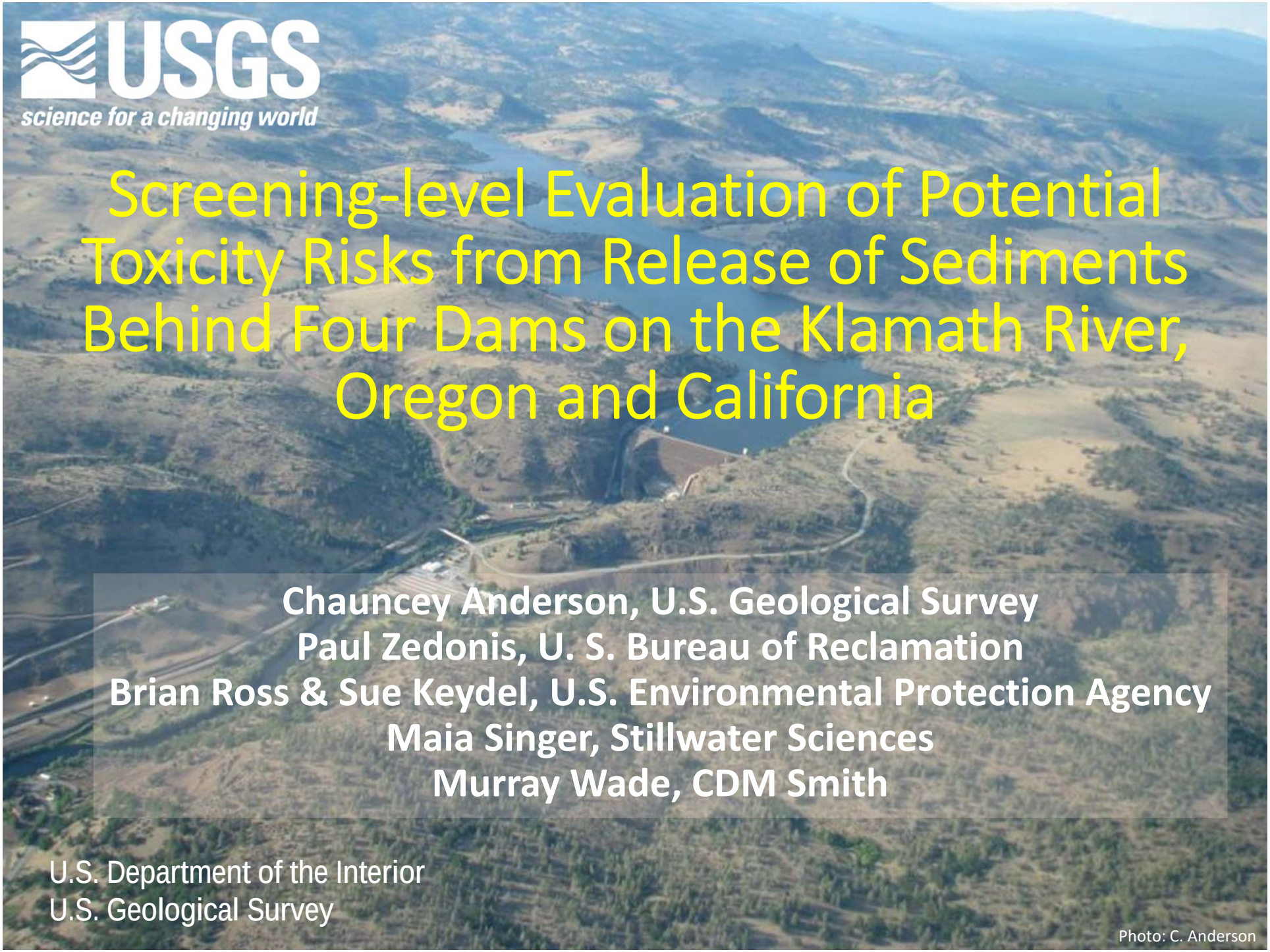

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# Screening-level Evaluation of Potential Toxicity Risks from Release of Sediments Behind Four Dams on the Klamath River, Oregon and California


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U.S. Department of the Interior
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Photo: C. Anderson

# Outline

- Contaminants and dam removals
- Review findings from *Secretarial Determination on the Removal of Four Dams on the Klamath River (2009-13)*
  - sediment transport estimates
  - Sediment Contaminant Study
- Brief update on current Klamath dam removal planning (if time)
- Dissolved-oxygen considerations of sediment release (if time)

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# Contaminants & Dam Removals

- To date, a limited number of removals where contaminants were a significant issue, & documented
  - Fort Edwards Dam, Hudson R, 1973 (Evans, 2015)
    - PCBs released, required post-removal dredging of downstream sediment.
  - Milltown Dam, 2008 (Evans and Wilcox, 2014)
    - Mining wastes (metals), including several mitigation strategies
  - Olentangy & Scioto Rivers, OH, 2012-13 (Davis et al., 2017)
    - Hg, Se, chlorinated OC's (including PCBs)
- *SOS Dam Removal Sediment Guidelines* (Randle & Bountry, 2018) provides a generalized process
- We may be approaching more dam removal situations where contaminants are present

