CDFW Guidance on Fish Passage and Stream Restoration

- ***Fish Bulletin 183: The Use of Boulder and Log Weirs in Stream Habitat Restoration***
- ***Fish Bulletin 184: The Use of Large Wood in Stream Habitat Restoration***
- ***Fish Bulletin 185: The Use of Low-Tech Process-Based Stream Habitat Restoration***

CONSERVATION ENGINEERING BRANCH

Kristine M. Pepper, PE – Senior Hydraulic Engineer

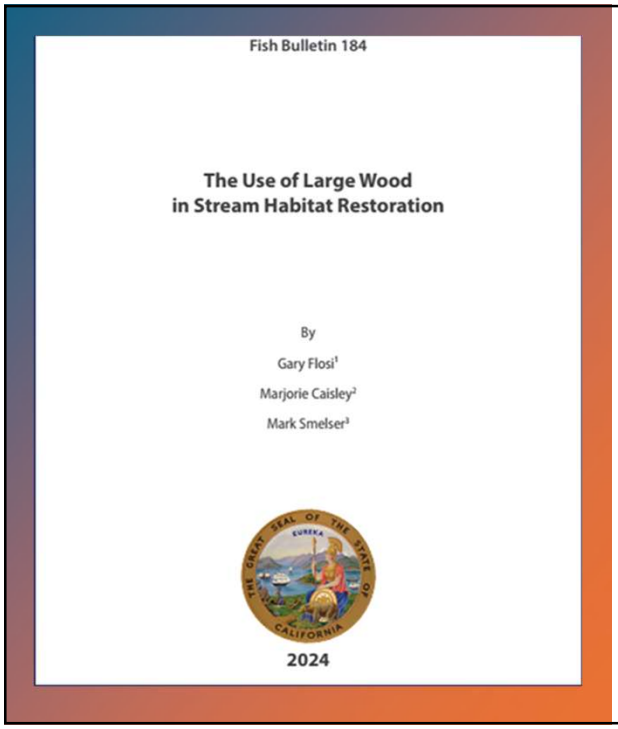
1

Fish Bulletins and Manual Updates

Proposed new restoration manual chapters as prioritized in 2015:

- ***Boulder and Log Weirs (FB 183)***
- ***Large Wood (FB 184)***
- ***Beaver Dam Analogs / Low-Tech Process-Based Stream Habitat Restoration (FB 185)***
- *Off-channel and Side Channel Habitat*
- *Boulder Clusters*
- *Floodplain Connectivity*
- *Water Conservation*
- *Gravel Augmentation*
- *Estuary Restoration (including tide gates)*
- *Meadow Restoration*
- *Small Dam Removal*
- *Stream Bank Stabilization*
- *Diversion Improvement (includes fish screens)*

2



Fish Bulletins

Intention

- Signal CDFW support for these methods where appropriate
- Provide practitioners and Dept staff guidance: planning, design, implementation and monitoring of techniques in CA
  - Focuses on structural interventions
  - Points towards other resources

Not intended

- Not a permitting/grant review checklist

3

Outline

- Purpose/goal of each Fish Bulletin
  - Roles/Context/Need
  - Illustrations of techniques
- Project development
  - Geomorphic context
  - Risk factors
  - Site characterization
  - Construction considerations
  - Project design
  - Project implementation
  - Evaluation, maintenance, and monitoring
  - References

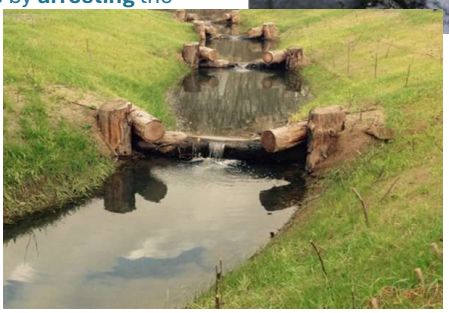
Garcia River May, 2023
Photo credit: TNC

4

FB183: The Use of Log and Boulder Weirs in Habitat Restoration

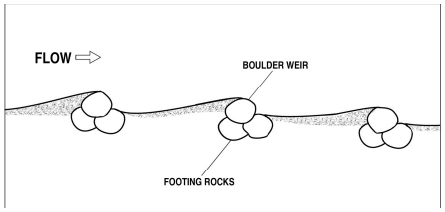
Log and boulder weir goals:

