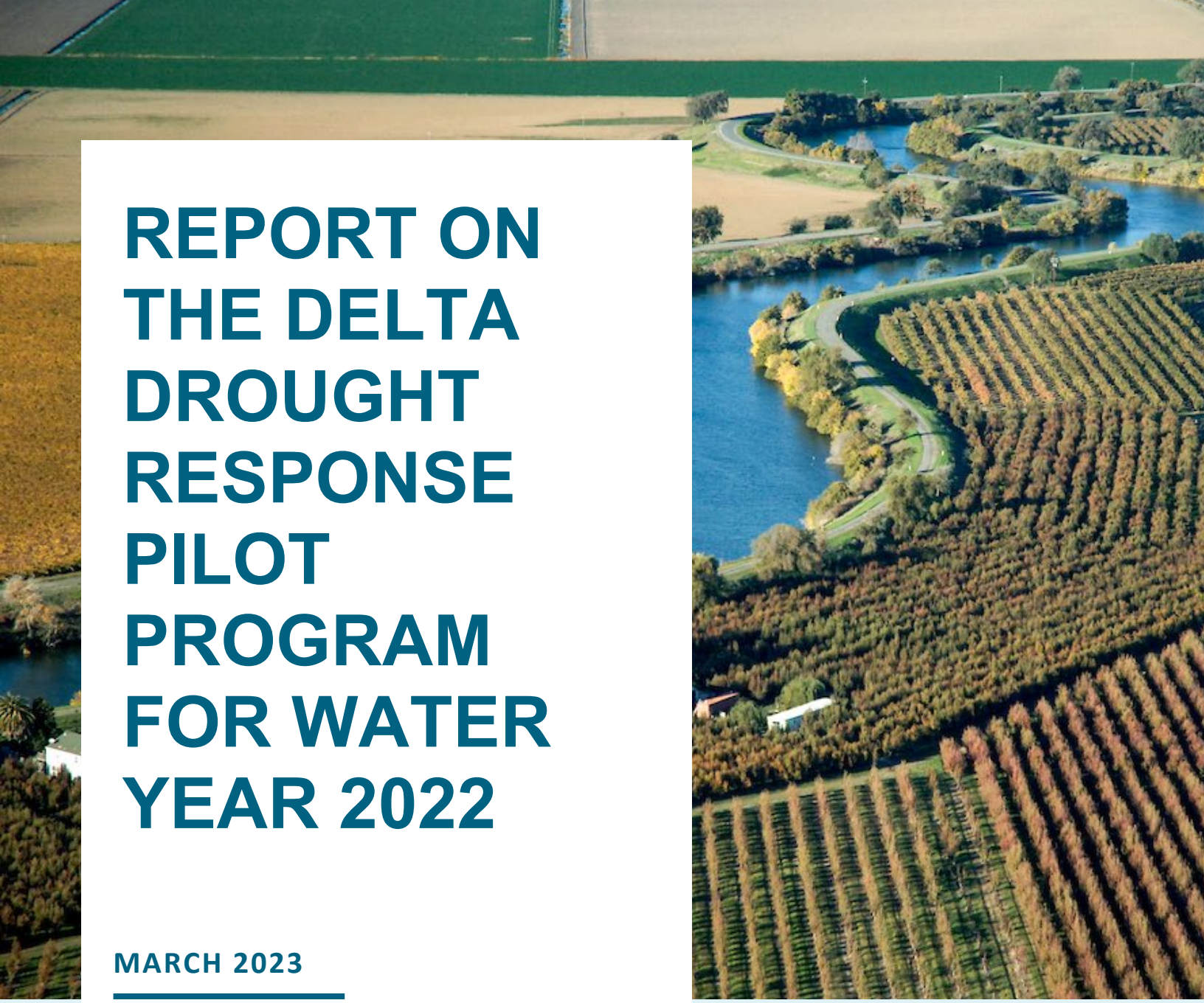

REPORT ON THE DELTA DROUGHT RESPONSE PILOT PROGRAM FOR WATER YEAR 2022

MARCH 2023

SACRAMENTO - SAN JOAQUIN
DELTA CONSERVANCY
A California State Agency

DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA

CALIFORNIA
Water Boards
STATE WATER RESOURCES CONTROL BOARD
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Report on the Delta Drought Response Pilot Program for Water Year 2022

Outline

I. Executive Summary

Facing the risk of continued drought in the Delta Watershed in 2021, the three Delta Water Agencies, consisting of the North Delta Water Agency, the Central Delta Water Agency, and the South Delta Water Agency, commissioned an ad hoc committee made of their management teams and trusted advisors (Delta Team) to develop a collaborative response proposal. The committee met, with facilitation from the Office of the Delta Watermaster, and reported periodic progress at monthly meetings of the three Agencies' Boards. In June of 2021, the Delta Team presented a unified drought response proposal to representatives of several State agencies (State Team: Department of Water Resources, Department of Fish & Wildlife, California Environmental Protection Agency, State Water Board, Natural Resources Agency) involved with implementing the Governor's proclamation of a drought emergency in the Delta watershed. [1]

Through a series of follow-up meetings between the Delta and State Teams, the group developed what came to be the 2022 Delta Drought Response Pilot Program (Program) for the ensuing water year (October 1, 2021 through September 30, 2022). The objective of the Program was to implement a variety of water conservation actions proposed by Delta agricultural water users and explore their effectiveness through a consistent assessment and data gathering effort. Assessment of crop evapotranspiration (ET) was made possible by the application of OpenET, a scientifically rigorous ET estimation tool relying on computer analysis of regular satellite images. The consumptive use of water on Project Sites implementing water conservation actions was estimated using OpenET. [2] Water conservation actions included planting non-irrigated crops, deficit irrigation of fields where crops were grown, managing idle lands without crops or irrigation, and forgoing a double crop. Each grantee was sorted into a category after their grant agreement was signed based on the grantees' description of their proposed water conservation practice.

[1] Executive Department of the State of California - Proclamation of a State of Emergency
[2] Home - OpenET (openetdata.org)

DDRPP 2022 was funded by the Department of Water Resources (DWR) and administered through an interagency agreement with the Sacramento-San Joaquin Delta Conservancy (Delta Conservancy). The Program solicited applications for grants from farmers willing to undertake water conservation actions during the remainder of the 2022 water year. A Selection Committee, including representatives from the Delta Conservancy, DWR, Office of the Delta Water Master (ODWM), California Department of Food and Agriculture (CDFA), and University of California Cooperative Extension and Merced campus, was formed to evaluate applications and recommend projects for funding. The Selection Committee reached out to applicants to ensure shared understanding of proposed practices, what business as usual practices would have been, and understand applicant methods for estimating water savings. Proposals were evaluated in the order they were received against six criteria: (i) diversity of locations; (ii) variety of proposed Actions; (iii) best estimates of prospective consumptive use savings; (iv) expected timing of such savings; (v) anticipated collateral benefits/detriments; and (vi) data research needs (see Appendix B for details).

The Delta Conservancy executed agreements with 33 unique Delta farmers, covering approximately 8,850 acres, at a total grant cost of $7,967,097, based on a fixed price of $900 per acre enrolled. Grants covered a variety of proposed water conservation actions and were spread among the various subregions of the Legal Delta (see Appendix C for details). Grant applicants were asked to make non-binding estimates of how much water their actions might save during the water year. Total water conservation during the 2022 water year was anticipated to be approximately 22,000 acre-feet for accepted grants. An Oversight Committee made of members representing the ODWM, DWR, the Delta Conservancy, the State Water Resources Control Board, CDFA, the University of California Merced, and the University of California Cooperative Extension was formed to work with farmers to carry out their proposed actions and to evaluate water savings.

Notwithstanding rigorous implementation of the water conservation actions from roughly March (when grants were executed) through September, water savings measured through OpenET were less than what grant applicants estimated. The Oversight Committee analysis (see Appendix A for details) estimated water conservation for the Program ranged from 3,300 to 5,500 acre-feet across 8,525 acres. Some enrolled acres were excluded from the analysis because of small or irregular field sizes. The Legal Delta experiences drought more as a threat to water quality and less as a physical shortage of water. The Oversight Committee analysis examines water saved (acre-feet/acre as estimated based on evapotranspiration) as a likely mechanism for improved water quality. Water quality data were not included in analysis of the initial pilot Program because the primary objectives of the analysis was to develop a method to estimate water savings, estimate total water saved by the Program, and understand how water savings differed among action types and field contexts. In future years, analyses may build upon these findings to examine effectiveness of water savings at improving water quality, though assigning a causal relationship between changes in field management, water quantity saved, and in channel water quality readings is likely to be challenging.

The Oversight Committee suggests several hypotheses for why measured water savings were less than anticipated savings. First, agricultural fields in the Delta occur at variable elevations, with many fields below the surrounding surface water levels outside of levees, and these conditions require extensive drainage systems to manage seepage and reduce losses to evapotranspiration (ET),

regardless of farming practices. The Oversight Committee analysis found when comparing ET on project fields in 2021 to 2022 that fields above sea level more consistently saved water than those below sea level. Water from the water table, adjacent drainage ditches, seepage, and runoff from nearby fields may have contributed to ET on project fields, particularly for crops with deeper root systems. Last, the Program required Healthy Soils practices, which maintained harvested crop stubble or a cover crop to reduce oxidation of peat soils or erosion of bare soils, and plant transpiration from stubble and cover crops can increase evapotranspiration. [3]

Though measured water savings were lower than those initially anticipated, the Program provided a wealth of data about water consumptive use, water use actions, and incentives in the unique and complex setting of the Legal Delta. One major pattern seen among these data was the variability in measured water savings among Project Sites, even when comparing like practices. Additional data gathered from more different types of sites may help reveal the mechanism driving this variability. The information derived from the 2022 DDRPP analysis was valuable enough to warrant refinement and redeployment of the Program during water year 2023.

Developing and implementing the 2022 Program facilitated collaboration among the Delta Water Agencies, the State Team, and Delta water users. The Program promoted a coordinated response to the common threat posed by the extended drought. Along the way, individuals and institutions developed better understanding of the perspectives, objectives, motivations, limitations, and opportunities from their concerted effort.

[3] Soil Health | Natural Resources Conservation Service (usda.gov)

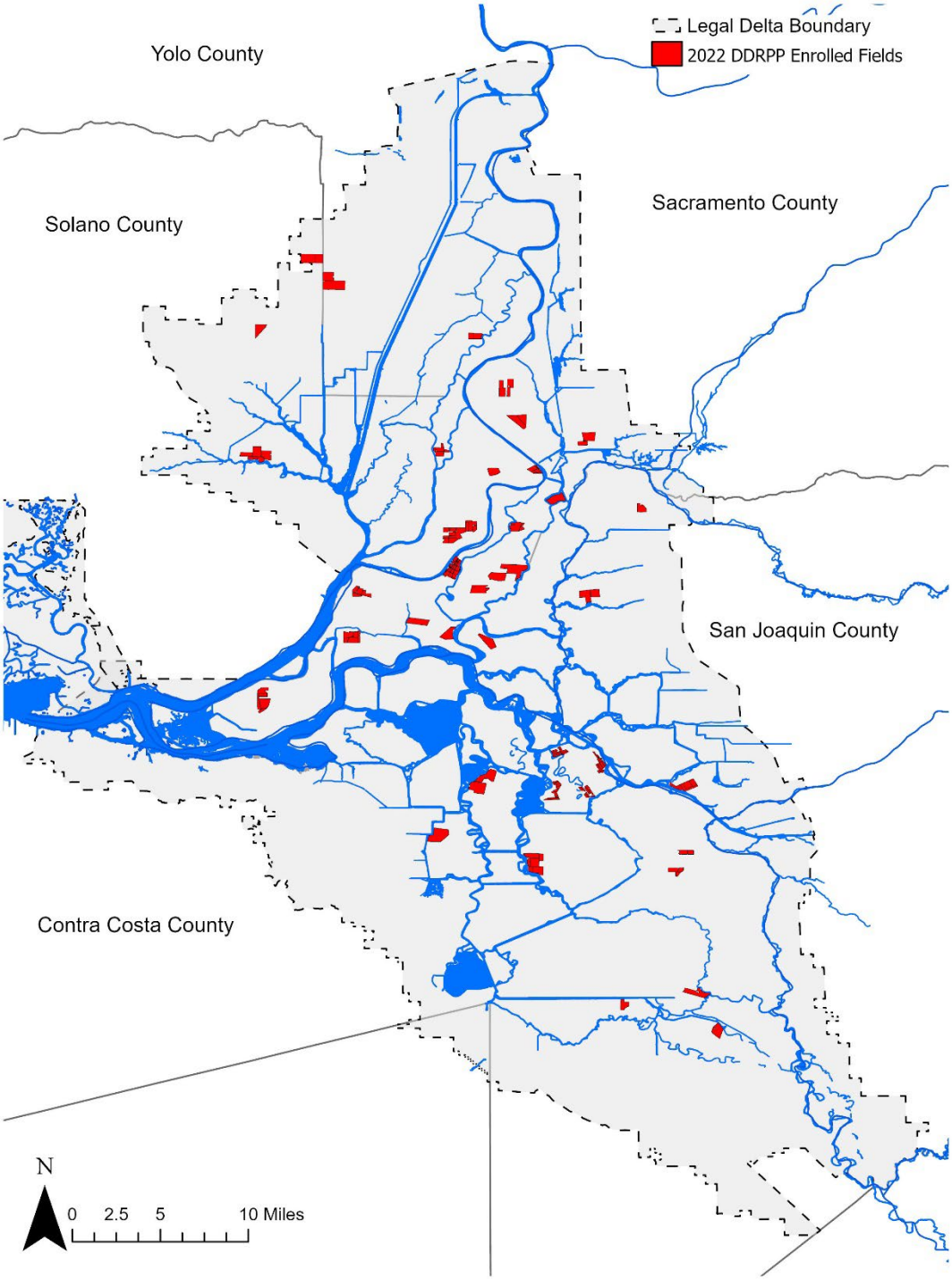

Figure 1. Areas enrolled in the 2022 DDRPP Program.