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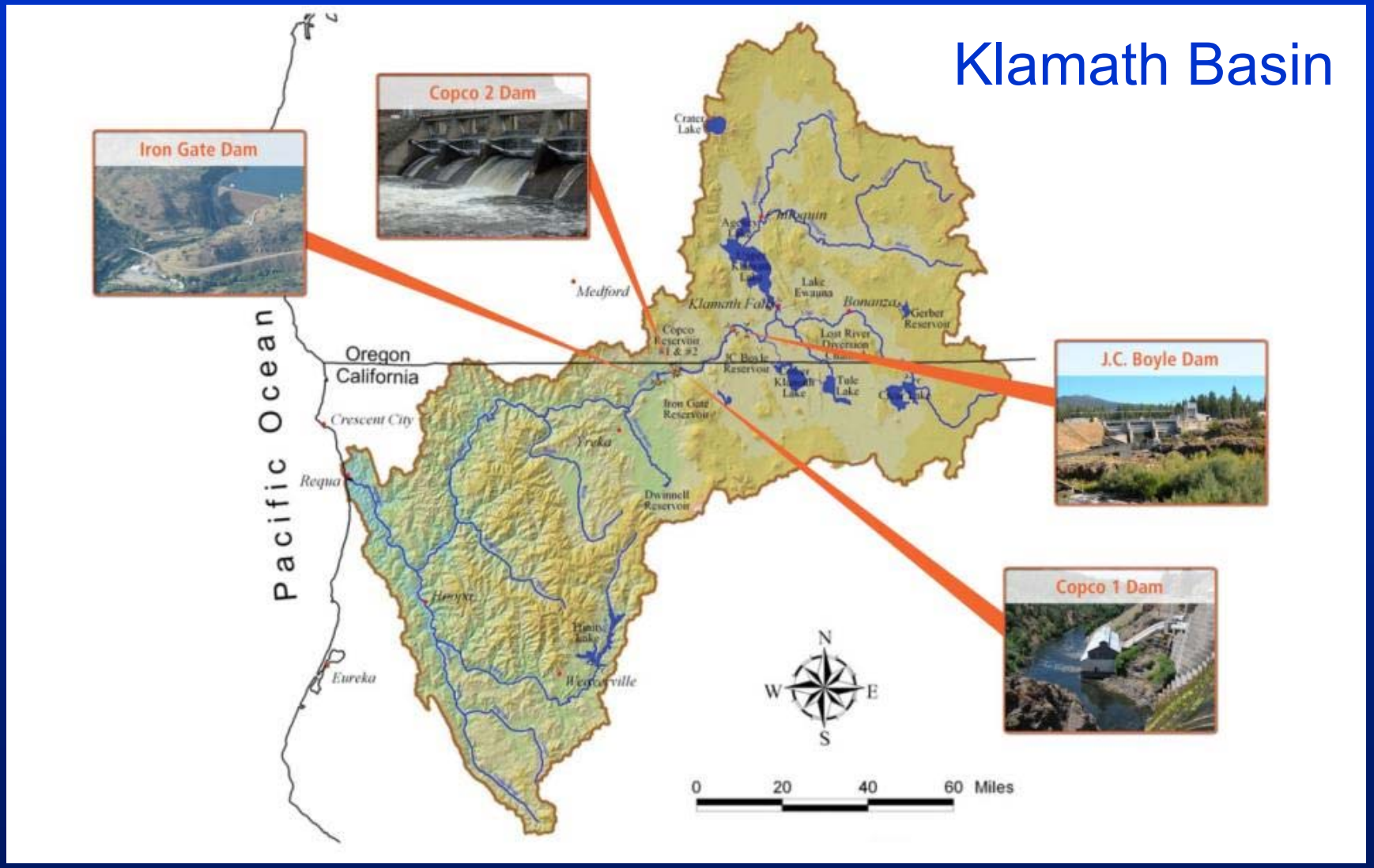
# Klamath River Basin

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# Key Factors

- Dams would all be removed in one year, beginning in November
- ~13-15 Million cubic yards of sediment
- Dredging deemed not viable. Sediments would be allowed to flush downstream during and after dam removal
- Sediments are about 70-90% fine material (silt and clay), with high organic content
- Modeling shows maximum suspended sediment concentrations of ~10,000 mg/L during winter, with ~1,000 mg/L for several months at a time, and returning to more normal levels by Fall.
- About 1/3 - 2/3 of sediments will be evacuated from reservoirs. Sediments are expected to mostly flush through the system rapidly with little deposition until reaching marine environment
- Fish mortality expected to be high in first year due to physical effects of sediments

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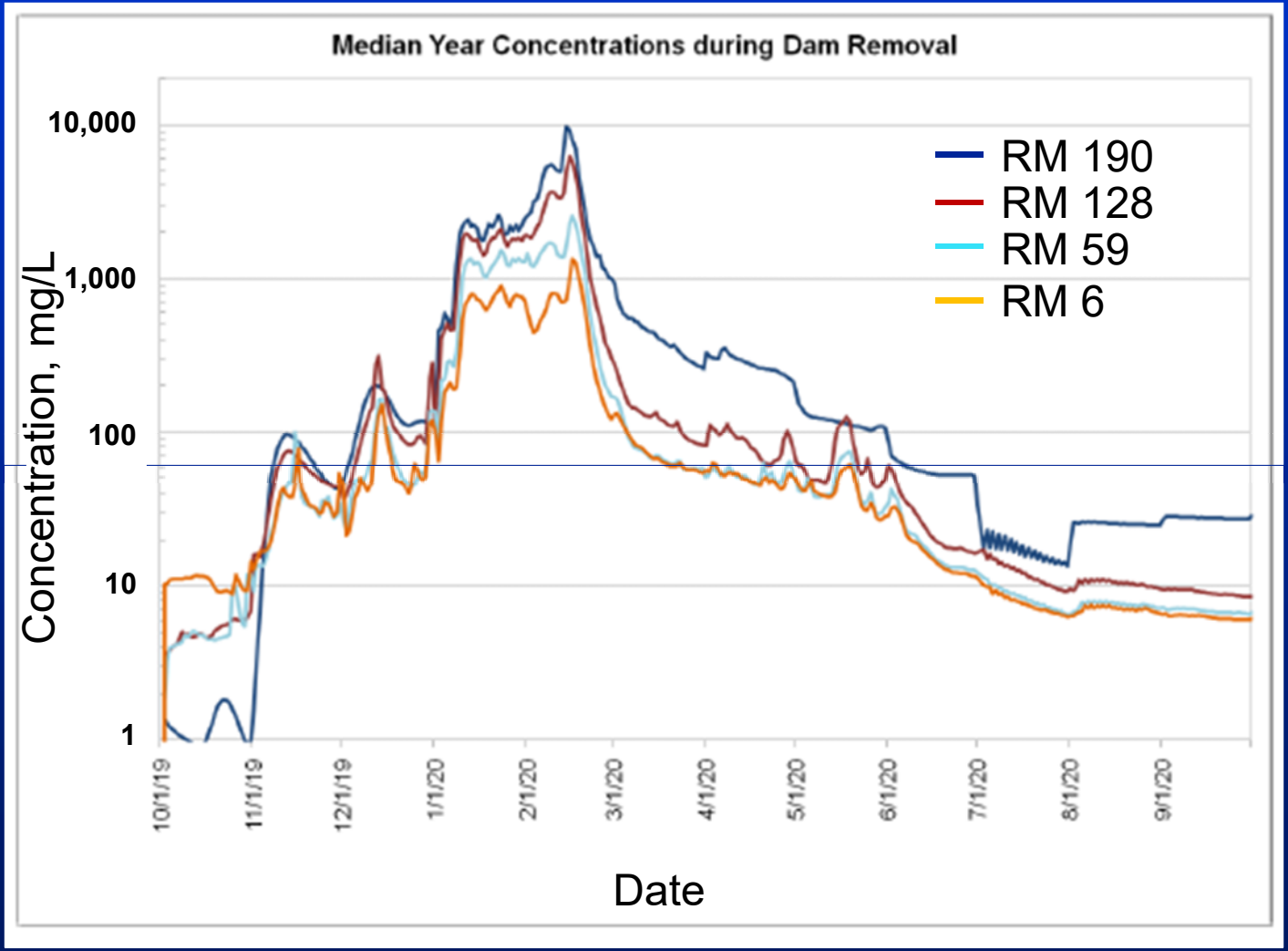
# Modeled TSS Concentrations during Dam Removal (Median Hydrology)

