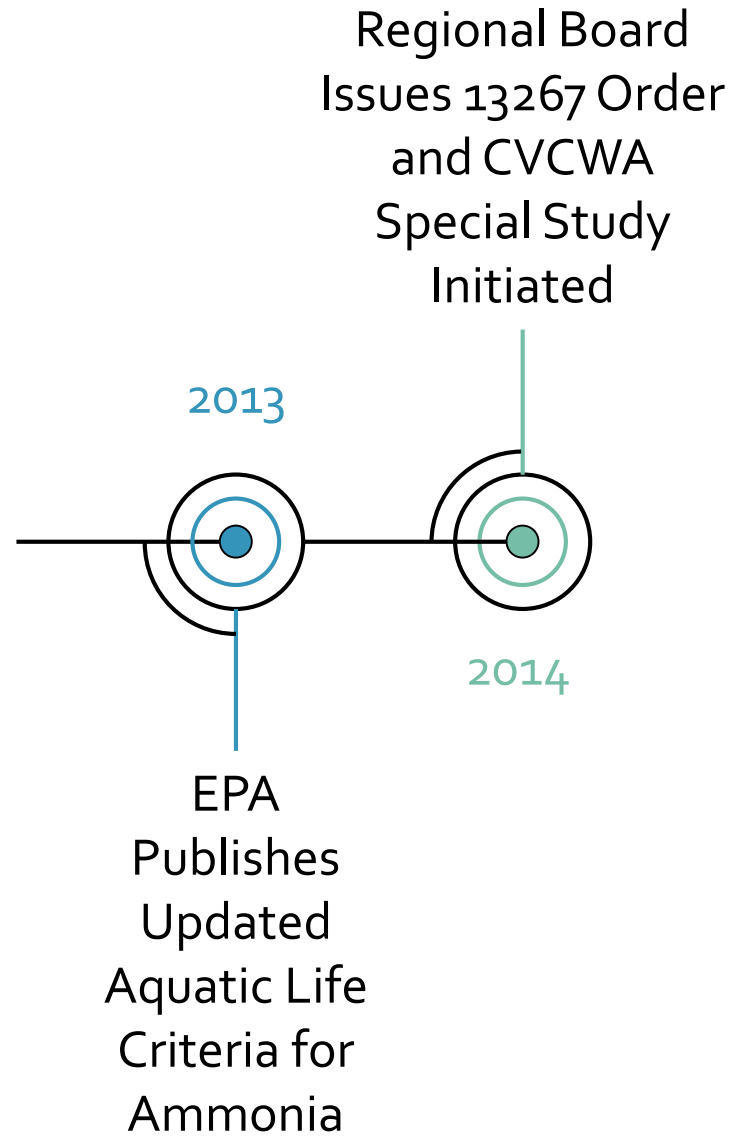# Site-Specific Recalculation of Aquatic Life Criteria for Ammonia

Brant Jorgenson, Ph.D.

2019 CVCWA Conference

Background

Regional Board Issues 13267 Order and CVCWA Special Study Initiated

2013

2014

EPA Publishes Updated Aquatic Life Criteria for Ammonia

Background

Discharger Location	Averaging Period	1999 Criteria (mg TAN/L)	2013 Criteria Mussels Present (mg TAN/L)	2013 Criteria Mussels Absent (mg TAN/L)
Foothills	AMEL	1.2	0.7	1.2
	MDEL	3.1	1.7	3.1
Delta	AMEL	1.1	0.3	0.7
	MDEL	2.1	0.7	1.9
Valley Floor	AMEL	1.1	0.2	0.7
	MDEL	2.1	0.7	1.9