II. Background and Introduction

The Delta watershed is dominated by the Sacramento River and its tributaries flowing south from the northern Central Valley and the San Joaquin River and its tributaries flowing north from the southern portion of the Valley. Much of the natural flow in those rivers and streams is diverted for

use in the watershed or for export to use outside the watershed. The remaining and quite variable flows of the two main rivers (as well as a few much smaller rivers) converge in the Legal Delta. The Legal Delta, defined in Water Code section 12200, covers about 750,000 acres (roughly the size of Rhode Island). It forms an irregular triangle from the City of Sacramento in the north, to the confluence of the San Joaquin and Stanislaus Rivers south of Stockton at Vernalis, to its outlet at the Carquinez Strait on the west. This inverted river delta is the inland portion of the San Francisco estuary, which is subject to both highly variable inflow from the rivers and highly predictable tidal ebb and flow from the Pacific Ocean.

The Legal Delta has been engineered to serve a variety of human uses. In the late Nineteenth Century federal and state government programs encouraged land speculators to "reclaim" the swamp and periodically overflowed marshes to make them suitable for farming.[4] Thus, the formerly meandering, dendritic channels of the upper estuary were dredged and confined by earthen levees to separate dry farmland within the levees' protection from the risk of regular or periodic inundation. The reclaimed land was contiguous to the resulting channels and, as such, had plentiful riparian water rights for beneficial use on the land.

Following the effective date of the Water Commission Act in 1914, government policy turned to meeting evolving challenges including (i) protecting the freshwater portion of the estuary from tidal salinity intrusion as upstream development and periodic dry conditions reduced the reliability of river inflows to the Delta and (ii) balancing the perceived overall surplus of water in the north with the deficit to the south. With the development, first, of the Central Valley Project (CVP) starting in the late 1930s and, later, of the State Water Project (SWP) starting in the 1960s, the Legal Delta became the hub of California's water supply system. The CVP and the SWP (together the Projects) operate separate export and conveyance facilities near Tracy in the southern part of the Delta and manage their respective facilities under a Coordinated Operations Agreement.[5]

Water years 2020 and 2021 were dry and critically dry, respectively, with subnormal precipitation throughout the Delta watershed.[6,7] These conditions are consistent with the pattern of aridity seen in California during the 21st century. Likewise, extreme drought events, which impact systems across multiple years, are projected to become more frequent in California due to climate change.[8,9] Due to the extremely dry conditions persisting across the 2020 and 2021 water years, the Projects' reservoirs were drawn down to meet environmental and water supply demands. As a result, water year 2022 started with abnormally low carryover storage reserves. On August 3, 2021 the State Water Board approved emergency curtailment measures for the Delta watershed, potentially

[4] Swamp Land Act of 1850

[5] Agreement between the United States of America and the State of California for coordinated operation of the Central Valley Project and the State Water Project

[6] Water Year 2020. Department of Water Resources. https://water.ca.gov/-/media/DWR-Website/Web-Pages/What-We-Do/Drought-Mitigation/Files/Publications-And-Reports/Water-Year-2020-Handout_Final.pdf

[7] Water Year 2021: An Extreme Year. Department of Water Resources. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Water-Basics/Drought/Files/Publications-And-Reports/091521-Water-Year-2021-broch_v2.pdf

[8] Swain, D. L., D. E. Horton, D. Singh, and N. S. Diffenbaugh. 2016. Trends in atmospheric patterns conducive to seasonal precipitation and temperature extremes in California. Science Advances 2:1–13.

[9] Yoon, J., S. S. Wang, R. R. Gillies, B. Kravitz, L. Hipps, and P. J. Rasch. 2015. Increasing water cycle extremes in California and in relation to ENSO cycle under global warming. Nature Communications 6:8657

impacting over 80% of water right holders in the Delta watershed.[10] Thus, the risk of another year of drought was amplified for both the environment and for water users dependent on the watershed.

III. Initiation of Drought Risk Response

As the risk of continued drought became apparent in February of 2021, water users in the Legal Delta considered a variety of risk mitigation strategies. None of the more than 2,000 diverters within the Legal Delta could impact drought risk individually; they needed to find a way to act collectively. The first obstacle to collective response was the fact that the Delta is made up of subregions, which face distinct water supply and water quality issues. Because of these differences, agricultural water users are generally organized through three separate State-chartered agencies, which are the North Delta Water Agency (NDWA) (approximately 300,000 acres), the Central Delta Water Agency (CDWA) (approximately 120,000 acres), and the South Delta Water Agency (SDWA) (approximately 137,000 acres). Each of the Delta Water Agencies has its own elected Board and management team. Each assesses the acres within its boundaries to support protection of water rights critical to the irrigation of its primarily agricultural uses. There are also agricultural areas in eastern Contra Costa County that are within the Legal Delta but not within the boundaries of the three Delta Water Agencies.

Effective engagement was another hurdle to collective response because of the many different parties involved. Seventeen State and federal agencies have regulatory, permitting, or water supply authority in the Delta. Some water users are in parts of the watershed that lie outside the Legal Delta, and some water users outside the watershed are dependent on the Delta watershed for some portion of their water supply. Because the Legal Delta is not homogenous, it can be difficult to identify a single or appropriate counterparty with whom to engage on water supply or water quality issues.

Additionally, the Legal Delta experiences drought differently in its subregions and, overall, differently than the rest of the watershed. These differences make it challenging to agree both on the problem and an effective response. Notwithstanding these sub-regional differences, the Legal Delta experiences drought more as a threat to water quality and less as a physical shortage of water. While water may remain physically present in the system, it may not be suitable for its intended use or legally available for diversion. Additionally, the Legal Delta is within the tidal zone of the San Francisco estuary and most of its channel bottoms are below sea level, which means there is always water in the Legal Delta whether the channels are filled by river inflow or backfilled by brackish water entering the western Delta on the ebb and flow of the tides. When river inflow is constricted during drought, tidal action can “pump” salinity into the Legal Delta, potentially rendering the water supply too salty at certain times to irrigate crops. Further, because the Legal Delta is wedged between the rivers and the ocean, the Delta faces more severe flood risk than other parts of the watershed.

Water users within the Legal Delta were interested in addressing these barriers through the leadership of the three Delta Water Agencies and the unifying influence of shared water quality risk.

[10] State Water Board approves emergency curtailment measures for the Delta watershed. Press Release. https://www.waterboards.ca.gov/press_room/press_releases/2021/pr08042021_delta_emergency_regulation.pdf

Thus, at their respective monthly meetings in February 2021, each of the Delta Water Agencies directed their managers and advisors to meet under the support of the ODWM to discuss collaborative response strategies and to report back on progress and options. Those representatives (Delta Team[11]) met virtually throughout the spring and gave progress reports to the three Delta Water Agency Boards at their March, April, and May meetings.

By early June, the Delta Team had developed a unified voice and was prepared to present a collective drought response proposal focused on water conservation, protection of water quality, and improved water use data. The draft summary "Delta Proposes a Voluntary Critical-year Response Program," began circulating on June 11, 2021.

IV. Development: The Delta Team and the State Team

With a draft response proposal endorsed by the three Delta Water Agencies, the Delta Team sought opportunities for constructive engagement with various State agencies about a possible coordinated drought response. The ODWM identified interested State representatives involved in both short- and long-term drought response. After confirming a set of common objectives, ODWM hosted an in-person meeting between the Delta Team and the State Team[12] at the CalEPA Building on June 29, 2021.

At the initial meeting, the participants expressed their respective views and objectives. The Delta Team expressed willingness to experiment with a variety of voluntary actions to protect water quality, capture reliable data, and conserve water. The State Team similarly expressed willingness to experiment with a variety of actions and explore the potential for agricultural water users in the Legal Delta to conserve water during the critical salmon migration season between January and June. The two teams continued to meet, virtually, throughout the summer of 2021, exchanging a series of progressively more refined proposals.

As Program development progressed, the discussions faced several impediments including:

- The Delta Team represented the interests of agricultural water users in the Legal Delta, but the actual water rights are owned by independent individuals and enterprises. There was no way to assure that enough users would participate in a response program to meet water conservation/quality objectives.
- Both teams seemed open to experimentation and monitoring to evaluate the effectiveness of a variety of potential water conservation actions, but there was little reliable data about how much water could be saved, through which actions, in what subregions, and during what periods.

[11] Members of the Delta Team: Melinda Terry, NDWA General Manager, John Herrick, SDWA General Manager, Tom Zuckerman, designated CDWA representative, George Hartmann, representative of several Delta reclamation districts, Gilbert Cosio, consultant to NDWA, Russell Ryan, Delta Island Manager for Metropolitan Water District, and Steve Mello, Chair of NDWA Board and farm operation advisor.

[12] Members of the State Team: Karla Nemeth, Director of DWR; Chuck Bonham, Director of the Department of Fish & Wildlife; Kristin Peer, attorney-representative of the Secretary of the California Environmental Protection Agency (CalEPA); Eric Oppenheimer, Deputy Director of the State Water Board; Nancy Vogel, Deputy Secretary for Water, Natural Resources Agency, and Erik Loboschefsky, Executive Division, DWR.

- Time was short. If farmers were going to implement water conservation actions during the 2022 water year beginning on October 1, 2021, the program needed to be finalized early enough to allow potential participants to adjust their cropping decisions.
- The teams recognized the cost of carrying out water conservation actions likely varied by crop, location, irrigation method, commodity price, and other factors, but there was no ready mechanism for price discovery, budgeting, and determining compensation.
- Drought funding had been made available for the fiscal year that began on July 1, 2021 through DWR's budget, but DWR did not have the apparatus to administer a program with many private parties.

V. Addressing Uncertainties

The two teams methodically addressed issues as they arose through collaboration and mutual accommodation. The major points of agreement, which eventually converged as the Delta Drought Response Pilot Program, included:

- DWR would execute an Interagency Agreement with the Delta Conservancy under which the Delta Conservancy would administer grants to individual water users to conduct water conservation actions on their farm properties in the Legal Delta.
- Farmers themselves are in the best position to propose water conservation actions best suited to their own fields and to estimate potential consumptive use savings. Savings should be monitored and measured through OpenET, a newly available method relying on computer analysis of satellite images to estimate evapotranspiration of crops at both the landscape and field scale.
- Water conservation actions would be undertaken with appropriate safeguards for soil health, following practices included in CDFA's Healthy Soils program. Most importantly, Program participants would be required to maintain appropriate soil protections, which included maintaining a cover crop, retention of a prior crop's stubble, weed management, appropriate drainage, or other suitable practices.
- Both teams recognized that similar water conservation actions would likely produce different results in the subregions of the Legal Delta based on variations in soil transmissivity, elevation of fields in relation to the water table, crop adaptations, irrigation practices, and other factors. To better identify and quantify such variations, the Program would seek to enroll participants throughout the subregions of the Legal Delta. Thus, variety in locations as well as in water conservation practices would augment other grant allocation criteria.
- Costs of typical water conservation actions (e.g. deficit irrigation, crop substitution, or soil management) also vary by location and conditions. Through outreach to potential participants, the Delta Team received cost estimates for incentive payments ranging from $600-$1500/acre; and because water consumption savings projections were educated guesses rather than experience-based estimates, there was no consistent way to equate acreage with water savings. Therefore, the teams agreed that, without a practical price discovery mechanism in time to launch the Program during water year 2022, grants would be funded at the fixed price of $900/acre. The teams recognized that fixing a single price within the estimated cost range would limit participation but simplify the application analysis.

- To implement the Program as quickly as possible, applications for enrollment in the Program would be evaluated and approved for funding as received. This meant each application would be considered on its individual merits and not strictly compared to all other applications, but this also created an incentive for interested applicants to apply quickly and begin their proposed water conservation actions.
- The Delta and State Teams recruited a Selection Committee to evaluate applications against Program objectives and an Oversight Committee to conduct field inspections, capture information and insights from participants, and collect and analyze data related to the water conservation actions and their impact on evapotranspiration.
- One of the principal Program goals would be to learn from farmers and to glean as much useful data as possible. All data, information, and insights from the Program would be made publicly available.

VI. Solicitation of Interest and Proposed Actions

Through the fall of 2021, the Delta Conservancy worked in close coordination with DWR and the ODWM to rapidly develop a grant program to solicit and evaluate proposals. The Delta Conservancy launched the water year 2022 DDRPP on January 18, 2021.The Delta Conservancy's announcement and 2022 Program Summary provide details on solicitation and awardee selection (Appendix B).

VII. Applications, Evaluation Criteria, and Selection Process

Between January 19, 2022 and March 4, 2022, the program received 85 project proposals and approved 33 projects enrolling just over 8,850 acres. Grantees estimated water savings of approximately 22,000 acre-feet. Through an interagency agreement, DWR provided the Delta Conservancy with $10 million in a one-time general fund drought response funding, supporting thirty-three grants, associated monitoring, and administrative support. The 33 approved awards expended all the available funding.

The program was significantly oversubscribed receiving a total of 85 proposals requesting to enroll 24,000 acres at a total cost of $21,600,000. A Selection Committee was established and met weekly to evaluate proposals as they were received. The Selection Committee included representatives from the Delta Conservancy, DWR, ODWM, CDFA, and University of California Cooperative Extension as well as Davis and Merced campuses. In most cases, members of the Selection Committee reached out to applicants to ensure shared understanding of proposed practices, what business as usual practices would have been, and refine proposals as needed. Proposals were evaluated in the order they were received against six criteria: (i) diversity of locations; (ii) variety of proposed water conservation actions; (iii) best estimates of prospective consumptive use savings; (iv) expected timing of such savings; (v) anticipated collateral benefits/detriments; and (vi) data research needs. More details can be found in the Solicitation Summary found in Appendix B.