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Source: Bureau of Reclamation, 2011

# Klamath Reservoir Sediment Chemistry Study, 2009-2010

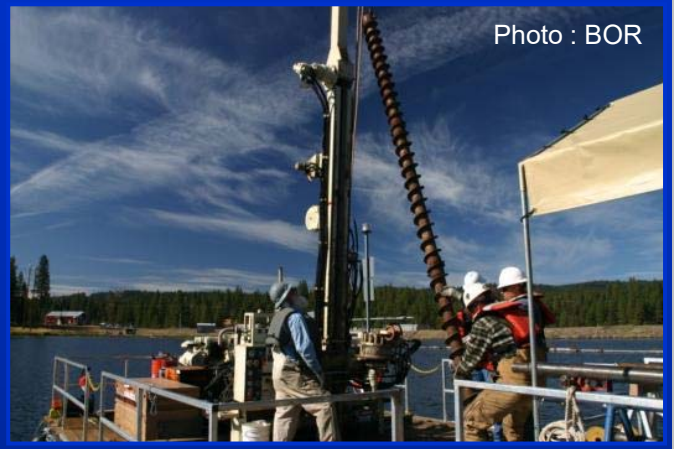
Photo : BOR

- Sampling led by Reclamation & Informed by:
  - Input from States & other agencies
  - Results from preliminary study in 2006
  - Early drafts of Dam Removal Sediment Analysis Guidelines
- 77 samples from 3 reservoirs + estuary
- Broad range of chemicals analyzed
  - Dioxins/furans, PCBs, OCs, VOCs, SVOCs, PAHs, PBDEs, metals, Hg, conventionals (TOC, nutrients, grain size)

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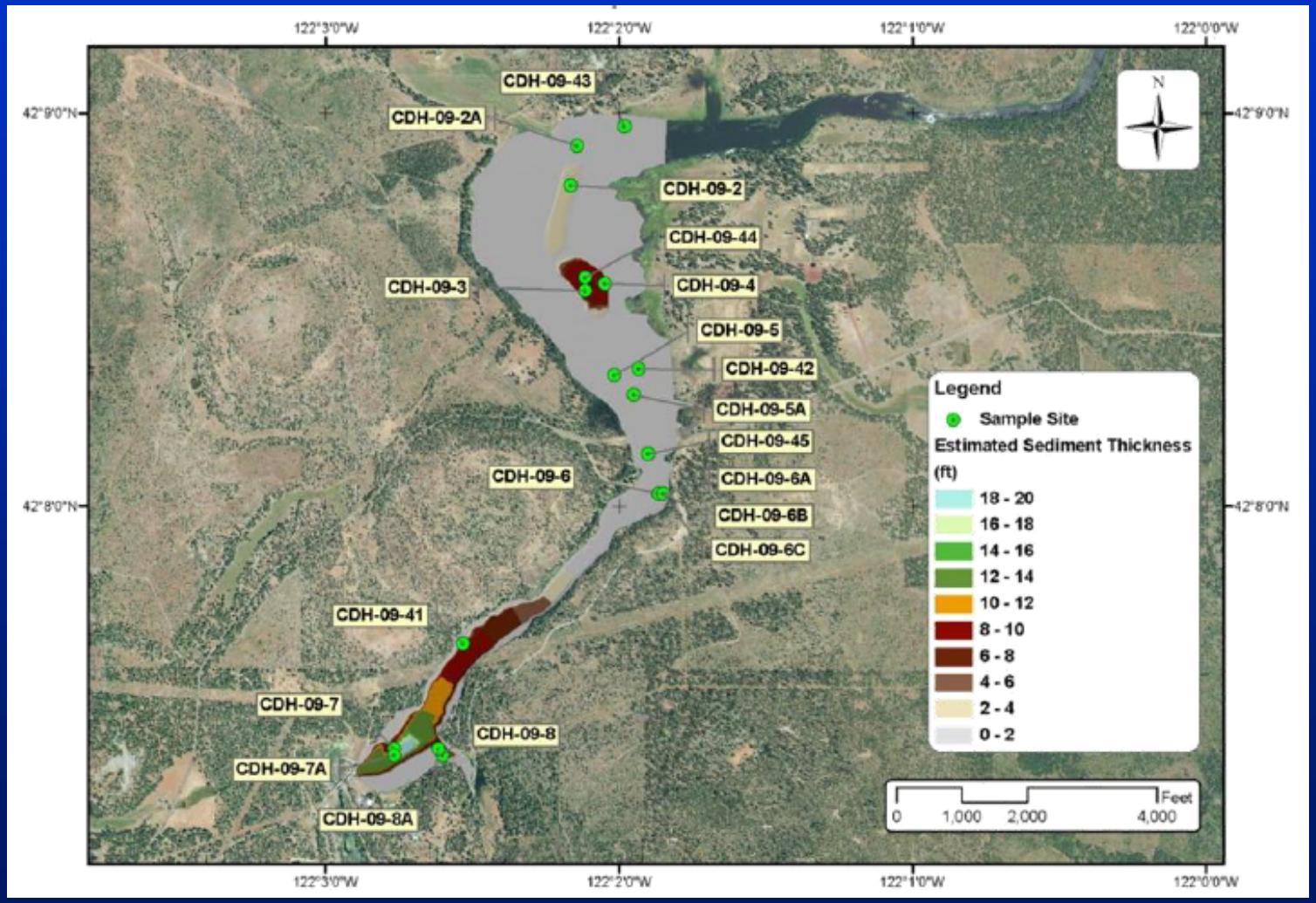
# J.C. Boyle Sampling Sites

