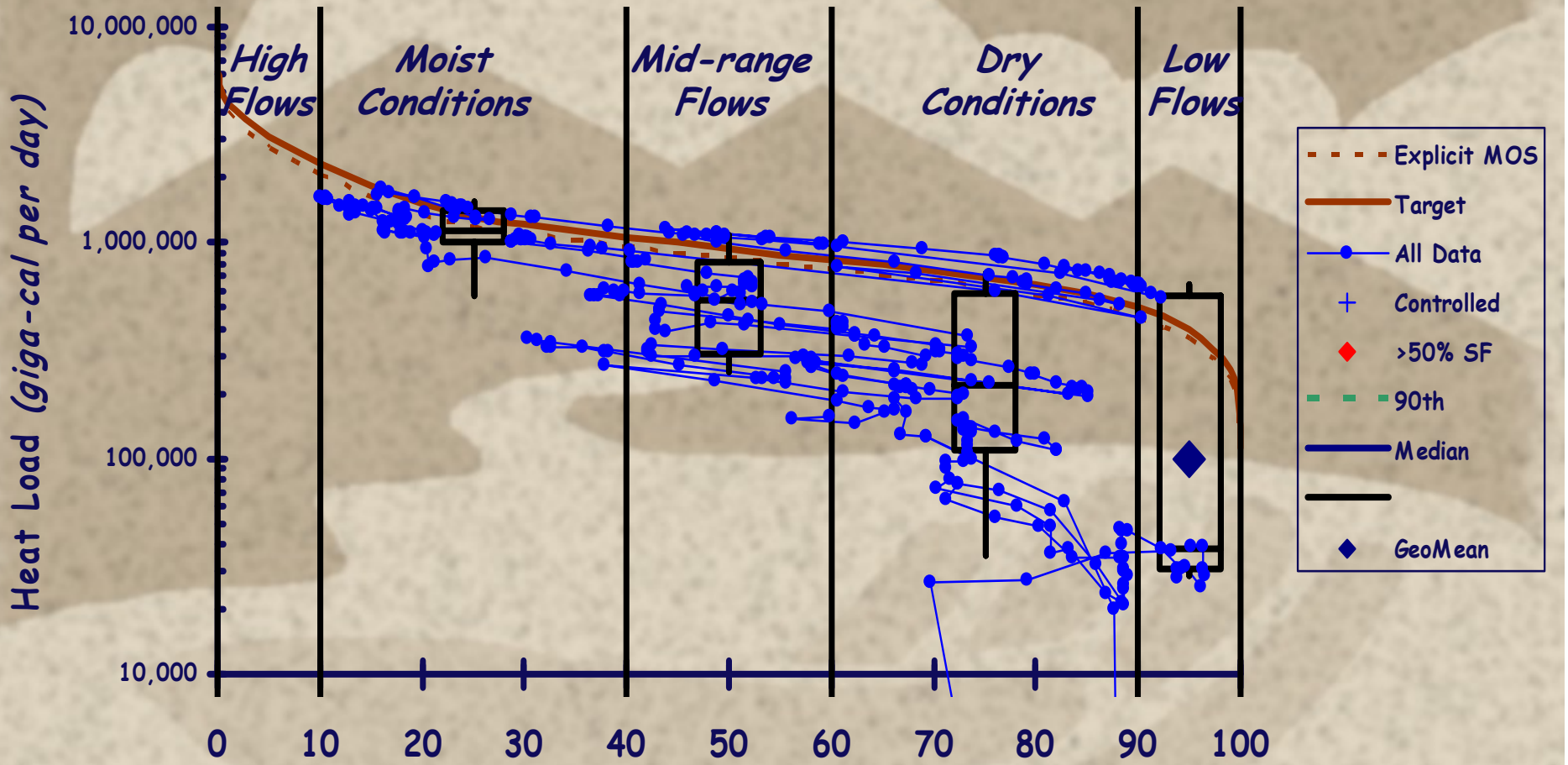
# Pend Oreille River

## Temperature Load Duration Curve *(Existing Conditions)*

### *Evaluation Area #4, Average Surface Temperatures at 35 km*

### *Gauge: 12395500*

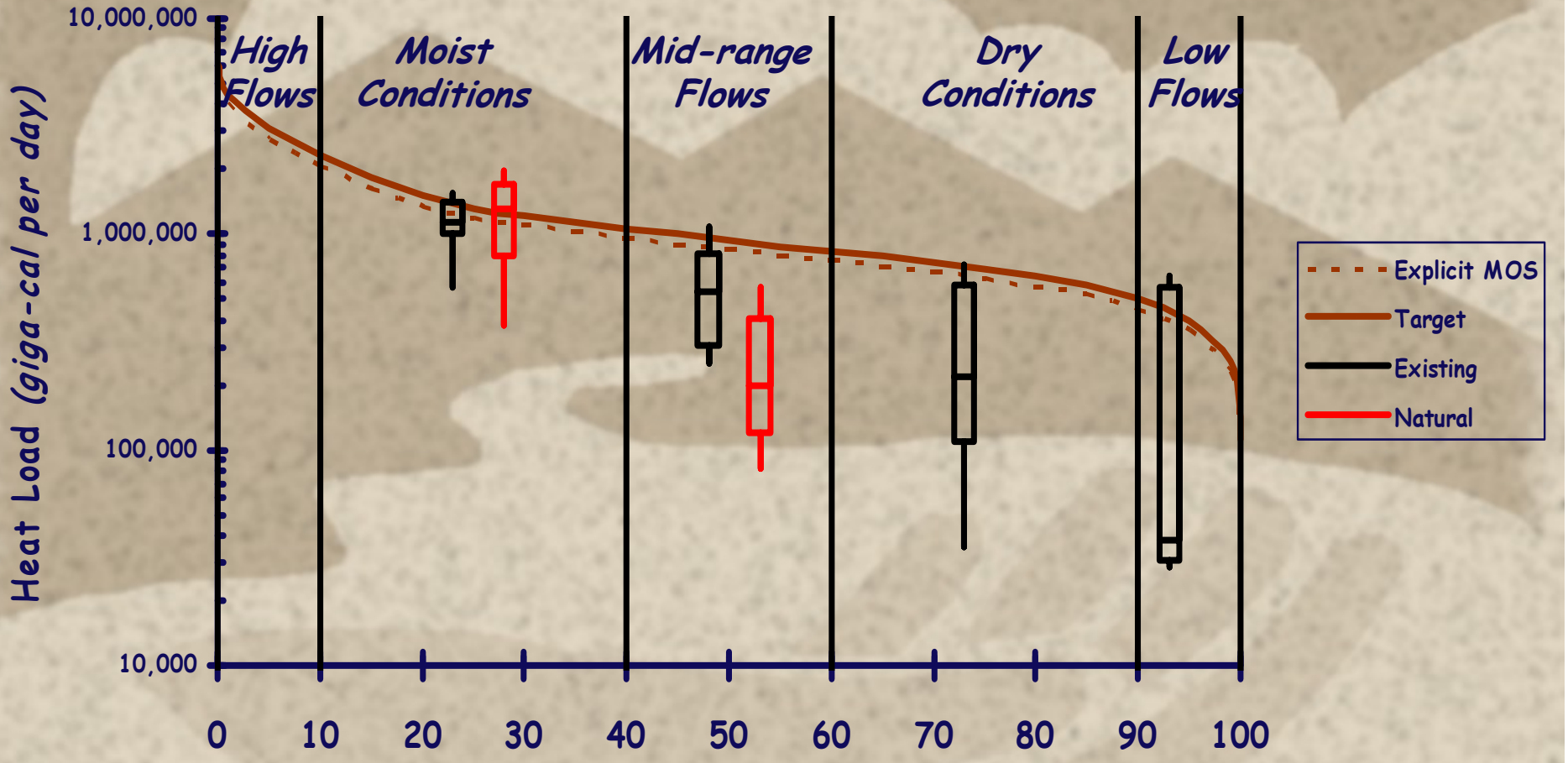





*USGS Data & Gage 12395500 Duration Interval*

*24,200 square miles*

# Pend Oreille River
# Temperature Load Duration Curve
## (Existing Conditions Compared to Natural Conditions)
### Evaluation Area #4, Average Surface Temperatures at 35 km
### Gauge: 12395500

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USGS Data & Gage 12395500 Duration Interval

