Goose Lake Watershed Irrigated Pasture Regulatory Recommendations

27 January 2021

I. Purpose

This document describes a draft proposal to exempt Goose Lake watershed irrigated pasture (and alfalfa; collectively referred to as irrigated pasture in this document) from the Irrigated Lands Regulatory Program (ILRP or Program), with recommendation for a potential future alternative regulatory framework. This watershed is located in Modoc and Lassen Counties, within the Sacramento Valley Water Quality Coalition (Coalition). Staff intends to solicit public feedback on the draft regulatory recommendations.

II. Overview

Concerns have been raised about the appropriateness of including irrigated pasture in the ILRP for some time. Justification for the concerns raised include low- to zero-use of pesticides and fertilizers, permanent vegetative cover, and low economic returns coupled with continually rising compliance costs. These concerns have grown since the ILRP evolved to address nitrate groundwater impacts, further increasing Program costs to address a high priority pollutant issue that Goose Lake irrigated pasture growers are not contributing to. Due to the low economic returns, this has unintentionally created the situation where an agricultural commodity likely impacting priority pollutant issues the least is paying the highest Program compliance costs in the context of per acre earnings.

Research findings and monitoring data indicate that ILRP high priority pollutant issues (e.g., surface water pesticides, toxicity, and groundwater nitrate concentrations) do not appear impacted by upper watershed irrigated pasture operations within the Goose Lake watershed. Recent findings have also shown that other pollutant issues such as *E.coli* do not appear to be a significant issue associated with irrigated pastures in this specific watershed and can likely be addressed through an alternative regulatory framework. Because much of the research information supporting this exemption proposal is specific to Goose Lake irrigated pasture, this document is limited in scope to the approximately 29 irrigated pasture operations within this watershed.

Irrigated pastures and meadows in California provide critical forage for livestock, particularly during the summer dry season. These forage production systems are broadly comprised of native and improved perennial forage grass species, perennial clovers, and other forage legumes. Forage from these systems are most commonly harvested by grazing livestock, and in some cases are harvested via a combination of grazing and haying. Pastures can be flood or sprinkler irrigated with surface and groundwater.

III. Technical Considerations and Discussion

Research conducted by the University of California, Davis (UCD), monitoring data collected under the ILRP, and county Agricultural Commissioner's Pesticide Use Reports collectively indicate that irrigated pastures in the Goose Lake watershed are of low risk to beneficial water uses. These findings are driven by the permanent vegetative soil cover and low agronomic inputs common on these systems.

First, the perennial forage species and moderate grazing intensities on Goose Lake irrigated pasture and meadows provide for constant vegetative soil cover, which acts to protect the soil surface from erosion and creates substantial filtration capacity for sediments as well as nutrients applied to the pasture. Irrigated pastures and meadows are essentially permanent crops, with stand establishment and associated cultivation occurring infrequently (>20 years) in improved species pastures, and never on native species meadows.

Second, pesticide and nitrogen applications are a rare practice on Goose Lake irrigated pasture and meadows primarily due to economics – there is limited opportunity to capture production returns. Thus, these systems are commonly nitrogen deficient and external nitrogen applied to pastures via irrigation water and as atmospheric deposition is quickly taken up by forage plants, consumed by grazing livestock, and harvested as livestock products (e.g., meat, milk). UCD research consistently finds the total amount of nitrogen entering these systems exceeds the amount discharged as tail water, with no excess annual nitrogen available for loss to ground water.

At the same time, costs associated with ILRP compliance are assessed on a per-acre basis and are the same for intensely cultivated regions with high pesticide and fertilizer use and low intensity, low input regions alike. This puts irrigated pasture operations at an economic disadvantage for participating in the ILRP when compared to other crops. Goose Lake irrigated pasture is likely the agricultural sector impacting high priority pollution issues (i.e., surface water pesticides, toxicity, and groundwater nitrate) the least within the Coalition region, while paying high- or the highest compliance costs when considering the per acre return on yields.

Goose Lake Farm Evaluation 2020 Summary

UCD evaluated the most recent Farm Evaluations for the 29 irrigated pasture and alfalfa growers in the Goose Lake watershed and provided a draft summary analysis report to the Water Board in September 2020 (2020 Farm Evaluation Report; see Appendix 1 for the full report). Table 1 provides some characteristics of the Goose Lake Farms from the 2020 Farm Evaluation Report. This report also provides information on growers and acres that reported using 22 different management practices.

Table 1. *Characteristics of Irrigated Pasture and Alfalfa Operations, Goose Lake (see note below table)*

Characteristics	2019 Farm Survey Summary
Acres, Total Irrigated	7,060
Acres, Alfalfa	631 (9%)
Acres, Grass Pasture	6,429 (91%)
Total Number of Growers	29
Acres, sprinkler irrigated	4,094 (58%)
Acres, flood irrigated	2,965 (42%)
Acres, N application	993 (14%)
Acres, field-scale pesticide use	0
Growers, herbicide spot treatment on weeds	6

Acres, N application Note: 6 growers, all sprinkler irrigated.

Goose Lake Irrigated Pasture & Alfalfa 2020 Economic Analysis

In collaboration with Goose Lake Resource Conservation District and the Natural Resources Conservation Service, UCD distributed a survey to the 29 irrigated pasture and alfalfa growers in the Goose Lake watershed in late 2019- early 2020. The voluntary survey was designed to obtain additional economic and operational information to accompany the Farm Evaluation findings. Twenty-eight of the 29 growers completed the survey. UCD prepared a summary report of the survey findings (please see Appendix 2 for the report; referred to here at the 2020 Economic Analysis). Table 2 below provides a summary of information from the 2020 Economic Analysis.