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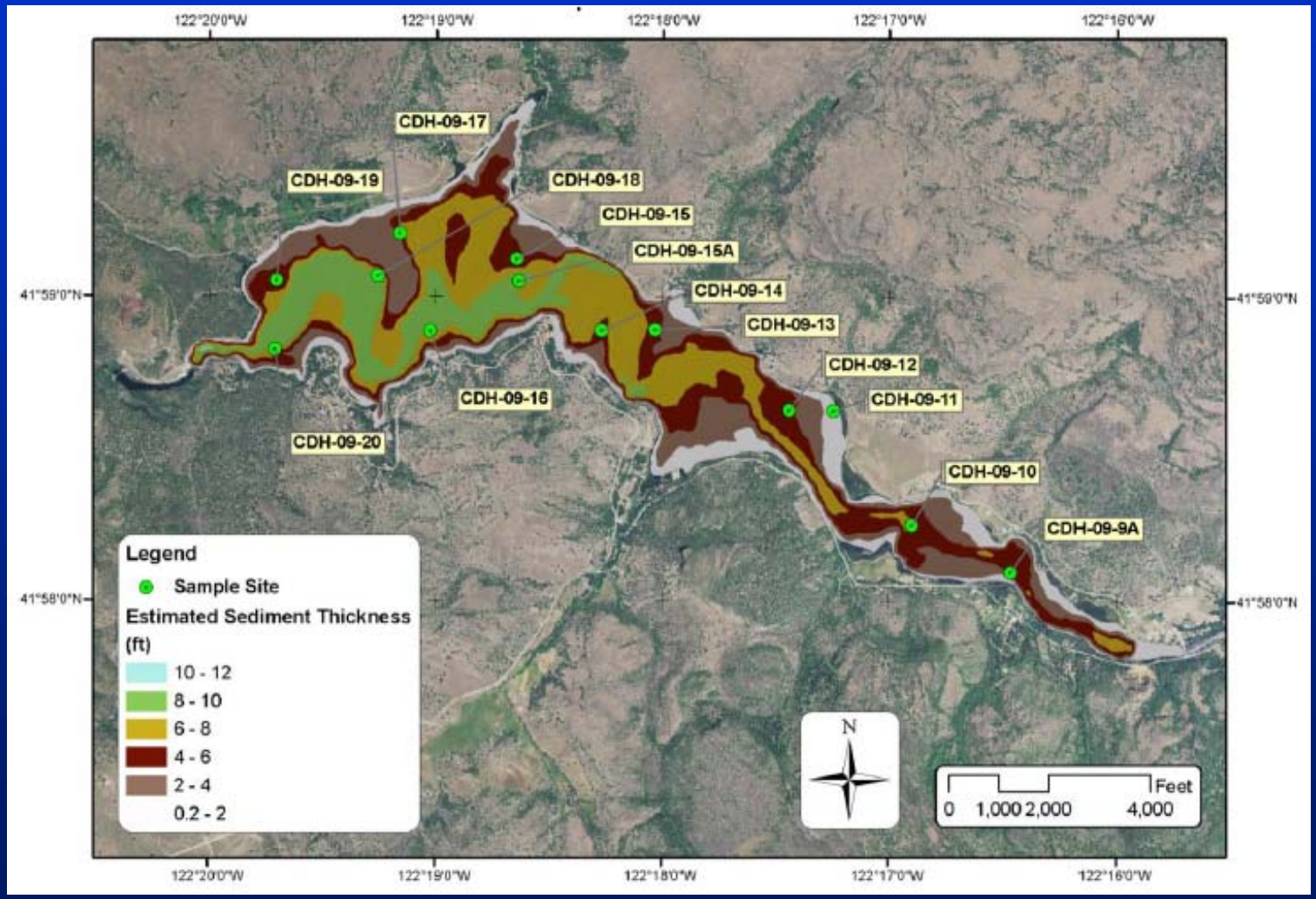
Source: CDM et al., 2013

# Copco 1 Sampling Sites

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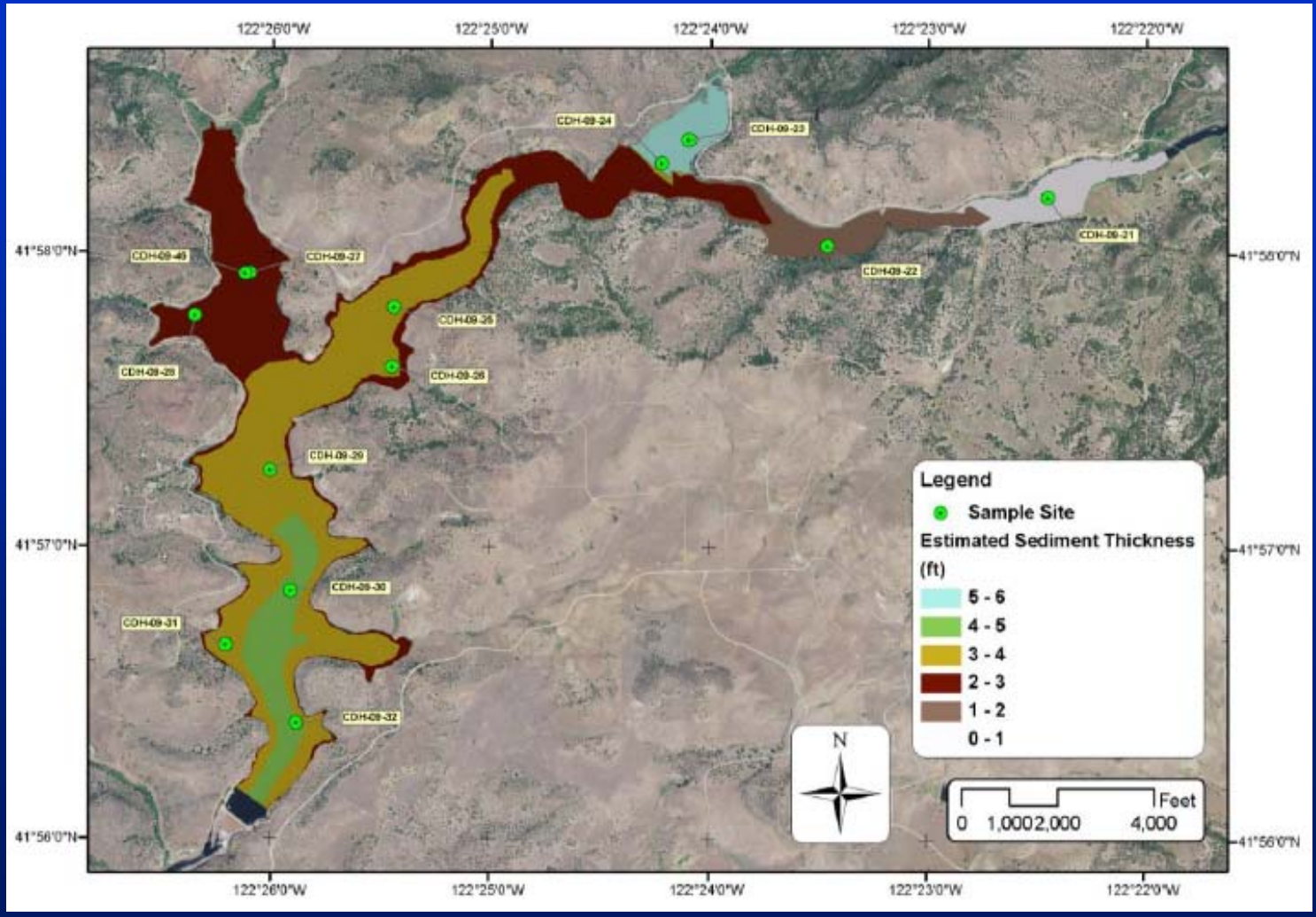
Source: CDM et al., 2013