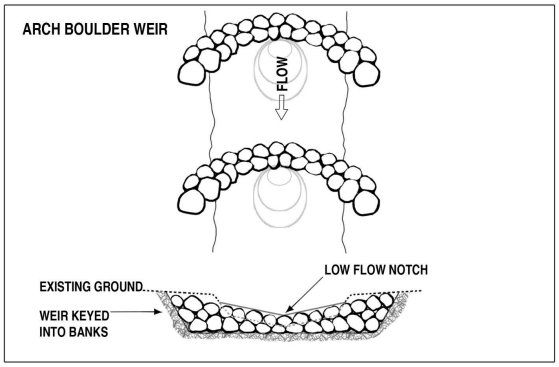
- Improve fish passage at barriers by **backwatering** the stream reach.
- **Control connection** to off-channel and side-channel habitat features.
- **Raise the bed** of an incised stream to **reconnect** it with its floodplain.
- Maintain upstream channel characteristics by **arresting** the upstream **migration of a head-cut.**
- Provide **fish cover** from predators.
- Provide **thermal refugia**.
- Increase invertebrate production.
- Increase **dissolved oxygen** saturation.
- Provide low velocity **resting areas**.
- Create **spawning habitat**.



5

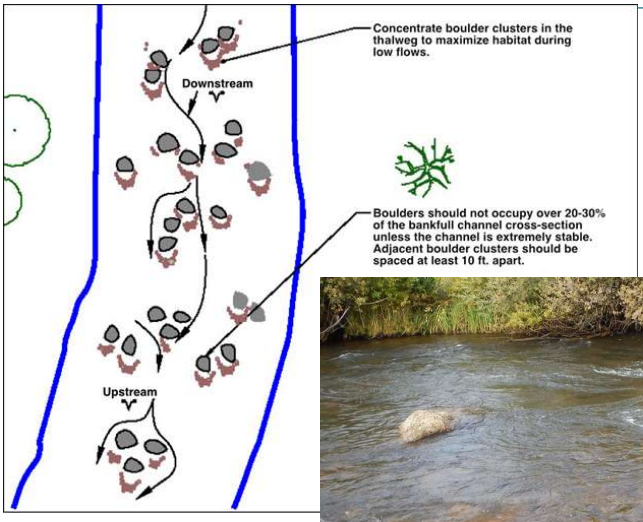
FB183: The Use of Log and Boulder Weirs in Habitat Restoration