VIII. Execution of Grant Agreements

The Selection Committee and Delta Conservancy staff recommendations were presented to the Delta Conservancy Board Chair and Vice Chair for approval, and grants were executed as quickly as possible. A list of the 2022 DDRPP award recipients can be found in Appendix B.

IX. Analysis & Conclusions

- Analysis of the data derived from the Program during water year 2022 was collected in the Technical Appendix. These analyses were led by the DDRPP Oversight Committee, and Oversight Committee members are listed in the Technical Appendix. 8,525 acres were analyzed of the 8,850 acres enrolled. Acres were excluded across different grants because the field size and shape were too small to reliably query data from OpenET. Minimum field size was identified as an important selection criterion for future iterations of the program.

The major conclusions from the 2022 Program are:

- Agricultural water users within the Legal Delta are highly motivated to protect water quality threatened by periodic drought conditions in the watershed, can self-organize and pursue effective voluntary action through their Delta Water Agencies, and can effectively collaborate with State agencies on matters of aligned interest.
- The Legal Delta experiences drought not as a physical shortage of water but as a threat to water quality, primarily from salinity intrusion from the ocean and, sub-regionally, the recirculation of salts from San Joaquin Valley agricultural irrigation with drainage to the San Joaquin River. Water quality data (e.g. salinity) and other indicators of water quality (e.g. prevalence of harmful algal blooms and aquatic invasive plants) were not included in the analysis of the 2022 DDRPP because the primary objectives of the 2022 analysis were to develop a method to estimate water savings for each field enrolled, estimate Program water savings, and understand how water savings differed among action types and field contexts. In future years, analyses can build upon these findings to examine how effective water saving is at improving water quality, though assigning a causal relationship between changes in field management, water quantity saved, and in channel water quality readings is likely to be challenging.
- Subregional differences within the Legal Delta are important to understand and account for; however, allowing for those differences does not preclude dialogue, concerted response to drought risks, or collaboration with State drought management efforts.
- Water conservation actions conscientiously implemented by agricultural water users in the Legal Delta during the second half of water year 2022 produced less consumptive use savings than predicted. Estimated water savings are between 3,300 to 5,500 acre-feet across 8,525 acres; approximate 15 to 25 percent of the expected 22,000 acre-feet. Results from the 2022 Program suggest several hypotheses to explain this difference and highlights the need for further data.
- The need for additional data is highlighted by the variation in water savings among fields, even when comparing like practices. This, in addition to continued drought, called for renewing a modified DDRPP for water year 2023.
- Results from field level measurements of ET in 2023 will be useful to identify potential systematic biases in ET estimates from remote sensing and other nuances.
- While overall Program savings are modest, there may be value for incentivizing actions that reduce consumptive use during specific months and in specific geographic locations, particularly to provide improved water quality for sensitive species and/or when water quality and outflow objectives are difficult to meet.

- The Program's fixed-price-per-acre, though necessary to launch and implement the Program quickly, may not have been economically efficient for incentivizing water conservation, though it was highly effective in gathering credible and close-to-real-time water use data. Based on that insight, a reverse auction and fixed application date was used in the 2023 Program selection process. A report on the 2023 program will be prepared after the close of the water year.
- OpenET is a critical new tool for measuring water use in the Legal Delta. It provides a scientifically rigorous, transparent, timely, consistent, objective, and credible measurement of crop evapotranspiration. Further investment in and refinement of OpenET is warranted.
- Notwithstanding differences in missions, authorities, budgets, and constituencies, DWR, the Delta Conservancy, CDFA, CDFW and ODWM exhibited skill in coordinating effective response to drought risk. All the State agencies identified areas for further improvement, including streamlining grant administration and expanding dialogue with Delta water users and their intermediaries.
- Farmers need planning lead-time to alter their field management to accommodate practices aimed at alleviating drought impacts. Generally, an effective drought response should be organized and implemented by the beginning of the water year (October 1) to be responsive to when farmers are making field management and cropping decisions, which varies among individuals.

X. Technical Appendix

Summary

Analysis of the fields enrolled in the Delta Drought Response Pilot Program (DDRPP or Program) was done by the Oversight Committee (Committee) consisting of members from the Department of Water Resources (DWR), the Sacramento-San Joaquin Delta Conservancy (Delta Conservancy), the State Water Resources Control Board (SWRCB), the California Department of Food and Agriculture (CDFA), the University of California Merced, and the University of California Cooperative Extension.

The Committee's analysis compared evapotranspiration – or the combination of water vaporization from soil (i.e. evaporation) and plants (i.e. transpiration) - of DDRPP participant fields, and fields managed by "business-as-usual" practices. The Committee used data from OpenET, which provides satellite-based estimates of evapotranspiration (ET), to make these comparisons. OpenET is a scientifically rigorous, consistent, credible (with both water users and regulatory agencies), transparent, accessible, and inexpensive source of data to compare ET across practices and evaluate the water savings attributable primarily to the incentivized conservation actions under the Program. OpenET data was queried by Committee members with access to its beta application programming interface (API). OpenET has monthly data back to 2016, enabling the Committee to query ET data from both the 2021 water year and the 2022 water year for this analysis

The Committee's findings for DDRPP 2022 suggest that the incentivized actions Managed Idle Lands and Deficit Irrigation produced the largest consumptive water use savings. Non-Irrigated Crops and Not Double Cropping actions showed modest ET savings. However, there was substantial variation among fields, even when comparing within action types. Combined DDRPP consumptive water use savings (estimated to be between 3,300 to 5,500 acre-feet across 8,525 acres) were more modest

than anticipated at the outset (22,000 acre-feet, as estimated by participants). This technical appendix describes methods used to draw these conclusions. The Committee welcomes a critical review of these consumptive use estimation methods and feedback from interested parties.

OpenET Background

OpenET provides satellite-based estimates of water transferred from the land surface to the atmosphere through the process of evapotranspiration (ET). This is referred to as actual ET because it represents an estimate of the amount of ET that occurred at targeted fields/crops under actual conditions. OpenET uses six satellite-driven models (Table 1) to calculate a single "ensemble value". These six models have been reviewed and applied by a range of government agencies responsible for water use reporting and management in the western U.S. The value added through OpenET is based on a multi-year development process to make data from these models publicly available with exhaustive query and display tools to support consistent decision making by water users, researchers, and regulators. The models in Table 1 use Landsat satellite imagery to produce ET data at a spatial resolution of 30 by 30 meters (0.22 acres per pixel). Additional inputs vary across models and include gridded weather variables such as solar radiation, air temperature, humidity, wind speed, and precipitation. These weather variables in OpenET models use inputs from the California Irrigation Management Information System (CIMIS), developed and maintained by DWR. CIMIS is a network of over 145 weather stations throughout California (several stations are located within or near the Legal Delta). More information about CIMIS can be found at: https://cimis.water.ca.gov.

Table 1: Models currently Included in OpenET.

Model Acronym	Model Name	Primary References
ALEXI/DisALEXI	**A**tmosphere-**L**and **Ex**change **I**nverse / **Dis**aggregation of the **A**tmosphere-**L**and **Ex**change **I**nverse	Anderson et al., 2007; Anderson et al., 2018;
eeMETRIC	Google **E**arth **E**ngine implementation of the **M**apping **E**vapo**t**ranspiration at high **R**esolution with **I**nternalized **C**alibration model	Allen et al., 2005; Allen et al., 2007; Allen et al., 2011
geeSEBAL	**G**oogle **E**arth **E**ngine implementation of the **S**urface **E**nergy **B**alance **A**lgorithm for **L**and	Bastiaanssen et al., 1998; Laipelt et al., 2021
PT-JPL	**P**riestley-**T**aylor **J**et **P**ropulsion **L**aboratory	Fisher et al., 2008
SIMS	**S**atellite **I**rrigation **M**anagement **S**upport	Melton et al., 2012; Pereira et al., 2020
SSEBop	**Op**erational **S**implified **S**urface **E**nergy	Senay et al., 2013;

	Balance	Senay et al., 2018

Many factors may lead to ET variations among fields and regions, even within the same vegetation or crop type. Factors driving this variation include soil texture, salinity, ground cover, crop maturity, irrigation system type and distribution uniformity, production goals, fertilizer application, pest and pathogen pressure, field management practices, and other factors.

More information about the models, development team, their funders, and an accuracy assessment can be found on the OpenET website: https://openetdata.org.

Sorting Projects by Action Type

The Committee sorted the fields enrolled in DDRPP 2022 into four categories based on the applicant's proposed water conservation actions. Some grant agreements were split into multiple samples for the analysis because different actions were being taken on different fields at the same farm. Water conservation action categories include Non-Irrigated Crops, Deficit Irrigation, Managed Idle Lands, and Not Double Cropping. Table 2 shows the distribution of total project acreage across the four different actions. 8,525 acres were analyzed of the 8,850 acres enrolled in the Program. Acres across different grants were excluded from the analysis because the field size and shape were too small to reliably query data from OpenET.

Table 2: Summary of Project Action Types.

Action	Number of Projects	Total DDRPP Project Acreage	Average Acreage	Median Acreage	Minimum Acreage	Maximum Acreage
Non-Irrigated Crops	33	5,002	151.1	131.7	26.1	538.8
Deficit Irrigation	12	1,498	122.8	112.1	61.3	200.0
Managed Idle Lands	9	1,476	154.4	121.3	47.4	452.2
Not Double Cropping	5	549	109.7	106.6	40.6	205.1

Non-Irrigated Crops were fields planted with crops that were not actively irrigated during the grant period (roughly March to September of 2022). These fields may have naturally received water from under seepage. An example of a Non-Irrigated Crops field is a grantee who proposed to grow non-irrigated safflower instead of irrigated corn. Other non-irrigated crops in the Program were barley, sorghum, corn, triticale, and wheat.

Deficit Irrigation where fields where crops were grown with limited to no irrigation. An example of this action is a grantee who proposed to reduce the number of irrigations for alfalfa from four to one in the season. Other deficit irrigated crops included corn, carrot, and pasture ryegrass.

Managed Idle Lands were defined as lands that were neither irrigated nor planted with a cash crop. For instance, a grantee in the Program proposed to forgo the planting of a corn crop and instead left the field fallow during the grant period. Other foregone crops included wheat, alfalfa, and pasture. Weed growth also varied across these idle fields. For the protection of soil resources, grantees were required to minimize tillage for weed management but could employ spraying and mowing.

The fourth action type was Not Double Cropping. In a business-as-usual growing season, these fields would have had both a winter and summer crop. Instead, grantees in this category only planted a winter small grain crop, left the fields fallow during the summer, and left residual stubble after harvest to protect the soil.

Within each of these categories, there was a range of practices, including different crops, number of irrigations, weed management practices, and others. Hereafter, these will be described as sub-practices.

Determining “Business-as-Usual" Comparison Fields

The Program was evaluated during the periods of October 1, 2020-September 30, 2021 (hereafter water year 2021) and October 1, 2021-September 30, 2022 (hereafter water year 2022) using ET data from the project fields and a group of comparison fields. The purpose of identifying “business-as-usual” comparison fields was to provide ET comparisons for the water conservation actions in the Program. The Committee sought comparison fields with similar crops, soil classification, elevations and relation to the water course, and comparable farming practices, which included irrigation type, and planting and harvest dates to project fields. The aim was to identify comparison fields with the same crop(s) as the project field in 2021 and 2022, to allow comparisons before (2021) and during (2022) the water conservation actions. Comparison fields were at least 15 acres, and each field was at least 660-feet wide to ensure an accurate query of OpenET. Preferably, the project and comparison fields were managed by the same farmer or land manager. Site visits were done for some comparison fields to verify site location, crop condition, and irrigation type.

Committee members worked with grantees to identify these comparison fields. Desirable characteristics were discussed with grantees to help them identify suitable comparison fields for the Committee to use in this analysis. Google Earth and Sentinel Hub Playground satellite imagery were used to pinpoint field locations. The USDA SoilWeb interface was used in Google Earth to review the comparison field and project field soil classifications. It was difficult to identify comparison fields as suitable controls for several project fields. Some farmers did not have a good comparison field because the crop rotation pattern did not match that of the project field. Other problems included comparison fields that were too distant from the project field, had different inherent characteristics (e.g., soil classification, elevation, etc.), or were managed by different farmers. For these reasons, some of the comparison fields were not ideal comparisons to the Program fields. For the Not Double Cropping category, no comparison fields could be identified for any project, so the consumptive use analysis was limited for this action type. This action also had the fewest enrollees.

Drawing Shapefiles for Project and Comparison Fields

Project field boundaries were derived from the original descriptions in the associated grant agreements. Comparison field locations were determined in collaboration with the grantees as described previously. Committee members used Google Earth to draw polygon files (using zipped keyhole markup language format, or KMZ) for both the project and comparison fields. Paved roads and large drainage ditches were excluded from the polygons to increase precision of ET estimates.

8,525 acres were analyzed of the 8,850 acres enrolled in the Program. Acres across different grants were excluded from the analysis because the field size and shape were too small to reliably query data from OpenET. Committee members were responsible for drawing project fields and comparison fields. Individual polygons were converted into shapefiles and combined using QGIS (version 3.22.4). A 30-meter negative buffer reduced the shapefile footprint by 30 meters on all sides to avoid edge effects and isolate the ET of the agricultural field being analyzed. Without the negative buffer the ET for nearby areas, including roads, water bodies, nearby fields, and buildings, could have distorted the data. The combined shapefile attribute table was updated to include a unique name for each shape, the water conservation action category, crop type in 2021 and 2022 (if available), and if it was a project or comparison field.