# Iron Gate Sampling Sites

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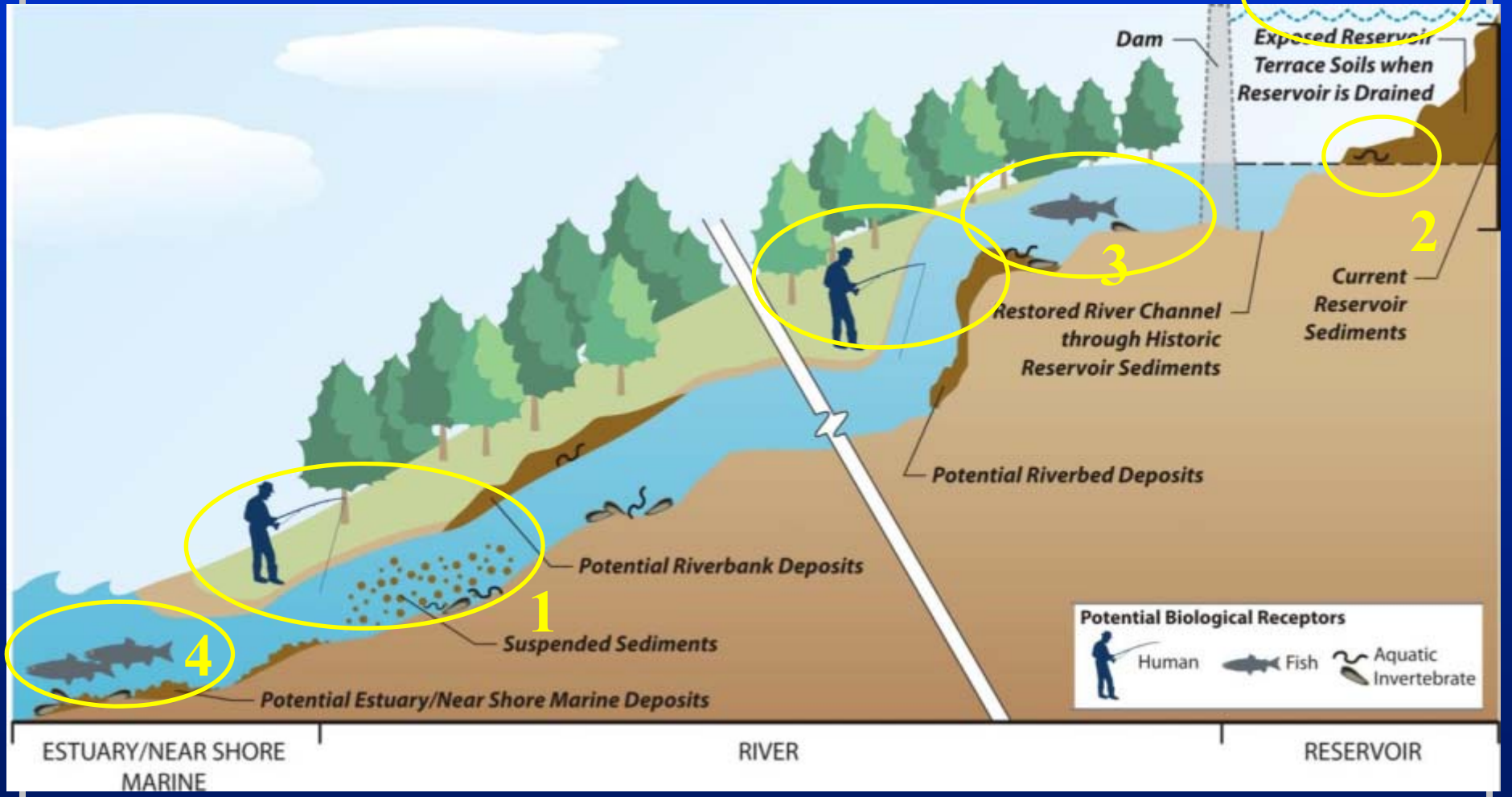
Source: CDM et al., 2013