AMEL: Average Monthly Effluent Limit
MDEL: Maximum Daily Effluent Limit

Source: CVRWQCB 2014
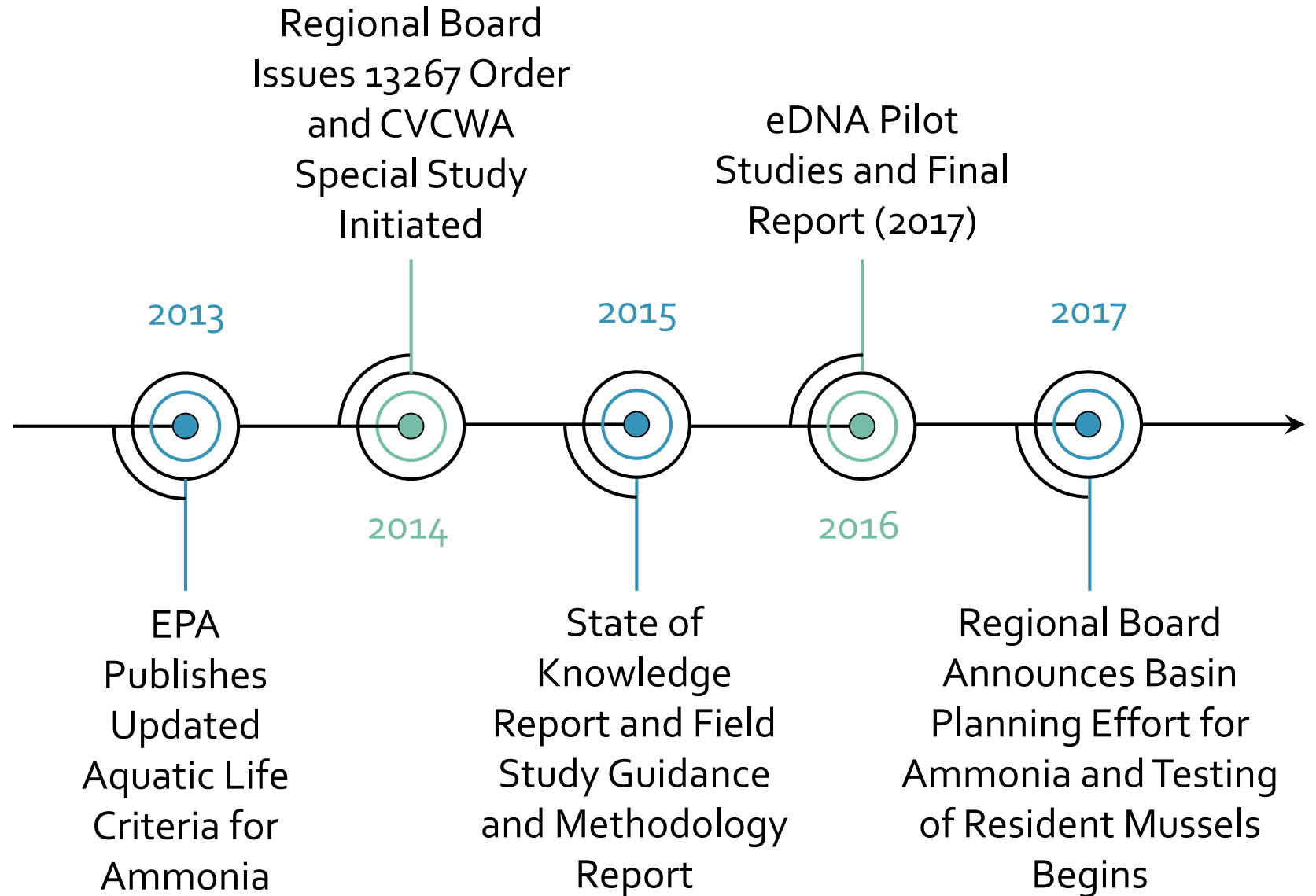
Central Valley Ammonia Criteria

Recalculation of USEPA Aquatic Life Criteria for Ammonia

Objective of Recalculation

To develop ammonia criteria suitably protective of the unique assemblage of aquatic life in the watersheds of the Central Valley