The combined shapefile was added to a Google Earth Engine account and shared with openet@googlegroups.com. This enabled Committee members to query the OpenET API using Google Collaboratory, an online python code executor. Will Carrara (CSU Monterey Bay and the OpenET team) wrote the Python code used to query the OpenET API. The data query used the buffered shapes described above (hereafter referred to as sampled acreage) to retrieve ensemble ET values, minimum ET values, and maximum ET values. Minimum and maximum ET values were from a specific model that contributed to the ensemble ET value, but the model that produced the minimum or maximum value varied through the year. All data analysis was performed using these values. Following a training period, it took about five minutes to upload a shapefile, update Collaboratory code to reference this shapefile, run the code, and retrieve the OpenET data.

Data Analysis

Once ET data for the project and comparison fields were retrieved, the data were processed in R (version 4.2.1) and MS Excel. Data were downloaded at a monthly resolution for each field from October 2021 thru September 2022. Data were analyzed to estimate total ET savings across all enrolled acres, and average savings per acre for the different water conservation actions.

Monthly ET values were summed for each water year to create a total ET value for each project or comparison field (hereafter Annual ET). Annual ET was divided by 12 to convert from acre-inches/acre to acre-feet/acre. Due to roads or irrigation ditches separating fields, some project and comparison fields were subsampled using multiple polygons. Weighted means were calculated across the subsamples using the formula:

$$W = \frac{\sum_{i=1}^{n} w_i X_i}{\sum_{i=1}^{n} w_i}$$

where n is the sample size, w_i is the weight applied (sampled acreage of each subsample) to the data values (x) to be averaged (ensemble ET values). Weighted means were calculated at a monthly timestep, then summed across the year to determine the differences among water conservation practice types. For analysis of differences among sub-practices, subsamples were summed across the year then a weighted mean was calculated.

Annual ET values from water year 2021 and water year 2022 were used to estimate ET savings. Methods to estimate ET savings were developed by Committee members and in consultation with OpenET and DWR staff (Table 3). Each method represents a different way to estimate ET savings, each of which attempts to minimize potential sources of error.

Table 3: Methods Used to Estimate ET Savings.

Method Name	**Method Equation**
Comparison Field Change	(2022 Comparison Field ET – 2022 Project Field ET) + (2021 Project Field ET – 2021 Comparison Field ET)
Scaled Comparison Field	(2022 Comparison Field ET —2022 Project Field ET) x (2021 Comparison Field ET / 2021 Project Field ET)
Alternate-Scaled Comparison Field	(2021 Project – 2022 Project) x (2022 Comparison Field ET / 2021 Comparison Field ET)
Same Field Change	2021 Project Field ET – 2022 Project Field ET
2022 Change	2022 Comparison Field ET – 2022 Project Field ET

Since not all project fields had an appropriate comparison field the Committee created a calculation (Same Field Change, Table 3) which did not use a comparison field and would avoid error introduced by comparison fields. Similarly, there was more uncertainty about comparison field operations (irrigation methods, crop types, etc.) in the 2021 water year, so the 2022 Change calculation lessened this source of possible error. None of the calculations in Table 3 represent actual ET savings; rather the five methods provide a range of estimates of ET savings.

ET Savings by Water Conservation Action Type

Annual ET values for each project and comparison site were used to estimate ET savings as described in Table 3. Mean ET savings for each water conservation action were calculated by taking the weighted mean of ET savings within each action type based on the sampled acreage. Error is shown as standard deviation about the mean as calculated for a weighted mean, which is calculated using the following equation:

$$\sqrt{\frac{\sum_{i=1}^{N} w_i (x_i - \overline{x^*})^2}{\frac{(M-1)}{M} \sum_{i=1}^{N} w_i}}$$

where N is the sample size, M is the number of non-zero weights, w_i is a vector of the weights, x_i is a vector of the values used to calculate the mean, and x is the weighted mean.

Across the calculation methods (Table 4), the greatest average ET savings came from Managed Idle Lands, with an average of 0.77 ac-ft/ac, followed by Deficit Irrigation, with an average of 0.67 ac-ft/ac. The lowest potential ET savings was from Non-Irrigated Crops, with an average of 0.20 ac-ft/ac. Not Double Cropping also resulted in a low potential ET savings; however, there were few sites employing that practice and none of the sites had a comparison field. While Managed Idle Land had the highest average savings, it also had the widest spread in the data, meaning there is uncertainty in the actual ET savings. Similar variability was seen within the other action types.

Table 4: ET Savings for each conservation action type across calculation methods. Values represent the weighted means across sites plus or minus the standard deviation, followed by the range of potential ET savings in parentheses. Values indicated by an asterisk are not replicated because no appropriate comparison fields for this conservation practice category.

Calculation Method	Deficit Irrigation ET Savings (ac-ft/ac)	Managed Idle Lands ET Savings (ac-ft/ac)	Non-Irrigated Crop ET Savings (ac-ft/ac)	Not Double Cropping ET Savings (ac-ft/ac)
Comparison Field Change	0.69 ± 0.81 (-0.12 to 1.50)	0.49 ± 0.76 (-0.27 to 1.24)	0.12 ± 0.44 (-0.32 to 0.56)	-0.54*
Scaled Comparison Field	0.64 ± 0.60 (0.04 to 1.24)	0.59 ± 1.03 (-0.43 to 1.62)	0.37 ± 0.77 (-0.40 to 1.14)	0.69*
Alternate-Scaled Comparison	0.70 ± 0.73 (-0.04 to 1.70)	1.02 ± 0.81 (0.20 to 1.83)	0.07 ± 0.39 (-0.32 to 0.46)	0.03*
Same Field Change	0.66 ± 0.68 (-0.02 to 1.33)	1.18 ± 0.98 (0.21 to 2.16)	0.10 ± 0.37 (-0.27 to 0.47)	0.49 ± 0.72 (-0.23 to 1.20)
2022 Change	0.67 ± 0.68 (-0.00 to 1.35)	0.57 ± 1.01 (-0.43 to 1.58)	0.34 ± 0.64 (-0.30 to 0.98)	0.49*
Average ET Savings across Calculation Methods	0.67	0.77	0.20	0.23

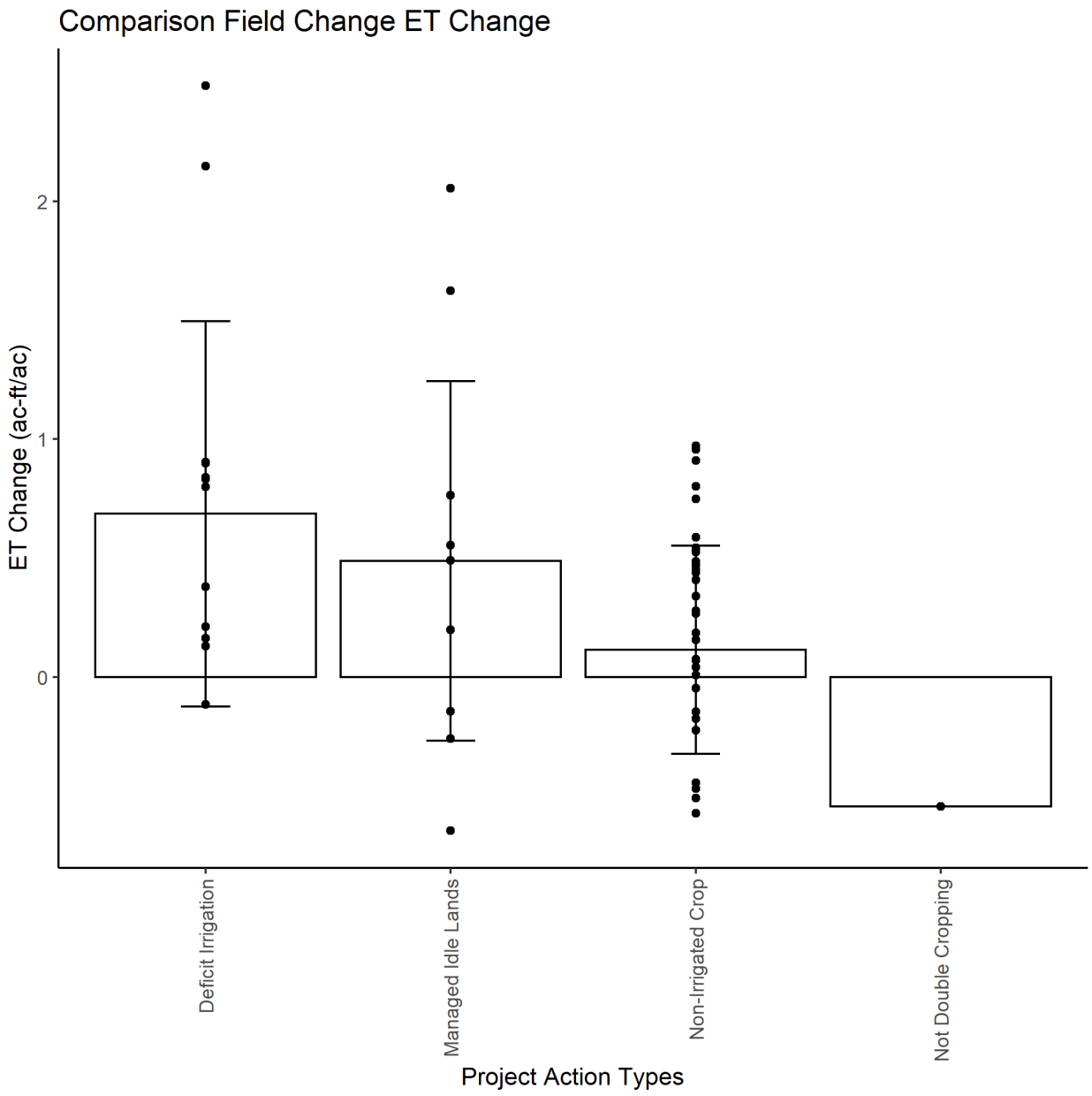

Figure 2: Estimated ET Savings calculated using Comparison Field Change method.

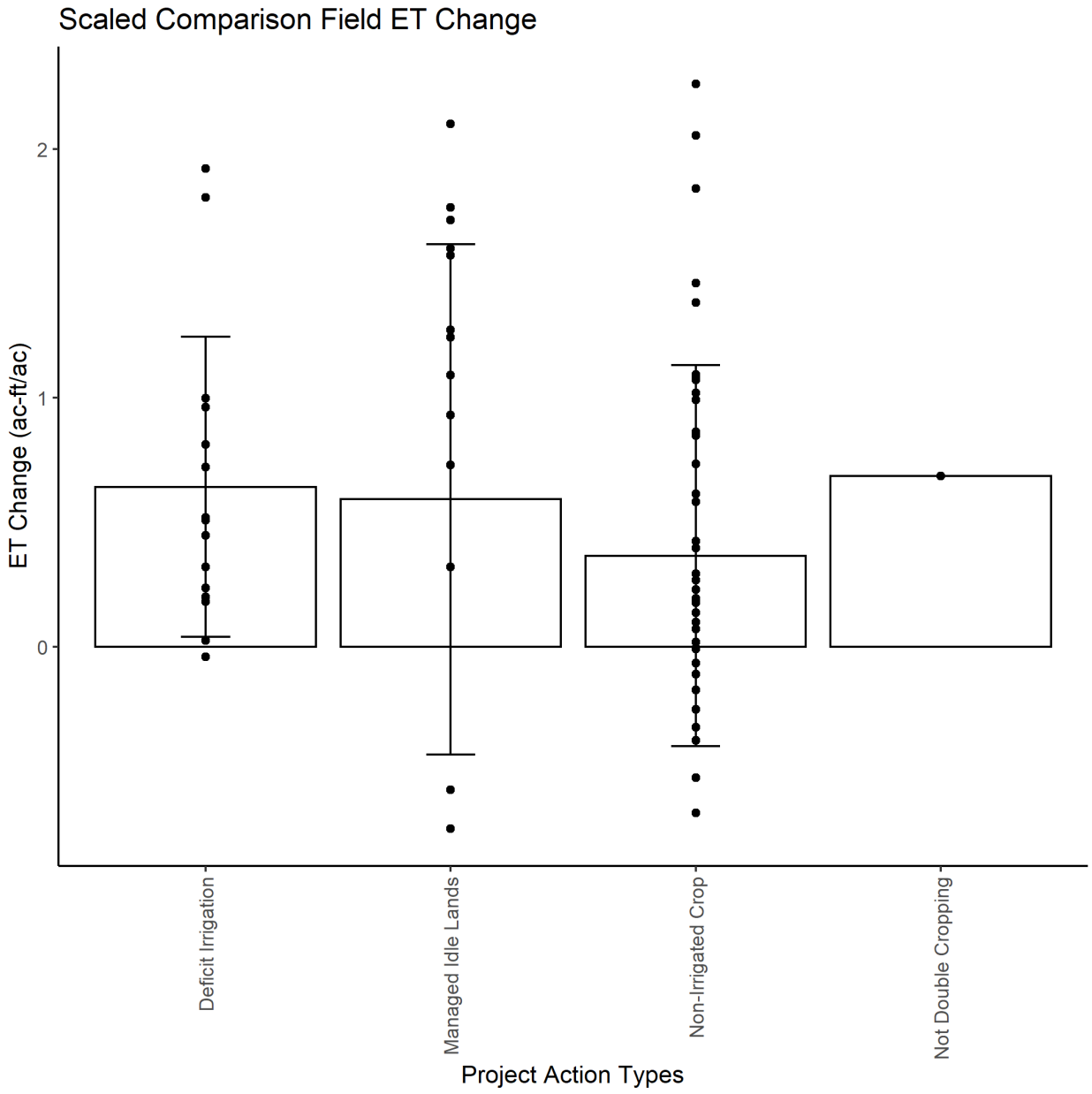

Figure 3: Estimated ET Savings calculated using Scaled Comparison Field method.