Table 2. *2020 Economic Analysis Summary (see notes below table)*

Primary Crop	Acres	Average Yield per Acre	Average Gross Revenue per Year	Average Operating Costs per Year	Estimated Average Net Revenue per Year
Forage Harvested by Livestock	3,850	6 AUMs	$150 / acre	$198 / acre	$ - 48 / acre
Grass Hay	2,563	3 Tons	$690 / acre	$304 / acre	$386 / acre
Alfalfa Hay	527	4 Tons	$900 / acre	$522 / acre	$378 / acre
Total	6,940				

Primary Crop Note: 95% (6,569) of the total acres reporting in the survey are grazed by livestock at some time throughout the typical calendar year, with a total of 27,135 AUMs for the year. Each acre is grouped here for its primary crop type/revenue source.

Forage Harvested by Livestock, Average Yield per Acre Notes:

- An Animal Unit Month (AUM) is a measure used to quantify the amount of forage required to support a 1,000 lb. beef cow for one month.
- UCD estimates the value at $25 per AUM for Goose Lake irrigated pasture.

The 2020 Economic Analysis also provided an analysis of ILRP compliance costs for Goose Lake irrigated pasture growers. The report identifies an issue with the ILRP compliance costs being virtually identical across all members of a Coalition, which they describe as subsidization by low-risk growers and crops of high-risk growers and crops. This issue is further problematic when the low-risk crop is also the lowest (or one of the lowest) earning crops, as is the case with Goose Lake irrigated pasture in the Sacramento Valley Water Quality Coalition. This creates unjustified inequity when growers not contributing to water quality impacts are paying a much higher percentage of net profit than those causing and contributing to the water quality impacts.

An example is provided in the 2020 Economic Analysis showing that under the current program compliance costs, a hay producer is paying eight times more than an almond grower in the Coalition when considering revenue figures. The typical hay grower will not use pesticides or fertilizer, while the almond grower likely will do so.

E.coli Studies

Research studies have demonstrated that irrigated pasture operations do not contribute to ILRP high priority pollutants (surface water pesticides, toxicity, and groundwater nitrate). The pollutant most often associated with irrigated pasture runoff is the fecal coliform bacteria *E.coli*. There are numerous studies on this issue available in the literature, and only a few are highlighted in this document. Overall, research has found that well-managed irrigated pastures can greatly reduce livestock fecal bacterial runoff to surface waters with the use of appropriate management practices.

To examine potential *E.coli* issues specifically at Goose Lake irrigated pastures, UC Davis and UC Cooperative Extension conducted a study[1] over the four-month 2020 irrigation season at 10 flood-irrigated pastures adjacent to streams. They measured *E.coli*, nutrients, TSS, turbidity, conductivity, and several field parameters in the stream, both upstream and downstream of each pasture. At each sampling event, they recorded the number and type of livestock grazing, streamflow rate, and irrigation application rate. One of the study’s findings reported that 80 percent of mean downstream concentrations were below 235 cfu/100 ml (ILRP *E.coli* water quality trigger limit). They also found statistical correlations between increased *E.coli* levels and increased stocking density, increased water application rates, and reduced streamflow, which show that pasture management practices affect E.coli runoff levels. Studies in 2007[2] and 2008[3] found similar and related correlations between various management practices and *E.coli* runoff concentrations.

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[1] Tate, K.W., D.F. Lile, T.L. Saitone. In prep. Mitigating Water Quality Impacts from Grazed Irrigated Pastures. Sustainability. See Appendix 3 for full report.

[2] Knox, A.K., K.W. Tate, R.A. Dahlgren, and E.R. Atwill. 2007. Management Reduces *E.coli* in Irrigated Pasture Runoff. California Agriculture. 61:159-165. <http://calag.ucanr.edu/Archive/?article=ca.v061n04p159>

[3] Knox, A.K, R.A. Dahlgren, K.W. Tate, and E.R. Atwill. 2008. Efficacy of Flow-Through Wetlands to Retain Nutrient, Sediment, and Microbial Pollutants. J. Environmental Quality. 37:1837-1846.

A 2019 study[4] found that controlling cattle access to streams is a critical step in reducing *E.coli* runoff. This study found that cattle-stream access management practices, including stream fencing, hardened stream crossings, and off-stream drinking water systems can reduce the overall mean fecal coliform concentrations by over 95 percent.

IV. Draft Recommendations

Since available information shows that Goose Lake irrigated pasture operations are unlikely to cause or contribute to detrimental beneficial use impacts from prioritized agricultural pollutants, exemption from participation in the Irrigated Lands Regulatory Program is reasonable and can be recommended. If future information shows otherwise, these operations should be included in the ILRP again.

While it has been established that irrigated pastures have the potential to contribute *E.coli* in surface water runoff, the 2020 study described above did not find significant issues in this watershed. Research has found that proper management practice implementation can reduce *E.coli* runoff levels by over 95 percent. Elevated *E.coli* levels in surface water have been found to be a widespread non-point source issue throughout the Central Valley, including in the ILRP, other Water Board programs, and outside monitoring efforts. Sources of *E.coli* found in surface water also vary, including but not limited to grazing livestock, confined animal facilities, septic system leachate, other domesticated animals such as pets, and wild animals.

While this cross-program water quality issue is one that the Central Valley Water Board would like to address, limited resources coupled with multiple high priority water quality pollutants has led to limited capacity to address it thus far. The Water Board (at the State and/or Regional Water Board level) should consider how best to address E.coli throughout the state and/or region and consider how it may fit into annual workplans. For now, Goose Lake irrigated pastures could be considered low threat to water quality, while the ILRP focuses on addressing those pollutants that are causing greatest impacts to beneficial uses. The Water Board may require Goose Lake irrigated pasture operations to participate in an *E.coli* monitoring and control program if one is developed.