24,200 square miles

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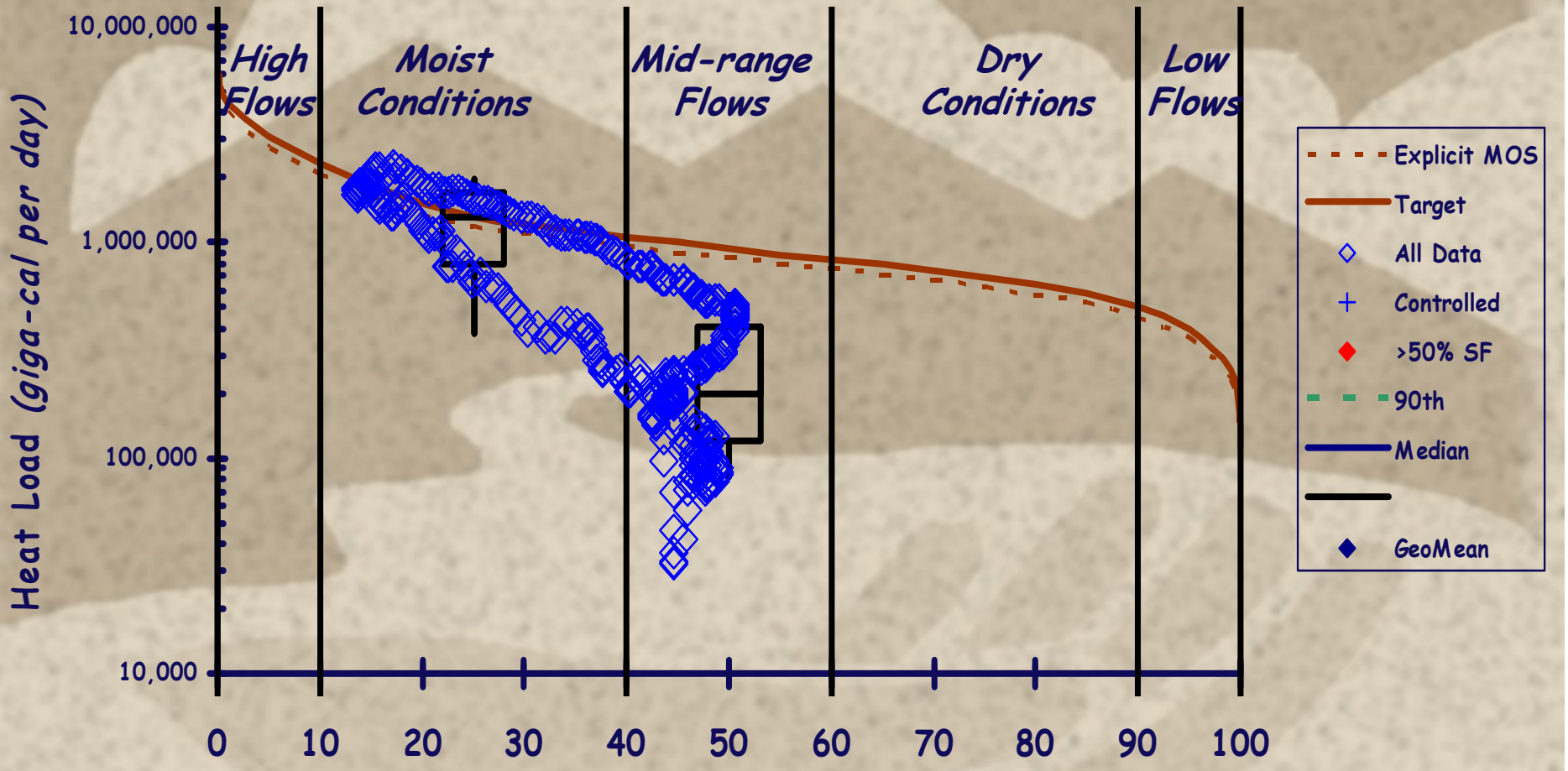