*Anodonta californiensis*
California floater

Margaritifera falcata
Western pearlshell

Gonidea angulata
Western ridged mussel

Overview of Recalculation Procedure

- Geographic Scope
- Dataset Addition
  - Resident unionid mussel testing
- Dataset Deletion
- Site-Specific Dataset
- Criteria Calculation
- Criteria Equation Formulation
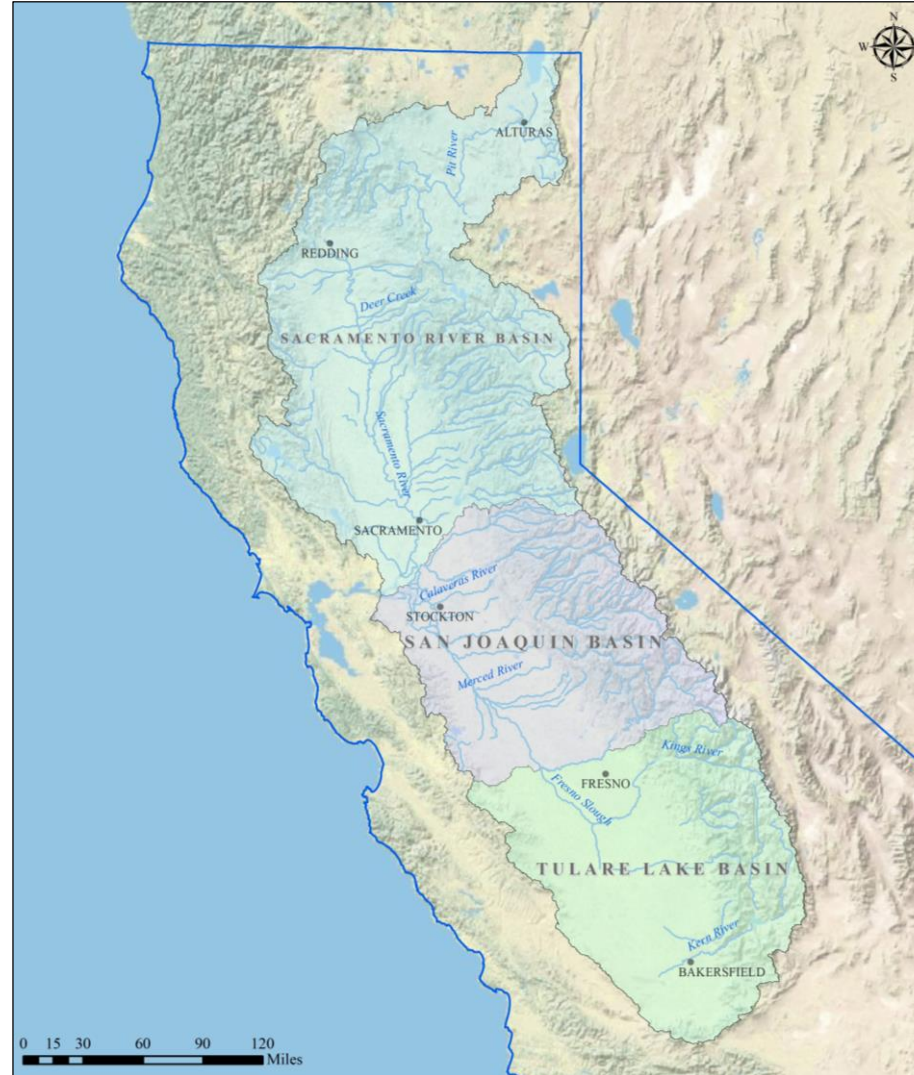 - pH and temperature dependency
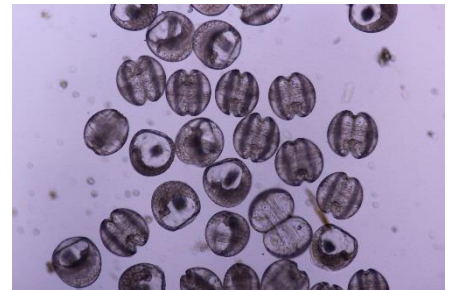
Barnhart, 2018

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

RESIDENT UNIONID MUSSEL TESTING

- All testing by Pacific EcoRisk
  - *Anodonta oregonensis* (2016)
  - *Anodonta californiensis* (2018)
  - *Gonidea angulata* (2018)

- Juvenile culturing by Dr. Christopher Barnhart (Missouri State University)

- Acclimation and testing per ASTM E2455-06
  - 96-hour Static-renewal tests (in duplicate)
  - <5 day old newly transformed juvenile mussels
  - Survival endpoint (foot movement)

MUSSEL TESTING RESULTS
(mg TAN/L at pH 7 and 20°C)

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

	Anodonta oregonensis	*Anodonta californiensis*	*Gonidea angulata*	*Margaritifera falcata*
SMAV	63.67	104.7	59.81	61.23
GMAV	81.65		59.81	61.23
Rank	22		10	11

SMAV: Species Mean Acute Value
GMAV: Genus Mean Acute Value
Rank: Rank of GMAV when added to EPA's National Dataset

Barnhart, 2018

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

- Followed USEPA's revised Deletion Process
- Removed 21 SMAVs from acute national dataset
  - 17 non-resident unionid mussels
    - Substituted with *Anodonta*, *Gonidea*, *Margaritifera*
  - Atlantic salmon, White perch, Sunshine bass, Mountain whitefish
- Replaced non-resident unionid mussel GMCVs with surrogate resident GMCV
  - Geometric mean of resident GMAV divided by taxon specific ACR from 2013 Criteria document
  - Analogous to surrogate value for Phylum Annelida