# Five Potential Exposure Pathways Evaluated

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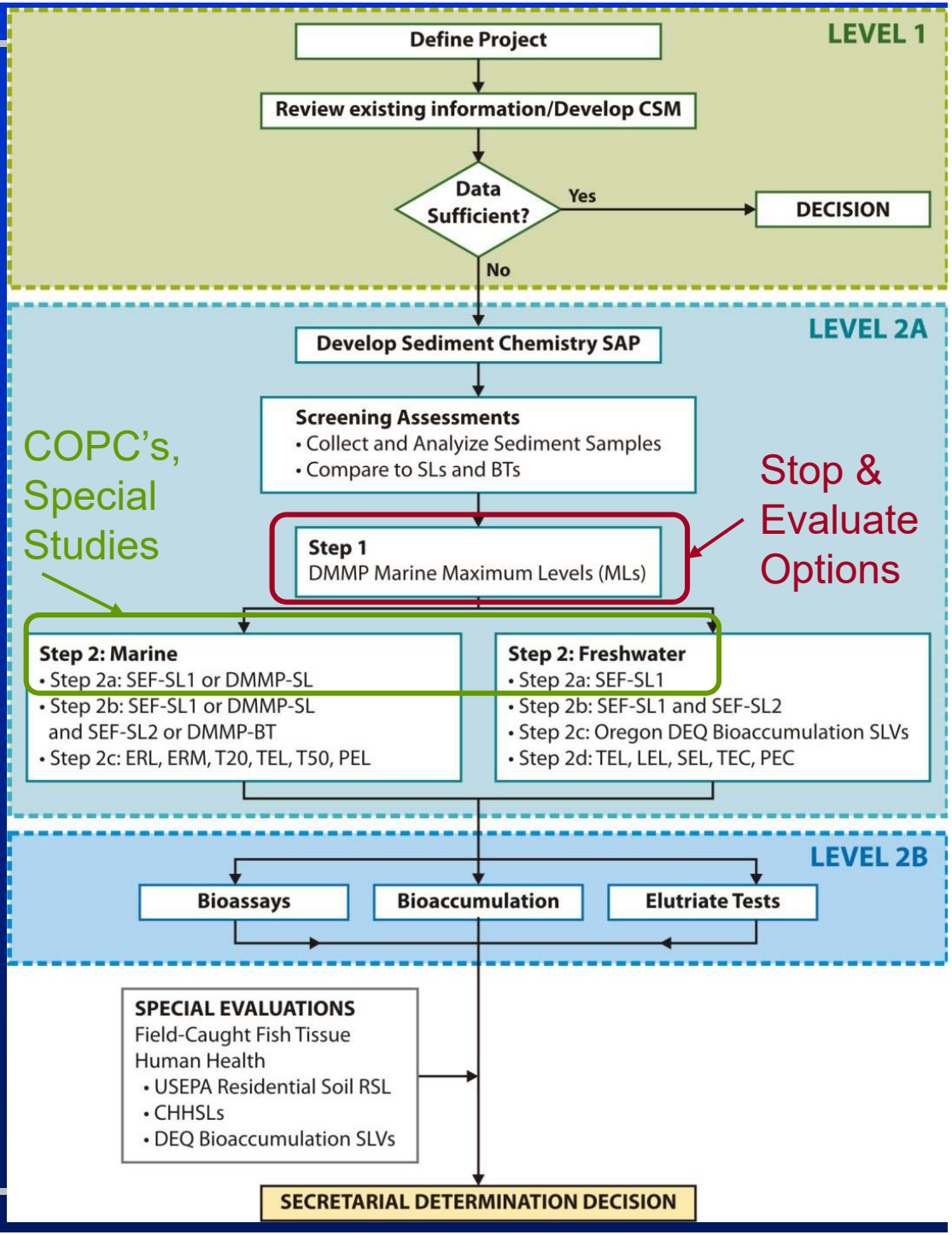
Source: CDM et al., 2013

# Sediment Evaluation Framework (SEF)

- Common, step-wise approach to sediment disposal decisions in the PacNW
- Comparisons to guidelines from Dredge Materials Management Program (DMMP), SEF, and Oregon's Sediment Bioaccumulation Screening Level (BSLV)
- Adapted for Klamath dam removal needs

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# Application of Lines of Evidence to Exposure Pathways

| Line of Evidence | Exposure Pathways | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **SEF Level 2A Step 1** | | | | | |
| 1. DMMP Marine MLs | | | | + | |
| **SEF Level 2A Steps 2a, 2b, 2c, 2d** | | | | | |
| 2. Ecological SLs (freshwater and marine) | | | + | + | + |
| 3. Ecological TEQ SLVs (sediment) | | | + | + | + |
| **SEF Level 2B** | | | | | |
| 4. Elutriate WQC (ecological) | + | | | + | |
| 5. Chironomus Bioassay | | | + | + | + |
| 6. Hyalella Bioassay | | | + | + | + |
| 7. Trout Bioassay | + | | | + | |
| 8. Corbicula Bioaccumulation Study/BSAF | | | + | | + |
| 9. Lumbriculus Bioaccumulation Study/BSAF | | | + | | + |
| 10. Corbicula Tissue TRV | | | + | + | + |
| 11. Lumbriculus Tissue TRV | | | + | + | + |
| **Special Evaluations –Human Health in Sediment and Fish Tissue** | | | | | |
| 12. Perch Tissue TRV (ecological) | | | + | + | + |
| 13. Bullhead Tissue TRV (ecological) | | | + | + | + |
| 14. Fish Tissue TEQ (ecological) | | | + | + | + |
| 15. HHSLs | | + | + | | + |
| 16. HH TEQ SLVs (sediment) | | + | + | | + |
| 17. Elutriate WQC (human health) | | | | | |
| 18. Perch Tissue TRV (human health) | | | + | | + |
| 19. Bullhead Tissue TRV (human health) | | | + | | + |
| 20. Fish Tissue TEQ (human health) | | | + | | + |

+, Applicable to pathway

**ML**: maximum level

**SL**: screening level

DMMP: Dredged Material Management Program

**TEQ**: Toxic Equivalency

**SLV**: Screening Level Value

**TRV**: Toxicity Reference Value

**BSAF**: Biota-Sediment Accumulation Factor

**HHSL**: Human Health Screening Level

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# Chemicals of Potential Concern (COPCs)

- Compiled iteratively based on exceedances of screening levels and guidelines throughout the SEF process
- Included ambiguous results
  - No guidelines available but of concern to stakeholders
  - Chemicals not detected but reporting levels > guideline values)
- Led to inclusion in bioaccumulation studies (lab exposures with invertebrates, field caught reservoir fish)
- Evaluate COPCs in Exposure Pathways

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# COPC Results

- No DMMP-ML's exceeded
- Fresh Water SL-1 sediments:
  - Reservoirs: Ni, dieldrin, DDx, dioxin (2,3,7,8-TCDD), Fe
  - Estuary: Cr, Ni, Fe, bis(2-ethylhexyl)phthalate
- Oregon BSLVs
  - Reservoirs: As, Ni, DDx, 13 dioxin/furan congeners, dieldrin
  - Estuary: As, Ni
- Elutriates: No COPCs after accounting for dilution during dam removal
- Lab bioassays: No COPCs

Photo: BOR

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# Summary of Sediment Chemistry Effects for Five Exposure Pathways

| | Exposure Pathway | | Ma… Biota | Terrestrial Biota | Humans |
|---|---|---|---|---|---|
| 1 | Short term; suspended sediments | 🟢 | 🔵 | ▬ | ▬ |
| 2 | Long term; exposed river ban… deposits | ▬ | ▬ | ⚫ | 🔵 |
| 3 | Long term; new river c… deposits | 🔵 | ▬ | ▬ | 🔵 |
| 4 | Long term; marin… | ▬ | 🔵 | ▬ | ▬ |
| 5 | Long term; re… (Dams-In) | 🟢 | ▬ | ▬ | 🟢 |

Bottom Line – No Significant Adverse Effects

- ⚫ No Adv…
- 🔵 On… present, adverse effect unlikely
- 🟢 One … icals present, limited adverse effect possible
- 🔴 At least … hemical detected with potential for significant adverse effect
- ▬ Exposure pathway incomplete or insignificant

