Appendix 9

Environmental – Terrestrial and Riparian/ Aquatic

Contents

Environmental – Terrestrial and Riparian/ Aquatic page 2
Theme Subcommittee Members page 2
Engagement Process page 5
Available Research, Data, and Tools page 6
Research Needs and Gaps page 11
Prioritization Process page 14
Top Ten Research, Data, and Tools Actions page 14
Top Three Research, Data, and Tools Actions page 16

Environmental – Terrestrial and Riparian/ Aquatic

Theme Subcommittee Members

The Flood-MAR Environmental – Terrestrial and Riparian/Aquatic Subcommittee consists of 4 co-chairs and 45 subcommittee members. Subcommittee members are listed by name and affiliation below.

Position	Name	Affiliation
Co-Chair	Nat Seavy,	Point Blue Conservation Science
Co-Chair	Rene Henery	Trout Unlimited
Co-Chair	Marc Commandatore	California Department of Water Resources
Co-Chair	Joshua Viers	University of California (UC), Merced
Subcommittee Member	Daniel Nylen	American Rivers
Subcommittee Member	Ryan Luster	TNC
Subcommittee Member	Michelle Newcomer	Lawrence Berkeley National Laboratory
Subcommittee Member	Peter S. Nico	Lawrence Berkeley National Laboratory
Subcommittee Member	Ted Grantham	UC Berkeley
Subcommittee Member	Jason Faridi	Rivers Partners
Subcommittee Member	Michelle Workman	East Bay Municipal Utility District
Subcommittee Member	Rachel Esralew	U.S. Fish and Wildlife Service (USFWS)
Subcommittee Member	Joe Kiernan	National Oceanic and Atmospheric Administration (NOAA)
Subcommittee Member	Julie Retner	River Partners
Subcommittee Member	Anke Mueller-Solger	U.S. Geological Survey
Subcommittee Member	Briana Seapy	California Department of Fish and Wildlife (CDFW)
Subcommittee Member	Abigale Hart	TNC

Position	Name	Affiliation
Subcommittee Member	Samantha Arthur	Audubon California
Subcommittee Member	Jacob Katz	California Trout
Subcommittee Member	Kathy Wood-Mclaughlin	Consultant
Subcommittee Member	Ann Hayden	EDF
Subcommittee Member	Bruce Orr	Stillwater Science
Subcommittee Member	Ric Ortega	Grasslands Water District
Subcommittee Member	Todd Manley	Northern California Water Association
Subcommittee Member	Dave Vogel	Northern California Water Association
Subcommittee Member	Paul Buttner	California Rice Commission
Subcommittee Member	Andrew Rypel	UC Davis
Subcommittee Member	Mark Biddlecomb	Ducks Unlimited
Subcommittee Member	Julie Zimmerman	TNC
Subcommittee Member	Anna Schiller	EDF
Subcommittee Member	Rachel Johnson	NOAA
Subcommittee Member	Josh Isreal	BOR
Subcommittee Member	Paul Robins	Resource Conservation District of Monterey County
Subcommittee Member	Tim Frahm	Trout Unlimited
Subcommittee Member	Abby Taylor-Silva	Grower-Shipper Association of Central California
Subcommittee Member	Rachel Hutchinson	South Yuba River Citizens League
Subcommittee Member	Kristin Wilson	TNC
Subcommittee Member	Luke Hunt	American Rivers
Subcommittee Member	Kelly Nelson	San Mateo County Resource Conservation District
Subcommittee Member	Chris Bowles	CBEC
Subcommittee Member	Kevin Schaffer	CDFW
Subcommittee Member	Meghan Hertnel	Audubon California
Subcommittee Member	Kim Forest	USFWS
Subcommittee Member	Dan Teater	USFWS
Subcommittee Member	Michelle A. Reimers	TID

Position	Name	Affiliation
Subcommittee Member	Mark Tompkins	Flow West
Subcommittee Member	Lisa Lurie	Resource Conservation District of Santa Cruz County
Subcommittee Member	Aysha Massell	American Rivers
Subcommittee Member	Jason Roberts	CDFW

Engagement Process

The co-chairs invited 45 universities, non-governmental organizations, private consulting firms, state and federal agencies, and irrigations districts. The co-chairs engaged with these experts by holding a webinar, soliciting participant feedback through an online survey, and soliciting feedback on an online document with priority research topics and priorities.

Available Research, Data, and Tools

Central Valley Flood Protection Plan Conservation Strategy

Plan that can be used as a source of measurable objectives for quantifying ecosystem improvements that can be generated through Flood-MAR projects.

https://water.ca.gov/LegacyFiles/conservationstrategy/docs/cs_draft.pdf
No additional comments

No Contact

SAGBI

A map of recharge potential across the California. Can be used to identify where ecosystem enhancement projects also provide groundwater recharge potential.

https://casoilresource.lawr.ucdavis.edu/sagbi/

This layer is focused on agriculture, so some of the assumptions are not applicable to habitat projects.