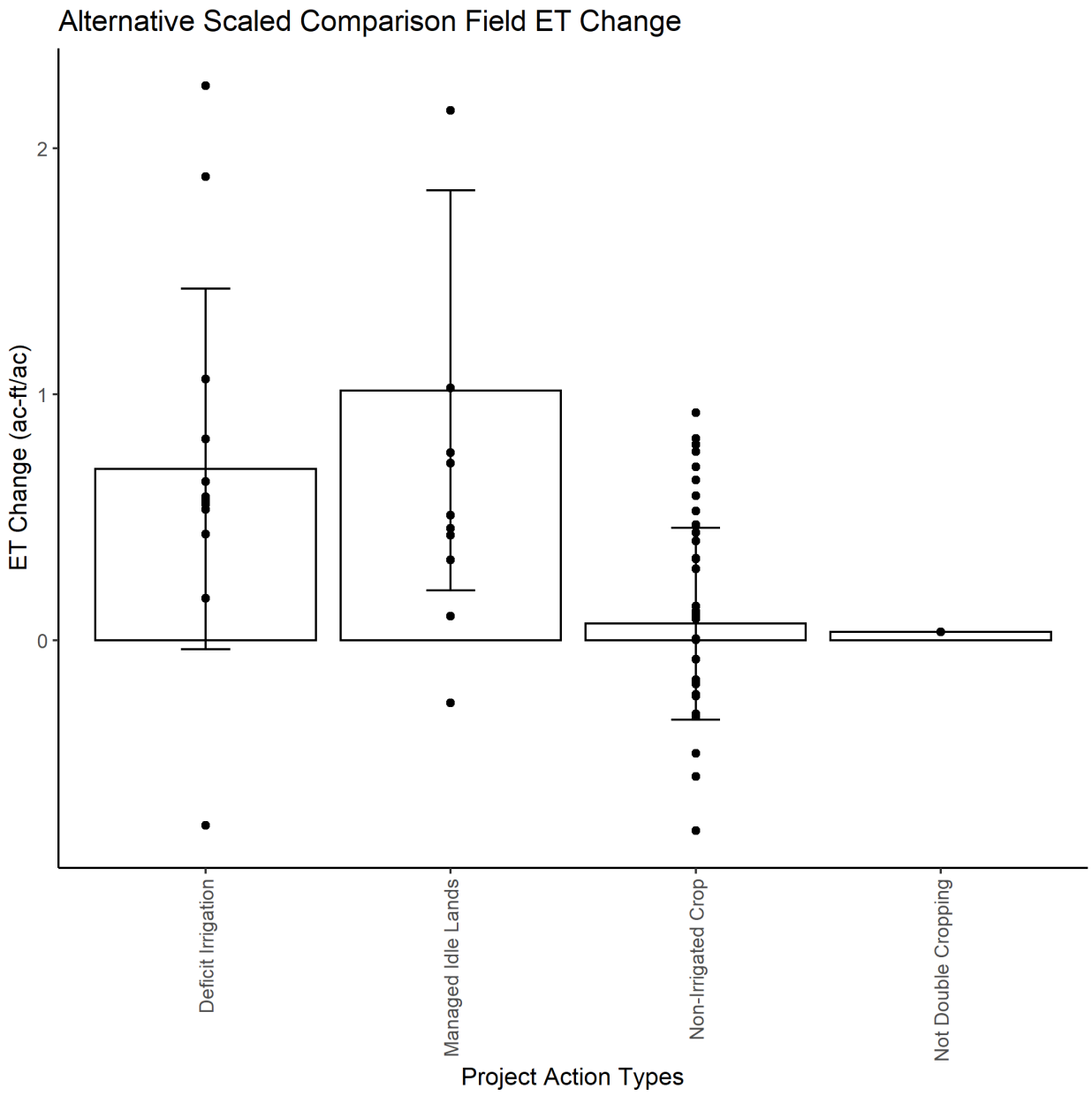

Figure 4: Estimated ET Savings calculated using Alternate-Scaled Comparison Field method.

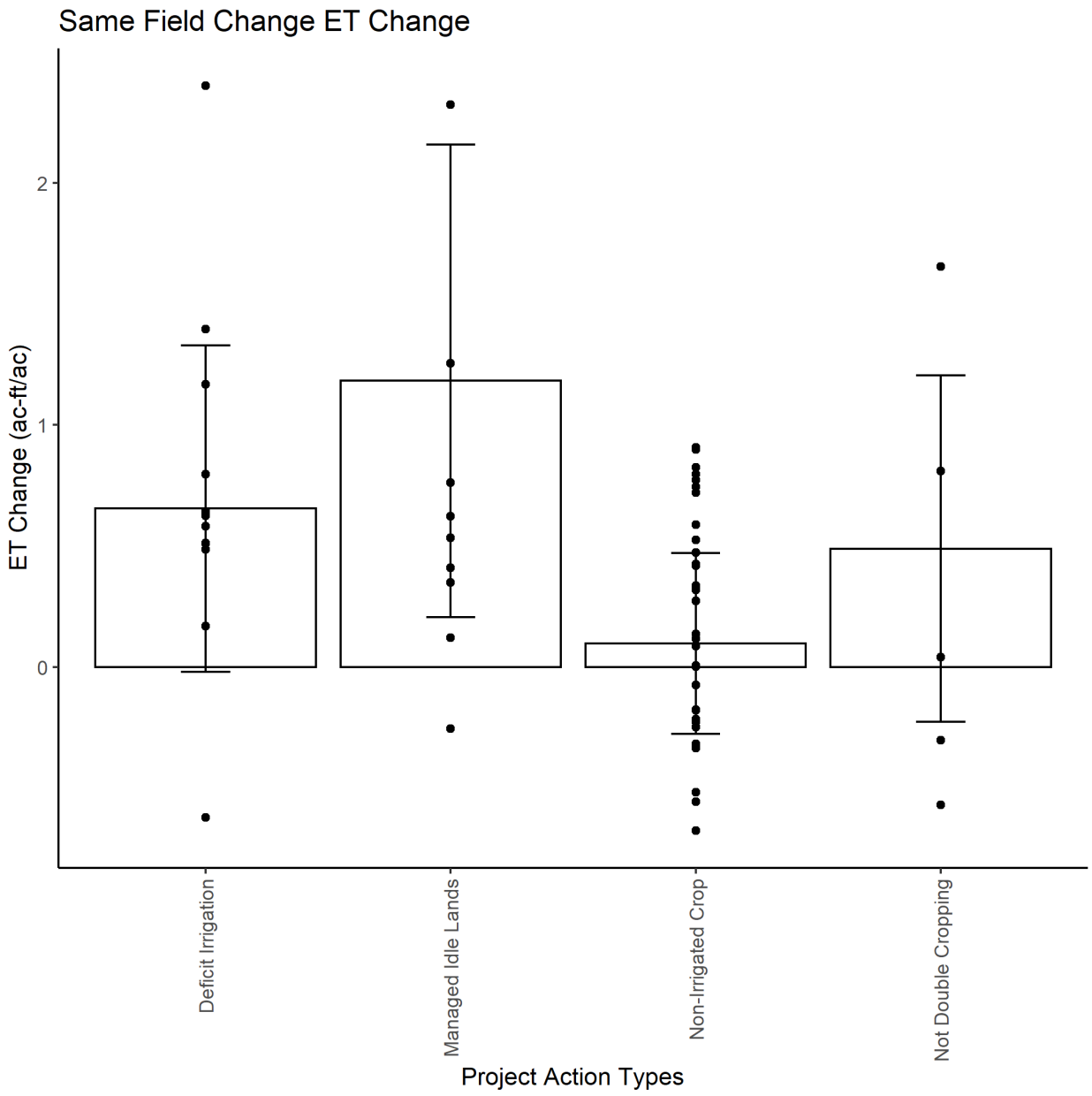

Figure 5: Estimated ET Savings calculated using Same Field Change method.

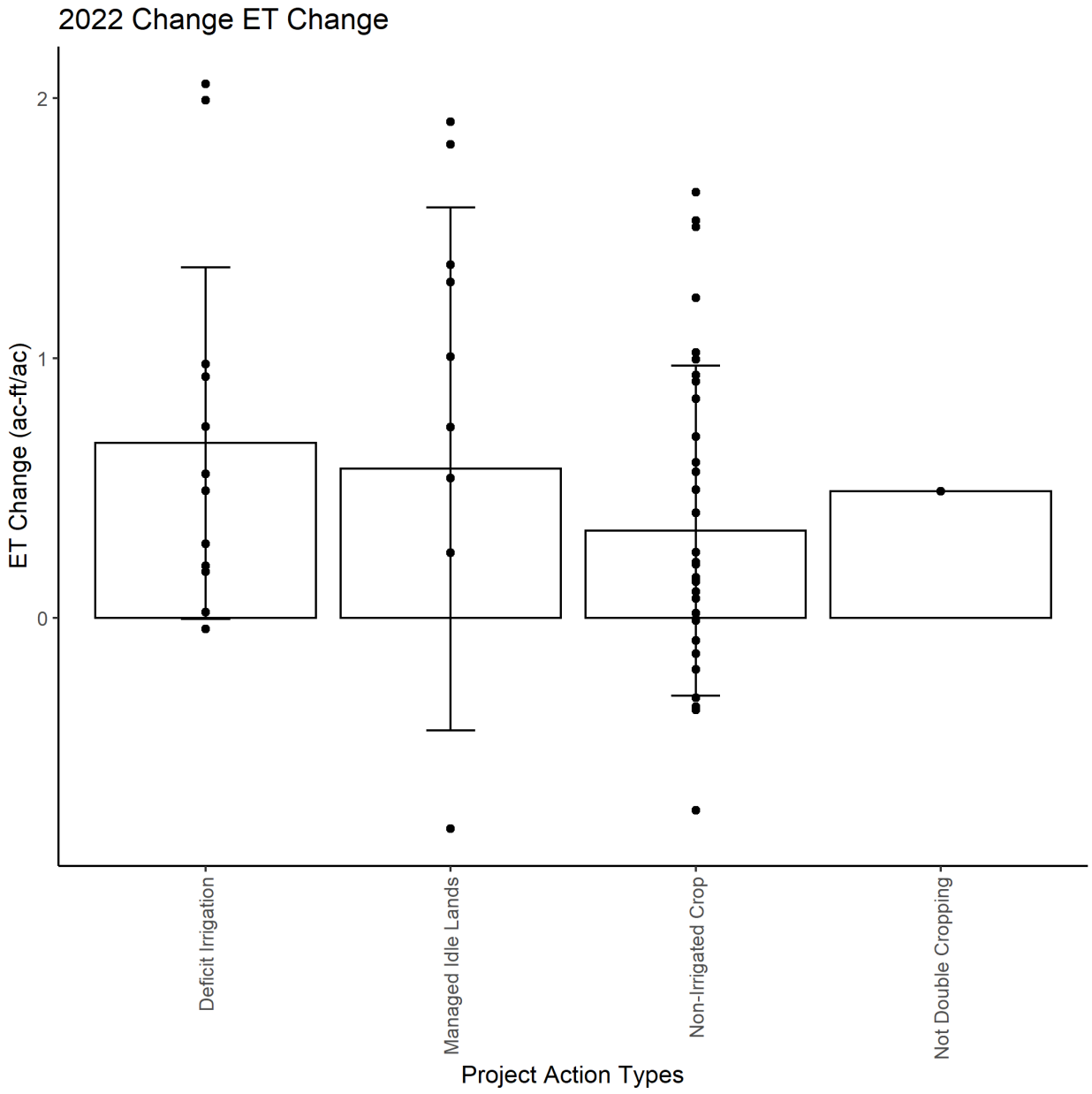

Figure 6: Estimated ET Savings calculated using 2022 Change method.

The Committee used the five methods detailed in Table 3 to estimate total ET savings across all DDRPP project fields. Each project field's calculated ET change (using the five methods) was multiplied by the project area to estimate total ET change for that project. That value was summed across every DDRPP project field to estimate total ET savings.

Table 5 summarizes the total savings of each calculation method, which range from about 3,300 to 5,500 ac-ft of savings across 8,525 acres. When grantees applied for the Program, they estimated consumptive use savings for their actions, which totaled about 22,000 ac-ft for the selected projects. Based on data from OpenET, and using the calculations in Table 3, the savings are less than anticipated. Nevertheless, the Program achieved the goal of reducing consumptive use, just not at the scale initially anticipated.

Table 5: Combined ET Savings across all 2022 DDRPP Project Fields

	Comparison Field Change (ac-ft)	Scaled Adjacent Field (ac-ft)	Alternative-Scaled Field (ac-ft/ac)	Same Field Change (ac-ft)	2022 Change (ac-ft)
Total WY 2022 ET Savings	**3,330**	**5,486**	**3,254**	**3,625**	**4,759**
% of Expected 22,000 ac-ft savings	**15%**	**25%**	**15%**	**16%**	**22%**

Evaluating Incentivized Actions by ET Savings and Elevations

Next, water conservation actions were further subdivided based on the "business-as-usual" sub-practices (Table 6). This subdivision helped tease out nuances, as shown in Table 6. Certain actions, like managing idle land instead of growing corn produced modest savings (between 0.19 to 0.51 ac-ft/ac). Managing Idle land instead of growing pasture appeared to have greater savings (between 1.71 to 2.32 ac-ft/ac); however, there was a small sample size for this practice, so this pattern should not be seen as conclusive. Notably, the pasture example was a site with elevation above sea level, and the elevation may have impacted water savings more than foregone crop. Identifying these nuances in the DDRPP 2022 data influenced plans for the second iteration of DDRPP for the 2023 water year.