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[4] Lewis, D.J., D. Voeller, T.L. Saitone, and K.W. Tate, 2019. Management Scale Assessment of Practices to Mitigate Cattle Microbial Water Quality Impairments of Coastal Waters. Sustainability. 11: 5516.

APPENDIX I

Goose Lake Farm Evaluation
2020 Summary

DRAFT 2.0

Goose Lake Sub-Watershed Farm Evaluation Summary

Prepared by

Kenneth W. Tate[5] and Tina L. Saitone[6]

UC Davis

September 23, 2020

Background and Purpose

In collaboration with the Goose Lake Resource Conservation District (RCD), the Natural Resources Conservation Service (NRCS), and twenty-nine grower members, UC Cooperative Extension and the Central Valley Regional Water Quality Control Board (WB) have compiled data and information on irrigated pasture (grass and grass-legume mixes) and alfalfa production in the Goose Lake sub-watershed of the Sacramento Valley Water Quality Coalition. The purpose being to provide information on 1) agronomic practices such as nitrogen fertilization, pesticide use, and irrigation methods; 2) best practice adoption for livestock grazing, irrigation water application, and tail water management to protect water

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[5] Professor and Rustici Specialist in Rangeland Watershed Sciences, Dept. of Plant Sciences, University of California, Davis. Email: kwtate@ucdavis.edu.

[6] Cooperative Extension Specialist in Livestock and Rangeland Economics, Dept. of Agricultural and Resource Economics, University of California, Davis. Email: saitone@primal.ucdavis.edu.

quality; and 3) agricultural productivity and economics. This information will aid WB staff and leadership, among others, in consideration of an alternative regulatory program/strategy for this sub-watershed group, similar sub-watershed groups, and/or similar commodities.

We collected this information in late 2019 and summer 2020 from 29 growers via two written survey tools – Section 2 of the Goose Lake Farm Evaluation (addressing points 1 and 2 above), and the UCCE Irrigated Pasture and Alfalfa Survey (primarily addressing point 3 above). In the preliminary summary reported in this document, we focus on information collected via the Farm Evaluation. Full analysis of the UCCE Survey is in progress at the time of this preliminary report.

The Goose Lake Farm Evaluation consists of four main sections including: 1) instructions and certification, 2) management practice information, 3) well information, and 4) management unit maps. In order to preserve the anonymity of the sub-watershed group members (growers) completing the farm evaluation and UCCE survey, the RCD entered all data from section 2 of the farm evaluation (management practice information) and created unique identifiers for each grower to cross-walk farm evaluation and UCCE survey data for each grower.

Results

Pasture Types and Irrigation. Respondents report a total of 7,060 acres of permanent irrigated pasture and alfalfa in the Goose Lake sub-watershed. No annually cultivated crops were reported (e.g., small grains, vegetables). Pasture types identified can be categorized as 1) grass (i.e., Timothy, fescue, orchard grass, and native grasses); 2) alfalfa; and 3) alfalfa mixed with some type of grass.[7] Due to the granularity of the farm evaluation question regarding crop type, we were not able to discern the percentage of alfalfa v. grass cover on the mixed pasture type parcels. As such, if a parcel had both alfalfa and grass

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[7] One respondent listed plums as a permanent crop. This operation is a very small percentage of the total acres (<0.04%) reported.

on the same parcel, it was categorized as alfalfa for the purposes of this summary. Using this convention, just over 8.9% (630.5 acres) of the acres in the sub-watershed are alfalfa or an alfalfa grass mix, and remaining 91.1% (6,429.5) was permanent grass pasture. Nearly 58% of the total reported acres were irrigated using some type of sprinkler system (i.e., hand line, wheel line, or pivot), with all acres of alfalfa reported as sprinkler irrigated. The remaining 42% of the total reported acres were flood irrigated.

External Nitrogen Application. The majority of acres in the sub-watershed (nearly 86%, 6,067 acres) do not receive any external nitrogen application. No nitrogen applications were reported for alfalfa. In total, six respondents in the Goose Lake Sub-watershed applied external nitrogen to irrigated pasture. All six of these growers irrigate with sprinklers (wheel-line/pivot), and 4 of them harvest exclusively as hay crop with no grazing and that no tail water is generated from their sprinkler irrigated parcels.

Pesticide Use. No respondents reported the use of field-scale broadcast spraying of pesticides on irrigated grass pasture, alfalfa grass pastures, or alfalfa. Pesticide use is limited to occasional, targeted spot treatments of invasive weed species (e.g., scotch thistle) on an as needed basis. Of the 29 respondents, only 6 (21%) reported engagement in targeted weed management with herbicides (e.g., spot treatment of individual weedy plants at the border of a field/pasture or within a field/pasture) – several as part of a county managed pest management program.

Irrigation Application BMPs. Fifty-eight percent of acres are reported with sprinkler irrigation systems – with no tail water runoff generation reported as an outcome/best management practices (BMP). All of the respondents (29) used at least one irrigation management best management practice (BMP). Twenty-two respondents utilized two or more irrigation management BMPs. Table 1 provides a breakdown by type of irrigation management BMPs reported on the farm evaluation.

Table 1. *Irrigation Application BMP Utilization*

Practice	Number of Respondents (%)	Acres Reported
Appropriate Application Rate	13 (45)	2,494
Soil Moisture Monitoring	4 (14)	565
CIMIS Potential Evapotranspiration	3 (11)	417
Uniform Application	19 (66)	5,683
Visual Observation	25 (86)	6,284

Summarizes responses to question 2.4a from Farm Evaluation.