No Contact

A horizontal permeable reactive barrier stimulates nitrate removal and shifts microbial ecology during rapid infiltration for managed recharge.

Research data on surface water quality and how groundwater infiltration removes major pollutants and nutrients as a driver of primary production.

https://www.sciencedirect.com/science/article/abs/pii/S0043135418305827

Results from field experiments linking hydrology, geochemistry, and microbiology during infiltration at a field site that is used for managed aquifer recharge (MAR).

A. Marc Commandatore, Department of Water Resources, Riverine Stewardship Program, (916) 651-9630

angelo.commandatore@water.ca.gov

Natural Community Conservation Plan (NCCP) Program

Provides regional conservation plan, regional conservation reserve commitment, and take permit for California Endangered Species Act (CESA) listed species. Ground and surface water interactions with species' habitat requirements are both affected by and affect NCCPs.

https://www.wildlife.ca.gov/Conservation/Planning/NCCP
There are currently (Dec. 2018) 16 NCCPs signed by CDFW and new NCCPs in development.

Shannon Lucas, Department of Fish and Wildlife, Landscape Conservation Planning Program

Regional Conservation Investment

Provides new (established 2017) tool for voluntary regional conservation. Provides comprehensive, science-based strategy for conserving species, habitats, waters, and other conservation elements. Advance mitigation credits may be developed through Mitigation Credit Agreements (MCA) based on conservation actions in approved RCISs. Credits may be sold or transferred to offset project impacts.

https://www.wildlife.ca.gov/Conservation/Planning/Regional-Conservation

There are currently (Dec. 2018) six RCISs submitted to CDFW for review and approval, or in development. Proposition 68 funds will be available from the Wildlife Conservation Board in 2019 to prepare RCISs.

Ron Unger, Department of Fish and Wildlife, Landscape Conservation Planning Program

Conservation and Mitigation Banking Program

Banks provide mitigation credits which may be sold or transferred to offset project impacts on species, habitats, and wetlands/waters.

https://www.wildlife.ca.gov/Conservation/Planning/Banking

No Additional comments

Beatrice (Betty) Rambarran, Department of Fish and Wildlife, Landscape Conservation Planning Program

Infiltration Measurement Techniques

Geophysical measurements to track infiltration and use as inputs to models.

https://eesa.lbl.gov/new-approach-restock-california-groundwater/

No Additional comments

Michelle Newcomer, mnewcomer@lbl.gov, Lawrence Berkeley National Laboratory

Numerical Models for Infiltration Prediction

Numerical models that ingest and utilize data-assimilation techniques for predicting infiltration and recharge given floodplain inundation geophysical measurements.

https://www.grac.org/media/files/files/72b39279/25-2-a-4-ulrich.pdf

No Additional comments

Michelle Newcomer, mnewcomer@lbl.gov, Lawrence Berkeley National Laboratory

Data to support balancing groundwater extraction and recharge related to river flow contribution.

River flows ought to be considered an action related to GW recharge and valued as such in GSPs. How much does overdraft of GW degrade surface flows?

https://onlinelibrary.wiley.com/doi/abs/10.1002/hyp.11468

San Joaquin River contributes much more to groundwater recharge today than it did historically. Managing surface flows may be an important component of multi-benefit GW recharge, be-it with floods or base flows.

Julie Rentner, jrentner@riverpartners.org, River Partners

Water Tracker

An automated system that provides up-to-date and accurate data on surface water distributions in the Central Valley. This information is useful for water and wetland managers when making decisions about water management.

Tool can be used to identify where there is standing water on the landscape and how long it persists.

Matt Reiter, mreiter@pointblue.org

CVPIA Science Integration Decision Support Model

Life cycle model for salmon and other fish species that relates various factors, including flow rates and floodplain habitat, to effects on salmon populations in the Central Valley.

No Link

No Additional Comments

No Contact provided

Sacramento River Winter-run Chinook Salmon Life Cycle Model

Life cycle model for salmon and other fish species that relates various factors, including flow rates and floodplain habitat, to effects on salmon populations in the Central Valley.

https://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/CAWaterFix/WaterFix%20Biological%20Opinion/cwf_appendix_h.pdf

No Link

No Additional Comments

No Contact provided

Central Valley Habitat Exchange Habitat Quantification Tools

Tools that quantify floodplain habitat for salmon and other species, based on flow rates, topography, and other factors.

http://cvhe.org/

No Link

No Additional Comments

No Contact provided

Wildlife-friendly Recharge Site Selection Tool

Optimization model that evaluates agricultural fields for their potential to be converted to recharge sites with intermittent wetland habitat.