Table 6: List of estimated ET savings from different sub-practices. Non-Irrigated Crop and Managed Idle Land sub-practices are categorized based on what was shifted away from during implementation of the water conservation action as opposed to "business as usual" (e.g. shifting away from growing corn to growing a non-irrigated crop).

Sub-practice	Savings Range (ac-ft/ac)	Average Elevation (ft)	Area (ac)	Number of Projects
Non-Irrigated Crop - From Corn	0.11 to 0.58	-9.3	3936	22
Non-Irrigated Crop - From Tomato	0.14 to 0.30	-2.9	376	4
Non-Irrigated Crop - From Alfalfa	0.36 to 0.50	-10.5	332	3
Non-Irrigated Crop - From Triticale	-0.33 to 0.37	-9.8	358	3
Deficit Irrigation - Alfalfa	0.99 to 1.17	5.3	1089	9
Deficit Irrigation - Corn	0.19 to 0.25	-12.9	288	2
Deficit Irrigation - Rye	-0.75 to 0.02	-9.9	120	1
Managed Idle Land - From Alfalfa	0.53 to 2.10	-4.0	121	1
Managed Idle Land - From Corn	0.19 to 0.51	-11.0	558	6
Managed Idle Land - From Pasture	1.71 to 2.32	19.8	452	1
Managed Idle Land - From Wheat	0.41 to 1.77	-7.0	123	1
Managed Idle Land - From Tomato	0.27 to 0.87	3.6	222	1
Not Double Cropping - Sudan Grass	1.18*	20.8	246	2
Not Double Cropping - Corn	-0.41*	-11.0	98	2
Not Double Cropping - Carrot	-0.54 to 0.69	9.3	205	1

**Not replicated. No appropriate comparison fields for this conservation practice category.*

As indicated in Table 6, elevations across the Delta vary significantly. Portions of the Delta are below sea level, as shown in Figure 7. Dikes (commonly referred to as levees) protect most land in the Delta from inundation. In areas below sea level, the water elevation in the channel is higher than the adjacent land elevation behind the levee. Because of this significant elevation difference, channel surface water percolates under the levees (often called under seepage) so many Delta islands require drainage facilities to prevent under seepage from inundating the land and preventing crop cultivation. This seepage water likely influences crop ET in the Delta. The Committee hypothesized that elevated land had greater potential for water savings from DDRPP than land at or below sea level because there would be less seepage at higher elevations.

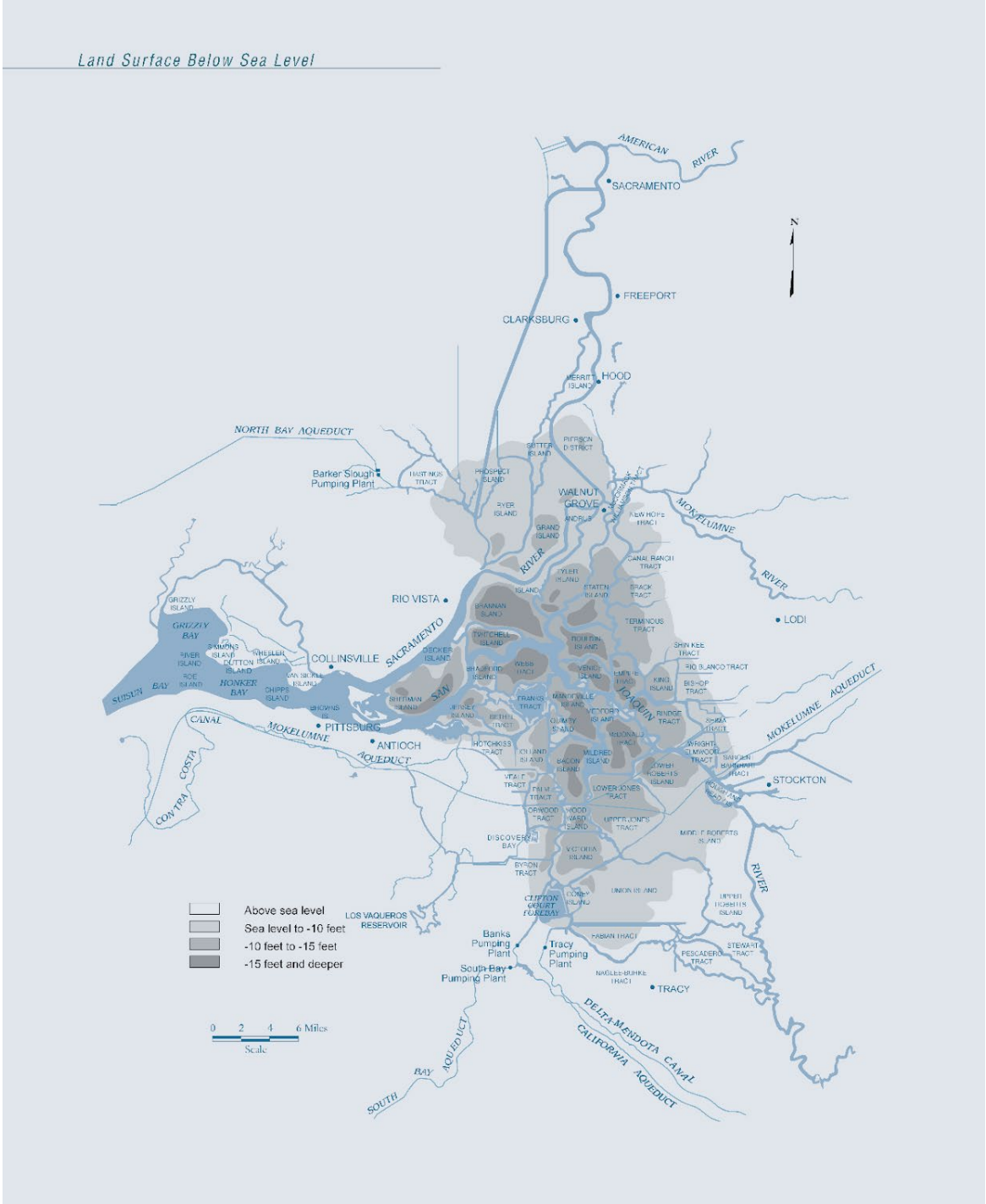

Figure 7: Map of Land Surface Below Sea Level (DWR Sacramento-San Joaquin Delta Overview, 2004, p. 26).

To test the elevation hypothesis, a linear regression using Excel was done to investigate a possible relationship between ET saving and land elevation at the project fields. Data from the Same Field Change calculation method (see Table 3) was used for this analysis.

Across all project sites, there was a weak relationship (R^2 value of 0.27) between land elevation and the change in ET between Water Year 2022 and Water Year 2021 (Figure 8). ET savings for specific projects were graphed as a positive number. With only one exception, all project sites above sea level had estimated water savings with the Program action, and all but one of the project sites that

consumed more water during the Program were below sea level. Nevertheless, many project fields had ET savings even though they were below sea level.

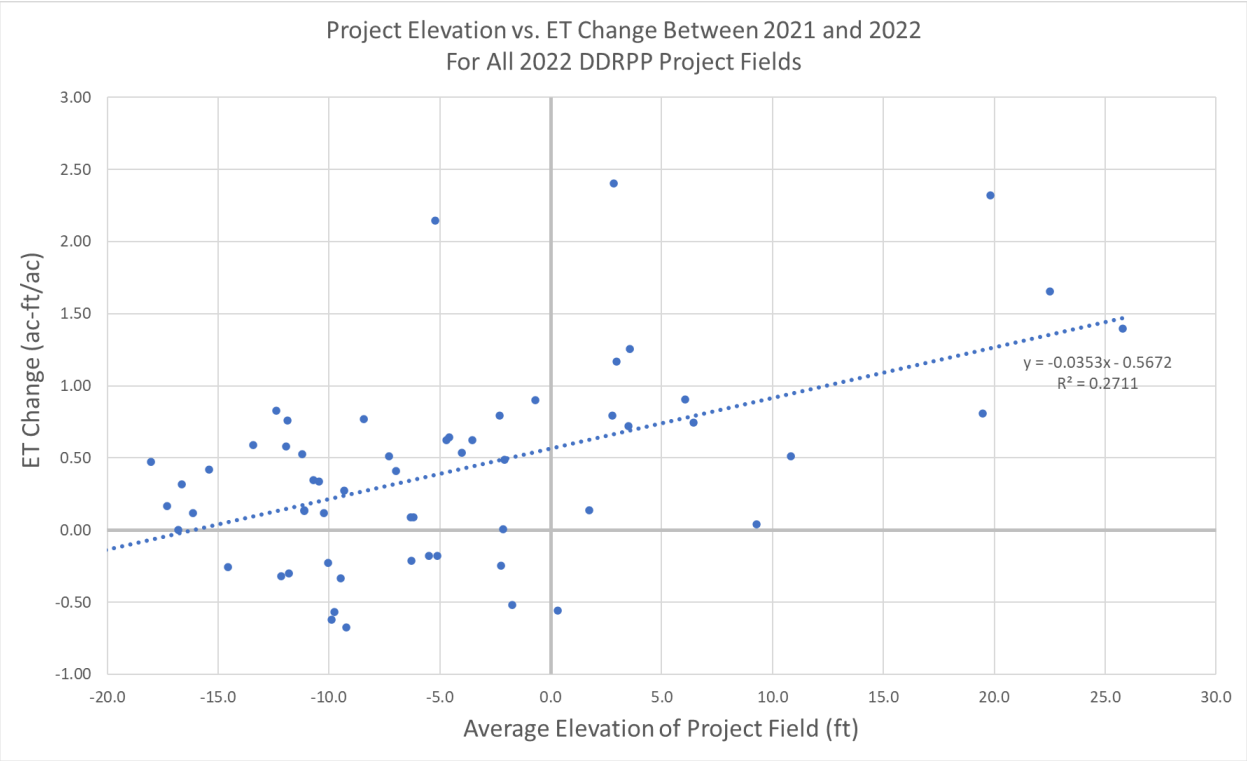

Figure 8: Relationship between project site elevation and ET change between Water Year 2022 (Program year) and Water Year 2021 (comparison year). Positive values of ET change indicate water savings from the Program action.

The Committee ran a similar analysis for each action category (Figures 9-12). For Non-Irrigated Crops and Deficit Irrigation, there was little to no relationship between elevation and the Change in ET for Non-Irrigated Crops. The relationship was strong for the Not Double Cropping and Managed Idle Lands practices; however, the sample sizes were small for those two categories.

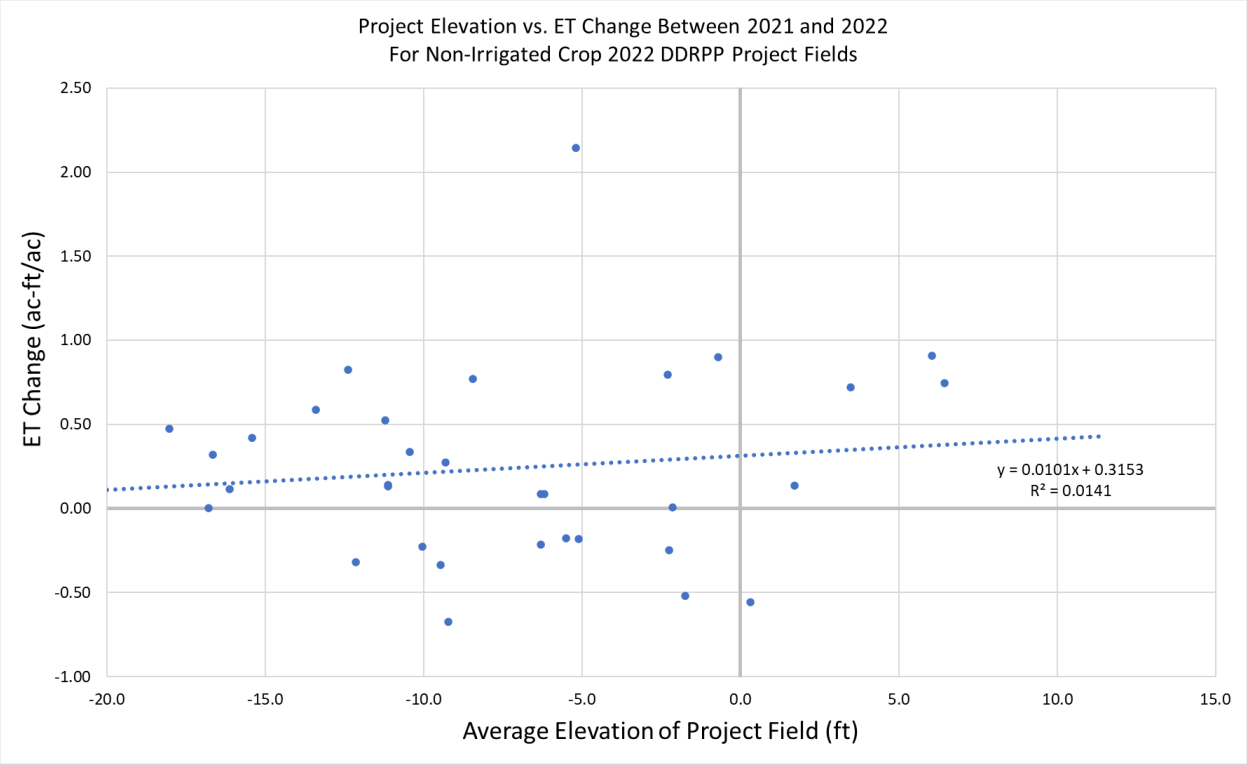

Figure 9: Graph of Non-Irrigated Crop Project Elevations Compared to ET Change of the Project Field from Water Year 2021 to 2022.