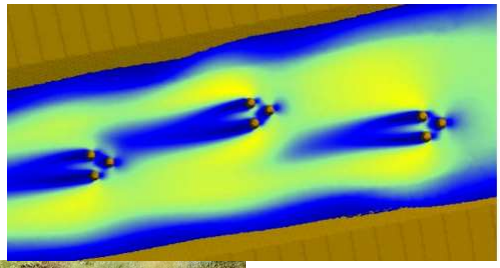


6

FB183: The Use of Log and Boulder Weirs in Habitat Restoration



Boulder Clusters

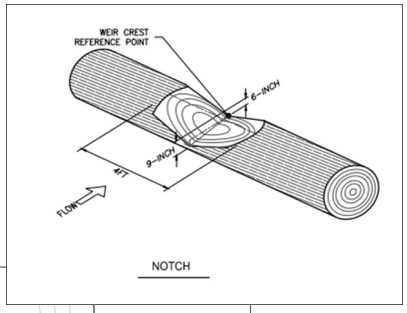


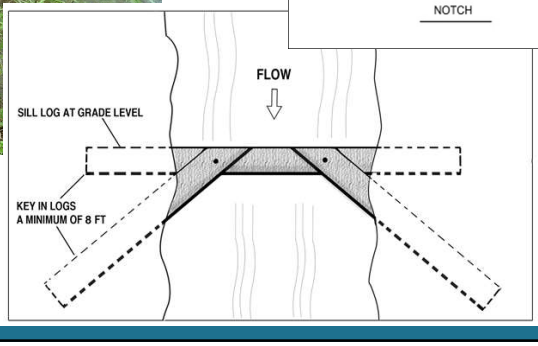
2D model
Velocity shadow

7

FB183: The Use of Log and Boulder Weirs in Habitat Restoration

Straight log weir with low flow notch.
Photo credit: Trevor Tollefson

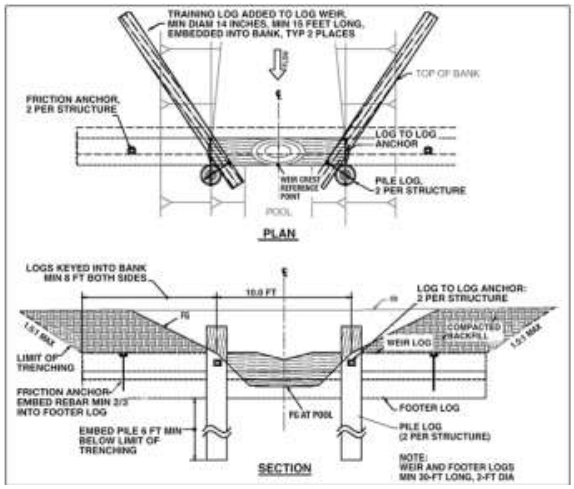




8

FB183: The Use of Log and Boulder Weirs in Habitat Restoration

Horizontal log weirs with guide logs in series

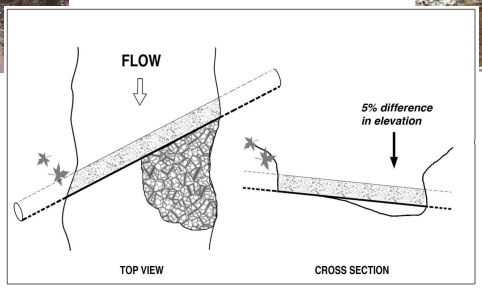


9

FB183: The Use of Log and Boulder Weirs in Habitat Restoration

Pitched log weir. Photo credit: Michael Love.

Single log diagonal weir



Diagonal log weirs in series. Photo credit: Sanctuary Forest.

10

FB184: The Use of Large Wood in Habitat Restoration

Large Wood goals:

- **Control connection** to off-channel and side-channel habitat features.
- **Raise the bed** of an incised stream to **reconnect** it with its floodplain.
- Provide **fish cover** from predators.
- Provide **thermal refugia**.
- Increase invertebrate production.
- Increase **dissolved oxygen** saturation.
- Provide low velocity **resting areas (refugia)**.
- Create **spawning habitat**.

11

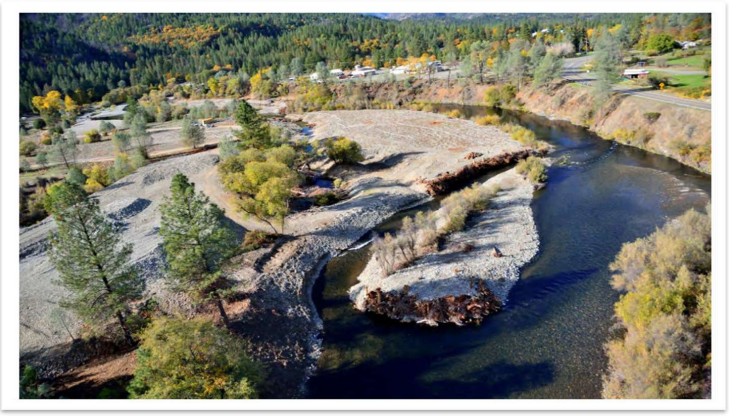
FB184: The Use of Large Wood in Habitat Restoration

Incised , exposed bedrock, plain bedform, disconnected floodplain, high stream power = continued incision

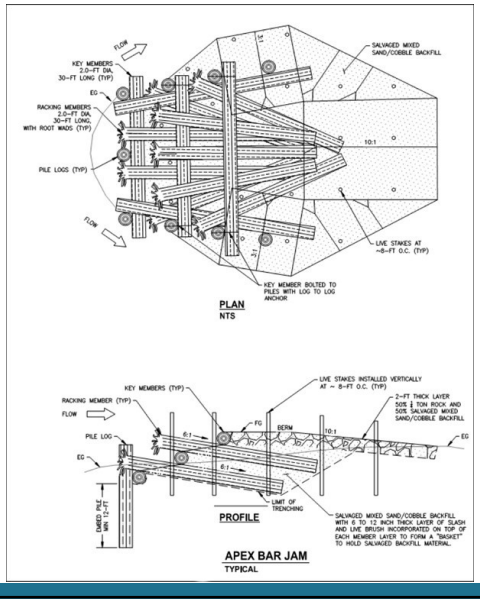
Large wood – simple structure.
Photo credit: Scott Monday, CDFW R1.