Grazing BMPs. Of the 29 total respondents, 22 graze the irrigated acres that they manage, the remaining 7 harvest solely as hay. Of the 22 who manage grazing livestock, 20 use one or more grazing best management practices to safeguard water quality. The majority (17 respondents) used two or more grazing BMPs. Table 2 provides a breakdown by specific grazing best management practice.

Table 2. *Grazing BMP Utilization*

Practice	Number of Respondents (%)	Acres Reported
Appropriate Stocking Rate	15 (68)	5,699
Livestock Rotation	10 (45)	2,444
Pasture Rest Before Irrigation	12 (55)	5,643
Livestock Removed During Irrigation	11 (52)	1,360
Fencing to Control Access to Waterbodies	8 (36)	5,343
Defined Stream Crossings	8 (36)	4,919
Drinking Water Away from Waterbodies	8 (36)	2,098
Salt/Supplement Away from Waterbodies	18 (82)	6,167
Drag Pastures	16 (73)	5,844
Grazing Management Plan	5 (24)	831

Summarizes responses to question 2.4b from Farm Evaluation. Note: Share of the 22 respondents who manage grazing livestock.

Tail Water BMPs. The majority of respondents (23 respondents, 82%) use one or more tail water management BMPs. Seven respondents use two or more tail water management BMPs. Table 3 provides tail water BMP-level utilization details.

Table 3. *Tail Water Management BMP Utilization*

Practice	**Number of Respondents (%)**	**Acres Reported**
Tail Water Recovery/Return System	4 (14)	2,056
Vegetated Ditch/Buffer/Strip	4 (14)	518
Catchment/Sediment Basin	5 (18)	1,560
Wetlands to Filter Runoff	5 (18)	2,101
Pasture is Lower Elev. than surrounding terrain	2 (7)	63
No Tail Water	17 (61)	3,161
Evening Discharge	3 (11)	1,467

Summarizes responses to question 2.4c from Farm Evaluation.

APPENDIX II

Goose Lake Irrigated Pasture & Alfalfa 2020 Economic Analysis

DRAFT 1.0

Goose Lake Sub-Watershed Irrigated Pasture and Alfalfa Production Survey Summary

Prepared by

Tina L. Saitone[8] **and Kenneth W. Tate**[9]

UC Davis

October 19, 2020

Background and Purpose

In collaboration with the Goose Lake Resource Conservation District (RCD), the Natural Resources Conservation Service (NRCS), and twenty-nine grower members, UC Cooperative Extension and the Central Valley Regional Water Quality Control Board (WB) have compiled data and information on irrigated pasture (grass and grass-legume mixes) and alfalfa production in the Goose Lake sub-watershed of the Sacramento Valley Water Quality Coalition. The purpose being to provide information on 1) agronomic practices such as nitrogen fertilization, pesticide use, and irrigation methods; 2) best practice adoption for livestock grazing, irrigation water application, and tail water management to protect water quality; and 3) agricultural productivity and economics.

A summary of information gathered with respect to items 1 and 2 above has been provided in an earlier document ("Goose Lake Sub-Watershed Farm Evaluation Summary"). The summary in this

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[8] Cooperative Extension Specialist in Livestock and Rangeland Economics, Dept. of Agricultural and Resource Economics, University of California, Davis. Email: saitone@primal.ucdavis.edu.

[9] Professor and Rustici Specialist in Rangeland Watershed Sciences, Dept. of Plant Sciences, University of California, Davis. Email: kwtate@ucdavis.edu.

document distills the information gathered from the UCCE Irrigated Pasture and Alfalfa Survey (addressing item 3 above), which was conducted simultaneously with the Goose Lake Farm Evaluation between late 2019 and summer of 2020. The survey was not required for compliance with the Irrigated Lands Regulatory Program (ILRP). Twenty eight producers voluntarily completed the survey in order to provide the WB with more information about the productivity and economic value generated from the agricultural activities on their irrigated lands in the Gooselake Sub-watershed.[10] This information will aid WB staff and leadership, among others, in consideration of an alternative regulatory program/strategy for this sub-watershed group, similar sub-watershed groups, and/or similar commodities.

In order to preserve the anonymity of the sub-watershed group members (growers) completing the farm evaluation and UCCE survey, the RCD entered all data from the farm evaluation (management practice information) and created unique identifiers for each grower to cross-walk farm evaluation and UCCE survey data for each grower.

Results

Survey respondents (28 producers) reported information on a total of 6,940 acres of permanent irrigated pasture (i.e., grasses including timothy, fescue, orchard, and native species) and alfalfa in the Gooselake sub-watershed. Six operations exclusively used livestock to harvest forage produced on irrigated pasture, 12 operations used a combination of livestock and equipment to harvest forage, 7 operations (4 who grow alfalfa and 3 who grow some variety of grass hay) exclusively used machinery to harvest, 2 operations grow alfalfa and use livestock to graze the residual after harvest, and 1 operation grows both grass hay and alfalfa and used a combination of grazing and machinery to harvest.

In order to ascribe economic value and assess productivity of the agricultural activities conducted in the sub-watershed, we categorize acres according to commodity type (e.g., alfalfa, grass hay) and

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[10] Only one producer elected not to complete the survey.

primary forage harvest mechanism (tons harvested mechanically as hay, or supporting grazing livestock). This is done to ensure that we do not double count (i.e., over value) the economic value associated with agricultural activities in the region. Table 1 (columns 1 and 2) summarize this categorization and area (i.e., acres) for the Gooselake Sub-watershed.