No Link

This tool is designed to assist landowners and water managers in selecting sites to be used for recharge with habitat benefits.

Anna Schiller, aschiller@edf.org, Environmental Defense Fund

Research Needs and Gaps

Listed below are the needs and gaps in research, data, and tools related to the Environmental theme. These needs and gaps were determined by the subcommittee members.

Topic: River/groundwater interactions

Project: Contribution of floodplain inundation to groundwater recharge.

Description of Use: A tool to calculate groundwater recharge that occurs from floodplains inundation. It would be used to quantify groundwater benefits of flooding that provides habitat for fish and wildlife.

Synergies with other Subcommittees: Hydrology Observation and Prediction; Soils, Geology, and Aquifer Characterization; Recharge and Extraction Methods; Tool and Application Development

Topic: River/groundwater interactions

Project: Data for river-aquifer interactions facilitating biogeochemical transformations.

Description of Use: This project would improve our understanding of how groundwater recharge would impact water quality of instream flows by quantifying nitrate degradation potential.

Synergies with other Subcommittees: Soils, Geology, and Aquifer Characterization; Water Quality

Topic: River/groundwater interactions

Project: Baseline environmental flow quantification

Description of Use: Tools or data that indicate how much surface water must remain in streams for the environmental and how much is available for diversion to Flood-MAR project sites during peak flows.

Synergies with other Subcommittees: Hydrology Observation and Prediction; Local, State, Federal Policies and other Legal Considerations; Tool and Application Development

Topic: River/groundwater interactions

Project: Specific information related to residence time of floodwater in the vadose zone of broad floodplains and the relationship between draining and seasonal baseflows.

Description of Use: This information would be used to articulate and plan floodplain restoration projects to optimize streamflow benefits related to expanded floodplains.

Synergies with other Subcommittees: Hydrology Observation and Prediction; Soils, Geology, and Aquifer Characterization; Tool and Application Development

Topic: Multiple benefits/risks

Project: Conceptual Model that outlines the environmental benefits of moving surface water to a location to begin MAR.

Description of Use: This conceptual model would describe the existing convergence of the complex and dynamic hydrology and microbiology that is linked to both aquatic and terrestrial species life history. The Conceptual Model would include assumptions about the basic relationships to MAR and aquatic and terrestrial species habitat.

Synergies with other Subcommittees: Crop Suitability; Soils, Geology, and Aquifer Characterization; Land Use Management; People and Water; Economic

Topic: Multiple benefits/risks

Project: A map that prioritizes sites for Flood MAR projects based on additional habitat benefits, including groundwater dependent ecosystems.

Description of Use: This project would integrate a SAGBI-type-tool with habitat maps and maps of groundwater dependent ecosystems and other information in order to identify Flood-MAR habitat expansion/improvement opportunities.

Synergies with other Subcommittees: Soils, Geology, and Aquifer Characterization; Land Use Management; Tool and Application Development

Topic: Multiple benefits/risks

Project: Species risk assessment

Description of Use: Data on species present at Flood-MAR sites and potential impacts to species from periodic inundation. This could include

risks to terrestrial species that may use Flood-MAR sites during dry years.

Synergies with other Subcommittees: Local, State, Federal Policies and other Legal Considerations

Topic: Multiple benefits/risks

Project: Assessment of environmental benefits of current recharge

Description of Use: Assessment of existing Flood-MAR projects and how they provide habitat/environmental benefits and how they could be improved. This project would use existing recharge projects as model systems for quantifying these benefits.

Synergies with other Subcommittees: Crop Suitability; Soils, Geology, and Aquifer Characterization; Land Use Management; Local, State, Federal Policies and other Legal Considerations; Tool and Application Development

Topic: Geomorphology

Project: Accessible 'digital' database of all well-log measurements to inform model sediment properties for accurate infiltration prediction

Description of Use: Currently many researchers rely on paper logs and do not have resources to translate the wealth of data into a digital format. Models require this type of data and would require significant resources to create a digital database for the state of California.

Synergies with other Subcommittees: Soils, Geology, and Aquifer Characterization

Topic: Geomorphology

Project: Subsurface maps of aquifer morphology

Description of Use: Recent work from Stanford's Center for Groundwater Evaluation and Management (GEM) has been used to map below-ground reservoirs to support GW sustainability planning for the Tulare Irrigation District. Similar mapping would be valuable across the entire floodplain of the SJR to identify the magnitude of GW deficit supporting baseflows during dry years. Mapping could be conducted using SkyTEM technology.

Synergies with other Subcommittees: Soils, Geology, and Aquifer Characterization

Prioritization Process

After the introductory webinar, the co-chairs asked the subcommittee to develop a list of information (e.g., research, data, and tools) available and needed to design, implement, and evaluate groundwater recharge projects with environmental benefits.