# Summary of Klamath Reservoir Sediment Chemistry Studies

- Sediment Evaluation Framework (SEF) for dredged materials disposal was appropriate structure for reservoir sediment contaminant evaluation
- Multiple lines of evidence including biotic and lab tests
- No major differences between reservoirs or other spatial patterns
- For some exposure pathways, one or more chemicals are present at concentrations that could cause an adverse impact
- No chemicals are present at levels that would preclude their release downstream (EPA concurs)

Photo: USFWS

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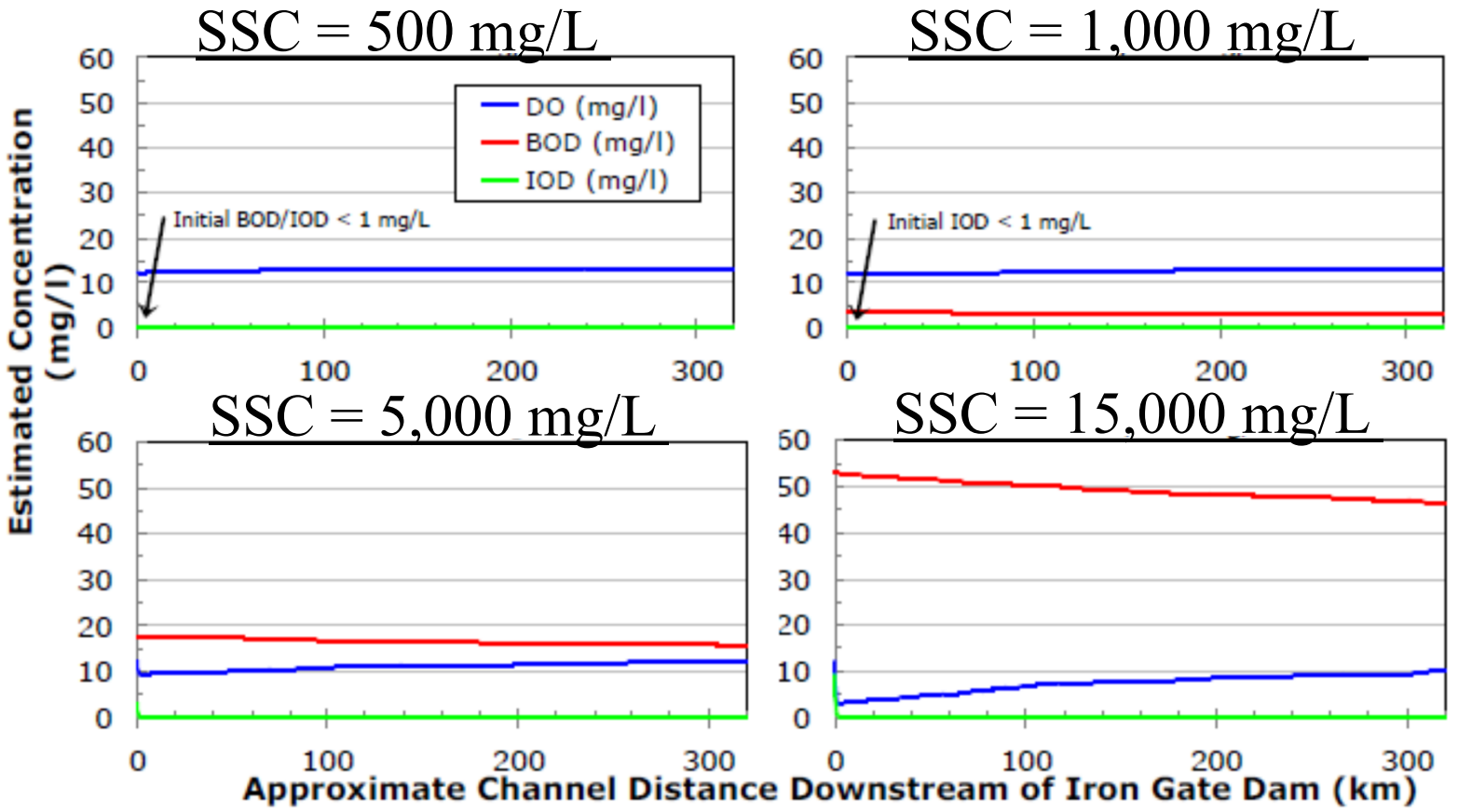
# Oxygen Demand – Data Collection


# DO Depletion is Highly Dependent on Sediment Concentrations, Incoming DO




Uses “Median Hydrology (1976)” Flow assumptions and modeled sediment concentrations

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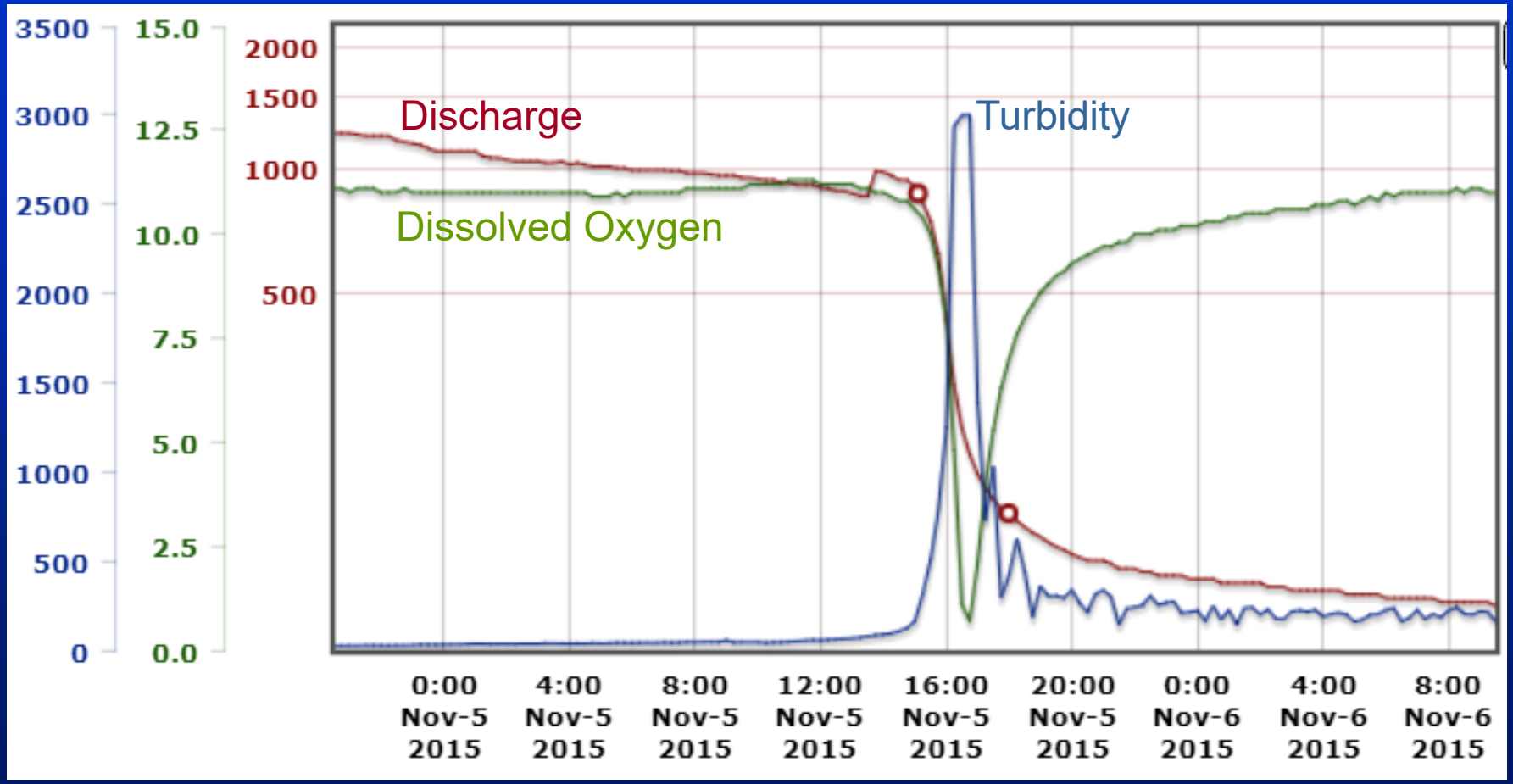
Source: Stillwater Sciences, 2011