Table 1. *Commodities, Acreage, and Gross Revenue*

Primary Commodity & Harvest Mechanism	**Acres**	**Average Yield/Acre**	**Average Gross Revenue**
Forage Harvested by Livestock	3,850	6 AUMs	\$25/AUM[a]
Grass Hay	2,563	3 Tons	\$230/Acre
Alfalfa Hay	527	4 Tons	\$225/Acre

Note: [a] An Animal Unit Month (AUM) is a measure used to quantify the amount of forage required to support a 1,000 lb. beef cow for one month.

Value of Forage Harvested Via Livestock

Nearly 95% (6,569 acres) of the total irrigated acres reported in the survey are grazed by livestock at some time throughout the typical calendar year.[11] The economic value derived from grazing is often quantified based on animal unit months (AUMs), i.e., the amount of forage required to support one 1000 pound beef cow for one month. Across the entire sub-watershed, survey responses indicate that a total of 27,135 AUMs were supported by the total irrigated acres grazed. The average grazing season reported was 4.6 months per calendar year.

Some acres are only grazed while other operators cut hay from irrigated pasture before allowing livestock to graze on the same acreage. For these operations we assume that the value of grazable forage left following haying is negligible. Survey responses indicate that 3,850 acres are harvested exclusively by livestock. Based on the 6 respondents who only utilize grazing livestock to harvest forage, we are able

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[11] In some cases, these acres are grazed following hay being harvested.

to determine the average AUMs supported when irrigated pasture is harvested using only livestock – 6 AUMs per acre.

University of California (UC) Cost and Returns Studies provide estimated values for irrigated pasture in the Sierra Foothills (Macon and Steward, 2020) ranging from $25 - $55 per AUM.[12] Given that the irrigation and grazing seasons are longer in the Sierra Foothills (7 to 8 months) than the Gooselake area, we would anticipate that the value of an AUM in the Gooselake area is at the lower end of this range. Based on $25/AUM, acres in the sub-watershed that are harvested with livestock will generate an average of $150/acre/year. It should be noted that this is gross revenue and does not take into account any of the costs associated with production or management. Forero et al. (2015) quantifies the total operating costs for irrigated pasture at $198/acre.[13,14]

Value of Grass Hay Harvested

A total of 2,563 acres of permanent irrigated pasture (i.e., grasses including timothy, fescue, orchard, and native species) were reported by survey respondents to be harvested as hay. The prototypical irrigation season reported by respondents mimics that of pasture harvested by livestock (i.e., 4.6 calendar months). The average yield of hay cut from irrigated pasture is 3 tons/acre.

The same UC Cost and Returns study that covered irrigated pasture harvested by livestock (Macon and Stewart, 2020) provides an estimate of the price for hay harvested from pasture at $230/ton.

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[12] Macon, D. and D. Stewart. 2020. “Sample Costs to Establish, Reestablish, and Produce Irrigated Pasture in the Sierra Nevada Foothills.” *University of California Agricultural and Natural Resources.* Available at: https://coststudyfiles.ucdavis.edu/uploads/cs_public/bb/94/bb94edc2-fbfb-4be0-8853-6565b486e032/20pasturesnfhproduction.pdf.

[13] Forero et al. 2015. “Sample Costs to Produce Pasture in the Sacramento Valley.” *University of California Agricultural and Natural Resources.* Available at: https://coststudyfiles.ucdavis.edu/uploads/cs_public/0e/23/0e230982-8610-42a4-8a26-32a0b10a4c5c/pasture_sv_2015.pdf.

[14] Total operating costs in the study include irrigation (i.e., water delivered) and fertilizer, which are deducted from the cost presented here.

This is based on U.S. Department of Agriculture (USDA) estimates for the Sacramento Valley region during 2019 and 2020. However, this price is consistent with premium orchard grass prices reported by USDA for the North Inter-Mountain Region of California of $243/ton (October 16, 2020). Using $230/ton, acres in the Gooselake sub-watershed will generate $690/acre/year in gross revenue. The same cost and returns study suggests that the total operating costs associated with grass hay production were $304/acre.[15]

Value of Alfalfa Hay Harvested

A total of 527 acres of alfalfa hay were reported by survey respondents in the Gooselake sub-watershed. The irrigation season spans the months May to September; with the average respondent reporting irrigating 4.7 calendar months per year. Survey responses indicate that the average yield in the sub-watershed is 4 tons/acre and that alfalfa fields are replanted, on average, every 10.5 years.

A recent (2020) UC Cost and Returns study of alfalfa production in the Sacramento Valley documents a price of $225 per ton for premium quality hay; the study notes that prices vary in any given year by $50 – 100 per ton based on quality, season, and supply and demand factors.[16] Using $225/ton, acres in the Gooselake sub-watershed will generate $900/acre/year in gross revenue. The same cost and returns study suggests that the total operating costs associated with alfalfa production were $522/acre.[17]

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[15] These total operating costs do not include cash overhead (e.g., office expenses, liability insurance) or non-cash overhead (e.g., tools, replacement parts, pipe). The cost study included irrigation costs and land lease rates, these have been removed from this figure.

[16] Long et al. (2020). Sample Costs to Establish and Produce Alfalfa Hay. *University of California Agricultural and Natural Resources.* Available at: https://coststudyfiles.ucdavis.edu/uploads/cs_public/02/ee/02ee0710-8c2c-41ea-8b25-736d1854b737/alfalfasvdraft10420.pdf.

[17] These total operating costs do not include cash overhead (e.g., office expenses, liability insurance) or non-cash overhead (e.g., tools, replacement parts, pipe). Irrigation district water fees and pumping costs were netted out of this cost estimate.