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*24,200 square miles*

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## Hydrograph

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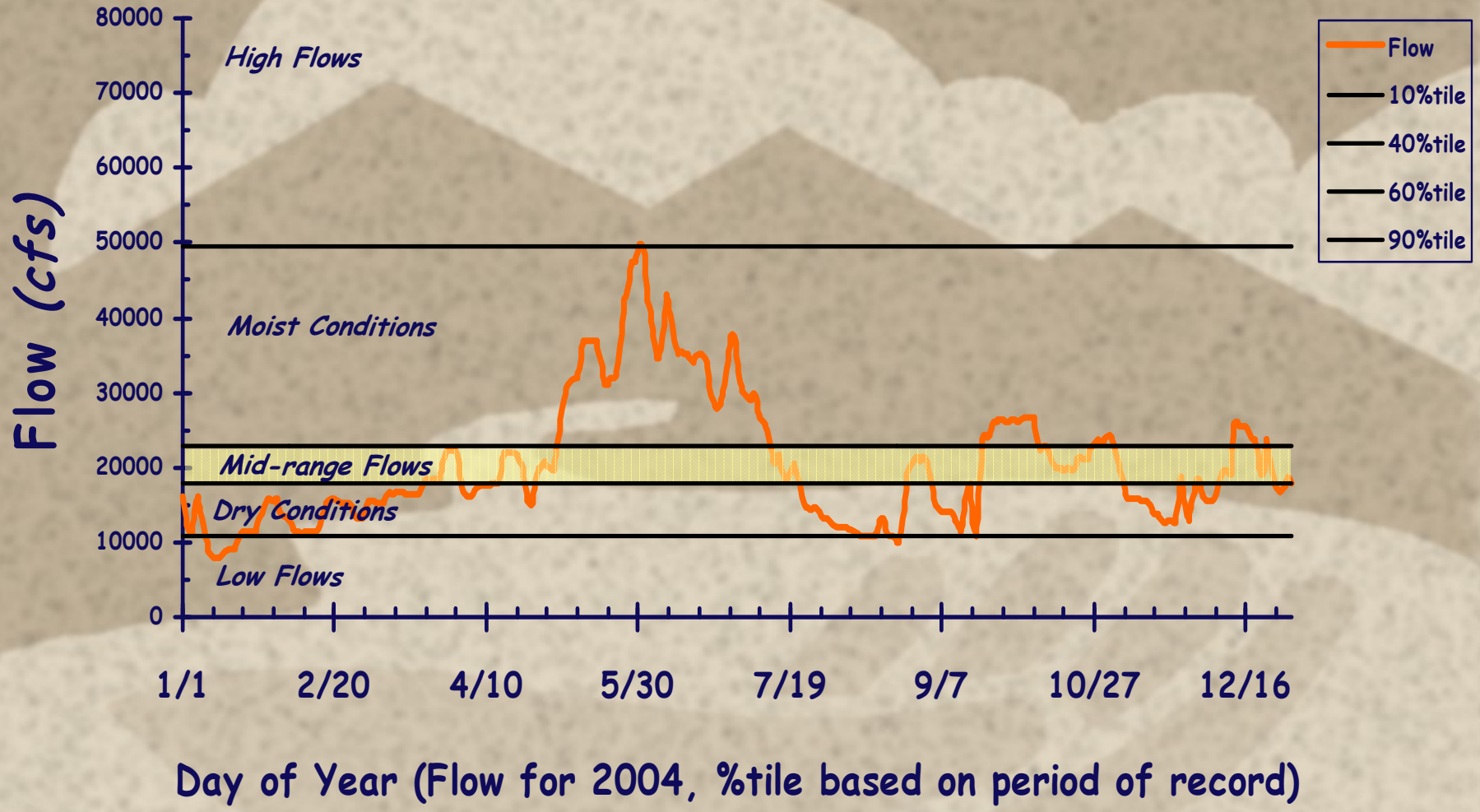