# DO Depletion during Drawdown at Fall Creek, Oregon




https://waterdata.usgs.gov/nwis/uv?site_no=14151000

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# Thank You

## KlamathRestoration.gov


**References:**

CDM and Stillwater Sciences, 2011, Screening-Level Evaluation of Contaminants in Sediments from Three Reservoirs and the Estuary of the Klamath River, 2009-2011: Prepared for U.S. Department of Interior, Klamath Dam Removal Water Quality SubTeam, Klamath River Secretarial Determination, Sacramento, CA. 155 pp + appendixes, available at *KlamathRestoration.gov*

BOR, 2011, Analysis, and Quality Assurance Findings for Klamath River Reservoirs and Estuary, October 2009 – January, In Support of the Secretarial Determination on Klamath River Dam Removal and Basin Restoration, Klamath River, Oregon and California: U.S. Bureau of Reclamation, Sacramento, CA., 53 pp. + appendixes available at *KlamathRestoration.gov*

Shannon & Wilson, Inc. 2006a. Upland Contaminant Source Study. Submitted to California State Coastal Conservancy. Appendix A of GEC (2006), Klamath River Dam and Sediment Investigation


Photo: C. Anderson

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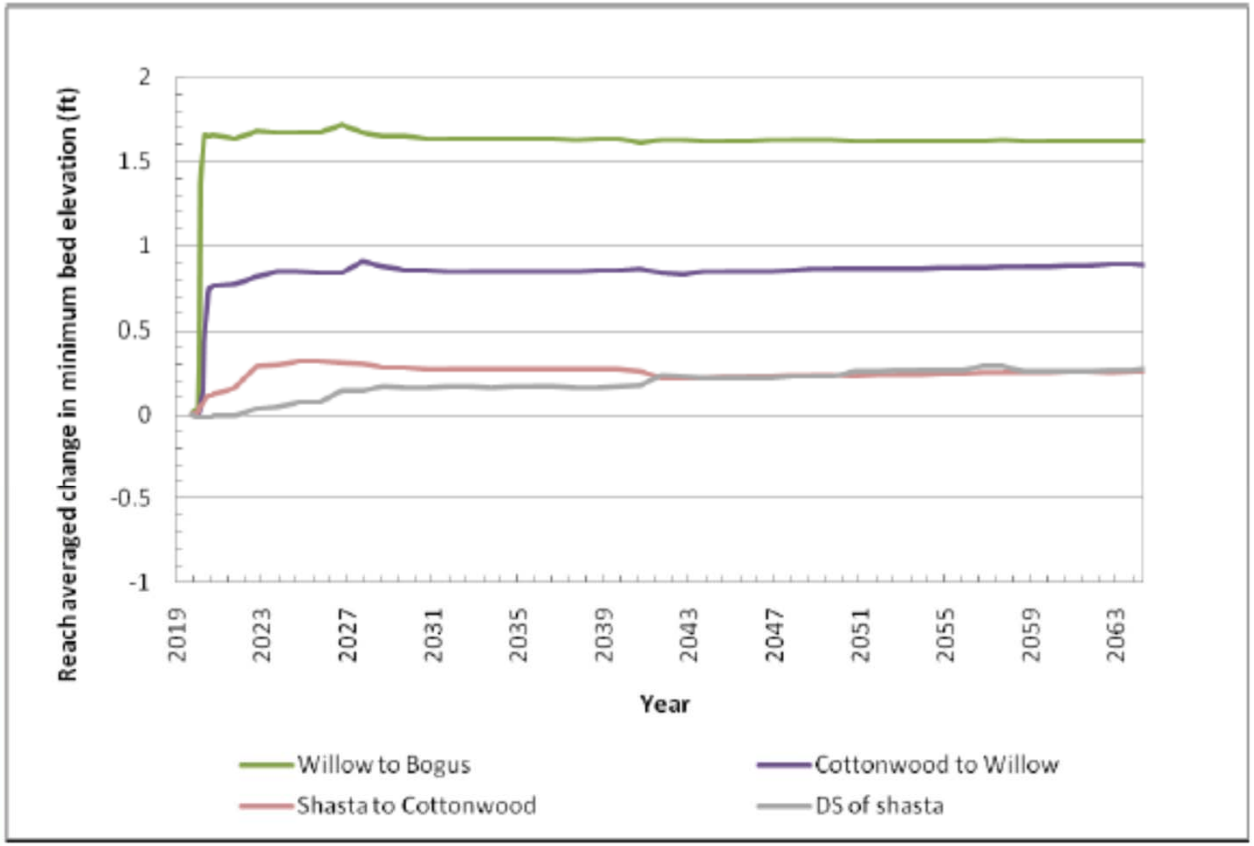


Figure 9-29. Reach Averaged Deposition from Iron Gate to Shasta River for Scenario 8. Median Start Year.

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