Context & Economic Implications for Gooselake Sub-watershed Members in the IRLP

Despite the low-threat nature of the agricultural activities conducted in the Gooselake Sub-watershed, the fees associated with compliance with the Irrigated Lands Regulatory Program are the same as other, more intensely cultivated regions, in the Sacramento Valley Water Quality Coalition (SVWQC). One of the fundamental issues with the ILRP's compliance costs being apportioned on a per acre basis is those fees are not necessarily correlated with risk – not all acres pose equal risk to water quality. Given this structure, cross-commodity subsidization occurs with lower-risk growers and agricultural activities subsidizing higher risk growers and crops. Extensive agricultural activities (e.g., irrigated pasture, grass hay, alfalfa hay) have lower net returns per acre but pay, in aggregate, more than their intensively cultivated (e.g., almonds, walnuts) counterparts. As an illustration, compare grass hay ($690/acre gross revenue in the Gooselake Sub-watershed) and almonds ($5,500/acre gross revenue in the Sacramento Valley). This means that a hay producer would have to farm nearly 8 acres to generate the same revenue as a single acre of almonds.[18] Each would be approximately the same total IRLP compliance assessment fee of $3/acre. As such, the hay producer would pay $24 in IRLP fees to generate $5,500 in revenue while the almond grower would pay $3 – the hay producer pays *8 times* more to comply with the same regulations because he manages an extensive, low-threat agricultural crop.

During Fiscal Year (FY) 2018/19, the members of the Gooselake Sub-watershed were assessed $3.04/acre – the sum of State Board fee, SVWQC assessments, and Gooselake Sub-watershed compliance costs. During this FY, the State Board Fee was $0.95/acre and accounted for 31% of a Gooselake Sub-watershed member's total IRLP assessment. SVWQC assessment – the sum of site-specific monitoring costs and compliance reports and prorated coalition expenses – accounted for 40% ($1.22/acre) of the total IRLP for Gooselake Sub-watershed members. The remaining 29% ($0.88/acre) was associated with sub-watershed specific monitoring, compliance, and staffing expenses.

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[18] Although we present this information in terms of gross revenue herein, the results are very similar if comparisons are made based on net profit.

APPENDIX III

Tate, K.W., D.F. Lile, T.L. Saitone. In prep.

Mitigating Water Quality Impacts from Grazed Irrigated Pastures. Sustainability.

DRAFT 1.0
Managing Irrigated Pastures to Mitigate Microbial Pollutant Transport to Surface Waters

Prepared by

Kenneth W. Tate[19], David F. Lile[20], and Tina L. Saitone[21]
UC Davis and UC Cooperative Extension

November 3, 2020

Background and Purpose

In response to concerns over potential microbial pollution of surface waters from flood irrigated pasture systems across northern and central California UC Rangelands has completed a series of studies to examine the effectiveness of 1) vegetative filters (e.g., wetlands and buffer strips); 2) pasture grazing management; and 3) irrigation management to mitigate waterborne transport of microbial pollutant to surface waters. This document briefly summarizes these findings in the context of documenting low threat conditions to water quality – as indicated by *Escherichia coli* (*E. coli*) concentrations – associated with irrigated pasture systems with appropriate best management practices (BMPs). This information will aid water board staff and leadership, among others, in consideration of an alternative regulatory program/strategy for the Gooselake Sub-watershed group and similar sub-watershed groups. Studies included in the summary are 1) an observational study of water quality immediately upstream and downstream of irrigated pastures on 10 upper watershed ranches in Modoc and Lassen Counties (Tate et al. In

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[19] Professor and Rustici Specialist in Rangeland Watershed Sciences, Dept. of Plant Sciences, University of California, Davis. Email: kwtate@ucdavis.edu

[20] Cooperative Extension Advisor in Natural Resource and Livestock, University of California, Lassen County. Email: dflile@ucdavis.edu

[21] Cooperative Extension Specialist in Livestock and Rangeland Economics, Dept. of Agricultural and Resource Economics, University of California, Davis. Email: saitone@primal.ucdavis.edu.

Preparation[22]); 2) a study of water quality from foothill pastures treated with a gradient of grazing and irrigation intensities and timings (Knox et al. 2007[23]); and 3) a study of the efficacy of small wetlands to filter pollutants in irrigated pasture tail-water (Knox et al. 2008[24]).

Research Results

***1) On-Ranch Irrigated Pasture Water Quality Survey*.** The research paper for this study is currently in preparation for publication, thus we provide a bit more detail on scope and methods here than in the following two published studies. We conducted bi-weekly stream water quality sampling immediately upstream and downstream of 10 irrigated pastures for the entire course of the irrigation season. Irrigation season ranged from April through July across the study sites, typical of these types of systems in the region. Study sites enrolled in the survey were single pasture systems immediately adjacent to a stream reach. Each pasture was flood irrigated from an in-stream diversion immediately upstream of the pasture, with tail-water from the pasture returning directly to the stream reach via numerous return points and as diffuse sheet flow (Figure 1). The downstream sample site was located immediately downstream the last observed tail-water return from the pasture. *E. coli* concentrations (colony forming units per 100 milliliters (cfu/100 ml)) for all samples were determined via direct membrane filtration and incubation on a selective agar (Derose et al. 2020[25]). Triplicate samples were collected and analyzed at each sample event and each sample site (n = 20), generating 428 samples in total across all 10

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[22] Tate, K.W., D.F. Lile, T.L. Saitone. In prep. Mitigating Water Quality Impacts from Grazed Irrigated Pastures. Sustainability.