Priority Research Topics

Using the information assessment, the co-chairs developed a list of three priority research topics and 10 priority research projects. The three major information topics where more information is needed to design, implement, and evaluate groundwater recharge projects with environmental benefits are: River/groundwater interactions, multiple benefits/risks, and geomorphology. Within each of these topics there are multiple projects that could be implemented to generate the information that is need.

These three topics were presented to the Flood-MAR RAC at the February 26, 2019, Flood-MAR RAC Workshop to identify synergies with priority research topics identified by the other subcommittees.

Top Ten Research, Data, and Tools Actions

Action 1: Develop a tool to calculate groundwater recharge that occurs when floodplains are inundated.

Description: This tool would be used to quantify the groundwater benefit of flooding that provides habitat for fish and wildlife.

Action 2: Develop a map that prioritizes Flood MAR sites based on additional habitat benefits that can be achieved at those sites.

Description: This project would integrate SAGBI type tools with maps of habitat potential, groundwater dependent ecosystems, and other environmental information to identify opportunities for implementing Flood MAR and achieving other environmental outcomes.

Action 3: Map subsurface geology of floodplains to identify areas with the greatest potential for deep aquifer recharge.

Description: Recent work from Stanford's Center for Groundwater Evaluation and Management (GEM) has been used to map below-ground reservoirs to support GW

sustainability planning for the Tulare Irrigation District. Similar mapping would be valuable across the entire floodplain of the SJR to identify the magnitude of GW deficit supporting baseflows during dry years.

Action 4: Develop a conceptual model that describes the environmental benefits of moving surface water to a location to begin MAR.

Description: This conceptual model would describe the existing convergence of the complex and dynamic hydrology and microbiology that is linked to both aquatic and terrestrial species life history. The Conceptual Model would include assumptions about the basic relationships to MAR and aquatic and terrestrial species habitat.

Action 5: Develop tools that can be used to quantify minimum desired flows.

Description: Tools or data that indicate how much surface water must remain in streams for the environmental and how much is available for diversion to Flood-MAR project sites during peak flows.

Action 6: Assessment of environmental benefits of current groundwater recharge projects.

Description: Assessment of existing Flood-MAR projects and how they provide habitat/environmental benefits and how they could be improved. This project would use existing recharge projects as model systems for quantifying these benefits

Action 7: Conduct a risk assessment for species or habitat that could be negatively impacted by Flood MAR implementation.

Description: Data on species present at Flood-MAR sites and potential impacts to species from periodic inundation. This could include risks to terrestrial species that may use Flood-MAR sites during dry years.

Action 8: Quantify how groundwater recharge of floodplains will impact water quality of instream flows.

Description: This project would identify benefits and risks to instream water quality that could result from Flood MAR activities.

Action 9: Quantify the residence time of floodwater in the vadose zone of floodplains and the relationship between draining and seasonal baseflows.

Description: This information would be used to articulate and plan floodplain restoration projects to optimize streamflow benefits related to expanded floodplains.

Action 10: Create a digital database of all well-log measurements to inform models and improve infiltration predictions.

Description: Currently many researchers rely on paper logs and do not have resources to translate the wealth of data into a digital format. Models require this type of data and would require significant resources to create a digital database for the state of California.

Top Three Research, Data, and Tools Actions

Action 1: Develop a tool to calculate groundwater recharge that occurs when floodplains are inundated.

Description: This tool would be used to quantify the groundwater benefit of flooding that provides habitat for fish and wildlife.

Implementation Strategies: Contract with a consultant or academic to develop the tool. Product should include a clear list of uncertainties and assumptions that can be improved with future research.

Cost Estimates: $100,000

Action 2: Develop a map that prioritizes Flood MAR sites based on additional habitat benefits that can be achieved at those sites.

Description: This project would integrate SAGBI type tools with maps of habitat potential, groundwater dependent ecosystems, and other environmental information to identify opportunities for implementing Flood MAR and achieving other environmental outcomes.

Implementation Strategies: Contract with a consultant or academic to develop the tool. Product should include a clear list of uncertainties and assumptions that can be improved with future research. Engage agencies and NGOs in a meaningful way in this process.

Cost Estimates: $500,000

Action 3: Map subsurface geology of floodplains to identify areas with the greatest potential for deep aquifer recharge.

Description: Recent work from Stanford's Center for Groundwater Evaluation and Management (GEM) has been used to map below-ground reservoirs to support GW sustainability planning for the Tulare Irrigation District. Similar mapping would be valuable across the entire floodplain of the SJR to identify the magnitude of GW deficit supporting baseflows during dry years.

Implementation Strategies: Contract with a consultant or academic to conduct this work.

Cost Estimates: $2,000,000