*USGS Flow Data (2004)*

*24,200 square miles*

# Pend Oreille River

## Temperature Load Duration Curve *(Existing Conditions)*

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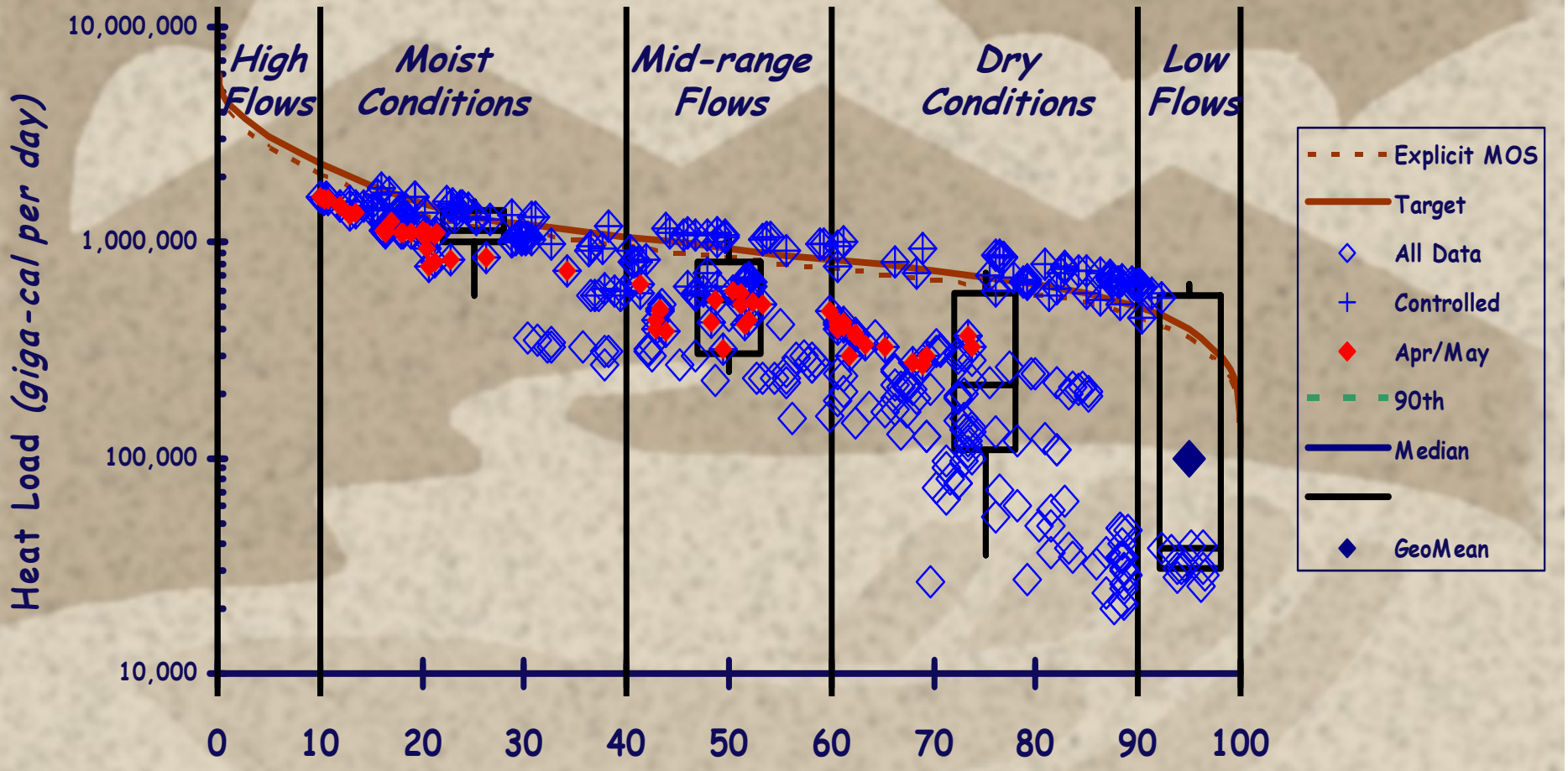