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

○ National Dataset
● Nonresident Mussels
▲ Resident Mussels (Not in National Dataset)

GMAV (mg/L TAN) at pH7 (20°C for invertebrates)

Cumulative Fraction (GMAV)

Anodonta oregonensis/californiensis (Pacific EcoRisk)

Margaritifera falcata (USGS)

Gonidea angulata (Pacific EcoRisk)

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

GMAV (mg/L TAN) at pH7 (20°C for invertebrates)

▲ Resident Mussel
○ Other Genus

Margaritifera falcata (USGS)

Anodonta oregonensis/californiensis (Pacific EcoRisk)

Gonidea angulata (Pacific EcoRisk)

Cumulative Fraction (GMAV)
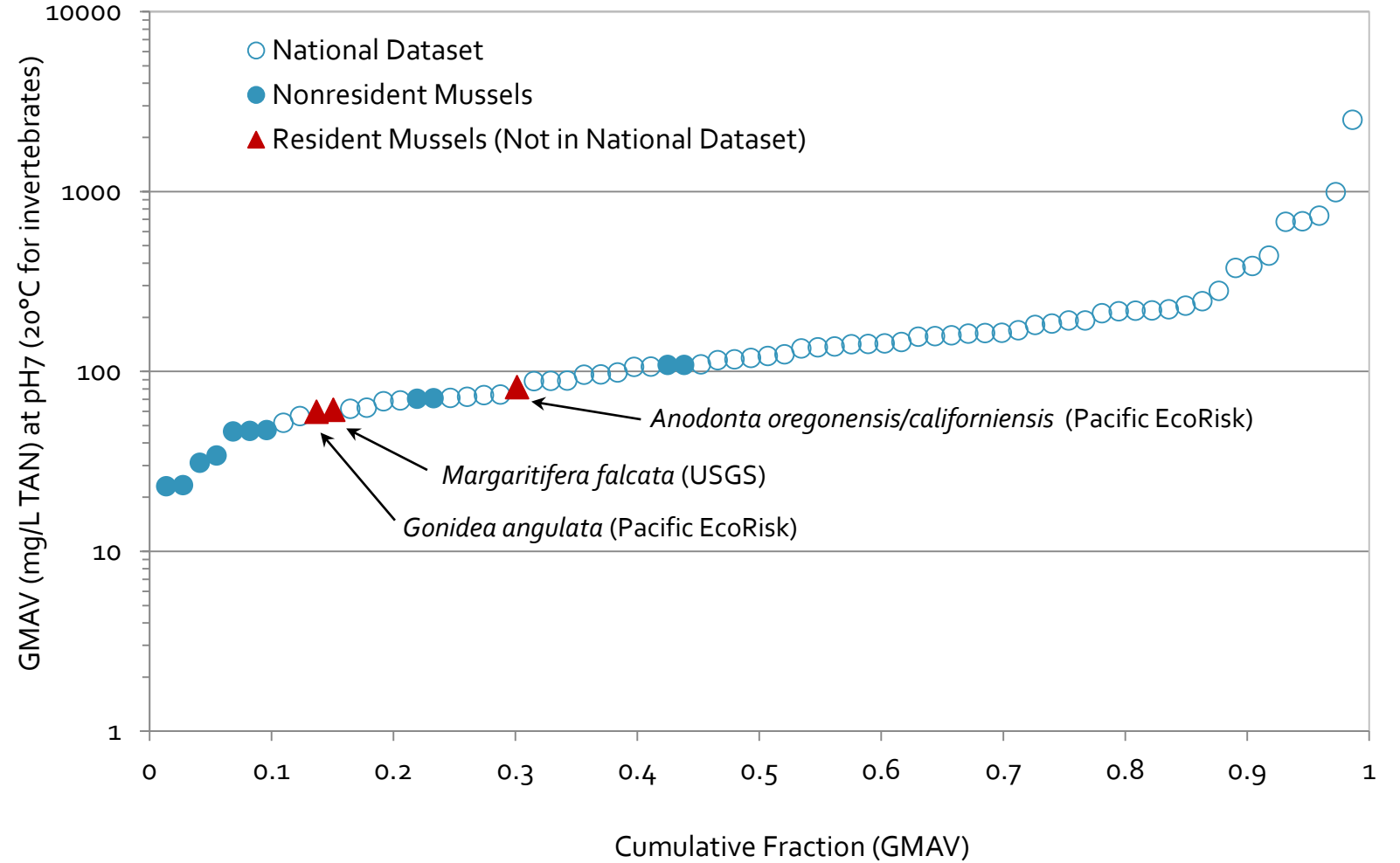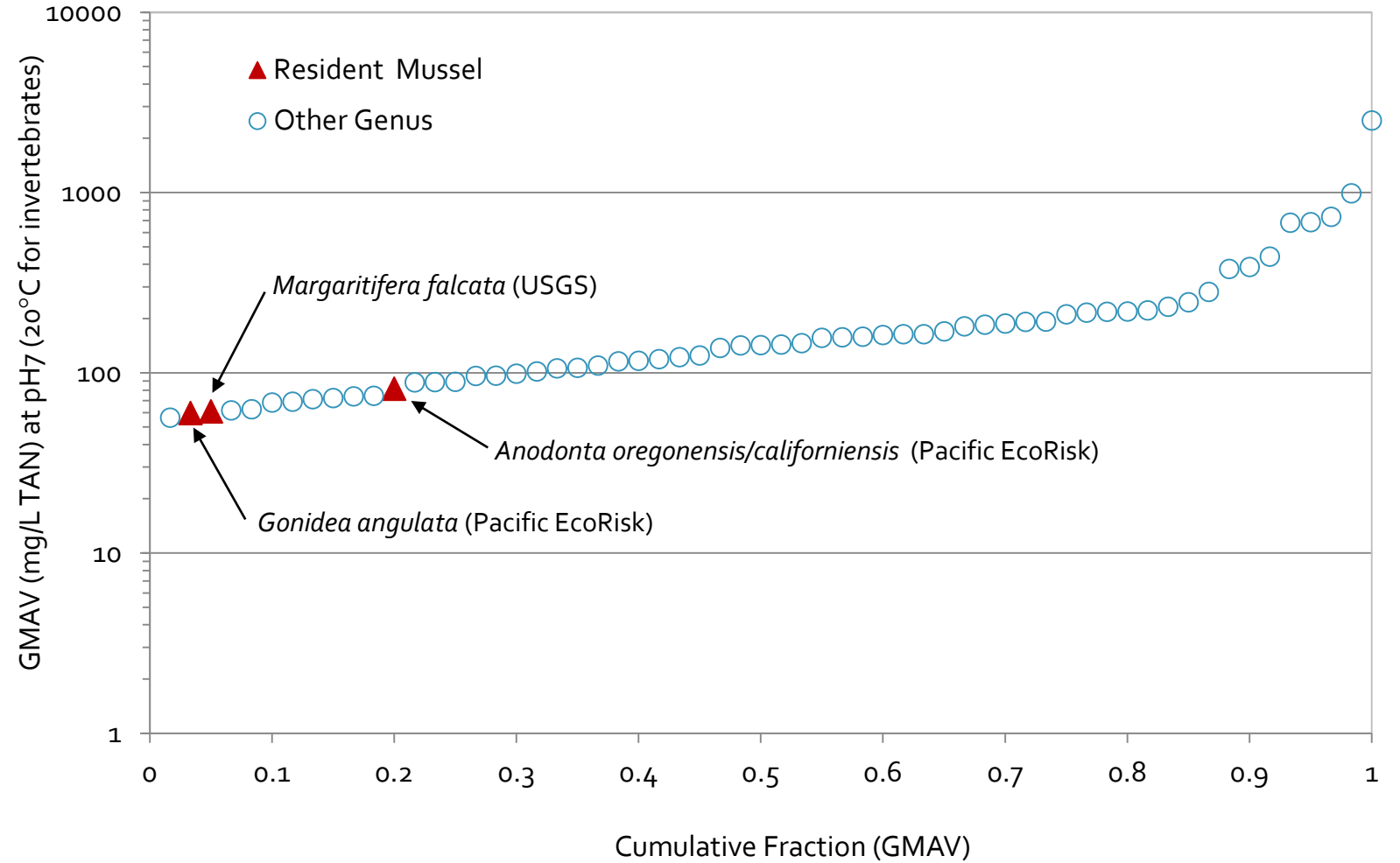
Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

Mussels Present
Acute and Chronic Criteria (mg TAN/L)