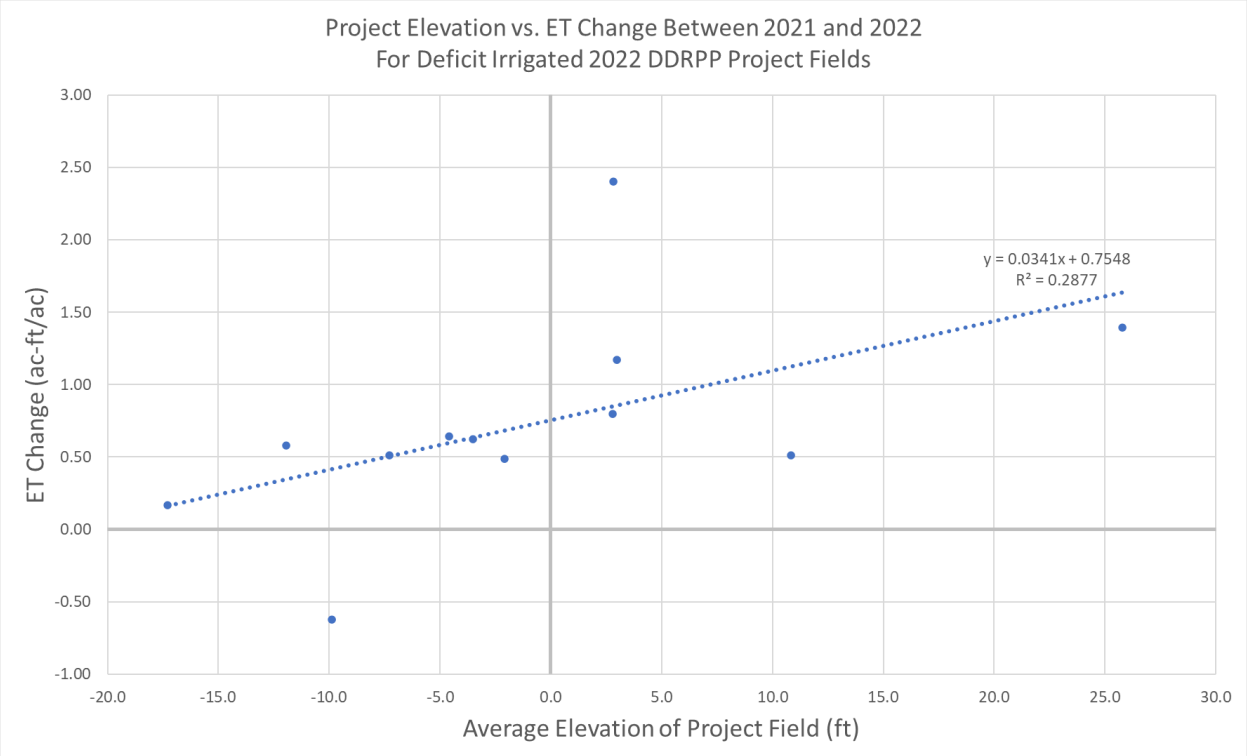

Figure 10: Graph of Deficit Irrigated Project Elevations Compared to ET Change of the Project Field from Water Year 2021 to 2022.

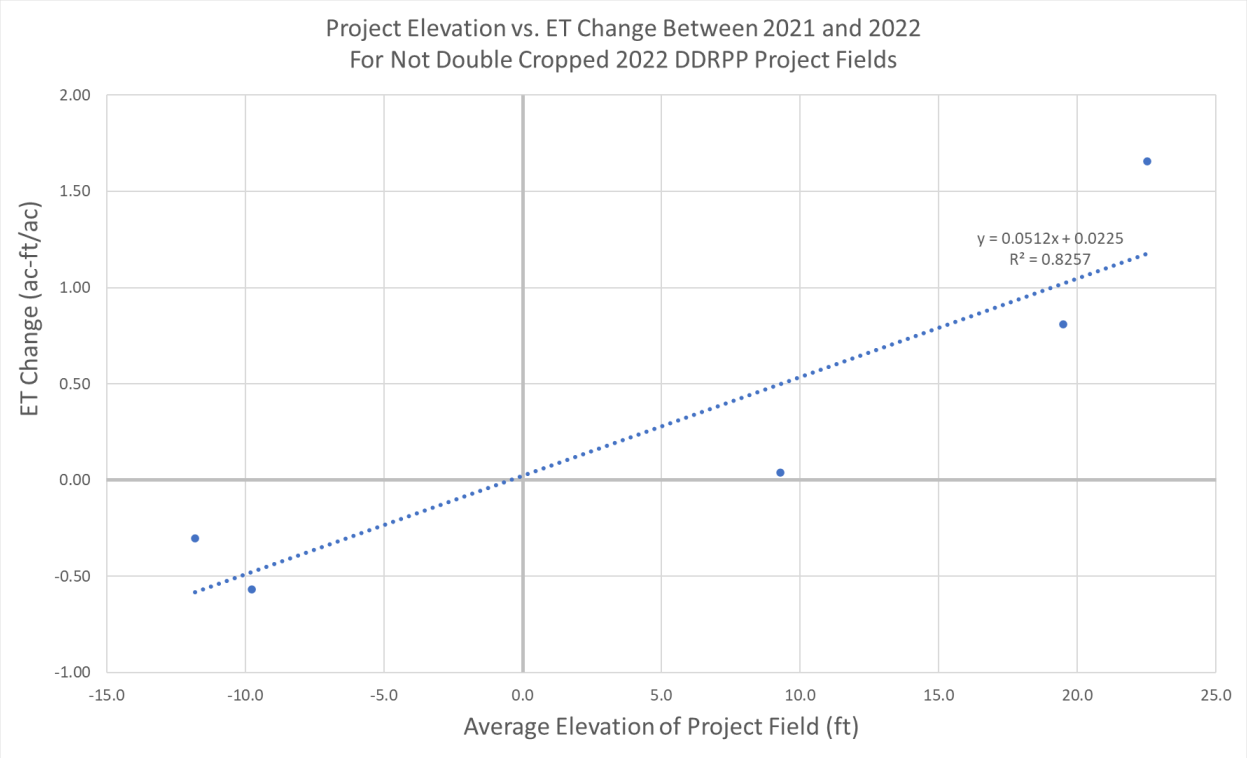

Figure 11: Graph of Not Double Cropped Project Elevations Compared to ET Change of the Project Field from Water Year 2021 to 2022.

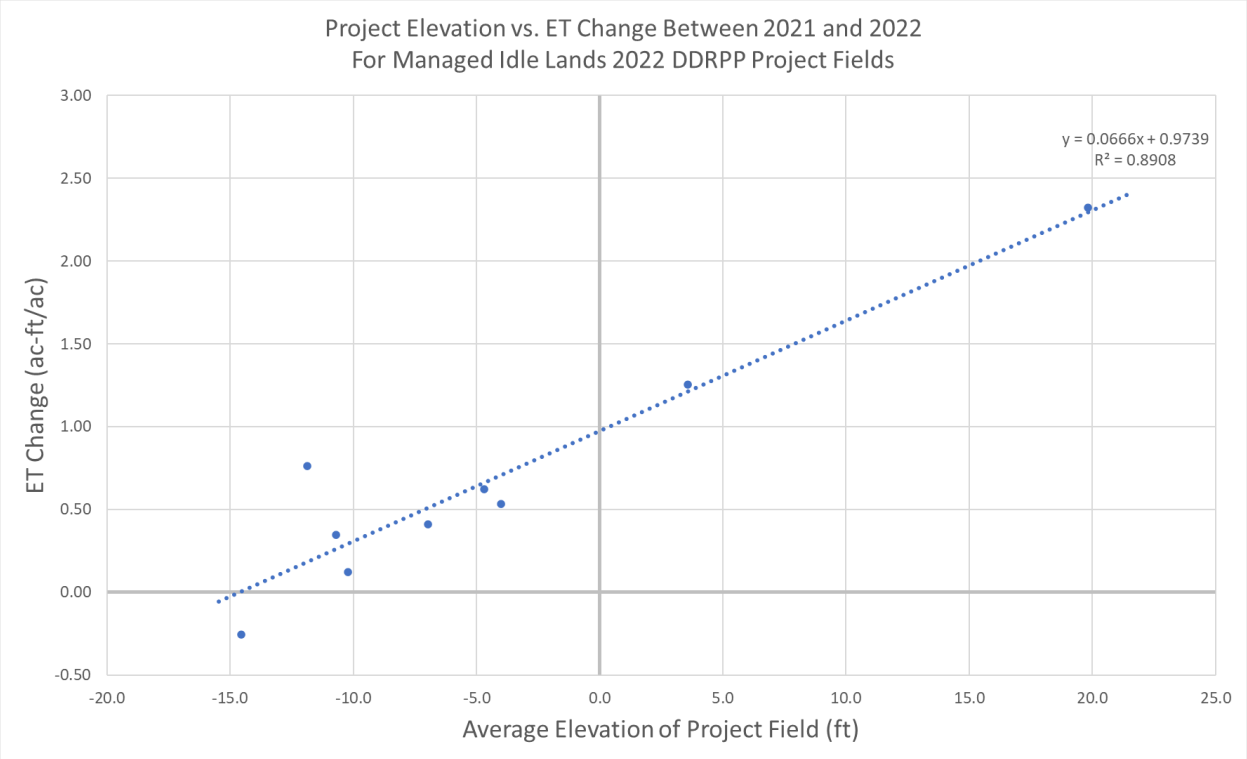

Figure 12: Graph of Managed Idle Lands Project Elevations Compared to ET Change of the Project Field from Water Year 2021 to 2022.

Recommendations for Further Analysis

The Committee recommends that data gathered from the 2023 DDRPP Program should aim to refine the range of potential ET savings for different water conservation actions and evaluate alternative ways of categorizing the data. The number of Not Double Cropping sites should be increased to better understand and quantify water saving actions from that practice. Lastly, further study could reveal whether Delta land elevation has a role in ET savings by measuring soil moisture, evaluating root zone water contributions from seepage, and communicating with farmers about drainage practices. Additionally, preliminary data explorations suggest that ET savings vary across different months of the year, and such temporal patterns should be further explored in future years.

This analysis also suggested several improvements for the Program, which were incorporated into the 2023 DDRPP. First, a minimum of 100 contiguous acres per incentivized action was required to ensure fields could be measured using OpenET. The 2023 grant budget was focused (75%) on practices this analysis suggested saved more water (deficit irrigation, managed idle lands, not double cropping) with a smaller amount of the budget (25%) targeted at other practices (e.g. Non-Irrigated Crops or other unique practices) to continue gathering data to refine our understanding of all practice types. Finally, the need to gather additional data about timing of field management practices will be addressed through an updated grantee reporting process in 2023.

Conclusions

The DDRPP Oversight Committee estimated consumptive water use savings for the 2022 Delta Drought Response Pilot Program. This analysis showed ET estimates varied among and within water conservation actions and among methods of calculating ET savings. Differences among calculation methods are likely driven by the way each method incorporates the comparison field and how well the comparison field matched the project field. Variation among fields was likely driven by numerous factors including soil texture, salinity, ground cover, crop maturity, irrigation system type and distribution uniformity, production goals, fertilizer application, pest and pathogen pressure, field management practices, and other factors. Results suggest that Managed Idle Lands and Deficit Irrigation produced the greatest consumptive use savings; although Managed Idle Lands also had the widest range of savings among project sites. Non-Irrigated Crops and Not Double Cropping showed modest ET savings. Overall, consumptive use savings resulting from the water conservation actions were more modest than anticipated at the outset of the Program.

The level of variability among projects sites makes assessing project outcomes challenging. Future studies should aim to refine the range of potential ET savings from these practices and determine what (if any) field characteristics impact potential ET savings. Refining ET savings estimates may be possible by comparing remotely-sensed data with ground measurements. Such ground measurements are planned for the 2023 DDRPP. Additionally, because there were only a few Not Double Cropping sites, and none had comparison sites, future studies that aim to quantify water savings from Not Double Cropping would help to inform future programming.

To explore the variability within each water conservation practice type, we examined the role of crop type and elevation on ET savings. A sub-practice analysis provided additional insights, but

limited sample sizes prevented statistically robust conclusions. The analysis suggested projects above sea level more reliably save water than those on sites below sea level, though many project fields that were below sea level had ET savings. Further study could help reveal the role of Delta land elevation in ET savings.

Oversight Committee members (in alphabetical order) were Lisa Crowley, Jason Harbaugh, Lindsay Kammeier, Michelle Leinfelder-Miles, Idy Lui, Josue Medellin-Azuara, Jeff A. Smith, Rae Vander Werf, Lauren Wacker, and Rachel D. Wigginton. This analysis could not have happened without the dedicated work of all Committee members. This diverse group brought their expertise and insight to craft this analysis.

XI. Solicitation Summary

Delta Drought Response Pilot Program
A Collaboration among Delta Water Users and State Agencies

Objectives:	Reduce drought stress in the Delta watershed, protect Delta water quality, and improve mutual understanding of agricultural practices and water conservation opportunities in different regions within the Legal Delta.
Background:	The Delta Drought Response Pilot Program (Pilot Program) is in response to consecutive dry years, low combined storage in Project reservoirs, and drought-constrained water deliveries to Project contractors. Funds are available to incentivize agricultural water users in the Legal Delta to take actions expected to reduce crop consumptive water use and protect water quality. Water conserved through incentivized actions in the Pilot Program will be allocated to protecting Delta water quality and will not be available for diversion or exports. By rigorously monitoring the outcomes and impacts of a variety of actions in different settings throughout the Legal Delta, the Pilot Program will provide data to support targeted water conservation/quality protection responses to sustained and/or future droughts.
Collaborators:	The North, Central, and South Delta Water Agencies in collaboration with the California Environmental Protection Agency, California Natural Resources Agency, and the California Department of Food and Agriculture (collectively, the Agencies).
Administrator:	Pursuant to an Interagency Agreement between the Department of Water Resources and the Sacramento-San Joaquin Delta Conservancy (Conservancy), the Conservancy will administer the Pilot Program.