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## *(Existing Conditions Compared to Natural Conditions)*
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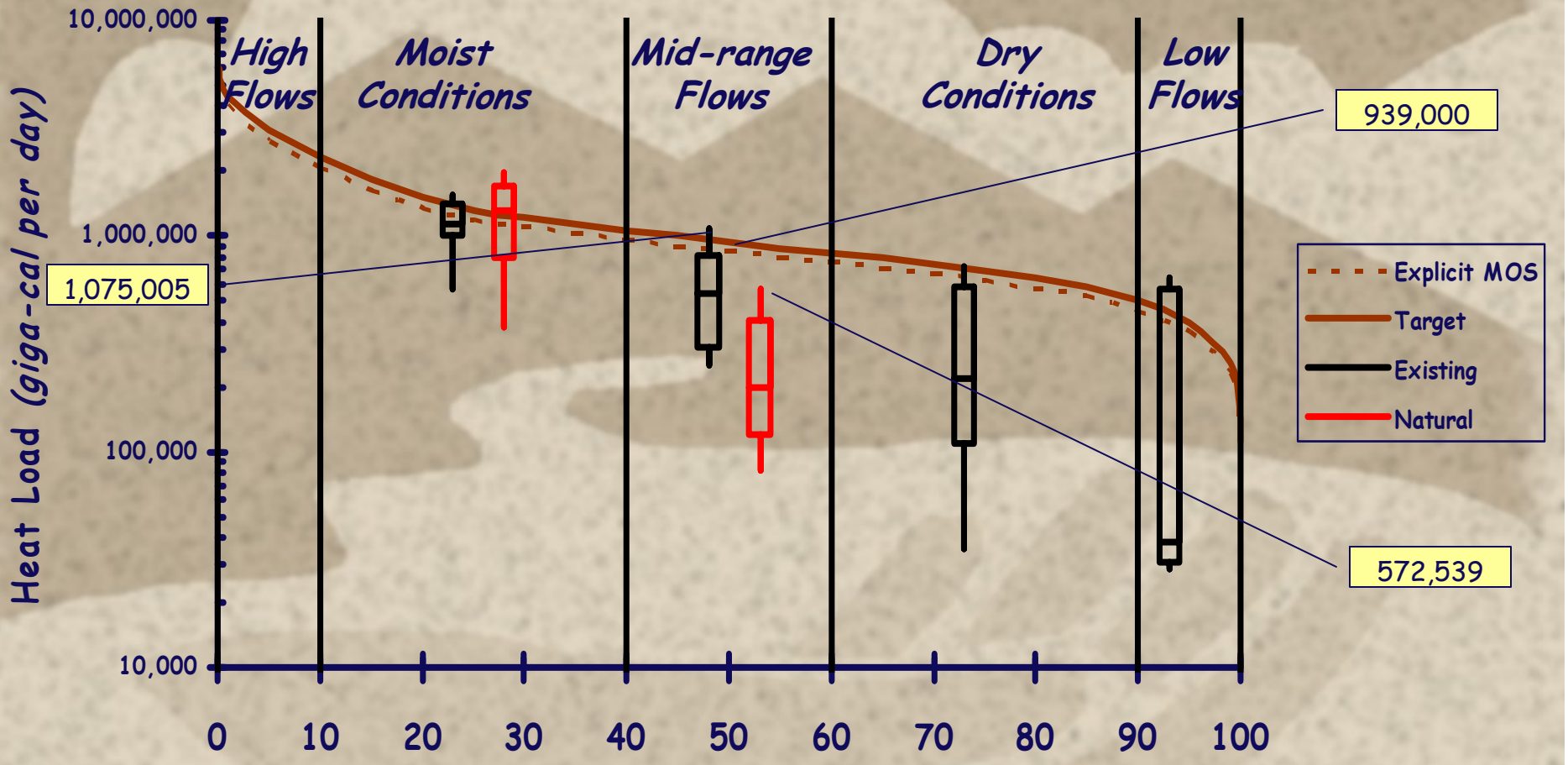


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*24,200 square miles*

# Suggested Allocation

- Using the 90th percentile
- Reduce heat load during "Mid Range Flows"
- Mid Range Flows are between 17,900 and 22,900 cfs
- TMDL goal is to reduce daily heat load from 1,075,005 Gcal to 939,000 Gcal or by 136,005 Gcal/day
- An Explicit Margin of Safety for Mid Range Flows is 939,000 – 845,100, or 93,900 Gcal/day

- A TMDL with implicit Margin of Safety requires a 12.6% reduction in heat load
- A TMDL with an explicit margin of safety requires a 21.4% reduction in heat load.

$$TMDL \le WLA + LA + MOS$$

$$TMDL \le (0) + (939{,}000) + (-93{,}900)$$

$$TMDL \le 845{,}100$$

Where :

TMDL = Total Maximum Daily Load

WLA = Waste Load Allocation (point source)

LA = Load Allocation (nonpoint source)

MOS = Explicit Margin of Safety



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