12

FB184: The Use of Large Wood in Habitat Restoration



Apex bar jam redirecting flow into a side channel.
Photo credit: David Bandrowski, Yurok Tribe.



Construction details of a typical apex bar jam (Michael Love & Associates (2016).

13

FB184: The Use of Large Wood in Habitat Restoration

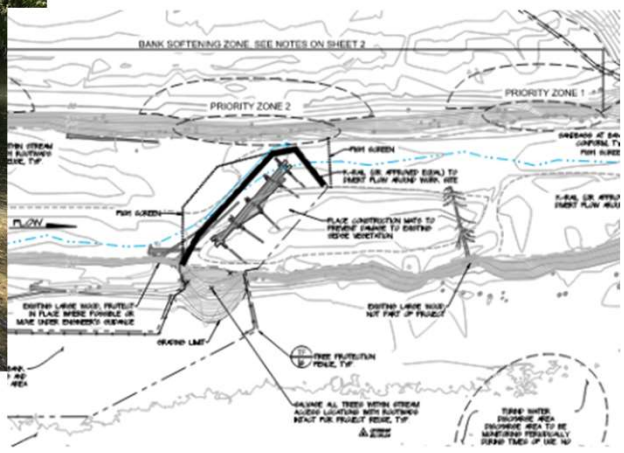
Vertical logs used for weaving angled logs rather than for structural stability.
Photo credit: Clackamas Soil and Water Conservation District.

Combination of native streambank material, boulders, and logs used as ballast.

14

FB184: The Use of Large Wood in Habitat Restoration

- Large wood structure – deflector jam
  - Purpose to induce bank erosion



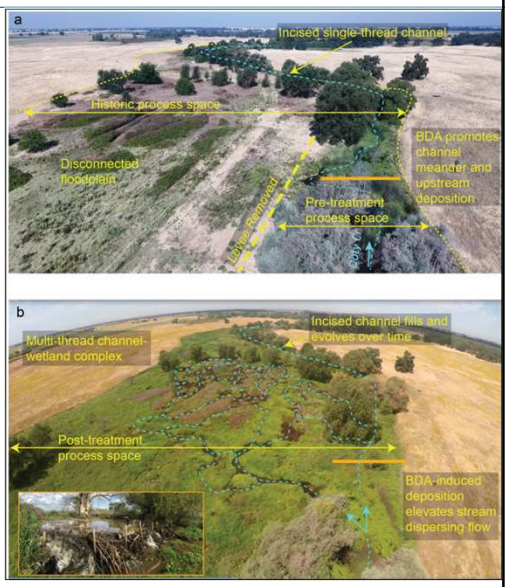
15

FB185: The Use of Low-Tech Process-Based Stream Habitat Restoration

LTPBR Concepts/Principles

1. **Streams need space**
2. **Structure forces complexity and builds resilience**
3. The importance of structure varies
4. Inefficient conveyance of water is often healthy
5. **It is okay to be messy**
6. There is strength in numbers
7. Use natural building materials
8. **Let the system do the work**
9. **Defer decision making to the system**
10. Self-sustaining systems are the solution

(Wheaton et al. 2019)



Doty Ravine
Photo: Cioltti et al. (2021)