[23] Knox, A.K., K.W. Tate, R.A. Dahlgren, and E.R. Atwill. 2007. Management Reduces *E. coli* in Irrigated Pasture Runoff. California Agriculture. 61:159-165. http://calag.ucanr.edu/Archive/?article=ca.v061n04p159

[24] Knox, A.K, R.A. Dahlgren, K.W. Tate, and E.R. Atwill. 2008. Efficacy of Flow-Through Wetlands to Retain Nutrient, Sediment, and Microbial Pollutants. J. Environmental Quality. 37:1837-1846.

[25] Derose, K.L., L.M. Roche, D.F. Lile, D.J. Eastburn, and K.W. Tate. 2020. Microbial Water Quality Conditions Associated with Livestock Grazing, Recreation, and Rural Residences in Mixed Use Landscapes. Sustainability. https://www.mdpi.com/2071-1050/12/12/5207

pastures. Although not reported here, we also determined nutrient concentrations (total N, NO_3-N, NH_4-N, total P, PO_4-P, dissolved organic carbon), total suspended solid concentrations, turbidity, conductivity, pH, temperature, and dissolved oxygen concentrations for each sample. At each sample event on we recorded the number and type of livestock grazing the pasture, streamflow rate at each sample location, and rate of irrigation water application.

Figure 1. An example study site sample schematic with stream, in-stream irrigation diversions, irrigated pastures, tail-water returns, and sample collection sites.

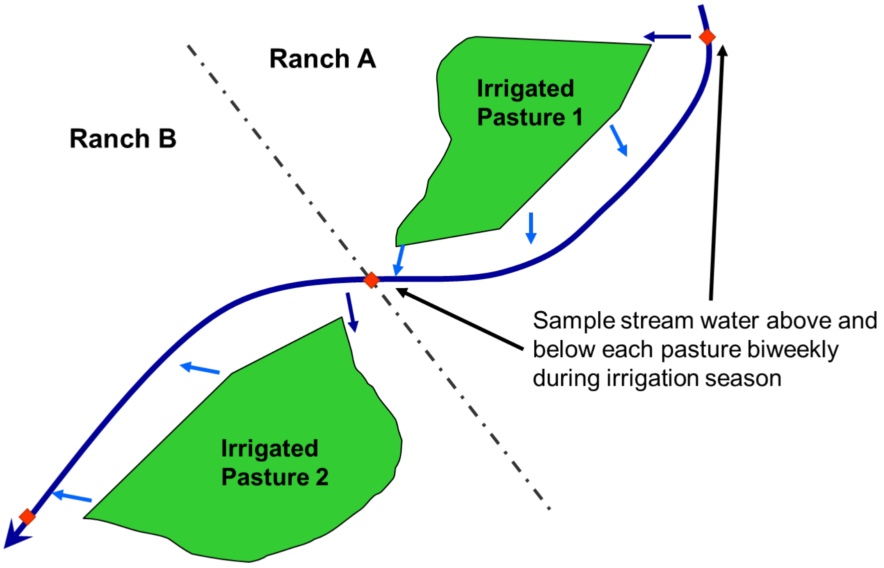

Table 1 reports mean *E. coli* concentrations (cfu/100 ml) observed over the irrigation season upstream and downstream of each irrigated pasture enrolled in the study, as well as the mean difference (change) in concentration downstream compared to upstream of each pasture (mean downstream concentration minus mean upstream concentration) – quantifying the impact of each pasture on in-stream microbial water quality. Eighty percent of mean downstream *E. coli* concentrations were below 235 cfu/100ml (current Irrigated Lands Regulatory Program microbial water quality objective), compared to 60% of upstream mean concentrations. Thirty percent (Steams 1, 9, 10) of pastures resulted in reduced downstream concentrations, forty percent (Streams 2, 3, 4, 6) resulted in a slight increase in concentrations (<20 cfu/100ml), and thirty percent (Streams 5, 7, 8) resulted in a substantial increase in concentrations. These results demonstrate substantial variation in site-specific impacts to in-stream microbial water quality, and substantial potential for pasture management of improve or have limited negative impacts on microbial water quality.

Table 1. Mean *E. coli* concentrations (cfu/100 ml) and one standard error of the mean observed over the irrigation season upstream and downstream of each irrigated pasture enrolled in the study. Mean difference (change) in concentration calculated as mean downstream concentration minus mean upstream concentration. A negative mean difference indicates reduced *E. coli*, a positive mean difference indicates increased *E. coli*, a difference near zero indicates no change.

	Mean *E. coli* (1 standard error) as cfu/100ml		
Stream	**Upstream**	**Downstream**	**Mean Difference**
1	357 (159)	123 (36)	-233
2	85 (33)	96 (14)	11
3	9 (3)	18 (4)	9
4	12 (4)	24 (6)	12
5	98 (28)	186 (62)	88
6	111 (17)	131 (13)	20
7	52 (17)	1117 (373)	1064
8	1074 (380)	1304 (244)	230
9	1171 (446)	135 (21)	-1036
10	363 (101)	180 (36)	-183

We are conducting statistical analysis to understand how site-specific grazing and irrigation management was associated with the range of downstream impacts reported in Table 1. Specifically, we have conducted preliminary linear mixed effects regression analysis to examine relationships between stocking density as animal units/hectare, irrigation application rate as millimeters of water applied per hectare per day, and downstream *E. coli* concentrations for each sample day. We are finding positive increases in downstream concentrations associated with increased stocking density (P<0.001), increased irrigation water application rates (P=0.015), and reduced streamflow (P=0.001). Preliminary analysis also indicates these factors are interacting. For example, downstream concentrations are higher under circumstances of relatively high stocking rate (fecal loading), irrigation application rate (hydrologic transport), and low flow conditions in the stream receiving pasture tail-water. We are currently analyzing relationships between grazing management, irrigation management and differences in observed upstream and downstream concentrations (actual water quality impact).