	Central Valley (pH 7, 20 °C)	EPA 2013 Criteria (pH 7, 20 °C)
Acute (CMC)	31	17
Chronic (CCC)	4.3	1.9

CMC: Criterion Maximum Concentration
CCC: Criteria Continuous Concentration

Constructing the Acute Criteria Equation
Mussels Present

$$CMC = 0.5401 \times \left(\frac{0.0114}{1 + 10^{7.204 - pH}} + \frac{1.6181}{1 + 10^{pH - 7.204}} \right) \times \text{MIN}\left(56.62, (59.81 \times 10^{0.036 \times (20 - T)})\right)$$

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

Constructing the Acute Criteria Equation
(Mussels Present)

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

$$CMC = 0.5401 \times \left(\frac{0.0114}{1 + 10^{7.204 - pH}} + \frac{1.6181}{1 + 10^{pH - 7.204}} \right) \times \text{MIN}\left(56.62, \left(59.81 \times 10^{0.036 \times (20 - T)}\right)\right)$$

Adjustment for pH
(Vertebrates and
Invertebrates)

Constructing the Acute Criteria Equation
(Mussels Present)

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

$$CMC = 0.5401 \times \left(\frac{0.0114}{1 + 10^{7.204 - pH}} + \frac{1.6181}{1 + 10^{pH - 7.204}} \right) \times \text{MIN}\left(56.62, \left(59.81 \times 10^{0.036 \times (20 - T)}\right)\right)$$

Adjustment for pH
(Vertebrates and
Invertebrates)

Adjustment for
Temperature
(Invertebrates Only)

Constructing the Acute Criteria Equation
(Mussels Present)

$$CMC = 0.5401 \times \left(\frac{0.0114}{1 + 10^{7.204 - pH}} + \frac{1.6181}{1 + 10^{pH - 7.204}} \right) \times \text{MIN}\left(56.62, \left(59.81 \times 10^{0.036 \times (20 - T)}\right)\right)$$

Protection for Temperature Invariant Fish

Adjustment for pH (Vertebrates and Invertebrates)

Adjustment for Temperature (Invertebrates Only)

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

Constructing the Acute Criteria Equation
(Mussels Present)

$$CMC = 0.5401 \times \left(\frac{0.0114}{1 + 10^{7.204-pH}} + \frac{1.6181}{1 + 10^{pH-7.204}} \right) \times \text{MIN}\left(56.62, \left(59.81 \times 10^{0.036 \times (20-T)}\right)\right)$$

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

Ratio of CMC/GMAV$_{lowest}$
(Control for Extrapolation)

Protection for
Temperature Invariant
Fish

Adjustment for pH
(Vertebrates and
Invertebrates)

Adjustment for
Temperature
(Invertebrates Only)

Final Mussels Present Acute Criteria Equations

Geographic Scope

Dataset Addition

Dataset Deletion

Site-Specific Dataset

Criteria Calculation

Criteria Equation

Mussels Present and Salmonids Absent

$$CMC = 0.5401 \times \left(\frac{0.0114}{1 + 10^{7.204 - pH}} + \frac{1.6181}{1 + 10^{pH - 7.204}} \right) \times \mathrm{MIN}\left(56.62, \left(59.81 \times 10^{0.036 \times (20 - T)} \right) \right)$$

Mussels Present and Salmonids Present

$$CMC = \mathrm{MIN} \left(\begin{array}{c} \left(\dfrac{0.275}{1 + 10^{7.204 - pH}} + \dfrac{39.0}{1 + 10^{pH - 7.204}} \right), \\ \left(0.5401 \times \left(\dfrac{0.0114}{1 + 10^{7.204 - pH}} + \dfrac{1.6181}{1 + 10^{pH - 7.204}} \right) \times \left(59.81 \times 10^{0.036 \times (20 - T)} \right) \right) \end{array} \right)$$

Additional special protection for commercially and recreationally important species

Summary

Mussels Present Criteria Comparison (mg TAN/L)

pH 7 and 20°C

Criterion	EPA 1999	EPA 2013	Central Valley
Acute (CMC)	24[a]	17	24[a]
Chronic (CCC)	4.5	1.9	4.3[a]

pH 8 and 25°C

Criterion	EPA 1999	EPA 2013	Central Valley
Acute (CMC)	5.6[a]	2.6	5.0[a]
Chronic (CCC)	1.2[b]	0.56	1.3[a]