16

FB185: The Use of Low-Tech Process-Based Stream Habitat Restoration

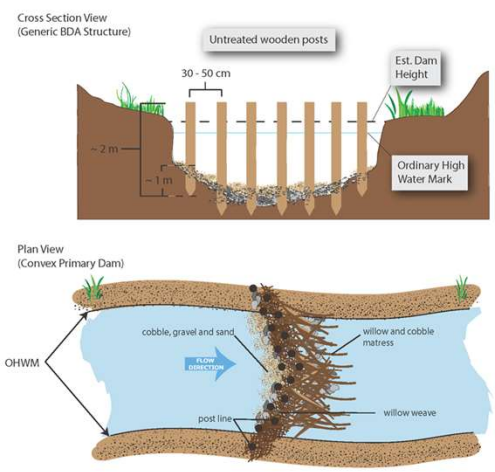
Role of LT-PBR

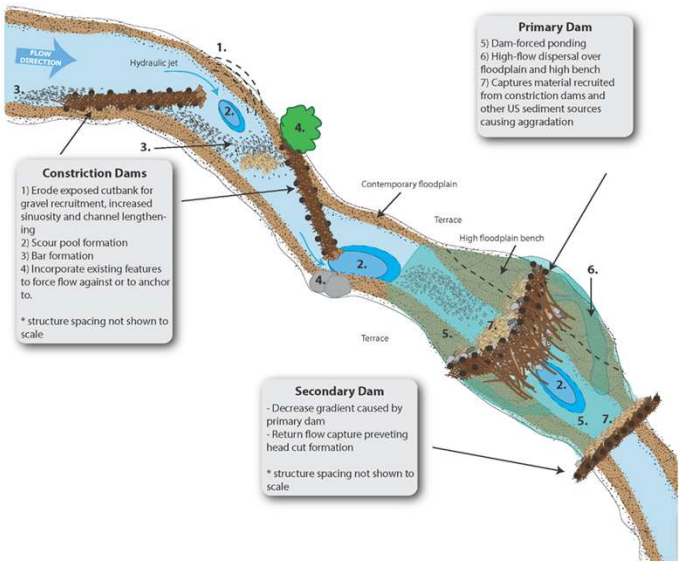
- Provide structure (like large wood does) that slows water, causes aggradation, reconnects floodplains, elevates groundwater and can improve habitat.
- Beaver Dam Analogs (BDAs) and Post-assisted Log structures (PALS) are cheaper to build than permanent in-stream interventions (i.e., large wood structures), so more can be built over longer reaches.
- More is better – even if some structures fail. Think 'jumpstarting' variable geomorphic functions.

17

FB185: The Use of Low-Tech Process-Based Stream Habitat Restoration

Objective: Mimic the form and function of beaver dams and LWD, function together





18

Project Planning and Design Process

"The impact if large wood on a stream depends on the geomorphology of the stream,

the stream size related to the dimensions of the wood,

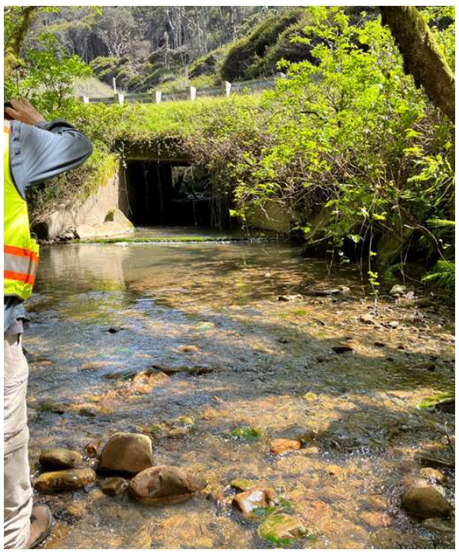
and the hydrology of the stream."

NF Salmon River: Red Bank Off-Channel Fisheries & Riparian Habitat Enhancement Project
Photo: Trevor Lucas (September 17, 2024)

19

Project Planning and Design Process

- Restoration Opportunities
  - Identify location with a need - Watershed assessment, stream habitat inventories
- Constraints and Risk Considerations
- Site Characterization
  - Scale the process to the scale of the objectives
- Describe the problem and define project goals and objectives
  - Design objectives should be specific, realistic, achievable, and measurable.
  - The scale of the objectives to scale of need
- Project Design