2) Grazing and Irrigation Intensities and Timing. We conducted a study of foothill flood irrigated pastures under which we manipulated the 1) timing of livestock grazing relative to the timing of regular irrigation events; and 2) rate of irrigation application and thus tail-water to examine relationships between these practices and *E. coli* concentrations in pasture tail-water (Knox et al. 2007). This is published research, and the reader is directed to the paper for full methods and findings. We found that *E. coli* concentrations in tail-water directly from the pasture were highest when cattle were actively grazing during an irrigation event with high tail-water runoff rates. *E. coli* concentrations in tail-water were significantly reduced with increasing rest time between grazing and irrigation. However, the relationship was not linear, and *E. coli* reductions became smaller with each additional day of rest. For example, the *E. coli* concentration was 23% lower after 9 days of rest than after 1 day of rest, but only 2% lower after each additional day of rest after that. This reduction was likely due to two primary processes: (1) as cattle fecal pats age, the microbial pollutants in them naturally die off, and (2) as the pats dry, they develop shells that trap the bacteria inside. We also found that as irrigation tail-water runoff rates increased, *E. coli* concentrations increased in tail-water. This relationship can be attributed to the fact that higher runoff rates increase the tail-water's capacity for pollutant mobilization and transport.

3) Wetlands to Filter Pollutants in Irrigated Pasture Tail-water. In conjunction with the study reported in Knox et al. 2007) we also examined the capacity for small wetlands to serve as vegetative buffers to filter *E. coli* from flood irrigated pasture tail-water (Knox et al. 2008). This is published research, and the reader is directed to the paper for full methods and findings. On average, we found that a functioning wetland reduced *E. coli* load in tail-water by 68%. However, we found that that as tail-water runoff rate increased, the wetland was less effective at filtering *E. coli* and reducing concentrations in tail-water to the point that at high runoff rates the filtration capacity of the wetland was overcome. The increase in instantaneous tail-water runoff rate corresponded with a decrease in hydraulic residence time, which also likely reduced the amount of time for wetland processes that reduce *E. coli* concentrations, such as exposure to solar ultraviolet radiation and predation by other microbes. These results agree with research we have conducted across various grazing lands scenarios demonstrating the high filtration capacity of pastures and rangelands for waterborne microbial pollutants (Atwill et al. 2002[26]; Atwill et al. 2006[27]; Tate et al. 2006[28]).

Irrigated Pasture as a Microbial Water Quality Threat

Source identification and mitigation of microbial pollutant sources in mixed-use watersheds is an issue spanning the globe. Livestock agriculture, septic systems, wastewater treatment systems, and recreation

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[26] Atwill ER, Hou L, Karle BM, et al. Transport of *Cryptosporidium parvum* oocysts through vegetated buffer strips and estimated filtration efficiency. Appl Env Microbiol. 2002. 68:5517-27.

[27] Atwill ER, Tate KW, Pereira MGC, et al. Efficacy of natural grass buffers for removal of *Cryptosporidium parvum* in rangeland runoff. J Food Protect. 2006. 69:177-84.

[28] Tate KW, Atwill ER, Bartolome JW, Nader GA. Significant *E. coli* attenuation by vegetative buffers on annual grasslands. J Env Qual. 2006. 35:795-805. https://doi.org/10.2134/jeq2005.0141

are documented, potential anthropogenic sources of microbial pollutants. Studies also document the potential for microbial pollutant contributions from environmental sources such as wildlife, soil, and streambed sediments. Not surprisingly, studies often report detection of microbial pollutants from multiple sources, with the relative magnitude of contributions from sources varying over space and time due to watershed specific conditions. Thus, exceedances of *E. coli* in surface waters across California is an issue much broader than irrigated pasture. In fact, it is broader than the scope of the Irrigated Lands Regulatory program and agricultural land uses.

In our survey of 10 upper watershed irrigated pasture systems we found that while management decisions resulted in microbial water quality pollution at 3 sites, there were an equal number of instances where microbial water quality was improved due to pastures filtering polluted irrigation water. We found an approximately equal number of pastures associated with minor *E. coli* increases (<20 cfu/100ml). Based upon the studies detailed above, we can characterize irrigated pasture conditions that lead to microbial water quality impacts as having one or more of the following traits:

- **Excessive irrigation application and tail-water runoff rates**
- **Excessive livestock densities for long periods, limited rest or rotation of livestock**
- **Frequently grazed by livestock during irrigation events**
- **Discharge into low flow streams**

We have found the following best management practices managers employ to create low threat conditions on irrigated pasture – these practices are all also associated with improved agricultural productivity and profit:

- **Irrigate based on soil-plant water demand at application rates appropriate for soil infiltration capacity to reduce tail-water runoff rates and volumes**
- **Moderate livestock densities with rest and rotation during the irrigation season**

- **Rotate grazing and irrigation timing to allow rest before irrigation when and where possible**
- **Filter tail-water using vegetative buffer strips, vegetated ditches, hay pastures, and wetlands when and where possible.**

The management challenges and opportunities are different on each pasture and ranching operation. There is no single best management practice, stocking density, or irrigation application rate. The pasture manager can reduce water quality impacts by implementing one or more of these management options. The key is to make the effort to moderate stock density, runoff, and timing of grazing relative to irrigation whenever and wherever practically possible. Properly managed irrigated pastures pose low threat to microbial water quality.