[a] Salmonids present
[b] Early life stages present

Study Collaboration
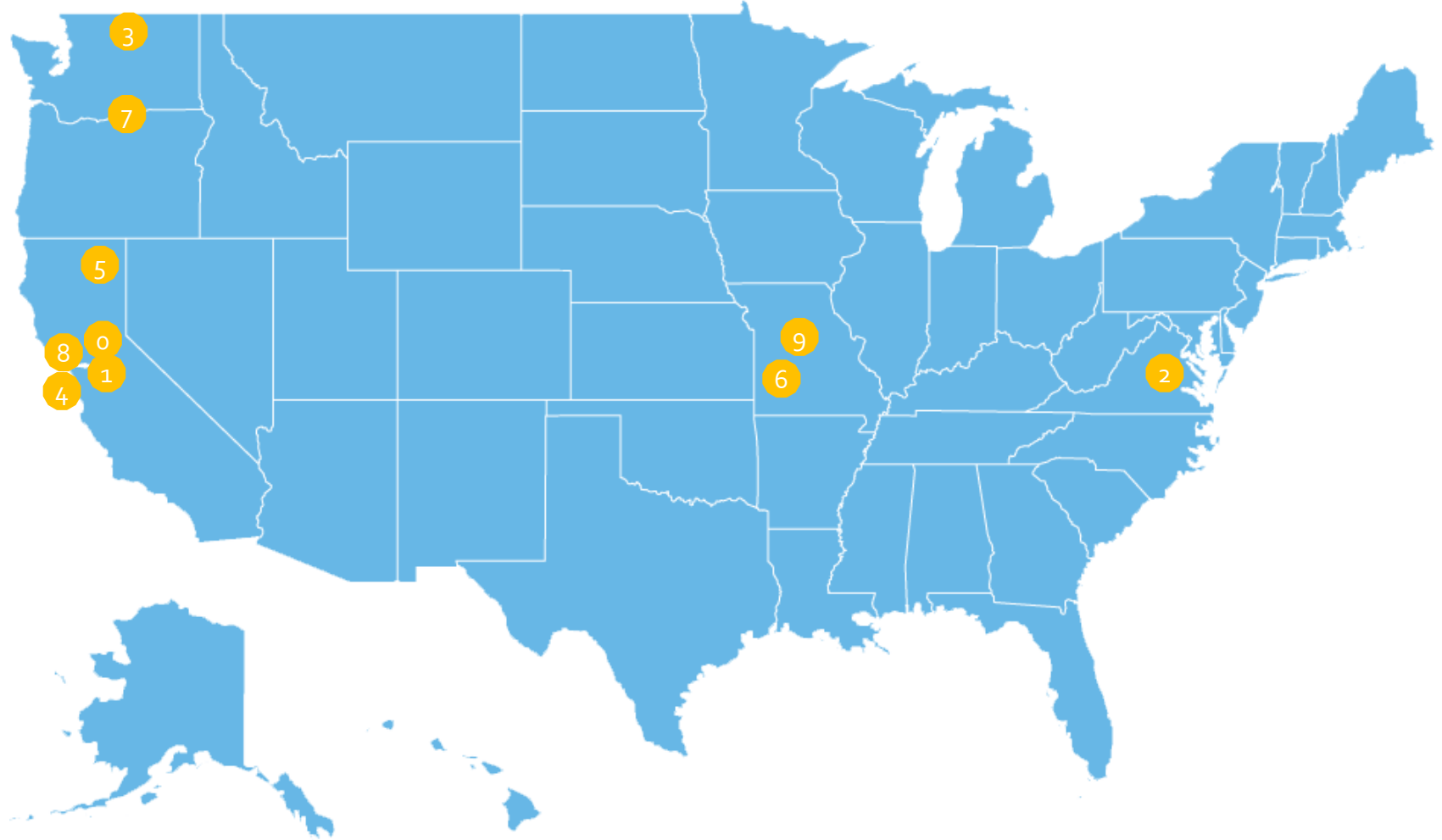
Permits
1) CDFW, 2) USFWS

Adult Collection
3) USFWS, 4) Presidio Trust, 5) Spring Rivers/Pacific EcoRisk

Juvenile Culturing
6) Missouri State University, 7) Confederated Tribes of the Umatilla Indian Reservation

Testing
8) Pacific EcoRisk, 9) USGS

Other Support
10) Nature Conservancy