20

Restoration Opportunities

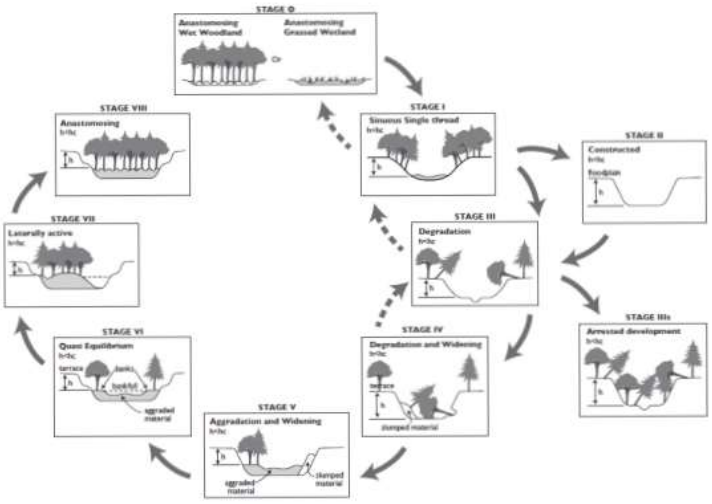
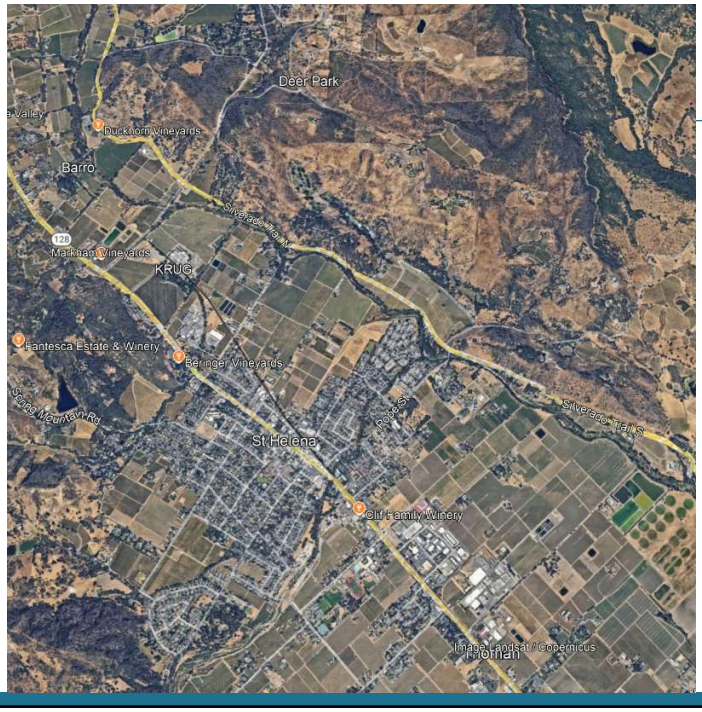


Figure 1. Stream Evolution Model (Cluer and Thorne 2014).

Raising the bed to reconnect to floodplains and side channels will

- Reduce stream power
- Deposit finer sediment such as gravel
- Allow pools to form at lower flows and scour deeper
- Retain spawning gravels
- Channels and floodplains become habitat again
- Food sources - invertebrate production
- Recover groundwater levels and increase summer base flows

21



Limitations

Define risks and uncertainties

- Habitat recovery
- Construction –
  - Access, staging of materials, and water management
- Property ownership
- State and federal regulations
  - E.g., FEMA – Flood Regulations
- Geotechnical
- Infrastructure
- Acceptable Level of Channel Dynamics
- Recreational User Safety
- Ecological benefit-Project Longevity – Design life

22

Site Characterization

- Geomorphic description of the stream reach
  - Planform, confinement, bed forms, floodplain, slope
  - Stable - aggrading or degrading – cause?
  - Substrate composition – scour potential, bedrock, subsurface
  - Streambank composition
  - Riparian vegetation / sources of wood
  - Construction access

23

Site Characterization

For high-risk projects (or complex structures)

- Additional studies required
  - Geomorphic study
  - Topographic survey
  - Hydrologic and hydraulic analysis
    - Water supply, quality, and sources
    - Design flow
      - Scour and stability calculations
    - Re-connecting floodplain or side channel
    - Water surface profiles and channel velocities

24

Project Implementation

Construction

- Requires skilled equipment operator/hand crew
- Attention to detail
- Designer on site
- Specifications of materials
- Considerations –lessons learned

Fish Bulletins offer guidance on permitting, construction techniques and best practices

25

Parting notes

- Structure should meet the need/scale
  - Craft significant change
  - Don't avoid complex structures or high-risk settings
  - Stream reach approach
- Site selection/characterization is an important for all projects to clearly define goals
- Risk must be assessed
- Engagement-reach out to coordination and collaboration

26

References/Resources

Fish Bulletins references are essentially a “greatest hits”

FRGP Guidance Documents:
https://wildlife.ca.gov/Grants/FRGP/Guidance
CDFW Beaver Program:
https://wildlife.ca.gov/Conservation/Mammals/Beaver#assisted

kristine.pepper@wildlife.ca.gov
will.acrand@wildlife.ca.gov
elijah.portugal@wildlife.ca.gov
jonathon.mann@wildlife.ca.gov

27

Thank you for participating in this training

28