Eligible Applicants: Individual agricultural water users having points of diversion within the Legal Delta who propose specific water conservation actions, subject to specified criteria and conditions.

Goal: Reduce consumptive use of water within the Legal Delta versus "business as usual" agricultural through:

1. Collection of credible data on criteria, affects, tradeoffs, and costs of short-term conservation/protection actions;
2. Acquisition of insight to inform collaborative development of potential predictable dry-year responses in future droughts;
3. Conservation of upstream freshwater storage;
4. Protection of Delta water quality control objectives (e.g., salinity intrusion);
5. Reduction of stress on migrating salmon and other aquatic, avian, and terrestrial species;
6. Minimization of collateral economic and social impacts of persistent drought;
7. Support of broader watershed-wide habitat enhancement measures; and
8. Mobilization of farmers' expertise to guide water conservation/protection actions.

Short-term Water Conservation/Protection Actions (Actions): Applicants will propose to carry out Actions likely to advance the Goals as they deem appropriate for their locations and agricultural capabilities. Proposed Actions must be reasonably expected to reduce net crop consumptive use of water in the Applicants' agricultural operations during the 2022 water year (i.e., no savings in one area offset by practices in another). If selected for participation in the Pilot Program, the Applicant will be offered a grant agreement specifying Actions that they will carry out on specified fields under their control during specified periods during the 2022 water year. Among the most promising such Actions suggested through extensive outreach to experienced farmers in the Delta:

1. Foregoing a planned cash crop (e.g., maintaining idled farmland with appropriate drainage and appropriate healthy soil protections);
2. Shifting irrigation practices to conserve water, reduce or adjust timing of diversions, increase reuse, and/or protect water quality (e.g., converting to 60" furrows on flood irrigated crops, foregoing a portion of the irrigation cycle, replacing flood

irrigation with subsurface irrigation, etc.); and
3. Shifting to less water-intensive crops (e.g., cultivating small grains like winter wheat or safflower that require little or no diversion of surface water for irrigations, instead of a more water-intensive summer crop like corn or tomatoes).

The Collaborators encourage Applicants to propose other innovative Actions designed to accomplish one or more of the Goals.

Grant Amount:

Grantees will receive a grant of $900 per enrolled acre payable as follows. Twenty five percent (25%) is payable upon execution of the Grant Agreement. Up to fifty percent (50%) is payable upon satisfactorily completing deliverables and key project milestones to be specified in the grant agreement. The balance of the grant is payable upon completion of all tasks specified in the grant agreement. The fixed-formula grant has been determined based upon:

- Experience with other agricultural water conservation programs in California;
- Recognition of costs associated with carrying out water conservation/protection actions while maintaining healthy soils;
- Feedback from farmers with experience both in the Legal Delta and in the wider Delta watershed and export areas;
- The need to gather data to inform future water conservation/protection programs; and
- Urgency to implement a practical program during the unique 2022 water year.

Selection of Grantees:

The Collaborators recognize that the same or similar Actions may have widely different costs (such as foregone opportunity costs, drainage expense, weed management, etc.) and widely different water conservation/protection outcomes across different areas of the Delta (based on variations in soil type, weather conditions, depth to groundwater, and other factors). Moreover, Actions appropriate for one area may be inappropriate, ineffective, or impossible to undertake in another area. Because of the need to identify and quantify such variabilities, grants will be awarded to maximize the anticipated value of comparative data as well as the potential water conservation/protection effects of proposed Actions.

The Conservancy will convene a Selection Committee composed of

knowledgeable individuals nominated by the Collaborators to evaluate and select Applicants to be offered Grant Agreements based on (i) diversity of locations; (ii) variety of proposed Actions; (iii) best estimates of prospective consumptive use savings; (iv) expected timing of such savings; (v) anticipated collateral benefits/detriments; and (vi) data research needs. The Selection Committee will meet to review applications on a rolling basis as they are received. Following initial Selection Committee review, the Conservancy may contact Applicants to discuss refinements or other aspects of their proposals. The Conservancy will exercise its best efforts to respond to all Applications within 14 days of receipt.

Baselines for Measuring Conservation:

The Applicant and the Conservancy will discuss and agree on the appropriate baseline for comparison to establish the water conservation/quality protection impacts of proposed Actions. The appropriate baseline will be specified in each Grant Agreement. Baseline establishment approaches could include: Evapotranspiration (ET) on a field selected for fallowing during 2022 could be compared with ET on the same field during 2021. The ET savings associated with changing irrigation practices could be measured against similar fields/crops during the Pilot Program. Savings associated with crop substitution actions could be measured against 2022 ET on comparable fields supporting the original crop.

Measurement of Crop ET:

For purposes of the Pilot Program, crop ET will be measured by the State Agencies through OpenET (https://openetdata.org/) and evaluated by the Oversight Committee (see Monitoring and Evaluation below).

Monitoring and Evaluation:

Monitoring and evaluation of the Pilot Program will be as transparent and objective as available data allow. The Conservancy will consult with the Collaborators to select a technical oversight committee (Oversight Committee). In cooperation with Grantees, the Oversight Committee will gather and share all data related to the Pilot Program. To augment measurement of crop ET through OpenET, the State Agencies will organize a Monitoring Team, comprised of academic researchers, to assist with data gathering, monitoring, and synthesis of data from the Pilot Program. Representatives of the Conservancy, and the Collaborators will meet regularly to assess the Pilot Program. The Conservancy and

	the Office of the Delta Watermaster will prepare a written draft evaluation of the Pilot Project for public review and comment prior to finalization.
Access for Monitoring and Verification:	The Grant Agreement will include permission from the Grantee for representatives of the Conservancy (including Collaborators, Selection Committee, Oversight Committee, and Monitoring Team) to access the site for monitoring and verification purposes. Such representatives will provide at least 24-hours advance notice to the Grantee and follow appropriate safety protocols while on site. Site visits will be at the sole risk of the representatives; Grantee will have no liability for the safety of the representatives related to site visits. In addition, a limited number of Grantees may be asked to host field measurement equipment. Conditions for the field equipment will be specified in the applicable Grant Agreements.
Program Costs:	All costs associated with implementing Actions are to be borne by Grantees. All costs for monitoring and administering the Pilot Program will be borne by the State Agencies.
Application Submission:	Applicants should complete proposals for grant funding on the Delta Drought Pilot Program Application Form.
Contact Information:	www.deltaconservancy.ca.gov/grant-program If you have questions, please contact the Conservancy at Contact@DeltaConservancy.ca.gov or (916) 375-2084.

XII. Grant Summaries

DDRPP04

- **Grantee:** Deadhorse LP
- **Amount Awarded:** $167,400
- **County:** Sacramento
- **Acres:** 186
- **Project Title:** Deferred Drainage and Unirrigated Crop Substitution

DDRPP07

- **Grantee:** J.H. Johnson & Sons, Inc.
- **Amount Awarded:** $107,100
- **County:** Sacramento
- **Acres:** 119
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover

DDRPP08/09

- **Grantee:** Joe Sanchez Farms, Inc.
- **Amount Awarded:** $226,800
- **County:** Sacramento
- **Acres:** 252
- **Project Title:** Eliminate Irrigation of Alfalfa, and Rye Grass Hay and Pasture

DDRPP10

- **Grantee:** Mello Locke Ranch
- **Amount Awarded:** $161,244
- **County:** Sacramento
- **Acres:** 179.16
- **Project Title:** Eliminate Irrigation of Alfalfa

DDRPP11

- **Grantee:** Jackson Land & Cattle, LP
- **Amount Awarded:** $292,500
- **County:** Contra Costa
- **Acres:** 325
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover at Jackson Ranch

DDRPP12

- **Grantee:** Ryan Katsuki
- **Amount Awarded:** $274,725
- **County:** Sacramento
- **Acres:** 305.25
- **Project Title:** Forego Corn Crop and Discontinue Irrigation of Triticale

DDRPP13

- **Grantee:** Aaron Beaver
- **Amount Awarded:** $179,100
- **County:** Sacramento
- **Acres:** 199
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover

DDRPP14

- **Grantee:** Ross Rasmussen
- **Amount Awarded:** $405,000
- **County:** Solano
- **Acres:** 450
- **Project Title:** Discontinue Irrigation of Pasture

DDRPP15

- **Grantee:** Knob Hill Mines, Inc. dba Hastings Island Land Company
- **Amount Awarded:** $337,500
- **County:** Solano
- **Acres:** 375
- **Project Title:** Install Drip Irrigation and Safflower

DDRPP17

- **Grantee:** Jaques Brothers Farming Co.
- **Amount Awarded:** $147,600
- **County:** San Joaquin
- **Acres:** 164
- **Project Title:** Single Mid-summer Irrigation of Mature Alfalfa

DDRPP22

- **Grantee:** Jaques Brothers Farming Co.
- **Amount Awarded:** $180,000
- **County:** San Joaquin
- **Acres:** 200
- **Project Title:** Forego a Second Carrot Crop; Manage Prior Crop Residue

DDRPP25

- **Grantee:** Hubert Denis VanDeMaele
- **Amount Awarded:** $317,700
- **County:** Sacramento
- **Acres:** 353
- **Project Title:** Eliminate Irrigation in Fields and Optimize for Dryland Barley and Corn

DDRPP26

- **Grantee:** KC Farming LLC
- **Amount Awarded:** $400,500
- **County:** Solano
- **Acres:** 445
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover

DDRPP28

- **Grantee:** Anna Solari
- **Amount Awarded:** $243,000
- **County:** San Joaquin
- **Acres:** 270
- **Project Title:** Severely Limit or Withhold Surface Irrigation; Maintain Ground Cover

DDRPP31

- **Grantee:** Coleman M. Foley, Jr.
- **Amount Awarded:** $405,000
- **County:** San Joaquin
- **Acres:** 450
- **Project Title:** Forgo Corn Planting and Maintain Healthy Soil Cover

DDRPP33

- **Grantee:** Mike Stokes Farming LLC
- **Amount Awarded:** $90,900
- **County:** San Joaquin
- **Acres:** 101
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover

DDRPP34

- **Grantee:** D&L Farms, Inc.
- **Amount Awarded:** $450,000
- **County:** San Joaquin
- **Acres:** 500
- **Project Title:** Reducing Irrigation Using Different Crops

DDRPP35/41

- **Grantee:** Steven Dinelli
- **Amount Awarded:** $343,638
- **Counties:** Sacramento and San Joaquin
- **Acres:** 381.82
- **Project Title:** Eliminate Irrigation of Grain Corn and Optimize for Dryland Grain Corn Crops

DDRPP37

- **Grantee:** Dennis Katsuki/DK Ag
- **Amount Awarded:** $323,100
- **County:** Sacramento
- **Acres:** 359
- **Project Title:** Forego Irrigation of 162 Acres of Triticale, and 197 Acres of Barley

DDRPP39

- **Grantee:** Richard Carli
- **Amount Awarded:** $179,190
- **County:** Sacramento
- **Acres:** 199.1
- **Project Title:** Forgo Corn Planting and Maintain Healthy Soil Cover

DDRPP40

- **Grantee:** Zuckerman Family Farms
- **Amount Awarded:** $450,000
- **County:** San Joaquin
- **Acres:** 500
- **Project Title:** Forego Planting Corn on 500 acres, Plant Non-irrigated Small Grains (Triticale and Barely)

DDRPP42

- **Grantee:** Doug Chan Farms
- **Amount Awarded:** $432,900
- **County:** Sacramento
- **Acres:** 481
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover

DDRPP44

- **Grantee:** Tyler II TIC
- **Amount Awarded:** $214,200
- **County:** Sacramento
- **Acres:** 238
- **Project Title:** Eliminate Irrigation and Plant Dryland Safflower

DDRPP45

- **Grantee:** Anthony Borba
- **Amount Awarded:** $94,500
- **County:** Sacramento
- **Acres:** 105
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover

DDRPP46

- **Grantee:** Wallace Chan Farms, Inc.
- **Amount Awarded:** $159,300
- **County:** Sacramento
- **Acres:** 177
- **Project Title:** Eliminate Irrigation and Plant Dryland Safflower

DDRPP47

- **Grantee:** John C. Backer
- **Amount Awarded:** $119,700
- **County:** Sacramento
- **Acres:** 133
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover

DDRPP48

- **Grantee:** Vincent Chavier
- **Amount Awarded:** $255,600
- **County:** Sacramento
- **Acres:** 284
- **Project Title:** Forgo Corn Planting and Maintain Healthy Soil Cover

DDRPP49

- **Grantee:** Del Carlo Farms, Inc.
- **Amount Awarded:** $214,200
- **County:** San Joaquin
- **Acres:** 238
- **Project Title:** Forego Planting Tomatoes, Plant Non-Irrigated Safflower

DDRPP51

- **Grantee:** Louis Biagioni
- **Amount Awarded:** $157,500
- **County:** Sacramento
- **Acres:** 175
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover

DDRPP52

- **Grantee:** Bruce Gornto
- **Amount Awarded:** $180,000
- **County:** Sacramento
- **Acres:** 200
- **Project Title:** Forgo Irrigation of Existing Alfalfa and Plant Wheat

DDRPP57

- **Grantee:** Frank D. Mills
- **Amount Awarded:** $254,700
- **County:** San Joaquin County
- **Acres:** 283
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover

DDRPP59

- **Grantee:** Dutra Hay & Grain
- **Amount Awarded:** $112,500
- **County:** Yolo
- **Acres:** 125
- **Project Title:** Forgo Irrigation on Existing Alfalfa

DDRPP60

- **Grantee:** Rivercrest Nut Co. LP
- **Amount Awarded:** $90,000
- **County:** San Joaquin
- **Acres:** 100
- **Project Title:** Eliminate Irrigation and Optimize Soil Cover